souvenir

IDEA 8th Convention & National Seminar 2nd & 3rd Sept. 2013

Indian Dairy Engineers Association (IDEA)

(www.dairyidea.com)

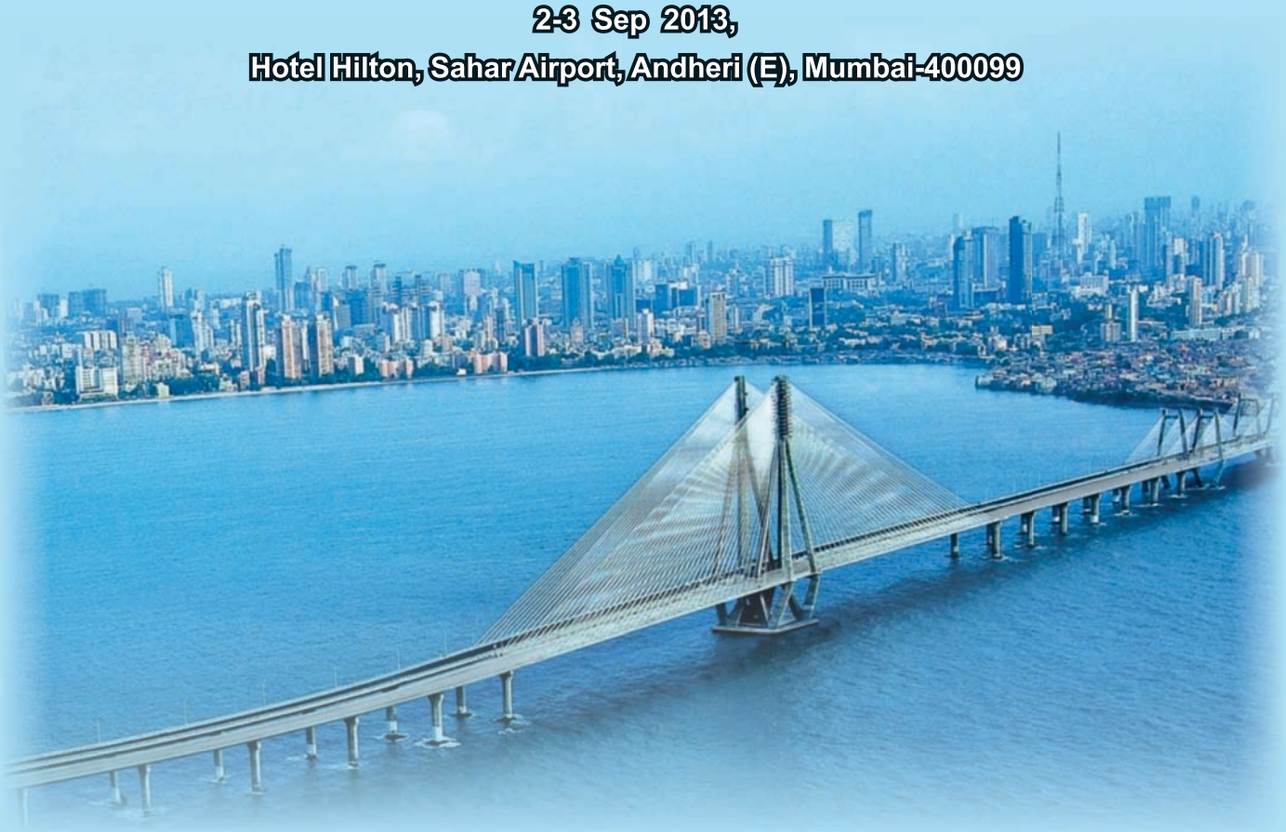
8th Convention of Indian Dairy Engineers Association

&

National Seminar on Mechanised Production of Indian Dairy Products

2-3 Sep 2013,

Hotel Hilton, Sahar Airport, Andheri (E), Mumbai-400099



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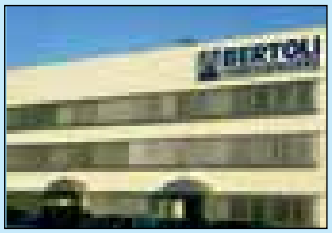

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to

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to

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on

Mechanised Production of Indian Dairy Products

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Shri. S.C.Aggarwal
President,
IDEA

Dr. J.V.Parekh
Chairman,
Organising Committee

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पूसा, नई दिल्ली-110 012
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KRISHI ANUSANDHAN BHAVAN-II
PUSA, NEW DELHI - 110 012

डॉ. नरेन्द्र सिंह राठौड़
उप महानिदेशक (इंजीनियरिंग)
Dr. Narendra S. Rathore
Deputy Director General (Engineering)

MESSAGE

I am happy that Indian Dairy Engineers Association (IDEA) is organizing its 8th Convention and a National Seminar on **"Mechanized Production of Indian Dairy Products"** during September 2-3, 2013 to serve as a forum for exchange of ideas and experiences and dissemination of information related to present state of art of technology available in the field. It is heartening that the seminar is industry oriented with an intention to acquaint dairy engineers with the latest trends available in the country and the global arena in the phase of automation and up-gradation of technologies suitable for dairy industries.

In this regard, this event will undoubtedly be of great help for dairy industries from across the country as it includes information and dissemination on number of associated issues, verbal presentation by the speakers from the industry.

I extend my warm greetings to the organizers and also convey my best wishes to them for the publication of their souvenir, which will definitely useful for professionals, technocrats, academicians and machinery manufacturers.

(Narendra Singh Rathore)

New Delhi
The 13th August, 2013

भारतीय कृषि अनुसंधान परिषद
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August 16, 2013

Message

I am pleased to learn that 8th Convention of Indian Dairy Engineers Association (IDEA) and National Seminar on "Mechanized Production of Indian Dairy Products" is being organized at Hotel Hilton, Sahar Airport, Andheri, Mumbai on 2nd–3rd Sep., 2013.

We may take pride in excelling in the total milk production in India, but are still behind in terms of percentage of total milk produced converted into value added products. It is incumbent on the dairy engineers to ensure that all the issues in the dairy value chain are effectively addressed. Mechanized Production of Indian Dairy Products has wide scope in gearing up the quality and production of marketable Indian dairy products and to complete globally in this field.

I congratulate the organizers for selecting an appropriate theme on Mechanized Production of Indian Dairy Products. I am sure that the delegates will discuss the issues involved and prepare implementable recommendations for the upliftment of this industry.

I wish the Convention be a successful event.

(Arvind Kumar)

राष्ट्रीय डेरी विकास बोर्ड
National Dairy Development Board

CHAIRMAN

21st August, 2013

MESSAGE

I am happy to note that the Indian Dairy Engineers Association (IDEA) is organizing its 8th Convention and a National Seminar on "Merchandised Production of Indian Dairy Products".

India is a proud nation to be the top milk producer of the world and having world class Milk Processing and Products manufacturing facilities. Dairy Engineers along with others have played a commendable role in creating these facilities with emphasis on increasing energy efficiency and use of renewable energy with conservation of natural resources.

Food safety has thrown up a great challenge requiring interventions by the Dairy Industry to usher in the manufacturing of indigenous milk products. The dairy industry needs to develop suitable technologies and equipment to manufacture indigenous milk products of quality conforming to food safety requirements. The effort being made by IDEA to organize the Seminar to address this issue is indeed commendable.

The Convention and Seminar will certainly throw up different possibilities with a proper blend of these aspects which can be implemented for the benefit of society as a whole.

I wish the seminar and the convention all success

(Amrita Patel)

[redacted]

राष्ट्रीय डेरी अनुसंधान संस्थान
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Prof. (Dr.) A. K. Srivastava
Director

संदर्भ सं./Ref. No.
दिनांक /Dated

It gives me immense pleasure to note that the Indian Dairy Engineers Association (IDEA) is organizing a two days National Seminar on "Mechanized production of Indian dairy products" at Mumbai during 2-3 September, 2013.

Indian dairy products are a rich and convenient source of nutrients and hold a very important place in the socio-cultural life in India. The production is conventionally carried out at small scale. There is a need to develop small and medium scale equipments for hygienic production. Looking at the demand, there is a great opportunity for the organized dairy sector in the country to undertake commercial production of traditional dairy products. Systematic efforts have been made by various researchers to standardize and mechanize the production process. Automated processing lines have already been commissioned for commercial production of products like paneer, dhai, lassi, srikhand, gulabjamun etc. There are many other products for which Industry-academia will have to work together to develop the industrial process. Also there is a need to work out strategy to develop international market for Indian sweets. In the mean time industry will have to focus in the areas of fully automated mechanized systems, packaging technology for the longer shelf life and quality assurance.

The organization of the National Seminar on this very important and topical issue is need of the day. I am sure all the above mentioned issues will eminently figure in the deliberations of the seminar and very important recommendations will emerge.

I wish the seminar a great.

(A.K. Srivastava)

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डा. आशिष कुमार मिश्रा
कुलगुरु
Prof. A. K. Misra
Vice Chancellor

MESSAGE

I am very glad to know that the Indian Dairy Engineers Association (IDEA) is organizing its 8th Convention and a National Seminar on 'Mechanized Production of Indian Dairy Products' at Mumbai on 2nd and 3rd September, 2013.

India ranks as the world's largest milk producer with an annual output of 137 million tonnes. With an annual growth rate of over 4%, India's milk production accounts for ~15% of the total global output. Constituting an important segment of the Indian rural economy, dairy and dairy products provide livelihood to millions of homes in villages and ensure supply of quality milk and milk products to people of both urban and rural areas.

Indian milk sweets have played a significant role in the economic, social, religious and nutritional well being of our people since time immemorial. It is estimated that about 50 to 55 % of milk produced is converted by traditional sector (halvais) into variety of Indian milk products, using processes such as heat and acid coagulation, heat desiccation and fermentation. The market for Indian milk products is estimated to be more than Rs. 65000 crores.

In view of the growing awareness among the people towards the safety aspects of milk based sweets in India and in order to overcome the inherent disadvantages associated with conventional methods of manufacture, it has become imperative to search for innovative techniques for manufacture of traditional Indian dairy products including designing of equipment and mechanization. The technology developed with mechanisation would certainly benefit both the milk producers and consumers and will promote entrepreneurial development by fetching a higher price for value added products.

I am sure the deliberations at the convention will be extremely fruitful and would come out with useful recommendations for overall development of dairy sector in India in general and mechanized production of Indian dairy products in particular.

I wish the organizers a grand success for the convention.

(A. K. Misra)

Date : 17/08/2013

Dr. N.R. Bhasin
Ph.D., D.Sc., IAS (Rtd.)
President

INDIAN DAIRY ASSOCIATION

Message

I am very happy to learn that the Indian Dairy Engineers Association (IDEA) is organising its 8th Convention and a National Seminar on "Mechanised Production of Indian Dairy Products" at Hotel Hilton, Sahar Airport, Andheri, Mumbai on 2-3 September, 2013.

The importance of indigenous products has already been recognised by the dairy industry. However, this sector requires additional support in investment and technological inputs to allow it to emerge as a mature segment of the industry.

I am sure that the Conference would focus on the existing gap between knowledge of latest technologies and the end users of our dairy industry. I also hope that it comes out with a blue print on automation and upgradation of technology.

I wish the Conference great success.

With best regards,

N.R. Bhasin

Date: 13th August 2013

(N.R. Bhasin)

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MESSAGE

It pleases me to be part of the 8th Convention of Indian Dairy Engineers Association (IDEA) and National Seminar on "Mechanised Production of Indian Dairy Products" being organised at Hotel Hilton, Sahar Airport, Andheri(E) Mumbai on September 2-3, 2013.

In the beginning itself, I take this opportunity to thank Dr. J.V. Parekh, a leading personality in the Dairy Industry and his team as without their huge efforts, this convention and Seminar would not have been possible.

Over the years, efforts at expanding liquid milk availability through increased production of milk and increase in productivity of animals , have resulted in surplus availability of milk. This all has happened due to visionary initiatives through various Operation Flood Programs of Late Dr. V. Kurien, popularly known as Father of White Revolution in India. Opportunity provided by this scenario is that milk can now be used for efficient manufacturing of Indian Milk Products with long shelf life.

Now with globalization and liberalization, numbers of foreign milk products are also finding their way in India and the Indian Dairy Industry has lot of resources and potential to market their milk products gainfully. The value addition is the most important aspect through which India can visualize a great boom in dairy export sector and future lot of Indian dairy farmers is largely dependent on this. With opportunity, we have enormous challenges also as under newly emerged circumstances, quality standards of production and processing milk cannot remain at variance with International standards. We have to design or redesign our processes whereby we can meet the International standards of Food Safety, security and hygiene. This calls for mechanization of processes for manufacturing Traditional Indian Milk Products as without which neither it is possible to standardize the products not it is possible to achieve quality standards.

Accordingly, the organizing committee needs applause and thanks for choosing topic of Seminar which is the need of hour and can benefit the Dairy Industry and dairy professionals in a big way to utilize the surplus milk and cater to the demand of Indian Dairy Products of Indian and foreign markets.

S.C. AGGARWAL
PRESIDENT, IDEA

DAIRY TECHNOLOGY SOCIETY OF INDIA
Division of Dairy Technology
National Dairy Research Institute
Karnal - 132 001 (Haryana), India

Dr. S. Singh
President

MESSAGE

It is a matter of great pleasure to learn that Indian Dairy Engineers Association (IDEA) is organizing Convention and a National Seminar on "Mechanized Production of Indian Dairy Products "at Hotel Hilton, Sahar Airport, Andheri, Mumbai on September 2-3, 2013.

Traditional dairy products have always played a pivotal role in preservation of milk and promotion of its assumption among masses. However, their production has been limited mostly under unorganized sector often in unhygienic conditions. Mechanized production, automation, adoption of quality management systems like GMP & GHP are the major challenges that require immediately.

I would like to congratulate IDEA that they have chosen such a topical topic for deliberation at this convention. I am sure this event will provide a platform for researchers, academicians, technologist, industrialist, policy makers and marketing personnels as well as people involved in manufacture and trade of these products to discuss various issues confronting them and then evolve strategies that will enable harnessing the full potential of these very value able group of food commodities.

I wish the Convention and National seminar a grand success.

Shivashakya Singh

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E-mail: arunpatilida@gmail.com
Web:www.idawz.org

16 August 2013

MESSAGE

I am happy to learn that Indian Dairy Engineers Association (IDEA) is organizing 8th Convention and a National Seminar on "Mechanised Production of Indian Dairy Products" on 2nd & 3rd September 2013, in Mumbai.

While India is the world's largest milk producer of milk, the quantity of milk processed is hardly 30% of the total production. Further, around 45% of the milk is converted into traditional milk products, mostly in the un-organized sector. This clearly provides huge opportunity for the organized sector to undertake mass production of traditional milk products in the most hygienic way by adopting the modern processing & packaging technologies. This will not only enhance the shelf life of the traditional milk products but it will also fetch better revenues to the rural milk producers.

I am sure the deliberations at the seminar will enable the dairy entrepreneurs to adopt the new techniques of manufacturing traditional milk products to meet the ever increasing global demand.

I wish the seminar every success.

Arun Patil
Chairman

MESSAGE

We are honoured to host 8th Convention of IDEA and a National Seminar on "Mechanised Production of Indian Dairy Products" in Mumbai and our organising committee is eager to welcome all of you.

The dairy industry needs to recognize the importance of indigenous products to sustain its overall growth. Secondly, enough attention and investments are necessary to raise the status of this product category from a dominantly non-organised level and allow it to emerge as a mature segment of the industry.

The seminar will facilitate exchange of information and discussion on "Desiccated Milk Based Products", "Heat Acid Coagulated Products", "Culture/ Fermented Products", "Fat Rich Products and Dairy Sweets", "Food Safety & Standard, Marketing, Entrepreneur Opportunities, etc.

I hope this seminar of IDEA will provide an excellent forum for interactions with experts, practitioners, researchers and policy planners to prepare road map for future growth of Indian dairy products.

I am sure the souvenir compiled on the occasion would be a helpful guide to the delegates and remain as a token of remembrance.

I wish you a very pleasant stay in Mumbai and lots of sweet memories of this seminar.

DR. J.V.PAREKH
Organising Chairman

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BRIEF HISTORY OF IDEA

INDIAN DAIRY ENGINEERS ASSOCIATION

Brief History of IDEA :

Keeping into the needs of Dairy Engineers' fraternity to have a common platform where they could exchange their ideas, share their views and experiences for the betterment of Dairy Industry in general and of their lot in particular, with the untiring efforts and wide Vision of our founder President Sh. M.M. Munjial, the Indian Dairy Engineers Association came into active being on 13.4.2002. We had formulated a VISION STATEMENT of Association as :

a) ***International Level :***
To establish linkages with similar International Associations for sharing information, technology transfer, upgrading knowledge, skills of members.

b) ***National Level :***
To make significant contribution in improving quality, productivity, profitability of business operations for upgrading global competitiveness of Indian Dairy, Food & Allied Industry (both Processing and Engineering).

c) ***Self Development :***
Each member will make substantial contribution in R & D activities for sharing experience, interaction and using engineering tools like Process Re-Engineering, Value Engineering, Value Addition and Cost Reduction for the benefit of Dairy Industry. And to upgrade knowledge, skills and information of its members through mutual interaction and training to enable them to occupy commanding management positions.

The Association is working continuously on its objectives which have been designed in our "Memorandum and Articles of Association" and is continuously striving to spread the knowledge on Engineering principles, practices, techniques and methods with the objective of equipping the Dairy Engineers with the latest developments in the field of Dairy Engineering and technology for the betterment of Dairy Industry. The association has given a strong platform to the Dairy Engineers where they can interact among themselves for their problems. We are progressing inch by inch as our strength is growing. As of now we have more than 150 life members.

So far we have organized seven Conventions as detailed below :

S.NO.	CONVENTION DATE	PLACE	THEME OF CONVENTION
1st	13/4/2002	Chandigarh	Role of Diary Engineers.
2nd	5/4/2003	NDRI, Karnal	Role of Dairy Engineers in Global Competitiveness of Dairy Industry with focus on Food Safety & Quality aspects of Dairy & Food Processing.
3rd	19/11/2005	NDRI, Karnal	Engineering Interventions in Quality Milk Processing.
4th	11-12/4/2007	Dairy Science College, Anand	Revamping Dairy Engineering Education & Industry.
5th	25-29/1/2008	College of Dairy Technology, Raipur.	Global Context Dairy Engineers for cause of Rural India.
6th	27-28/8/2010	Dairy Science College, Bangalore	Green Technologies in Dairy & Food Processing Industry.
7th	24-25/9/2012	Dairy Science College, Triputi	Automation in Dairy Industry.

Our last conference at the Dairy Science College, Triputi was highly successful which was attended by large number of delegates from across the country and was well organized with the efforts of Dr. Ravi Kumar, Prof. & Head, Dairy Engineering, Dairy Science College, Triputi. Let us make the Association more strong and active so that stated objectives are realized for the benefit of industry and our own profession.

Now we have assembled for our 8th Convention on the occasion of which we shall be attending a Seminar on a very usefull subject i.e. "Mechanized Production of Indian Dairy Products"

S C AGGARWAL
President, IDEA

INDIAN DAIRY ENGINEERS ASSOCIATION
(IDEA)
CITATION

For Professional Excellence to

Shri Keshavji Meghji Gosrani

Shri Keshavji Meghji Gosrani has been chosen by the IDEA for conferring this honour on him during the 8th Convention (2013), in recognition of his professional excellence in the field of Dairy Engineering. In fact he is a living example of how an engineer with a modest beginning in life can become a successful industrialist by his sheer vision and hard work.

Shri Keshavji Gosrani was born on 16th September 1940, at Jamnagar in Gujarat. He obtained Diploma in Mechanical Engineering from Pune University in 1965 and took up service in a manufacturing unit. However, his creative mind was never satisfied with monotonous job as he held the ambition to emerge as an enterpreneur. As a result in 1982, he started his own company manufacturing High Pressure Reciprocating Pumps. In 1991 there was a major break through as he developed High Pressure Homogeniser under the guideline of National Dairy Development Board, Anand, which was a perfect substitute for imported one.

Shri Keshavji Gosrani is the founder Chairman and Managing Director of Goma Engineering Company which apart from this pioneer product, has been successful in offering service to establish dairy plants on "Concept to Commissioning" basis. While fulfilling his dream, in 1997 Shri Keshavji Gosrani established his factory at Wada in Thane district, which has provided job opportunities to over 350 skilled workmen. Under his able guidance the company has obtained certification under ISO and OHSAS other than acquiring a certificate for "In House Research & Development Centre", which is additional feather in his cap.

His company has offered services to a host of dairy and food processing plants in Cooperative and Private Sector and also Educational Institutes and Overseas clients.

Shri Keshavji Gosrani has travelled world wide and attended many international dairy and food exhibitions. Through his strong Desire, Determination, Diligence and Dedication, he has set an example of an ideal Enterpreneur.

In recognition of his meritorious service to the Dairy Industry, the IDEA pays rich tribute to Shri Keshavji Gosrani and presents this Citation.

8th Convention of Indian Dairy Engineers Association
2-3 September, 2013
Mumbai

INDIAN DAIRY ENGINEERS ASSOCIATION
(IDEA)
CITATION

For Professional Excellence to

Shri Vibhakar Kaustubhrai Ghoda

Shri Vibhakar Kaustubhrai Ghoda has been chosen by the IDEA for conferring this honour on him during the 8th Convention (2013), in recognition of his professional excellence in the field of Dairy Engineering.

Shri Ghoda was born on 15th September 1949 at Junagadh in Gujarat. He graduated in Electrical Engineering from Gujarat University in 1972. He started his professional career in Amul Dairy followed by National Dairy Development Board (NDDB), Anand and worked in NDDB for 16 years. During this span he worked on multitude of projects viz, Renovation of Delhi Milk Scheme, F&MD Vaccine Plant, Hyderabad; Process Mechanization of Ethnic Products at Sugam Dairy, Baroda. He also worked as Principal at Mansinh Institute of Technology, Mehsana and as Group Head of the Dairy Plant Management Group.

Shri Ghoda was also a member of the Mission Team for Madagascar Dairy Development Project aided by the World Bank and in this context he studied Mega Dairy Projects in England & Ireland. Later on he was made the Project Leader for Mother Dairy, Gandhinagar. It is well known that this project completed by him has brought a revolution in automation concept for the Indian Dairy Sector. To Shri Ghoda's credit also stands Vidya Dairy, Anand a model dairy for students; which he conceived and designed as System Designer.

In 1994, Shri Ghoda rejoined Amul Dairy as General Manager and handled several projects across the country over a span of 13 years. He implemented Amul III Dairy Project and established India's largest Flavoured Milk Plant. He also played a leading role in introducing Total Quality Management and ISO System and energy & water conservation programmes.

Since 2007, Shri Ghoda is working as Director of Perfect Solution and providing services for designing and executing dairy projects in cooperative and private sector. His vast experience of over forty years is helping them to modernize and expand their plants with addition of new product lines and business remodeling.

In recognition of his meritorious service to Dairy Industry, the IDEA pays rich tribute to Shri Ghoda and presents this Citation.

8th Convention of Indian Dairy Engineers Association
2-3 September, 2013
Mumbai

INDIAN DAIRY ENGINEERS ASSOCIATION
(IDEA)
CITATION
For Professional Excellence to
Dr. Balmukund Punamchand Shah

Dr. Balmukund Punamchand Shah has been chosen by the IDEA for conferring this honour on him during the 8th Convention (2013), in recognition of his professional excellence in the field of Dairy Engineering.

Dr. Balmukund Shah was born on 26th February, 1953 at Vejalpur in Panchmahals district of Gujarat. He graduated in Mechanical Engineering from Sardar Patel University, Vallabh Vidyanagar. He completed his Masters Degree in Mechanical Engineering from the same University in 1979; and accomplished Doctorate of Philosophy in Dairy Engineering from Gujarat Agricultural University in 1993. In his entire career he achieved first class and distinction.

Dr. Balmukund Shah entered the field of Dairy Education as Lecturer in Dairy Engineering in 1975 and rose to the position of Principal and Dean of SMC College of Dairy Science, Anand and also Chairman of Vidya Dairy. During his professional career spanning over 38 years he has guided hundreds of students and has been a Major Guide for students at Masters and Doctorate level.

Dr. Balmukund Shah has many research accomplishments to his credit like I.C.A.R. project on "Evaluation and Reduction of Energy Losses in Dairy Processing" and Net Work project on "Mechanization of Basundi Making" other than NABARD' project on "Development of Air Purification System".

Dr. Balmukund Shah has to his credit over 60 research papers many of which are published in International and National journals. He has also published and presented over 50 technical papers some of which won the Best Paper Award from Institution of Engineers' India, Gujarat Science Academy, etc. The Most distinguished award however is the "Best College for Dairy Science" award given by Times Research, New Delhi in 2013 to the SMC College of Dairy Science, Anand which is headed by Dr. Balmukund Shah!

Dr. Balmukund Shah has been actively associated as a member on Research Councils, Academic Councils of the Agricultural Universities in Gujarat, Rajastan, Raipur, Nagpur. He has been a member of Academic Council and Scientific Research Council of NDRI, Karnal and was also involved by ICAR to reframe the courses of B.Tech and Dairy Engineering.

Dr. Balmukund Shah is an active member of IDEA. In recognition of his meritorious service to the Dairy Industry, the IDEA pays rich tribute to him and presents this Citation.

8th Convention of Indian Dairy Engineers Association
2-3 September, 2013
Mumbai

INDIAN DAIRY ENGINEERS ASSOCIATION
(IDEA)
CITATION
For Professional Excellence to
Shri Akhilesh Kumar Jain

Shri Akhilesh Kumar Jain has been chosen by the IDEA for conferring this honour on him during the 8th Convention (2013), in recognition of his professional excellence in the field of Dairy Engineering.

Shri A.K.Jain was born on 15th March 1960, at Karhal, District Firozabad in, Uttar Pradesh. He obtained his Bachelor's degree in Electrical Engineering from Malviya Regional Engineering College, Jaipur in 1981 and did Post Graduation in Business Management.

Shri A.K.Jain started his career in Rajasthan Electronics & Instruments Ltd, Jaipur (REIL) as Trainee Engineer in the year 1982 and through rank and files, rose to the level of Managing Director in March 2011.

During the span of last 30 years REIL, a Public Sector undertaking has achieved tremendous growth and exemplarily under the dynamic leadership of Shri A.K.Jain, it has been 81% more just in last two years. As a result, REIL is a well known name for its Electronic Milko Testers across the length and breadth of our country. These units are benefiting over 100000 villages and 4 crore milk producers ensuring fair payment to them apart from consumers getting whole some milk.

Shri A.K.Jain has been continuously working for upgrading the technologies for testing of milk and milk products which is also helping cooperative societies and Dairy Plants in Cooperative and Private Sector. As a result REIL has offered 'Data Processor Electronic Milk Tester', 'Automatic Collection System with Society Accounting & Management Software', 'Raw Milk Reception Dock System', etc which has brought electronic revolution in the Dairy Industry.

REIL has significantly contributed in the area of Renewable Energy and Information Technology. Since 1986 the company has entered into the business of Solar Photo Voltaic System (SPV), offering Power Solutions; their presence being felt in over 150000 villages in 30 states. They have also installed over 290 Solar Power Plants thus enriching the quality of life of over 50 lakh people.

Under the leadership of Shri A.K.Jain, REIL has received several awards like National R&D Award, National Electronics Award, Highest Export Award, Best PSU for Outstanding Performance Award of 2012, National Award on Energy Conservation of 2012, etc.

In recognition of his meritorious service to the Dairy Industry, the IDEA pays rich tribute to Shri A.K.Jain and presents this Citation.

8th Convention of Indian Dairy Engineers Association
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Technical Programme of National Seminar

Date : 02.09.2013, Monday

Time : 09:00 to 09:30 — Registration
Time : 09:30 to 11:00 — Inauguration
Time : 11:00 to 11:30 — Tea Break

Time: 11:30 to 13:00

Technical Session-I : Desiccated Milk Based Products

Session Chairman: Er. R.K.Chugh, General Manager, Haryana Dairy Development Co-op Fed. Ltd.
Co-Chairman: Dr. M.J.Solanky, Director of Research, Kamdhenu University, Amreli, Gujarat
Rapporteur: Shri R. C. Shah, General Manager, Kolhapur Zilla Sahakari Dudh Utpadak Sangh Ltd.

Sr. No.	Name of the Speakers	Title of the Topic
1	Dr. A.K.Dodeja (Principal Scientist) Dairy Engineering Division, Karnal, Haryana	Application of SSHE for Mechanized Production of Indian Dairy Products
2	Shri Dileep M Dravid (Managing Director) Agro Dairy& Food Consultancy Services, Anand, Gujarat	Growth & Innovation for Traditional Indian Milk Products.
3	Dr. Tanweer Alam, (Joint Director, IIP.) New Delhi	Innovation in Packing System for Traditional Dairy Products
4	Dr. Sunil Patel (Associate Professor) SMC College of Dairy Science, Anand, Gujarat	Mechanized Manufacture of Traditional Milk Products
5	Dr. G.R.Patil (Joint Director (Academic) & Dean) NDRI, Karnal, Haryana	Application of Newer Technologies for Industrial Production of Indigenous Milk Products

Time : 13:00 – 14:00 — LUNCH

Time : 14:00 - 15:30

Technical Session-II : Heat Acid Coagulated Products

Session Chairman: Dr. A.K.Agrawal, Prof. & Head (Dairy Engg), College of Dairy Technology, Raipur
Co-Chairman: Er. V. K. Ghoda, Director, Perfect Solution, Vadodara, Gujarat
Rapporteur : Shri Subhash R. Vaidya, General Manager, Dairy-Tech Consultancy Services, Mumbai

Sr. No.	Name of the Speakers	Title of the Topic
1	Dr. Józef Żuraw, Shri Maciej Raczyński Obram Sp. Z.o.o. Olsztyn, Poland	Mechanization of Paneer Production Process
2	Er. Uday Khare, Proprietor Malhar Industrial Associates Thane, Maharashtra	Innovation in Small Scale Manufacture of Desiccated Milk Based Products
3	Er. Shyam S Bhatnagar Tetrapak India Ltd, Pune	Engineering Aspects of Heat Acid Coagulated Products
4	Dr. A.G.Bhadania Professor and Head, Department of Dairy Engineering, SMC College of Dairy Science, Anand, Gujarat	Energy Requirements for the Manufacture of Tradition-al Indian Dairy Products
5	Dr. I.K. Sawhney Vice President of IDEA Principal Scientist, Dairy Engg. Division, NDRI, Karnal	Design and Development of In-Line Processing System for Manufacture of Multiple Indian Dairy Products

PROGRAM SCHEDULE

Time : 15:30 – 16:00 TEA BREAK
Time : 16:00 – 20:00 Technical Tour

Date: 03.09.2013, Tuesday

Time: 09:30 to 11:00

Technical session-III : Culture/ Fermented Products

Session Chairman: Dr. B. P. Shah, Principal & Dean, SMC College of Dairy Science, Anand Agricultural University, Anand
Co-Chairman: Dr. A.G. Bhadania, Prof. Head, Anand Agricultural University, Anand
Rapporteur : Dr. Rajendra D. Kokane, Professor, Department of Livestock Products Technology, Bombay Veterinary College, Parel, Mumbai

Sr. No.	Name of the Speakers	Title of the Topic
1	Dr. J.B.Prajapati (Professor) SMC College of Dairy Science Anand, Gujarat	Dahi Processing Equipment and their Design
2	Ms. Jahnavi Pandya Vidya Dairy, Anand, Gujarat	Opportunities for Technology Driven Market Growth of Fermented Products
3	Er. Jayesh Gosrani (Joint MD) Goma Engineering Works Thane, Maharashtra	Mechanized Production of Indian Dairy Products
4	Er. V. K. Ghoda, (Director) Perfect Solution, Vadodara, Gujarat	Dairy Market Application & Products
5	Er. Vimleshkumar (MD) Schnell Engineering, Vadodara, Gujarat	Automation for Improving Productivity, Quality and Quantity

Time : 11:00 – 11:30 TEA BREAK

Time: 11:30 to 13:00

Technical session-IV : Fat Rich Products and Dairy Sweets

Session Chairman: Dr. G.S.Rajorhia, Former Principal Scientist, NDRI, Karnal, Haryana
Co-Chairman: Shri P.R.Patel, Executive Director, Mehsana Dist. Co-op Milk Producers Union Ltd, Mehsana
Rapporteur: Shri Lalit Handoo, CEO, Modern Dudh Utpadak Udhyog Pvt Ltd, Mumbai

Sr. No.	Name of the Speakers	Title of the Topic
1	Shri Mayur N. Vyas Dairy Consultant Anand, Gujarat	Entrepreneur Opportunities for Large Scale Manufacture of Traditional Milk Products
2	Er. Rakesh Chopra, Addl. General Manager, Rajasthan Electronics & Instruments Ltd Jaipur, Rajasthan	Advances in Testing Methods for Traditional Indian Dairy Products
3	Shri Pritambhai Shah Director, Parag Dairy Pvt Ltd, Manchar, Dist. Pune	Marketing of Traditional Dairy Products
4	Shri P.R. Patel Executive Director Mehsana Dist. Coop Milk Producers Union Ltd. Mehsana, Gujarat	Entrepreneur Opportunity for Traditional Dairy Products
5	Shri Kailash Ashar Deep Training & Consultancy Mumbai	Training – a tool for change

Time : 13:00 – 14:00 LUNCH

Time : 14:00 – 15:30

Technical session-V : Food Safety & Standard Act, Marketing & Entrepreneur Opportunity of Indian Dairy Products

Session Chairman: Shri B. M. Vyas, Chairman, BMV Consultant, Anand, Gujarat

Co-Chairman: Dr. M.L.Naware, Dairy Advisor, Mumbai

Rapporteur: Dr. Sunil Patel, Associate Professor, SMC College of Dairy Science, Anand, Gujarat

Sr. No.	Name of the Speakers	Title of the Topic
1	Shri Mayur N. Vyas Dairy Consultant Anand, Gujarat	Entrepreneur Opportunities for Large Scale Manufacture of Traditional Milk Products
2	Er. Rakesh Chopra, Addl. General Manager, Rajasthan Electronics & Instruments Ltd Jaipur, Rajasthan	Advances in Testing Methods for Traditional Indian Dairy Products
3	Shri Pritambhai Shah Director, Parag Dairy Pvt Ltd, Manchar, Dist. Pune	Marketing of Traditional Dairy Products
4	Shri P.R. Patel Executive Director Mehsana Dist. Coop Milk Producers Union Ltd. Mehsana, Gujarat	Entrepreneur Opportunity for Traditional Dairy Products
5	Shri Kailash Ashar Deep Training & Consultancy Mumbai	Training – a tool for change

Time : 15:30 – 16:00 TEA BREAK

Time: 16:00 – 17:00 Valedictory Session

Time: 17:00 – 21:00 City Tour

CHALLENGES IN THE MECHANIZED RODUCTION OF TRADITIONAL DAIRY PRODUCTS

Dr. B. N. Mathur
Former Director, National Dairy Research Institute, Karnal

I deem this a great honor and privilege to have been invited to present the Keynote Address at its 8th Convention and a National Seminar of the IDEA on the "Mechanized production of Indian Dairy Products". This event is an eloquent testimony of the vast potential this sector of Indian dairy industry holds for orchestrating the future growth fine tuned to fulfill the cultural, dietary and nutritional requirements of our population. Strategic planning and concerted efforts of all stake holders – the entrepreneurs, the dairy industry, R&D institutions, developmental agencies and policy support for putting together the intensive final resources and infrastructure that are required to achieve the intended objectives of development and growth. I am very thankful to the organizers and sincerely hope that deliberations of the event will go in long way to provide new thrust for strengthening this sector of the Indian dairy industry.

INTRODUCTION

India has an enormously rich heritage of vast range dairy products, which have an excellent potential for industrialization. The age-old art and craft of mithai-making now needs to be transformed into an exact science and technology for developing appropriate equipments for the large scale production. For attaining this objective, intensive innovative R&D and infrastructure are required. Faster growth may be achieved through integration with newly emerging, energy efficient unit operations utilizing equipments available off the shelf for performing various unit operations required in the manufacturing process rather than developing specialized equipments de novo. These initiatives will go a long way to develop our dairy industry that meets the social, nutritional needs and conveniences for newly emerging life-styles. Tremendous scope exists for the strategic product diversification to improve the availability of dairy products for domestic market as well as exports for value added dairy products.

Traditional milk products represent the most prolific segment of the Indian Dairy Industry. Despite the immensity of volume of milk handled, preparation and marketing are confined to the unorganized sector. Transformation of the unorganized sector of dairy industry engaged in processing more than 54 percent of the milk produced in the country provides a formidable challenge. Only Halwais are known for their ingenuity to produce milk sweets having delectable taste; the art of preparation has been passed on from one generation to the next. Some products are very fragile and delicate to process and handle. Their preparation requires the kind of skills that are difficult to emulate mechanically. The overall standards of hygiene and manual handling that are statutorily required to be observed are quite stringent when the production is large. With the emergence of national brands like Haldiram's, Bikanerwala, K.C. Das, Chitale's, Ganguram's, Brijwasi, Ghasitaram, Ghantewala, Bhim Chandra Nag, Chandu, Aggrawal, etc, significant changes are already taking place in the scales of operation and range of traditional sweets. Newer packaging systems are being introduced. Fast changing socio-economic environment will drive the requirements for traditional dairy products to be processed and packaged in new forms.

However, the image of Indian sweets with regard to health and safety raises certain concerns. Persons with Obesity, Diabetes, and Cardiovascular Diseases are concerned about the high sugar and fat content. Recently, there have been adverse reports regarding adulteration. Scope is also indicated for the application of Biotechnology in developing innovative traditional dairy foods with enhanced nutritional and therapeutic attributes.

R&D NEEDS FOR THE WAY FORWARD

- Scientific documentation of the traditional practices for the preparation of the vast range of traditional milk products for preparing data bank of the traditional wisdom to obtain requisite product quality in terms of the physico-chemical and nutritional attributes so as to provide scientific basis for process development.
- Establishment of the regional preferences for the sensory, rheological and physico-chemical profile of the commercially important indigenous milk products through systematic surveys so as to provide scientific basis for standardization of product attributes for commercial trade practices.
- Incorporating the principles of energy conservation efficient by integrating newly emerging technologies / equipments for performing various unit operations involved in the large-scale manufacture. Unit operations / Technologies such as UHT-particulate processing, MF/UF/RO Membrane processing, microwave heating, aseptic packaging developed in the western food processing industry have the potential being utilized where ever appropriate and technologically feasible.
- Developing cost-effective and appropriate packaging systems represents an awesome challenge for the

industrialization of traditional Indian sweets. A wide range of packaging materials need to be evaluated for their suitability. Packaging equipments are high precision machines where design requires highly skilled engineering expertise. Collaboration with the world's leading packaging equipments represents a plausible approach to developing requisite equipments.

- Modified atmospheric packaging (MAP) and use of oxygen scavengers in the package are some of the recent trends to deliver better quality extended shelf life products. MAP extends the shelf life by reducing oxygen and/or increasing gases, such as carbon dioxide and nitrogen, in the food environment.
- Evaluation of the newly developed processes / equipments in relation to the product quality, shelf life and consumer acceptability. This feedback would permit sustained efforts for process refinement for greater commercial success. The newly evolved processes / equipments also need to be constantly evaluated for operational difficulties, process control, safety, electrical and mechanical failures, maintenance problems, cleaning and sanitation problems and operational costs for constant refinement and improvement.
- Demonstration of the performance of newly evolved processes and equipments to pave way for industrialization. These demonstration centers could also be utilized for training of personnel from industry as well as further R&D work.

INNOVATIONS IN MECHANIZATION:

Amongst the vast range of traditional sweets, shrikhand, gulabjaman, peda and probably mishti doi are so far the only one that has truly been mechanized and produced on an industrial scale. Some 3,000 tonnes of it is produced annually, at the Sugam Dairy, Baroda. Its large-scale manufacture is an outstanding example of the adaptation of equipments available off the shelf for performing various unit operations involved in the manufacture of sweets. Impressive advancements have been made in several of the R&D institutions as well as commercial dairy plants for the industrialization of a large range of indigenous milk products. The industrial production of indigenous milk products involves intensive engineering inputs for designing layout of the factory, selection of various equipments, selection of the manufacturing processes and evaluation of the techno-economic feasibility aspects of the industrial production.

TECHNOLOGY TRANSFER FOR MECHANIZED EQUIPMENTS

Considerable R&D work has been done at the National Dairy Research Institute, Karnal for the mechanized production of traditional dairy products. Employing single or multi stage scrapped surface heat exchangers (SSHE), feasibility of continuous production of Khoa, Burfi, Rabri, Basundhi and Malai laccha has been successfully demonstrated on pilot scale. Furthermore, SSHE has been integrated with a conical process vat for the production of khoa with superior sensory characteristics. Likewise processes have been developed for the commercial scale production of long life sterilized Paneer has been developed. Mechanical device involving kinematic half-turn nut pressing mechanism for paneer has been developed on pilot scale. It now needs initiative on part of the entrepreneurs to take all these developments to level of commercial production.

DAIRY EQUIPMENT INDUSTRY IN INDIA

At present there are around 20 units in the organized sector engaged in the manufacture of dairy process equipments such as milk reception equipment, storage tanks, cream separators, clarifiers, heat exchangers, homogenizers, cream deodorizers, evaporators, spray driers etc. These meet almost 95 percent of the requirement of domestic industry.

Demand for the mechanized equipments for the industrial production of traditional milk sweets will have emphasis on automation, energy conservation, technology, price, delivery as well as performance standards. These demand high level of technical capability and investment. Presently, linkages with the R&D institutions and equipment manufacturers are quite weak and need to be strengthened. Prospects for collaboration with the world's leading packaging equipment manufacturers need to be aggressively explored for accelerating the pace of development. Indian companies will have to develop technical capabilities to a level where they are competitive across the globe. This calls for strategic planning and policy support from the Government.

SCOPE FOR DEVELOPING SPECIAL DIETARY SEGMENT OF TRADITIONAL DAIRY PRODUCTS

Milk and milk products are perceived as healthy foods. Present day consumers are weight conscious, or those with diabetic condition are likely to limit their intake of milk sweets. It is plausible that by accentuating the positive attributes of inherent milk constituents and by reduction of fat and sugar content, the dairy industry can develop Indian milk products, which would appeal to such consumers. Understanding consumer needs and preferences are critical to successful marketing and enhancing marketing value of a product. Present day consumers prefer foods that promote good health and prevent disease. Furthermore, these foods must fit into current lifestyles providing convenience of use, good taste and acceptable price-value ratio. Such foods constitute current and future wave in the evolution of food development cycle.

The health-driven foods are commonly referred to as functional foods, designer foods, pharma foods or neutraceuticals. Molecular biology has been successfully deployed to impart unique nutritional and therapeutic attributes to fermented milk products. Milk proteins, apart from serving the growth requirements, provide a source of physiologically significant range of peptides that play an extra-nutritional role in maintaining normalcy of health and well being. Nutritionally

improved foods with at least one nutritional improvement over the conventional counterpart have been successful in the marketplace. Product modification strategies include removal or reduction of fat, cholesterol, sodium and calories, and fortification with vitamins, calcium, fiber and active cultures to align with health perception of the consumer. In addition, dairy products may be augmented with health-promoting ingredients like fiber, vitamins, minerals, and other functional ingredients. Recent advances in high intensity sweeteners and fat replacers show much promise in developing analogues of Indian sweets with reduced sugar, fat, and caloric content.

BIOTECHNOLOGICAL APPLICATIONS

Biotechnology has already made significant contributions in dairy industry. Biotechnology has recently emerged as the most powerful and sought after technology having endless possibilities in almost all areas affecting human life. Recent developments in Biotechnology have opened up new and exciting possibilities in Dairying and Animal Husbandry. Biotechnology can play a significant role in raising the status of dairy sector both in terms of milk production and processing. Dairy industry in particular can greatly benefit through the application and intervention of powerful magical tools of this technology such as rDNA technology, Genetic Engineering, Gene cloning, Hybridoma Technology and Transgenics, PCR technology and Bioprocess Engineering to develop commercial products and processes that use living systems to provide high quality nutritious, clean, wholesome and healthful dairy foods to all the people of our country.

EXPORT OF DAIRY PRODUCTS UNDER WTO REGIME – PROSPECTS AND STRATEGIES

Any assessment of marketing prospects in the national and international context must be seen in terms of anticipated socio-economic and demographic changes at global level. There is also expected to be greater urbanization of population in the developing countries, which are expected to double by 2025 when an estimated 50% of world's population will be living in cities of more than 1 million people. Asia is also urbanizing rapidly, with even such traditional rural countries as China and India would have hundreds of million of people living in towns and cities. According to United Nation projections, out of 26 agglomerations of more than 10 million people, in 2025, 22 will be in developing countries.

Prospects for the export of traditional milk products conforming to the international quality and packaging standards present exciting opportunities for orchestrating further growth. A large variety of Indian Dairy Products are sold in the super markets in North America, UK and South Africa produced by small scale entrepreneurs. Some 20 million Indians abroad, over half of them living in the west are a part of the upper income group. They constitute a major market for Indian milk-based sweets. Projected domestic demand for major traditional products is 250,000 tones. In North America alone, this market is estimated around US $1 billion. Several Canadian initiatives for a project to produce Indian milk products in North America are on the anvil. New initiatives have been taken by the dairy industry in Australia for developing exports oriented R&D for traditional Indian sweets. These all are an eloquent testimony to this growing trend. As the new wave gathers momentum, the production of dairy products conforming to the international standards of safety, hygiene, packaging and labeling present formidable challenges. For orchestrating further growth of traditional dairy products in the liberalized global economies, pragmatic planning is required to develop energy efficiency, eco-friendly technologies for processing, development of eco-friendly / cost effective packaging systems, good manufacturing practices to meet international norms for food safety, quality assurance.

- Impact of liberalization of world economies on international trade of Dairy commodities
- Identification of new avenues and commodities for global market
- Remodeling of legal framework in the light of new world economic order
- Identification of Dairy export zones
- Infra-structural development for export oriented units
- HRD strategies for sustainable dairy exports
- Technology management and interventions in processing, quality control and marketing
- Complexities in balancing external and internal demands
- Relevance of self-reliance in open economy
- International Competitiveness in milk production and processing
- Restructuring of Dairy industry
- Role of private investment in Dairy sector for export orientation
- Brand management

CONCLUSIONS

Undoubtedly, the dairy market of the future will be much more diversified in terms of products and their packaging, with an increasing no of niche markets. The future market will not be one of anonymous bulk products; rather, it will be focused on providing a range of highly specified products, tailored to meet the needs of ever-more demanding consumers throughout the world. The needs of the market will determine the change in technology that will be required in the future. Fast changing in socio-economic environment will drive the requirements for traditional dairy products to be processed and packaged in new forms. Time is opportune to provide critically appreciation of the prospects for traditional milk products in the newly emerging world scenario. There is need for all the stake holders, the dairy industry, entrepreneurs, R&D Institutions and Financial Institutions for providing requisite financial inputs and infrastructure to carry out developmental work for the industrial production of traditional dairy products.

Technical Session-I

Application of SSHE for Mechanized Production of I ndian Dairy Products

Dr. A.K. Dodeja
Head
Dairy Engineering Division,
N.D.R.I., Karnal

INTRODUCTION

Indian milk sweets have played a significant role in the economic, social, religious and nutritional well being of our people since immemorial. The operation flood programme, one of the world's largest and most successful integrated dairy development programme initiated in 1970, has led India to emerge as the largest milk producer in the world. It is estimated that milk production in India reached a record level of 127.0 million in the year 2012 accounting for more than 17% of the world's total production and about 50-55% of milk produced is converted by the traditional sector (halwai) into variety of Indian milk products. The market of Indian milk products is estimated to be more than 65000 crores. In view of the growing awareness towards the safety aspects of milk based sweets in India, the consumer shall prefer to buy these products from organized sector. Despite the widespread popularity and acceptability of traditional milk products in Indian market, the organized sector has so far not been able to tap into this market potential for many reasons such as lack of published literature on their technology, inadequacy of appropriate technology for their commercial production, inadequacy of appropriate packaging material, low keeping quality and lack of quality assurance systems.

Keeping in view the importance of indigenous dairy products and the limitation associated with the existing method, the National Commission on Agriculture long back recommended that the production of indigenous milk products and sweets derived therefrom should be taken up by organized plants. The Commission also suggested that efforts should be made to rationalize the technique of production of various indigenous milk products and explore the possibility of large scale production by improving their keeping quality and packaging with minimum expenses. For handling high viscosity products with or without particles, and for the products that tends to foul the heat transfer surface, the scraped surface heat exchanger (SSHE) is most suitable. In SSHE, the working fluid is spread in the form of a film over the heat transfer surface by rotating blades. Each blade scoops a certain amount of fluid from the pool and accelerates it along the heat exchanger surface. At any given instant the fluid picked up by the form of a fillet in front of blade. The blade action which is similar to that of a plough causes part of the fluid in the film to mix with that in the fillet. Simultaneously restoring the film thickness by allowing an equal amount of fluid to squeeze past the tip of the blade. This paper presents the recent innovations on equipment development for manufacture of large scale manufacture of products like burfi, khoa, basundi and rabri.

TWO STAGE SCRAPED SURFACE HEAT EXCHANGER (SSHE)

Two stage SSHE was conceived for continuous manufacture of khoa and the system was arranged in cascade fashion. The rotor of first SSHE was provided with four variable clearance blades and operated at 3.3 rotations per second (rps). Milk would concentrate in it upto 40-45% total solids in the first SSHE. This concentrate enters the second SSHE which has two variable clearance blades and two helical blades operating at a lower rpm of 2.5 rps. The steam pressure is adjusted to 250 kPa in the jackets of both the SSHE and milk flow rate is kept constant at 150 kg/h. Khoa is collected from the outlet of the second heat exchanger. khoa made from two stage TSSSHE is similar to that made from batch process. In this unit there was a saving of 66 kg steam for every 100 kg khoa compared to conventional method using steam jacketed kettle.

THREE STAGE SCRAPED SURFACE HEAT EXCHANGER (SSHE)

Based on the work done earlier with two stage SSHE, the design of three stage SSHE was conceived. It consists of three identical thin film scraped surface heat exchangers. A feeding tank is provided with screw pump and changing the speed of impeller provides variation in feeding rate which is measured by magnetic flow meter. The steam inlets are provided with Pressure gauges, I/P converter, Transmitter, pneumatic valves,

air pressure indicator and process controllers for automatic steam controlled system.

CONTINUOUS KHOA MAKING:

Khoa is partially dehydrated, heat desiccated milk product and is widely used as a base material for preparation of numerous indigenous sweets. The increased demand of khoa based sweets has created need for large scale production ensuring uniform product quality, product safety, energy conservation etc. In this direction three stage SSHE with state of the art technology by incorporating various operating features and instrumentation. The complete system and its working are described elsewhere (Nanadkishore, 2010). The performance of the system was evaluated for continuous manufacture of khoa.

Standardized buffalo milk (2, 3, 4 and 6% fat) was obtained by adding required amount of skim milk, separated from raw buffalo milk into the balance tank. Khoa was manufactured by using 3- stage thin film scraped surface heat exchanger. Following process parameters were selected based on the experience gained through running of 2- stage SSHE. The rotor speed of first and second stage was kept at 200 rpm and 3-stage was varied as 20, 30 and 40 rpm. The steam pressure was kept as 4 and 2 kg/cm2 in first and second stage and varied between 1 to 1.5 kg/cm2 in third stage in such a way as to get final product of nearly uniform consistency. The flow rate of milk in all trials was kept fixed as 200 kg/h.

Table 1 gives the sensory evaluation score of the product obtained by variation in speed of third stage SSHE for different fat levels.

The data given in table indicate that keeping the rotor speed of third stage SSHE at 20 rpm, the sensory scores of all samples were better compared to 30 and 40 rpm.It is also seen that khoa made from continuous process was compared with traditional method.

Table: EFFECT OF THIRD STAGE ROTOR SPEED ON SENSORY EVALUATION KHOA

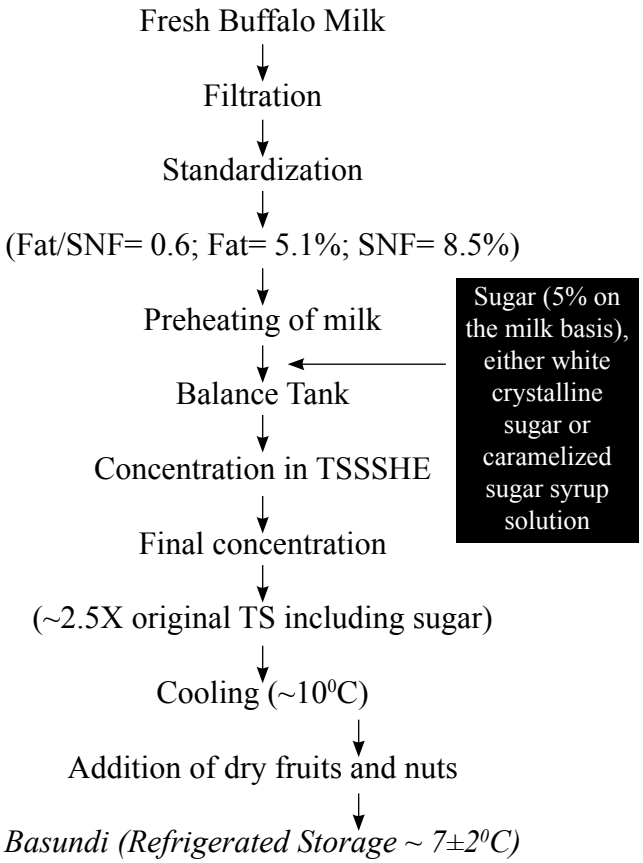
Fat(%) of initial milk	Rotor speed	Flavour	Body and texture	Colour and appearance
2	20	7.0	6.5	3.8
	30	6.8	6.35	3.8
	40	6.3	6.1	3.7
Conventional		7.2	6.7	4.0
3	20	7.4	6.85	3.9
	30	7.2	6.7	3.8
	40	6.9	6.2	3.8
Conventional		7.5	6.9	4.0
4	20	7.8	7.0	4.1
	30	7.5	6.8	4.0
	40	7.1	6.1	4.0
Conventional		8.0	7.2	4.2
6	20	8.2	7.5	4.0
	30	7.7	7.1	3.9
	40	7.4	6.0	3.8

CONTINUOUS BASUNDI MAKING:

Basundi is a traditional heat desiccated milk delicacy having sweetish caramel and pleasant aroma, light to medium brown colour, thick body and creamy consistency with or without soft textured flakes that are uniformly suspended throughout the product. It contains all the solids of milk in an appropriate concentration plus additional sugar and dry fruits. It is consumed directly as a delicious sweet dish. It is most popular in Maharashtra, Gujarat and parts of Karnataka and is mainly prepared at home by the housewives on some special occasions like festivals, weddings etc. and relished due to its rich, caramel, pleasant and nutty flavor and thick consistency (Pagote, 2003).

Total annual production of *Basundi* during 1996 was estimated to be 25000 tones and was mainly confined to cottage scale in non-organized sector (Aneja, 1997). Now-a-days, the popularity and demand of *Basundi* is increasing due to its delicacy. Hence its production and marketing is increasing in a few big cities of the country.

PREPARATION OF BASUNDI IN THREE STAGE SSHE:



First the buffalo milk is taken, filtered and standardized to a fat: SNF ratio. It is then preheated to 800C for few seconds. This preheated milk is mixed with either white crystalline sugar or caramelized sugar syrup solution in the balance tank. Then the steam valves of the steam header and three SSHEs, which were located at the rear side of three stages SSHE, are opened manually. The feed pump is then started and flow is varied between 100-200 kg/hr with the help of electromagnetic flow meter by controlling the rpm of feed pump from the control panel. The rotor blade assembly of first and second SSHE is switched on and the speed of both SSHE`s are kept between 100 to 175 rpm. Milk is first concentrated in first stage SSHE and then enters into the second stage where it is further concentrated. The mass flow rate is approximately so adjusted to get the concentration required in the Basundi. From second stage TFSSHE, the product formed is collected and cooled to 100C and then dry fruits were added to it @ 1.5% w/w of the Basundi.

Combinations of scraper blade speed with differ rent types of sugar were undertaken to get the best possible Basundi out of SSHE. The result obtained while performing statistical analysis based on the sensory score, proximate composition analysis and physico-chemical analysis concluded that the best possible combination for preparing Basundi was made by keeping rpm of first and second stage as 125 and steam pressure as 1.5 kg/cm2 in both SSHE and using caramelizes sugar gave product of excellent quality.

The Basundi prepared by best possible combination of operating parameters in SSHE has been compared with the Basundi prepared by standard batch process in proximate composition and physico-chemical characteristics and found that both types of Basundi were almost similar.

CONTINUOUS RABRI MAKING

First the buffalo milk is taken, filtered and standardized to a 6% fat and 9% SNF. The milk is analyzed for acidity to maintain the desired acidity level. If the acidity is lower than desired, the acidity of milk is adjusted by with addition of 2% citric acid solution @ 0.7 ml per 100 ml milk to raise 0.005 unit acidity. Sugar 3% w/w (white crystalline sugar: caramelized sugar syrup solution= 6.27: 1) of initial milk taken is added in the milk in balance tank. Then the steam valves of the steam header and three SSHEs, which were located at the rear side of three stages SSHE, are opened manually. The feed pump is then started and flow is varied between 120-200 kg/hr with the help of electromagnetic flow meter by controlling the rpm of feed pump from the control panel. The rotor blade assembly of first and second SSHE is switched on and the scraper speed of first and second SSHE are kept between 100 to 150 rpm (1.968 – 2.953 m/s) whereas third SSHE is kept at 15 rpm. Milk is first concentrated in first stage SSHE and then enters into the second stage and finally in third stage sequentially where it is further concentrated and desired flakes formation take place in the product. The mass flow rate is approximately so adjusted to get the concentration required in the Rabri. From third stage SSHE, the product formed is collected and cooled to 100C and packaged in cups then dry fruits were added to it and rabri cup is finally wrapped with aluminium foil. The product was then stored at temperature lower than 100C.

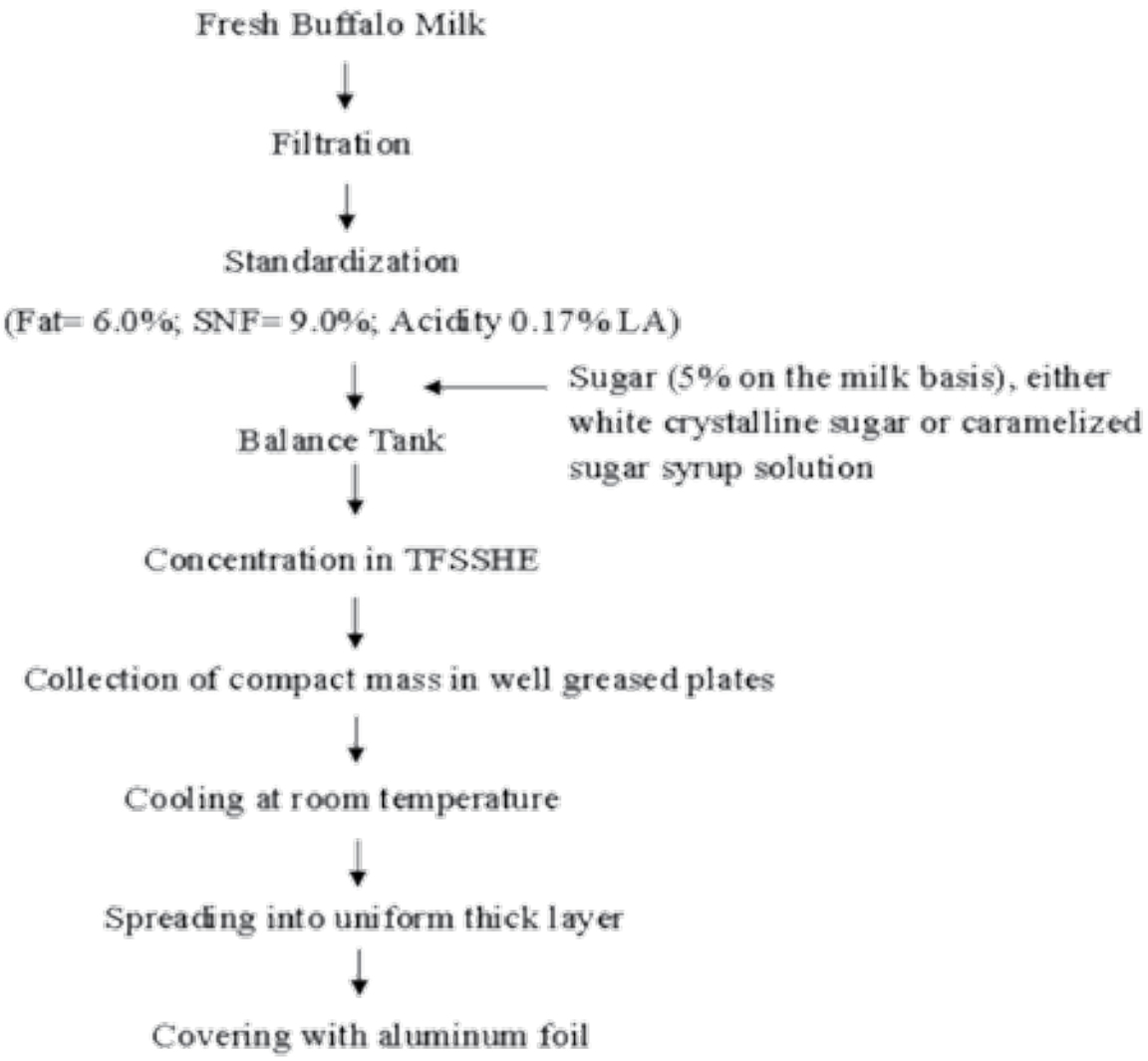
The Rabri prepared by using 3% sugar level of initial milk taken in combination of white crystalline sugar and Caramelized sugar syrup solution in the ratio of 6.27:1 has the desired caramel colour and flavour, and hence overall acceptability. The first and 2nd scraper speed have the significant effect on the sensory attributes, FFA, HMF, colour values (L*, a*, b*), firmness, stickiness of product, Rabri.

CONTINUOUS BURFI MAKING:

Burfi is the most popular Khoa based traditional confection all over India. The generic nomenclature “Burfi” covers a wide range of product variations that include plain, danedar, dudh, chocolate, fruit and coconut Burfi. It has variation in flavor, color, body and texture. Burfi is a popular milk based sweet in which the base material is essentially khoa. Sugar is added in different proportions and other ingredients incorporated according to the demand of consumers. Burfi is prepared by heating a mixture of milk solids (khoa) and sugar to a homogenous consistency followed by cooling and cutting into small cubes. Even today, regardless of volume of production, Burfi is manufactured primarily in jacketed kettles by ‘halwais’, which inherently suffers from several disadvantages such as

low heat transfer rates, high fouling behavior, batch to batch variation in product quality , poor hygiene and sanitary conditions.

In order to manufacture burfi continuously the buffalo milk was taken, filtered and standardized to a fat 6.0% and SNF 9.0%. This standardized milk is to be preheated to 900C for few seconds. This milk was mixed with either white crystalline sugar or caramelized sugar syrup solution in the balance tank. Then the steam valves of the steam header which are located at the rear side of three stages SSHE were opened manually. The feed pump was then started and flow was varied between 155-205 kg/hr with the help of electromagnetic flow meter by controlling the rpm of feed pump from the control panel. The rotor blade assembly of first, second and third TSSSHE was switched on and the speed of all three SSHE were kept fix by control panel. The steam pressure was fixed in first, second and third stage4 kg/cm2, 2 kg/cm2 and 1.5 to 2 kg/cm2 respectively. Milk is first concentrated in first stage SSHE and then enters into the second stage where it is further concentrated. In third stage, we adjust the steam pressure between 1.5 kg/cm2 to 2.0 kg/cm2 accordingly by observing the body of product coming into third stage, from second stage. The mass flow rate is approximately so adjusted to get the concentration required in the Burfi. From third stage, homogenous mixture of final product was collected in well greased plates and spreading into uniform thick layer. Then cooling was done at room temperature and it was covered with Aluminium foil. When Burfi got properly cooled, it was cut into pieces.



CONCLUSIONS:

Three stage SSHE which has been developed with state of the art technology by incorporating various instrumentation and process controllers has proved very successful for large production of Indian milk products.

Growth and Innovation For Traditional Indian Milk Products

By
Mr Dillep Dravid & Mr Abhay Bhargava

INTRODUCTION

- Milk and Milk products are still a commodity in Indian markets with little value additions and branding.
- There is huge scope for value additions as Milk and milk products are food items where consumers' value expectations are large and varied as per different geographies, age groups, income groups, social groups, ethnicity, festivals and occasions.
- For food item like Milk and Milk products, Consumers are not satisfied with commodity features and look for the brand features like:
- Quality assurance
- Reliability
- Quantity Assurance
- Hygienic Standards
- Products availability as per the personalized taste, preferences, flavor, appearances, Aroma etc.

PRESENT SCENE

- In the absence of the value addition and lack of branding initiatives, the growth of milk and milk products is getting commoditized and is not able to grow to the next orbit of value additions, branding and innovations.
- There are huge opportunities for converting traditional milk products like curd, mawa, paneer, lassi, Chach, milk shake, tea etc.
- There are new opportunities of milk products like Smoothie, fruit cream etc.
- Presently some of the traditional products are being offered by large scale plants.
- This is not the best way to handle opportunities, growth and innovations
- The better way, especially for food items, is to have the distributed Small and Mini operations but based on cutting edge technologies offering hygienic production, quality assurance, variety of tastes, packing for better shelf life and assured quality and quantity

WHY SMALL AND MINI

- Food items need to be based on local raw material and for local tastes and preferences.
- Milk items have low shelf life and should preferably be consumed same day of production.
- Large plants require infrastructure for milk collection from a larger catchment area and also have to resort to larger market area increasing cost of inventories of raw materials as well as finished products

PROPOSED GROWTH AND INNOVATION INITIATIVES

- Providing cutting edge technologies at small and Mini plants for traditional milk products like curd, mawa, paneer, lassi, Chach, milk shake, tea/coffee making, smoothie, fruit cream, milk powder as cooking/curry ingredient etc.
- Providing latest packaging solutions for above milk products to deliver hygienic products for assured quality and quantity, preferably in smaller packs.

OBJECTIVES

- To Improve the quality of traditional products with larger varieties added
- To improve the manufacturing processes in small and mini plants using latest technologies and systems
- To develop and offer latest equipment of mini and small scale capacities
- To develop and offer latest packaging equipment and materials for mini and small scale operations

PROJECT DETAILS

- Curd making and packing plant for a capacity of 1 tpd
- Mawa making and packing plant for a capacity of 500 Kgs per day. This should have at least 6-8 varieties of mawa making with different parameters and specifications
- Paneer making and packing plant with at least 8-10 flavors, shapes & textures
- Milk shake making machines for the road side vendors
- Tea making unit for road side vendors
- Milk powder in pouch packing for consumer use
- Milk powder packing in small pouches of 50-100 gm for curry cooking usage
- 5 liters per batch Lassi making machine
- 10 liters per batch chach making machine
- Smoothi making equipment
- Fruit cream making unit

CHALLENGES FOR TECHNICAL INNOVATIONS

- To develop the processes using small and mini scale operations
- To reengineer equipment for smaller capacities
- To develop control and PLC systems for small and Mini scale plants
- To develop packaging machines and packaging materials suitable for milk products. Materials need to be environmentally friendly

CHALLENGES FOR SME ENTREPRENEURS

- Mastering the product and its usage for different consumer groups
- Mastering the processes and technologies for the manufacturing the products
- Marketing products in local area
- Training manpower for production and for maintaining hygienic conditions
- Mastering packaging and packaging equipment

INNOVATION IN PACKAGING SYSTEMS FOR TRADITIONAL DAIRY PRODUCTS

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Joint Director & Regional Head
Indian Institute of Packaging, NRC Delhi

INTRODUCTION

In today's highly competitive marketplace, packaging is a vital link between farms to fork. Packaging is the primary means by which the quality and shelf life of dairy products is ensured. As soon as milk is let down from the udder of mammal it gets contaminated with spoilage of microorganisms that reduce its shelf life. In recent years, the major driving forces for innovation in packaging have been the increase in consumer's demand for minimally processed Dairy Products. Variety of shelf life-extending packaging technologies has been identified and transferred to the food industry like Modified-Atmosphere Packaging (MAP), Active Packaging (AP) technologies etc. MAP and AP are innovative packaging concepts in which the package, the product and the environment interact to prolong the shelf- life and safety while maintaining the quality attributes of the product. Several R & D efforts have been made for mechanization and upgradation of these methods of manufacturing Traditional Dairy Products. However, little attention has been paid for designing and developing innovative packaging systems for these products. On the contrary, very fast developments have taken place in Western countries where most of the dairy products are packaged in flexible packages like paper cartons, plastic pouches, laminates, molded containers etc. using continuous packaging systems and machinery. This technical paper focuses on innovative packaging solution for managing of spoilage of traditional dairy products of India.

PACKAGING OF TRADITIONAL INDIAN DAIRY PRODUCTS

India is top milk producing country of the world with an annual production of more than 110 million tonnes. About 46% of the total milk produced is consumed in liquid form and nearly 50 -55% of the total milk production in India is utilized for the manufacture of a wide range of traditional milk products viz., fat rich (Ghee), heat desiccated (khoa and khoa based sweets, rabri, basundi, etc.), acid coagulated (paneer, channa and channa based sweets), fermented (dahi, misti Doi, chakka and shrikhand) cereal based (kheer, payasam etc.) and frozen (kulfi) products. Most of these products, except 10-15% of total ghee production, are produced by private traders (halwais) using labour and energy intensive batch processes, resulting into large variations in their qualities. The rest 7% of the milk goes into the production of western products like milk powder, processed butter and processed cheese. The shelf life of traditional dairy products is generally low and does not commensurate with the principles involved in their manufacture. One of the major reasons for poor shelf life of traditional dairy products is either no packaging or inadequate packaging. Among the milk products manufacturing by the organised sector, some of the prominent ones are ghee, butter, cheese, ice cream, milk powders, malted milk food, condensed milk, infant food etc. Only 12% of the marketed milk is represented by packaged and branded pasteurised milk. The appropriate packaging of dairy products is of utmost importance not only to preserve nutritive value and saving of wastage, but also to improve the marketability to achieve better returns. Milk in its various forms gives ample challenging opportunities to the packaging manufacturers from the meadow of glass, metal, paper, plastics to novel packaging system. to innovate and introduce packaging solutions which can be easily adopted in our country. The challenge to the packaging fraternity is to deliver the nutritious dairy products to the consumer in most economical, hygienic, safe and environmentally friendly packages. For highly perishable commodities like milk and its products, packaging is very essential for safe delivery of the product to the consumer without altering its characteristics and nutritive value. Milk and milk products spoil rapidly at temperatures above refrigeration and in the presence of oxygen and other contaminating agents present in the atmosphere. The purpose of packaging is to protect these products from the adverse atmospheric conditions such as oxygen, moisture, heat, light etc. and to present the product in an appealing manner to the consumer. The important criteria for the selection of packaging materials and systems for dairy products are as follows:

- Microenvironment
- Ambient Microenvironment
- Physical, Chemical and Microbial Changes
- Material, Methodology and Compatibility
- Hazards (Gas, Moisture, Transport)
- Legislation, Convenience and Environment

PACKAGING OF PANEER

Paneer, a popular traditional Indian dairy product, is obtained by acid and heat coagulation of milk. It has a short shelf life of about 7 days at refrigeration storage and less than 24 hours at room temperature. A high moisture content (≈ 55%), post-manufacturing contamination and improper packaging are some of the major limiting factors of poor shelf life. The microbial spoilage in paneer occurs due to the surface growth of microorganisms. A greenish yellow slime forms on the

surface and the discolouration is accompanied by an off-flavour. Hence, it is invariably the surface that gets spoiled early while the interior remains good for a longer time at refrigeration storage. Use of an appropriate packaging material and creating air free environment, therefore, may contribute greatly in increasing the shelf life of paneer. Sachdeva et al (1991) used vacuum packaged paneer blocks of 10 x 4 x 6 cm size in cryovac polyethylene bags using vacuum packaging machine. No deterioration was observed upto 30 days at 6 ±10 C in vacuum packaged paneer samples. They had also reported that body and texture of paneer is also improved by vacuum packaging as it became more compact and better sliceable. Punjrath et al. (1997) reported that vacuum packaging of paneer in specific film (EVA/EVA/PVdC/EVA) followed by heat treatment at 900 C for one minute could help extending the shelf life upto 90 days at refrigeration temperature. Swati and Goyal (2008) reported that there is 200 % enhancement in shelf life of paneer by using MAP.

PACKAGING OF KHOA

Khoa is a partially heat desiccated traditional dairy product obtained by continuous desiccation of cow, buffalo milk or their admixture till the desired flavour, texture and consistency is achieved. Normally, it contains 65-70% total solids and the level of individual milk constituent in khoa depends on the initial values in milk and the degree of concentration of milk. The fat content should be more than 30% of dry matter as stipulated by PSSA. When khoa comes out from the processing kettle or continuous khoa making machine, the temperature is more than 900C and it is invariably free from microorganisms. Poor handling, packaging and storage conditions are responsible for heavy microbial contamination in khoa. The shelf life is 5 days at room temperature. Though, three types of khoa, viz. pindi, dhap and danedar are produced in the country, only pindi variety is marketed to large and metropolitan cities. One kg blocks of spherical or hemispherical shape are packed in a bamboo basket lined with green leaves or newspaper and covered with a gunny, cloth for transportation. Packaging of khoa in this manner is improper and unsuitable from hygienic and shelf life point of view. The most common defects occurring in khoa during storage are hardening /drying of the product, fat oxidation, yeast and mould growth, staleness etc. Selection of proper packaging system may, therefore, minimize these defects and extend the shelf life of khoa. According to Goyal and Rajorhia (1991) hot filling (80-90° C) of khoa in tin cans increased its shelf life upto 14 days at 37° C, while the use of 3-ply laminate made of paper/aluminium foil/LDPE or 2-ply laminate of MST cellulose/LDPE keeps khoa in good condition for 10 days at 370 C and for 60 days under refrigerated storage. High barrier structures/laminates based on polyester/ethylene vinyl alcohol (EVOH)/polythene are used by Punjrath (1995) for products like khoa and milk desserts. Such laminates can be used for bulk packaging of khoa in cold stores for longer duration. Tin cans and rigid plastic containers of 15 kg capacity can also be advantageously used for bulk packaging of khoa under vacuum and storage at room temperature. Danedar khoa, the main ingredient of khoa based sweets, is highly perishable. Its shelf life could be extended up to 60 days at 11 0C by packaging under nitrogen / vacuum in a flexible pouch of poster paper/ aluminium foil / LDPE (Sharma et al., 2001).

PACKAGING OF BURFI AND PEDA

Amongst the several khoa-based sweets, burfi and peda occupy most dominating place in terms of popularity and market demand. About 30% sugar (w/w basis) is blended vigorously with hot khoa for making these sweets. These sweets are largely prepared by unorganised sector (halwai s) on small scale and mostly packaged in paper cartons or duplex board boxes with or without butter paper lining. The traditional packages do not provide sufficient protection to milk sweets from atmospheric contamination and unhygienic handling and thus susceptible to become dry, hard and mouldy and develops off flavours. Only recently, some of the reputed manufacturers of these sweets have started packaging burfi and peda in HDPE/polypropylene boxes and cartons of 500g and 1 kg size, particularly on festivals. Palit and Pal (2000) investigated the influence of different packaging materials on the shelf life of burfi. Burfi was hot filled in pre-sterilized polyester tubs of 250 g capacity and subsequently vacuum packaged in multilayer co-extruded nylon high barrier pouches. They observed the shelf life of 52 days at 30 ° C in vacuum packaged samples against 16 days without vacuum packaging. No mould growth was observed in vacuum packaged samples. Kumar et al (1997) packed peda under MAP (80% nitrogen & 20% CO2) in bags made from high barrier multilayer (EVA/EVA/PVdC/EVA) film and also at normal atmospheric conditions in barrier bags containing oxygen scavenger pouch placed in barrier bags along with indicator tablet. Control samples were in cardboard boxes. Mould growth was observed in control samples after 7 days of storage. Samples with MAP showed shelf life of 15 days at 37° C and 30 days at 20° C. Packaging of peda with oxygen scavenger extended the shelf life up to 2 months at 37° C, 5 months at ambient temperature (30° C) and 6 months at 20° C.

PACKAGING OF GULABJAMAN AND RASOGOLLA

Gulabjaman is a khoa based sweet while rasogolla is prepared from channa. The similarity between the two is based on their shape, texture and method of storage. Both are spherical in shape, spongy (rasogolla more spongy than gulabjaman), porous and kept in sugar syrup. Their shape and porosity attributes are very critical and have to be maintained till product reaches to the consumer. On an average, they contain about 40% moisture and 50% sugar (including lactose and carbohydrates). Yeast and mould growth is a more common problem associated with yeasty/fruity flavour defects during storage in both the sweets. Since body and texture of rasogolla is very delicate and it has to be preserved in sugar syrup, it is invariably packaged in lacquered tin cans of 500 g and 1 kg capacity. The proportion of rasogolla and syrup is kept 40:60 and product stays in good condition for more than 6 months at

ambient conditions, because hot filling at 90°C technique is adopted. Gulabjaman is largely packaged without syrup in paper cartons or polyester boxes like burfi and peda. Though lacquered tin can is the most suitable packaging material for rosogolla and gulabjaman, it is very expensive. Goyal and Rajorhia (1991) suggested the need to develop plastic can similar to "Letpak" commonly used in European countries. "Letpak" is extruded and laminated with a PP-Al foil material. The foil provides the necessary water vapour barrier property, smooth curved corners and good printing surface for multi colour designs. The ends are injection moulded and lined with same type of laminate as used for the body. The size and the dimensions can be adopted to suit the distribution systems and consumers' needs. The material is heat resistant and thus hot packaging of syrup and products is possible.

PACKAGING OF TRADITIONAL FERMENTED DAIRY PRODUCTS

Dahi, Misti Dahi and Shrikhand are the popular indigenous fermented products. Their production was restricted by household and Halwais in earthen pots which provide firm body and texture to the product. But they are heavy in weight, breakable, expensive and cannot be covered properly leading to shrinkage of product during storage because of moisture seepage through the porous body of pot. Now many organized dairies have started commercial manufacturing and marketing of Probiotic Dahi, Lassi, Butter Milk, Misti Dahi and different varieties of Srikhands in better and attractive packaging. Polystyrene (PS) and polypropylene (PP) cups of 100, 200 and 500 g size are used for the packaging of Shrikhand, Dahi and Misti Dahi by the organized dairies. PS & PP cups are free from all the problems associated with earthen pots. The drawbacks with them are that wheying off of the product, particularly of Dahi, is rather fast and they are not eco-friendly. Although glass bottle is one of the old packaging medium for retail milk distribution, now single-service paper/plastic containers or PET bottles are increasingly being adopted for the same purpose. Dominated, in milk packing, by polyolefines (such as polypropylene and polyethylene's), used singly or blended to offer a wide range of materials, plastics have superseded paper in recent times. The polyolefines of interest are coating grades for cartons, film grades for sachets and extrusion/blowing grades for bottles. Cartons are made of combinations of food grade paper and wax or plastics. The distribution advantages of cartons are: maximum space utilization in vehicles and storage, ability to carry attractive printing, and convenience for the purpose of stacking milk on super-market shelves. The carton systems in common use are: Perga (U.K); Pure Pak (USA); Zupack, Blockpack (W. Germany); and Tetra Pack (Sweden). During filling of cartons, either pre-formed or pre-cut blanks may be used. Pre-formed cartons are supplied in a fully erect form ready for filling; in the pre-cut system the blanks are supplied in a knocked down shape and the final carton is set up, formed, filled and sealed on one machine. Since it is difficult to pour from sachets, they are usually equipped with a jug. The sachet systems in common uses are: Polypack, Bertopack (Switzerland); Finnpack (Finland); Milk Pack, Rotapack (W. Germany); and Prepac (France). Sachet filling of milk usually follows a form/fill/seal system. The sachets are formed from a reeled film over a shoulder and tube-forming sealer. Their size is changed simply by pushing a button without stopping the machine.

PACKAGING OF GHEE

Ghee (anhydrous butter-fat) is defined as pure butterfat obtained by heat clarification of cream or butter. Approximately 28% of total milk production is converted into ghee, which is next to the liquid milk consumption; hence it has great economical significance in our country. Since butterfat is most expensive constituent of milk, utmost care is taken in its processing (into ghee), packaging and preservation. The role of packaging material in transportation and preservation from tampering and spoilage of ghee is abundant. Ghee is prepared at a temperature of around 1100 C at which most of the microorganisms and enzyme (lipase) are eliminated and moisture content is maintained $\leq$ 0.5%. Hence there is no chance of microbial spoilage of ghee during storage. However, upon prolonged storage, ghee undergoes lipid deterioration resulting into either hydrolytic rancidity or oxidative rancidity defects. Contamination of ghee with lipase activating/producing microorganisms and presence of higher moisture are responsible for hydrolytic rancidity. Oxidative rancidity in ghee is more common and develops due to interactions of fat with oxygen content in ghee/package and accelerated by the presence of copper, iron and also by exposure to sunlight. The selection of right type of packaging material can play a vital role in delaying the onset of these defects in ghee. The packaging materials being used for ghee or have great potential are discussed here. Majority of dairies in public as well as private sector are using lacquered or even unlacquered tin cans of different sizes (250 g, to 15 kg.) for packaging of ghee. Some dairies sell loose ghee to local consumers through their sale depots or stores, where the possibilities of adulteration are fairly high. The advantages of using tin cans are manifold. They protect the product against tampering and being sturdy, can be transported to distant places without much damage and wastage during transport. The oxygen content in ghee can be reduced in case of tin cans by either hot filling or minimizing the headspace thereby preventing/delaying the oxidized flavour defect. It is very essential that tin cans be properly lacquered because rusted cans are liable to accelerate the lipid deterioration. Proper granulation in ghee is a highly desirable attribute from consumers' point of view, and ghee packaged in tin cans normally has better developed grains. The only drawback of tin cans is their high cost and involvement of foreign exchange. BIS specifications for different sizes of tin plate containers are available for packaging of ghee. Though glass bottles provide excellent protection, they do not react with the food material and can be used for high-speed operations; but are not in much use for packaging of ghee because of their fragility and high weight.

Semi-rigid plastic containers are replacing tin plate containers. These are mainly made from HDPE. The advantages of using these containers are that they provide a moderately long shelf life (not as long as tin cans), are lightweight, economical and transport-worthy. These are of several types viz., blow moulded HDPE, PET (polyethylene terephthalate) bottles, PVC (poly vinyl chloride) bottles, and recently introduced bag-in-box systems, lined cartons and tetrapacks. Blow moulded HDPE are, available in form of bottles (200, 400 g), jars (1 kg and 2 kg.), and jerry cans (2 kg, 5 kg, and 15 kg). PET bottles have excellent clarity are odour free and have gas barrier properties (Dordi, 1998). All these semi-rigid containers have good scope for packaging of ghee.

INNOVATIVE PACKAGING SOLUTIONS

A variety of packaging technologies are being developed to provide consumers with high quality, products that have a long shelf life. Technologies such as controlled-atmosphere packaging (CAP) or MAP, use of edible coating are the recent developments in the area of packaging. These developments have led to the concept of interactive packaging. It can be defined as packaging when it performs same role in the preservation of foods other than providing an inert barrier to outside influences.

FLEXIBLE AND RETORT POUCHES, PET BOTTLES, INNOVATIVE TUBS AND CUPS

In present circumstances the pouch packaging (retort or laminated flexible pouches), bottles (PET) and light weight metallic cannes have the strongest opportunities However, transparent attractive tubs and cups also expected to upward trend. Pouch demands are fueled by continued opportunities with faster gains in traditional dairy and cultured Dairy products. Bottle prospects will be aided by robust expansion for single-serving plastic bottles (PET) with milk and drinkable lassi and similar fermented health and functional drinks. The last segment benefitting from growing popularity being a portable and nutritious meal replacement. Tub and cup demand will be driven by favorable expansion in cultured dairy applications, largely resulting from healthy per capita consumption growth for lassi, butter milk and other probiotic fermented health drinks into single-serving cups. Slower expansion for cartons and boxes, and bags and wrap will result from the presence of mature applications as well as inroads by PET bottles and pouches. Flexible pouch may be made from laminates or multilayer films of different composition. The pouch may be in the form of pillow pouch or as stand-up pouches. Limited quantities of ghee are today packed in flexible pouches of less than 1 kg. The most attractive feature of packaging ghee in flexible pouches is that they are most economical than any other packaging system. The selection of a laminate or a multilayer film is governed primarily by the compatibility of the contact layer, heat sealability and heat-seals strength and shelf life required. While deciding a flexible film/pouch for ghee, the other properties that need to be considered are water vapour barrier and oxygen and light transmission rates which should be lowest. The aroma and grease barrier properties are also important considerations for flexible material for packaging ghee. The indigenously available flexible materials which have very low values for the above mentioned properties are HDPE, PP, Al foil, Nylon 6, PVC, Saran, Polyester and numerous laminates of flexible films (Dordi, 1998, Goyal and Rajorhia, 1991). Sachets made from a laminate of PVdC/Al foil/PP are suitable for long term storage of anhydrous milk fat or ghee (Dhar, 2002).

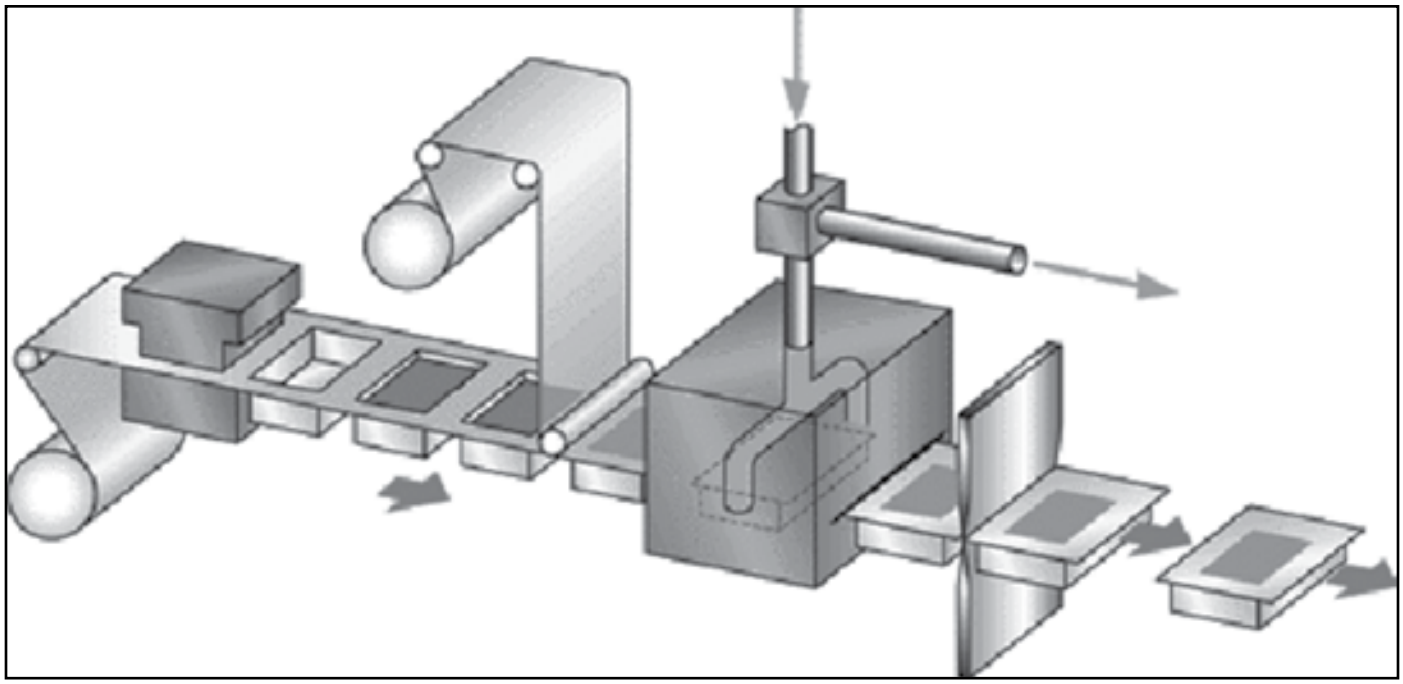
UHT PROCESSING AND ASEPTIC PACKAGING

The shelf life of tradional dairy and food beverage can be extended to six or more months without refrigeration in UHT-processed coupled with aseptic packaging. UHT processing uses very high temperatures to destroy all viable microorganisms. Aseptic processing includes environmental modifications that prevent the growth of surviving, dormant, nonpathogenic microorganisms under normal, unopened, non-refrigerated storage and distribution. Environmental modifications include packaging the commercially sterile dairy food in a hermetically (gas-tight) sealed container to prevent all recontamination. This also adds to the value and marketing channel of these products. This system is one of the promising systems for transportation and storage for rural population of India. Only limitation of this packaging system is cost.

MODIFIED ATMOSPHERE PACKAGING (MAP) FOR TRADITIONAL DAIRY PRODUCTS

Young et al., 1988; Tanweer Alam and Goyal 2008 reviewed and reported that MAP may be defined as the enclosure of food products in gas barrier materials, in which gaseous environment has seen changed. MAP is an enclosure of food products in high barrier materials, in which gaseous environment has been modified as a result of dynamic interaction between atmosphere and food products (Brody 1989, Tanweer Alam and Goyal 2007). MAP slows respiration rate, reduces microbial growth, and retards enzymatic spoilage with the final effect of enhancing the shelf life of the dairy product (Floros et al. 1997, Rosenthal et al. 1991, Tanweer Alam and Goyal 2007 a). The two major spoilage agents, namely aerobic bacteria and oxidative reactions, require oxygen. Therefore, its unavailability will inhibit spoilage and thus maximize quality and/or storage life (Tanweer Alam and Goyal 2011). Some deterioration however, will occur due to anaerobic/microaerophillic organisms and non-oxidative reactions. This is usually minimized by chilled storage. Danedar khoa, the main ingredient of khoa based sweets, is highly perishable. Its shelf life could be extended up to 60 days at 11 0C by packaging under nitrogen / vacuum in a flexible pouch of poster paper/ aluminium foil / LDPE (Sharma et al., 2001).

The MAP technique involves removing air from the pack and replacing it with a mixture of gases, the pressure of gas inside the package usually reaching about 1 atmosphere, i.e. equal to external pressure. This is usually achieved by one of following



types of packaging equipments:

- Horizontal Form-fill-seal (HFFS)
- Vertical Form-fill-seal VFFS machines
- Thermoform-fill-seal (TFFS)
- Vacuum machine with gas injection

ACTIVE AND INTELLIGENT PACKAGING

Developments in active packaging have led to advances in many areas, including delayed oxidation and controlled respiration rate, microbial growth, and moisture migration. Other active packaging technologies include carbon dioxide absorbers/emitters, odour a absorbers, ethylene removers and aroma emitters. While purge and moisture control and oxygen removal have been prominent in active packaging, purge control is the most successful commercially. An example is the drip-absorbing pad used in the poultry industry. In addition, active packaging technology can manipulate permeability, which is the selective permeation of package materials to various gases. Through coating, microperforation, lamination, coextrusion, or polymer blending, permeability can be manipulated o modify the atmospheric concentration of gaseous compounds inside a package, relative to the oxidation or respiration kinetics of foods. Certain nanocomposite materials can also serve as active packaging by actively preventing oxygen, carbon dioxide, and moisture from reaching food. Intelligent or smart packaging is designed to monitor and communicate information about food quality (Brody et al., 2001). Examples include time-temperature indicators (TTIs), ripeness indicators, biosensors, and radio frequency identification. These smart devices may be incorporated in package materials or attached to the inside or outside of a package. As of summer 2008, the commercial application of these technologies to food packaging has been small. However, the U.S. Food and Drug Administration (FDA) recognize TTIs has recognized their importance which may increase in the dairy food industry. Moreover, Wal-Mart, Home Depot and other retail outlets use radio frequency identification, so it is likely to become very suitable for prominent as a mechanism for tracking and tracing and checking adulteration and proliferation of traditional Dairy products. It will be boon for checking malpractices in traditional dairy food.

EPILOGUE

The traditionally, dairy productshave been packed in leaves, paper cartons or paper-board boxes. These materials do not provide sufficient protection to the product from atmospheric contamination and manual handling. The technological progress and revolutionary improvements in the efficiency and economy of distribution of milk and milk products have led to innovations in packaging line. New systems, materials, machinery, designs (taking into consideration the environmental concern) are some of the innovations in the dairy packaging sector. These innovations have provided greater convenience to consumers, extended the shelf-life of products, lowered the costs and also led to improvements in sales, better hygienic conditions and introduction of new products and easier handling. Innovative packagings have played a major role in introducing improvements in the packaging systems and therefore marketing of milk and milk products. Not only have they contributed in providing longer shelf-life and convenience but due to their hygienic nature, also helped to deliver the various products in a wholesome and safe manner to the ultimate user. However, to meet the global demands, the Indian dairy industry has to strive and match the product and packaging standards, for which continuous efforts and research is required.

MECHANIZED MANUFACTURING OF TRADITIONAL MILK PRODUCTS

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ABSTRACT:
The Indian value addition industry, especially the food and dairy sector, cannot escape from this vital fact – "Globalization has created a lot of opportunities but with stiffer competition." The value addition is the most important aspect through which India can visualize a great boom in its dairy and food sector exports.
The Indian food industry has witnessed substantial growth and is valued over Rs 70,000 crore and is expected to reach Rs. 95,382 crore by 2012. The country is also the top milk producing country in the world. The Indian dairy industry has registered phenomenal growth from an annual output of about 40 million tonnes of milk in the mid 1980s to about 128 million tonnes in 2012.
Traditional Indian Dairy Products (TIDP) are integral part of Indian heritage and have great social, religious, cultural, medicinal and economic importance and have been developed over a long period with the culinary skills of homemakers and halwais. In addition to preservation of milk solids for longer time at room temperature, manufacture of traditional dairy products add value to milk and also provide considerable employment opportunity. The important Indian traditional dairy products that have commercial significance are ghee, khoa, paneer, chhana, dahi, kulfi, shrikhand and several milk confections prepared from khoa and chhana such as burfi, peda, gulabjamun, milk cake, kalakand, rasogolla, sandesh, etc. In addition, there are many region-specific traditional products like rabri, basundi, kunda, kheer, payasam, etc. Each of these products has its unique flavour, texture and appearance. The age-old small-scale techniques for TIDP products cannot be adopted for industrial large-scale production. The rising demand and health awareness needs mechanization for economic and hygienic production of these products at commercial scale. Consequently, inefficient use of energy, intensive labour, poor hygiene, sanitation and non-uniform product quality associated with conventional method crept into mechanization for large-scale manufacture.
With rapid growth in these sectors, the technology and design of process equipment is also undergoing changes. The small-scale technology for the preparation of indigenous products cannot be exploited for large-scale industrial production. One of the strategies to enhance our presence in world dairy market is to promote R&D of value added quality products besides improving the traditional dairy products by innovative techniques, designing of equipment and mechanization for the manufacture of value added dairy products.
The SMC College of Dairy Science has designed and developed several state-of-the-art equipment like (i) Continuos Basundi making Machine, (ii) Batch type of Halwasan making Machine and (iii) Integrated plant for Traditional Indian Dairy Products for mechanized production of value added Traditional Indian Dairy Products (TIDP) like Basundi, Kulfi mix, Kheer,Khoa, Peda, Thabdi, Burfi, Gajar halwa, Dudhi halwa, and Halwasan with better hygienic, rheological qualities and improved shelf-life at lower cost of processing. These innovations in designing of equipment for the manufacture of value added TIDP would help in commercialization and promote small entrepreneurship through Public Private Partnership (PPP).

INTRODUCTION:
India is number one producer of milk in the world, with an average production of 128 Million Tones per annum in 2012; out of this about 50-55 of the total milk production is converted into traditional milk products, which is mainly confined to the cottage scale in the non-organized sector. With the rapid growth of dairy industry in our country, the technology and design of process equipment has also undergone needed changes and equipment for making indigenous products are no exception. The small-scale technology for the preparation of indigenous products cannot be exploited for industrial production.
India has made substantial growth of urban and semi-urban areas. As a result, increasing number of persons in the cities is desirous of purchasing quality milk products and milk-based sweets. The current methods for the manufacture of indigenous dairy products are based on the techniques that remained unchanged over ages. Regardless of the volume of the production, they are manufactured primarily in jacketed kettles, which inherently suffer from several disadvantages, where possibilities to control and optimize heat treatment processes are very limited. The equipment employed at the cottage level is enlarged for the industrial level of operation. Consequently inefficient use of energy, poor hygiene, sanitation and non-

uniform product quality associated with rural scale operation crept into large-scale manufacture due to the non-existence of processing equipment based on advanced techniques of production and sound engineering principles. It is high time that concerned efforts are made by the experts and scientists to formulate value added dairy products with engineering interventions of innovative design of equipment to produce hygienic products with economy of processing. The commercial large scale production of Value added dairy products with very good hygienic and sensory properties has necessitated sincere efforts for innovations in the designing of equipment for the manufacture of Value Added Dairy Products.

With the rapid growth of dairy industry in our country, the technology and design of process equipment is also undergoing changes. The small-scale technology for the preparation of indigenous products cannot be exploited for industrial production, therefore innovations in the designing of equipment for the manufacture of value added dairy products is the need to have premium prices for the locally produced high quality value added dairy products. One of the strategies to enhance our presence in world dairy market is to promote R & D of value added quality dairy products besides improving the traditional dairy products by innovative techniques, designing of equipment and mechanization for the manufacture of value added dairy products. India also needs to develop innovative dairy products and modernize manufacturing of traditional dairy products. The value addition of milk is an important aspect to be looked into by the dairy engineers, scientists and technologists. India can be a lead player to command the value added dairy products in the global market by introducing innovations in the designing of equipment for manufacture of value added dairy products. It also helps in opening new frontiers for indigenous dairy products through mechanization and innovations in designing of equipment to have exciting opportunities for development of the rural economy of India.

TRADITIONAL INDIAN DAIRY PRODUCTS:

A variety of traditional milk products are manufactured in India with most of them are region specific. The making of traditional milk products has essentially been a cottage scale enterprise within the basic process of their production, variations exist from one unit to another that give products their distinctive touch, taste and flavour. Now, technologies for mechanized production of these products on industrial scale are being standardized. The classification of traditional dairy products based on the principle of manufacture is given below:

S. No.	Principle of Manufacture	Products	Uses
1.	Heat Desiccation	Khoa	Khoa based sweets (Burfi, Peda, Gilabjamun, Kalakand, Milk Cake, Kunda etc)
		Rabri	Direct consumption
		Basundi	Direct Consumption
		Thabdi	Direct Consumption
		Halwas	Gajar Halwas, Dudhi Halwas, Chiku Halwas etc. for Direct Consumption
		Halwasan	Direct Consumption
2.	Heat & acid coagulation	Chhana	Channa based sweets (Rasogolla, Sandesh, Rasmalai, Chhana Murki, Chum-chum etc.)
		Paneer	Culinary dishes, Direct consumption
3.	Fermentation	Dahi	Culinary dishes, Direct consumption
		Chakka	Shrikhand, Shrikhand vadi
		Misti Dahi	Direct consumption
4.	Fat concentration	Makhhan	Direct consumption, Ghee making
		Ghee	Culinary dishes, Direct consumption
5.	Frozen	Indian Kulfi	Direct consumption
6.	Addition of cereals and desiccation	*Kheer, Payasam, Dhudh pak*	Direct consumption

MECHANIZED MANUFACTURE OF TRADITIONAL MILK PRODUCTS

Conventional methods of manufacture of Traditional Indian Dairy Products has inherent disadvantages such as inefficient use of energy, poor hygiene, fatigue on the operator, non-uniform product quality etc. In order to overcome these inherent disadvantages, attempt have been made for mechanization of the process to develop batch, semi-continuous, and continuous equipments for manufacture of these products on large and commercial scale.

MECHANIZED PRODUCTION OF KHOA:

Khoa is an indigenous milk product prepared by concentration of milk and is widely used in India and in neighboring countries as a base material for preparation of numerous sweets like penda, burfi, gulabjamun, kalakand, etc. Generally three main types of khoa namely pindi, dhap and danedar are recognized which differ mainly in body and texture characteristics and are required for specific types of sweets.

Processing of khoa mainly takes place in pans/kettles, where

the possibilities of controlling operating variables and optimizing heat treatment are generally very much limited. Increased demand for efficient and labour saving processes in dairy industry favours the use of mechanized system. The heat sensitivity of khoa adds to severe fouling on heating surfaces. At higher consistencies the wettability of heating surfaces further reduces and causes a reduction in thermal efficiencies for khoa processing. Under such conditions conventional heat exchangers do not provide satisfactory solution and therefore, the efforts are being made towards mechanizing the process of khoa making.

BATCH TYPE KHOA MAKING MACHINE

Rajorhia (1971) attempted a semi-commercial process of khoa making using jacketed steam heated stainless steel kettle with built-in-stirrer.

Khoa making unit suitable for village level operation has been developed by Sawhney et al.(1980) to overcome some of the problems faced in traditional method of khoa making. The unit consists of a hemi-spherical pan joined to a cylindrical water jacket with dead weight safety valve to control steam-water pressure. The pan has an easy operating rotary scraping mechanism. It can convert five litres of milk into khoa within 10 to 12 minutes when operated at 30 psig (206.85 Kpa) water-steam pressure. The milk in the pan is heated through water in the jacket by placing the equipment over a specially designed furnace. Anap and Kumar (1980) developed a rice husk or mixture of rice husk and dungcake heated, village level milk processing unit which can be modified for khoa making.

More (1983) developed a prototype khoa making machine working on the principle of SSHE and it has been claimed to perform satisfactorily on small and medium scale production. Agrawala et al. (1987) developed a conical process vat which consists of a steam jacketed S.S. conical vat with a cone angle of 60 degree. The steam jacket is partitioned into four segments to provide variable heating area for efficient use of thermal energy. The rotary scrapers have been designed to offer a uniform centrifugal force of scraping at all points on heat transfer surfaces. The scraping assembly is coupled to a variable speed drive unit for control of speed at different stages of khoa preparation, desired to obtain a better texture of the product.

More (1987) developed an equipment which consists of a stationary jacketed drum having steam inlet, condensate outlet through steam trap and pressure gauge. The jacketed drum is also provided with an opening at the top for entry of milk, exhaust of vapour and for observation of on going process. The unit is also provided with a water inlet with control valve for cooling the product at the end of the process and power operated spring loaded scraper assembly. Optimum operating conditions were reported to be a temperature of 121□C and scraper speed of about 28 r.p.m. The equipment was used to treat four kg of milk per batch.

A prototype khoa making machine of mild steel working on the principle of SSHE has been successfully developed by Christie and Shah (1988). Subsequently in their follow-up study an improved version of S.S. machine having capacity to convert 50 kg of milk into khoa per hour per batch was developed by Christie and Shah (1990). Sunil Patel (1990) has studied heat transfer performance of scraped surface heat exchanger during khoa making. The unit consists of steam jacket divided into three compartments for better control of heating process as the content reduces during later part of khoa making. The scraper blades are spring loaded on the assembly which is arranged in such a way that the whole surface is efficiently scraped. This khoa making machine was successfully used by Upadhyay et el(1993) for preparation of khoa based sweets like penda, halwa and other concentrated food products by altering the operating variables of the machine.

CONTINUOUS KHOA MAKING PROCESS

In order to overcome drawbacks of traditional method of khoa making, such as limited capacity, lot of time and labour requirement and necessity to clean pan between batches, Banerjee et al. (1968) designed and developed an equipment for continuous khoa making. It consists of a steam jacketed drum heater, open steam jacketed pans and power driven scrapers. In this equipment, milk at the rate of 50 litre per hour is gradually concentrated by heating it in a steam jacketed drum heater operated at 3 kg/cm2 (294.3 Kpa) steam pressure followed by further heating and concentrating it in open steam jacketed pans. Since the unit was made of mild steel, the product was prone to oxidation and discoloration (Rizvi et al., 1987) and the plant did not work effectively owing to the lack of controls for regulated supply of milk (Boghra,1979). The method for production of khoa with this machine was standardized by De and Singh (1970). Rajorhia and Srinivasan (1975) made improvements in the design of this plant by replacing mild steel with stainless steel.

Punjrath et al. (1990) have developed an inclined scraped surface heat exchanger for continuous khoa making. The unit comprises a feed balance tank, positive displacement pump and S.S. inclined scraped surface heat exchanger (ISSHE). The inner cylinder of ISSHE is surrounded by a three - compartment insulated steam jacket and equipped with a rotor that acts as both a scraper and a conveyor.

Dodeja et al. (1990) have described a continuous khoa making equipment operating on the principle of thin film scraped surface heat exchanger. The product quality was acceptable when the equipment was operated under standardized conditions (144 to 158□C temperature and 100 to 150 r.p.m of rotor). Higher rotor speed had adverse effect on flavour and texture of khoa.

Christie and Shah (1992) studied the feasibility of manufacturing khoa using scraped surface heat exchanger.

Dodeja et al. (1992) developed a continuous khoa making system which consists of two SSHE equipped with scraper assembly.

Bhadania (1998) has developed three stage continuous khoa making machine based on principle of scraped surface heat exchanger and has studied heat transfer performance of the machine.

USE OF ROLLER DRYER FOR MANUFACTURE OF KHOA

In order to find an alternative method of khoa making for mass production, Bhadania et al. (1986) studied the feasibility of using roller dryer for the manufacture of khoa. The concentrated milk of 50-55% TS prepared in a jacketed steam pan was used in the laboratory scale roller dryer. The unit was operated at 3 r.p.m. and between 1.5 and 1.8 kg/cm2 (147.15 and 176.58 Kpa) steam pressure. Organoleptic evaluation of the product showed that colour, body and texture were comparable to khoa made by the conventional method. The flavour and appearance score of the khoa were less than the control product. It has been reported that proper working of scraped material from the roller was an essential factor to get uniform body and texture of the product.

Singh and Rajorhia (1989) developed a method for production of khoa using standardized milk on roller dryer. The milk was vacuum concentrated to 50% TS, preheated to 74^{O}C for 10 minute and the operating variables like the milk feed rate, speed of roller, steam pressure and distance between knives and roller drums were adjusted. Khoa prepared by roller drying compared well in flavour, texture and chemical composition with that of traditional khoa. The product had a shelf life of <5 days at 30^{O} C and 15 days at refrigeration temperature. It was concluded that roller dryers can successfully be employed for large scale production of khoa in combination with a suitable kneading device.

Sharma et al.(1990) studied the effect of processing parameters (fat-SNF ratio, homogenization pressure, holding time of concentrate, addition of citric acid) on colour and acceptability of khoa prepared on drum dryers. It was concluded that khoa of satisfactory quality can be manufactured from milk with fat-SNF ratio of 0.549-0.659, concentrate holding time of 10-20 minute at 101-103^{O} C without homogenization or addition of citric acid (< 0.05 %).

MECHANIZED PRODUCTION OF HEAT DESICCATED MILK PRODUCTS:

Since long, various efforts have been made in mechanization of heat desiccated milk products like, Halwas, Burfi, Gulabjamun, Rabri, Kheer, Peda, Basundi, Halwasan etc.

HALWAS

Mechanization of manufacture of khoa based sweets like penda, halwa(Gajar Halwa, Dudhi Halwa) is tried using Batch type Stainless Steel Version of SSHE developed at SMC College of Dairy Science, Anand Agricultural University, Anand. The process parameters are optimized for and the product was compared favourably with products made by conventional method in the sensory and rheological profile, with better score and colour (Upadhyay et. Al, 1993). Jain (2010) manufactured 'Lauki Halwa' & 'Carrot Halwa' using batch type multi purpose SSHE developed at SMC College of Dairy Science, AAU, Anand, and studied its heat transfer performance.

BURFI

With a view to overcome the limitations of small scale batch method of Burfi making, a mechanized method of manufacture of burfi was developed by Palit and Pal (2005) adopting existing units such as scraped surface heat exchanger (SSHE) and Stephen processing kettle. It improved continuous manufacture of khoa using two stages thin film SSHE developed by Dodeja et al (1992), addition of sugar @ 30% is recommended by Reddy (1985); proper blending and kneading of khoa with sugar in Stephen processing kettle. Directly from Stephen processing kettle, Burfi was hot filled (at about 60 ºC) into previously cleaned and sterilized polystyrene containers of 250 g capacity and covered with plastic lids. Khojare and Kumar (2003) standardized the parameters for Burfi making in CPV from Khoa. Pre-weight khoa obtained from Thin Film SSHE was loaded in the CPV.

GULABJAMUN

A mechanized semi-continuos system is adopted for the manufacture of gulabjamun from khoa at Sugam Dairy, Baroda (Banerjee, 1997). The process involves mixing of khoa (60-70%TS) with 19-20% refined wheat flour and leavening agent (baking powder) in a planetary mixer. The dough is divided into 8 g portions and transported to the ball forming machine. Then the balls are shaped like a cylinder and are carried to afrying system containing oil at a temperature of 140 ºC. After frying, the balls are soaked in 62.5 % sugar syrup solution. The gulabjamuns swell and weight about 16 g each. The gulabjamuns are packed in plastic containers and an appropriate amount of hot syrup is added. Lids are applied on the cups and subsequently sealed. Packaged gulabjamuns are stored under refrigerated conditions. Canned gulabjamuns are stored at room temperature (Aneja, et. al, 2002).

RABRI

Efforts have been made to develop a commercial method for manufacture of Rabri employing SSHE for concentration of buffalo milk, and addition of shredded chhana/paneer in place of clotted cream to provide the desirable texture to the final product (Gayen and Pal, 1991 b). Pal, et. Al (2005) successfully developed a technology for the large scale production of Rabri using thin film scraped surface heat exchanger (TSSHE). It involved standardization of buffalo milk to 6% fat, addition of sugar @ 6% to preheated (85-90 ºC) milk and concentrating in TSSHE upto 50% solids, addition of shredded paneer and packaging in hot condition (80 ºC) and immediately cooling.

KHEER

Jain (2010) manufactured 'Kheer' using batch type multi purpose SSHE, and studied its heat transfer performance.

PEDA

The Industrial mechanized method of converting khoa into Kesar Peda had been developed at National Dairy Development Board (NDDB), Anand. It has been subsequently adopted later

by Sugam Dairy, Baroda. It involves heating of khoa at 60 ºC and adding sugar, flavour and other ingredients in planetary mixer. The peda mass thus obtained was cooled to 5 ºC by transferring into a cold room and fed to peda shaping machine followed by packing and storing under refrigerated conditions (Banerjee, 1997).

BASUNDI

Bandyopadhyay and Mathur (1987) reported use of a steam jacketed kettle for desiccating milk in the preparation of concentrated milk products. Patel et al. (2005) made Basundi by open pan concentration using steam jacketed kettle and products were evaluated for their proximate composition, physico-chemical properties and sensory attributes. Three pilot models viz. cylindrical type, conical type, and Karahi type were developed for Basundi making on the principle of scraped surface heat exchanger (SSHE). All the models were tested for Basundi making and their heat transfer behaviour at different operating conditions. Heat transfer and energy consumption were estimated for design optimization and to generate information for optimum operating conditions of the machine (Rajasekhar, 2001). Heat utilization in Basundi making was evaluated using cylindrical type, conical type and karahi type scraped surface heat exchangers (SSHEs). The heat utilization in these heat exchangers was evaluated with and without induced draught on milk surface (Shah, et al.; 2002). Mechanization of manufacture of Basundi is tried using Batch type Stainless Steel Version of SSHE developed at SMC College of Dairy Science, Anand Agricultural University, Anand. The process parameters are optimized for and the product was compared favourably with products made by conventional method in the sensory and rheological profile, with better score and colour (Patel, 2006). Manufacture of 'Basundi' was tried at NDRI, Karnal, using conical process vat and two-stage thin film SSHE with standardized buffalo milk. 'Basundi' prepared in conical process vat, was good in body, texture, appearance and overall acceptability for processing time between 80 to 100 min. (Agrawala et al., 1987a, More, 1987, Ranjeet, 2003, Dodeja et al., 2004). Patel et al, (2007) developed a mechanized system for Continuous Basundi Machine (CBM) based on the principle of thin film SSHE. It consists of concentration unit of three SSHEs with specially designed scrapers, variable frequency drive (VFD) to facilitate variation of speed of scrapers, resistance temperature detector (RTD) sensors and other controls to optimize processing parameters. The design of CBM machine, based on the principle of TFSSHE, is claimed to be energy efficient and produces better quality product as compared to traditional product. It consists of concentration unit of three SSHEs and chilling units of two SSHEs, with specially designed scrapers, variable frequency drive (VFD) to facilitate variation of speed of scrapers, resistance temperature detector (RTD) sensors and other controls to optimize processing parameters which resulted in better quality product in terms of sensory and rheological attributes is done for attaining a product of uniform standard and assured quality.

MECHANIZED PRODUCTION OF HEAT AND ACID COAGULATED PRODUCTS:

Panner and Chhana are two prominent traditional heat and acid coagulated milk products of India. Mechanized processes for industrial production of these products has been developed. Significant R&D at National Dairy Development Board (NDDB), National Dairy Research Institute (NDRI) and several agricultural universities has resulted in to optimization of processing variable for mechanized production.

PANEER

Batch production of paneer at a small scale employing the traditional process often results in an inconsistent product. A continuous paneer-making system was developed at NDRI, Karnal by Agrawala et al. (2001). In this system, the unit operations involved in paneer making have been mechanized. The continuous paneer making machine is designed to manufacture 80 kg paneer per hour by employing twin-flanged apron conveyor cum filtering system for obtaining the desired moisture content and texture attributes.

CHHANA

Attempts were made by different workers to mechanize the chhana-making process. Aneja (1998) reported a prototype for continuous chhana-making, capable of producing 40 kg/hr of chhana. Recently, workers at Indian Institute of Technology, Kharagpur developed a continuous chhana-making unit of 60 L/h of milk capacity (Sahu and Das, 2007). The unit has a duplex plunger pump and a helical coil heat exchanger for dosing of milk and acid and heating the milk prior to acid coagulation respectively. It also consists of a vertical column that gives residence time for the separation of milk solids to chhana. In this unit, the chhana-whey mixture, after being discharged from the top of the column, is moved over an inclined strainer through which the whey is removed.

CHHANA BASED CONFECTIONS

Bengali sweets are chhana based, like, Rasogolla, Rasomalai, Rajabhog, Khirmohan, Sandesh etc. They are popular world over for their delicacy.

RASOGOLLA

Different workers made successful attempts to mechanize the production process of rasogolla. Choudhury et al. (2002) developed a prototype mechanized unit for kneading of chhana and chhana ball-forming in a continuous manner. It was reported that such unit can handle 15–20 kg of chhana per hour and convert it continuously into chhana balls (approximately 6 g) as the final product. Recently, Karunanithy et al. (2007a,b & c) also tried to mechanize these unit operations in rasogolla making for its continuous production. The authors claimed that the resulting product from the developed continuous rasogolla making machine was comparable in quality with the control and market products.

SANDESH

Kumar and Das (2003) optimized the processing parameters viz. mixing, kneading and cooking of chhana and sugar mixture for the mechanized production of sandesh from cow milk. But, it was observed that the desired homogeneity after the initial mixing was lacking in the product. With a view to overcome this, Kumar and Das (2007) subsequently developed a single-screw vented extruder for cooking of chhana and sugar mixture that can be integrated with the mechanized method for the continuous production of sandesh from cow milk. With necessary modifications, this technology may also be adapted to continuous production of sandesh from buffalo milk.

MECHANIZED PRODUCTION OF FERMENTED MILK PRODUCTS

Fermented milk constitutes a vital component of human diet in many regions of the world. In the Indian sub-continent also, fermented milk products such as dahi (curd), lassi and butter milk figure prominently in people's diet.

DAHI

Many organized dairies are now preparing dahi adopting mechanized and standardized method (Singh, 2005). In this method, fresh, good quality milk is pre-heated and subjected to filtration and clarification. The milk is standardized to 4 to 5% fat and 10 to 12% SNF, homogenized and heat treated followed by cooling to incubation temperature and inoculated with specific dahi starter culture. It is then filled in suitable containers (plastic cups) of the appropriate size and incubated at 40–42°C for 3–4 hours. When a firm curd is formed and the acidity reaches to about 0.7%, dahi cups are transferred to cold room maintained at about 4–5°C and stored at that temperature till consumption. Kumar and Pal (1994b) studied the suitability of reverse osmosis (RO) concentrates for the manufacture of dahi and reported that the quality of dahi made from 1.5-fold RO concentrates was highly satisfactory.

MISTI DAHI

The technology for the manufacture of misti dahi in an organized manner was developed by Ghosh and Rajorhia (1990). The process involves standardization of buffalo milk (5% fat and 13% SNF) followed by homogenization at 5.49 MPa pressure at 65°C, sweetening with cane sugar (14%) and heating mix to 85°C for 10 min. Then cooling the mix to incubation temperature and inoculating with suitable starter culture and incubating the mix to obtain a firm curd. The firm curd is transferred to cold storage (4°C) and served chilled. Now, the organized
dairies for example, Mother Dairy, Delhi; Mother Dairy Gandhinagar is manufacturing and marketing misti dahi at large scale.

LASSI

Industrial process with mechanization is developed for manufacture of Lassi. Extension of shelf life of lassi is achieved by ultra high temperature (UHT) processing of product after fermentation and packaging it aseptically. Aneja et al. (1989) developed a method for manufacture of long-life lassi that does not settle down over extended storage in aseptic packs. Now, UHT-processed lassi and spiced buttermilk are commercially manufactured and marketed by different dairies in India. Kumar (2000) developed lassi for calorie-conscious and diabetic people using an artificial sweetener and reported that aspartame at a rate of 0.08% on curd basis was the most acceptable level to prepare low calorie lassi. Recently, Khurana (2006) developed suitable technologies for the manufacture of mango, banana and pineapple lassi along with their low-calorie counterparts using artificial sweeteners.

SHRIKHAND

A fully mechanized/continuous process has also been developed for industrial production of Shrikhand (Aneja and Vyas, 1983). In this process, Chakka is prepared by separating the whey from skim milk dahi employing 28" dia. Basket centrifuge at 1100 rpm. The resultant Chakka, sugar and plastic cream are then mixed in a planetary mixer. Dhotre (2006) developed and studied the performance of SSHE for continuous thermization of Shrikhand. Shrikhand was thermized at different operating conditions like temperature, scraper speed, and TS level in Chakka.

MECHANIZED PRODUCTION OF FAT RICH DAIRY PRODUCTS

In the traditional Indian dietary regimen, milk fat in the form of malai (cream), Makkhan (fresh-churned butter) and ghee contributes significantly towards nourishment of the people of all age groups. Many scientists has made attempt to mechanize production of these products on industrial scale.

CREAM

The various types of cream separators are developed for mechanized separation of cream from milk and sour milk are, (i) Warm milk separator (ii) Cold milk separator(iii) Power driven separator (iv) Hand driven separator (v) Open bowl or gravity fed separator (vi) Semi enclosed separator (vii) Hermetically sealed separator/ air tight/ pressure fed/ foam less separator (viii) Sour milk separator

MAKKHAN

Makkan is freshly churned butter without salt. Mechanized methods of production of white butter of industrial scale are available in batch and continuous process.

GHEE

Punjrath (1974) developed a prototype continuous ghee making plant of 100 kg/h capacity on the principle of flash evaporation using butter as base material. In another process Abichandani et al., (1995) a thin film scraped surface heat exchanger (TFSSHE) attached with a butter melter for continuous manufacture of ghee. The organoleptic and chemical quality of ghee prepared by this continuous mechanized method did not differ from that prepared by batch process. Recently, Patel et al. (2006)

developed an industrial method of ghee making with an aim to reduce fat and SNF losses by inclusion of serum separator and a spiroheater. It was claimed by the authors that the new method offers more commercial benefits than the existing methods. NDRI has perfected continuous equipment for manufacture of 500 kg ghee per hour (Abhichandani, 1997). This equipment is integrated with an efficient butter melter developed at NDRI.

MECHANIZED PRODUCTION OF FROZEN MILK PRODUCTS

Indian Kulfi is a popular frozen dessert of Indian origin produced by freezing a mix obtained from concentration of milk and sugar (like Basundi)

INDIAN KULFI

Patel (2013) has developed batch type basundi kettle and integrated plant for Traditional Indian Dairy Products and has prepared basic Indian Kulfi mix using both and prepared Indian Kulfi with better Rheological and sensory quality.

DESIGN AND DEVELOPMENT OF EQUIPMENTS FOR VALUE ADDED TRADITIONAL INDIAN DAIRY PRODUCTS AT SMC COLLEGE OF DAIRY SCIENCE, AAU, ANAND:

SMC College of Dairy science, Anand Agricultural University, Anand has designed and developed several equipments for mechanized production of value added Traditional Indian Dairy Products (TIDP), like Basundi, Kulfi mix, Kheer, Khoa, Peda, Thabdi, Burfi, Gajar Halwa, Dudhi Halwa, Halwasan etc. with better hygienic, rheological qualities and improved shelf-life at lower cost of processing. The mechanized production of value added dairy products will give the following advantageslike (i) Economic production (ii) Uniform quality of the product (iii) Hygienic production and better keeping quality (iv) Scale-up production (v) Less laborious process (vi) Less energy consumption (vii) Better control over the process parameters to maintain rheological and sensory attribute (viii) Promotes export of traditional Indian products like Basundi, Kulfi mix, Kheer, Khoa, Peda, Thabdi, Burfi, Gajar Halwa, Dudhi Halwa, Halwasan etc. through small and medium entrepreneurs. These innovations in designing of equipment for the manufacture of value added TIDP will help in commercialization and to promote small entrepreneurship through Public Private Partnership (PPP), for the benefit of the society to get hygienic and best quality value added dairy products.

(I) CONTINUOS BASUNDI MAKING MACHINE

'Continuous Basundi Making Machine (CBM)' is designed at SMC College of Dairy Science, Anand Agricultural University, Anand, based on the principle of Scrap Surface Heat Exchanger (SSHE). It is consists of concentration unit of three SSHEs and chilling units of two SSHEs with specially designed scrapers, Variable Frequency Drive (VFD) to facilitate variation of speed of scrapers, Resistance Temperature Detector (RTD) sensors and other controls to optimize processing parameters, which results in to better quality product in terms of sensory and rheological attributes. Standardization of mechanized production of 'Basundi' in terms of manufacturing techniques, sensory profiles, and compositional and physico-chemical attributes is done for attaining a product of uniform standard and assured quality. The method of hi tech production of 'Basundi', using 'Standard Process' and 'Continuous Basundi Making Machine' offers several advantages over traditional method of Basundi making.

(II) BATCH TYPE HALWASAN MAKING MACHINE

'Batch type Halwasan makimg Machine (BHM)' is designed at SMC College of Dairy Science, Anand Agricultural University, Anand, with funding support of 'Business Planning and Development Unit-Anand Agricultural University. Standardization of mechanized production of 'Halwasan' in terms of manufacturing techniques, sensory profiles, and compositional and physico-chemical attributes is done for attaining a product of uniform standard and assured quality. Halwasan prepared by using Batch type of Halwasan making Machine (BHM), is very good in hygienic quality as well as rheological attributes, having average sensory score of 92/100 as compared to sensory score 88/100 of Halwasan made by traditional/conventional method. The cost of processing in BHM is almost half than conventional method. The keeping quality at room temperature of Halwasan made by using BHM is 20-22 days compared to keeping quality of 8-10 days of Halwasan made by conventional method. The profit margin is around 90-100%.

(III) INTEGRATED PLANT FOR TRADITIONAL INDIAN DAIRY PRODUCTS

Integrated Plant for 'Traditional Indian Dairy Products' is designed and developed at Dairy Engineering Department, SMC College of Dairy Science, AAU, Anand, under AAU-BPD Unit-ICAR-NAIP-I Project. The Plant is designed for mechanized production of TIDP, having capacity of handling 250 kg of milk per hour. The plant is consisting of three basic units (i) Plate Heat Exchanger (PHE), (ii) Twin Cylinder Thin Film Scraped Surface Heat Exchanger (Twin SSHE) and (iii) Batch type Steam Jacketed Kettle. Patent filing for the plant and standard process of mechanized production of Basundi, Halwasan, Kulfi mix and Sandesh using this integrated plant is in process.

This integrated plant is suitable for mechanized production of value added Traditional Indian Dairy Products like Kulfi mix, Basundi,Kheer, Khoa, Peda, Thabdi, Burfi, Gajar Halwa, Dudhi Halwa, Halwasan etc. The mechanized production of TIDP has better control over the processing parameters to have hygienic production with better rheological quality of processed product. It also helps to overcome the limitation of traditional method of manufacture like inefficient use of energy, poor hygienic conditions, non-uniform product quality, intensive labour, small scale production etc. The processing cost of mechanized production of TIDP using this plant is almost half than the cost of processing of conventional method of production.

The mechanized production of such TIDP, will help in

commercialization and to promote small entrepreneurship through Public Private Partnership (PPP) to improve the socio-economical status of milk producing farmers. The technology developed with mechanization would benefit both the milk producer and consumers and will promote entrepreneurial development by fetching the higher price of value added products.

CONTINUOUS BASUNDI MAKING MACHINE

BATCH TYPE HALWASN MAKING MACHINE

COMMERCIALIZATION OF MACHINES DEVELOPED

AAU BPD Unit is commercializing equipment developed to promote small entrepreneurship through Public Private Partnership (PPP). Continuous Basundi making Machine and Batch type of Halwasan making machine is kept in AAU BPD Unit basket for its commercialization. MoU is also signed with 'Panchamrut Dairy, Godhara, for mechanized production of khoa using the machines developed at Dairy Engineering Department, SMC College of Dairy Science, AAU, Anand, resembling taste of khoa made by traditional method in karahi. We have also received many inquiries from the entrepreneurs for mechanized production of Halwasan, Burfi, khoa & Kulfi mix.

INTEGRATED PLANT FOR MECHANIZED PRODUCTION OF TRADITIONAL INDIAN DAIRY PRODUCTS

(i.e. Kulfi mix, Basundi,Kheer, Khoa, Peda, Thabdi, Burfi, Gajar Halwa, Dudhi Halwa etc.)

DAIRY ENGINEERING DEPARTMENT, SMC COLLEGE OF DAIRY SCIENCE

ANAND AGRICULTURAL UNIVERSITY, ANAND (Gujarat) – 388 110

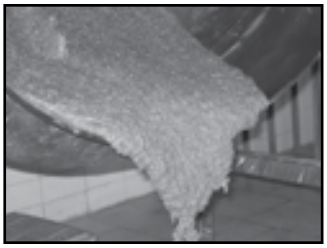
PHE

Twin SSHE

Integrated Plant for TIDP

Batch type Halwasan making Machine

Indian Kulfi



Halwasan

APPLICATION OF NEWER TECHNOLOGIES FOR INDUSTRIAL PRODUCTION OF INDIGENOUS MILK PTODUCTS

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Indian traditional milk products have played a significant role in the economic, social, religious and nutritional well being of our people since time immemorial. It is estimated that about 50 to 55 per cent of milk produced is converted by the traditional sector (halwais) into variety of Indian traditional milk products, using processes such as heat and acid coagulation, heat desiccation, and fermentation. Market size of Indian traditional milk products is estimated at more than Rs. 100,000 crores with an annual growth estimated at Rs. 5,000 crores. This fact underlines the significance of Indian milk sweets in the national economy. In view of the growing awareness towards the safety aspects of milk based sweets in India, the consumer shall prefer to buy these products from the organized sector. Despite the widespread popularity and acceptability of traditional milk products in the Indian market, the organized sector has so far not been able to tap into this market potential for many reasons such as lack of published literature on their technology, inadequacy of appropriate technologies for their commercial production, inadequacy of appropriate packaging materials and labeling to take care of new pattern in consumer demand, low keeping quality and a lack of quality assurance systems. Data from the national sample survey revealed the rising trend in the monthly per capita expenditure on milk and milk products. Interestingly, such expenditure in rural areas of the Northern India is usually higher (20-43%) than in urban areas. Recently a few organized dairy sectors have started the production of traditional milk products on a commercial scale but their impact has been limited. While many new innovations have been made recently to modernize this sector, it is necessary to look into short, medium and long term strategies to develop core technological strengths within our industry for envisioning a developed indigenous dairy products sector. A vision for this sector is only possible through identifying such core strengths and building on them.

2.0 OVERVIEW OF INNOVATIONS MADE SO FAR:

2.1 Mechanization of manufacture of traditional dairy products:

Deep rooted tradition offer a considerable scope for organizing and channeling the amount of milk going for conversion into Indian milk sweets. The major strength of the Indian milk sweets sector is the mass appeal enjoyed by such a wide variety of products. The market for these products far exceeds that for western dairy products. Their operating margins are also much higher, mainly due to lower raw material cost. It is estimated that the raw material costs of Shrikhand, Rasogolla, Gulabjamun, Khoa sweets (Peda, Burfi, Kalakand), Sandesh and Paneer is 29, 33, 34, 35, and 65 per cent of the sale price, respectively. For western dairy products, comparative costs are relatively much higher varying from 7 - 80%. (Chandan et al., 2002). Their production and marketing can bring about a remarkable value addition to the extent of 200 per cent, as compared to only 50 percent obtained by western dairy products. They can do wonders for organized dairy sector to better its prospects of financial stability and steady growth.

Increasing demand for these products presents a great opportunity for the organized dairies in the country to modernize and scale-up the production. The expanding business prospects provided by these products and their accompanying value-addition call for a thorough study of this sector. There is a need to look into various issues and accordingly re-evaluate and re-engineer ourselves to modernize traditional dairy products sector.

In order to overcome the inherent disadvantages associated with conventional methods of manufacture of traditional dairy products such as inefficient use of energy, poor hygiene and sanitation, non-uniform product quality, fatigue on the operator, etc; attempts have been made to develop batch, semi-continuous, and continuous equipment for the manufacture of these products. The first attempt to develop semi-continuous Khoa-making machine was made by Banerjee et al. (1968) which was followed by batch type semi-mechanized scraped surface heat exchanger developed by More (1989-90); batch type mechanical conical process vat developed by Agrawala (1987) and scraped surface continuous Khoa making machines developed by NDDB (Punjanath et al., 1990), Dodeja et al. (1992) and Christie and Shah (1992). Some of these machines are already in commercial use in some dairies. The contherm-convap scraped surface heat exchanger system developed by ALFA-Laval is also being commercially used for the manufacture of Khoa. Recently, NDRI has developed a three stage SSHE for manufacture of khoa, which produces khoa as good as the traditional process.

Successful attempts have also been made to mechanize the methods of manufacture of Khoa based sweets. Palit and Dharam Pal (1998-99) developed mechanized manufacture of Burfi involving Khoa-making by continuous machine followed by kneading and heating Khoa-sugar mixture in Stephen kettle. The Sagar Dairy, Baroda manufactures kesar Peda by adopting a large-scale mechanized process which involves manufacture of Khoa using continuous machine, heating Khoa -sugar mixture in planetary mixer, cooling, mechanical forming of Peda and packaging. Recently, Londhe (2006) standardized method of manufacture of brown (Mathura) peda for industrial application. Similarly, Gulabjamuns are being manufactured commercially using Khoa portioning and ball forming machines followed by deep fat frying and sugar syrup

soaking lines. (Banerjee, 1997). Pal et al. (2005) developed a method for large scale manufacture of rabri using thin film scraped surface heat excahanger.

Aneja et al. (1977) developed a prototype continuous Chhana making machine involving tubular heat exchanger, acid injection chamber, holding coil and strainer. A process has been developed on similar principle for the mechanized production of Chhana at IIT, Kharagpur, which involves indirect heating of milk in a tubular heat exchanger to 95ºC, cooling to 70 ºC, continuous coagulation with hot citric acid (70ºC) in a vertical tube, holding milk-acid mixture to permit complete coagulation, separation of whey in a continuous flow employing double wall basket centrifuge and chilling to 4º C by directly spraying chilled water on the layer of Chhana (Singh, 1994).

Considerable research has been carried out for optimization of the process for the manufacture of Paneer (Mathur et al., 1993). A prototype machine for continuous manufacture of Paneer has been developed recently at NDRI (Agrawala et al., 2001).

Developments have also been made in mechanization of Chhana-based sweets. Kumar et al. (1997) designed a screw conveyor for kneading of Chhana and a cutter provided at the exit split the Chhana into lumps of 10 g each. The lumps are made to fall on a spinning disc and stationary disc above, which converts lumps of Chhana into round balls. Another machine has recently been developed at NDRI, Karnal, which involves kneading of Chhana using screw conveyor, portioning Chhana into lump of 10 g each with a cutting device, and ball formation in a revolving cylinder (Chaudhary et al., 2001). Kumar (1998) developed a single screw vented extruder for continuous production of Sandesh.

A fully mechanized/continuous process has also been developed for industrial production of Shrikhand (Aneja and Vyas, 1983). In this process, Chakka is prepared by separating the whey from skim milk dahi employing 28" dia. basket centrifuge at 1100 rpm. The resultant Chakka, sugar and plastic cream are then mixed in a planetary mixer.

NDRI has perfected continuous equipment for manufacture of 500 kg ghee per hour (Abhichandani, 1997). This equipment is integrated with an efficient butter melter developed at NDRI.

2.2 Application of membrane technology in manufacture of traditional dairy products.

A process has been developed for the manufacture of Khoa using reverse osmosis (RO) (Dharam Pal and Cheryan, 1987). Khoa manufactured from RO concentrated whole milk (31% TS) was comparable in flavor and texture to conventional product, with net energy saving of 335 to 430 kcal/kg of milk.

Preparation of good quality Chhana using skim milk ultrafiltered/ diafiltered retentate and plastic cream has been reported (Sharma and Reuter, 1991). Heat treated (92ºC for 5 min) skim milk is subjected to ultrafiltration followed by diafiltration (23 % TS) and the resultant retentate is mixed with plastic cream and mixture heated to 90ºC for 5 min and coagulated with lactic acid to develop soft coagulum. The granular mass is pressed to remove free moisture, yielding Chhana. The yield of the product is 18-19 % extra due to recovery of whey proteins.

Production of good quality Paneer using ultrafiltration has been reported by Sachdeva et al. (1993). The process offers advantages like access to mechanization, uniform quality, improved shelf life, increased yield, and nutritionally better product. The process consists of ultrafiltration of heat-treated milk, cold acidification of retentate (40%TS), packaging in containers, and texturization by microwave heating. An innovative approach employing in-package sterilization of acidified UF retentate resulting in in-package coagulation and texturization was developed by Rao, (1991). The process yields long-life Paneer-type product with three-month shelf life at room temperature.

Adoption of membrane filtration process for manufacture of Chakka and Shrikhand results in high product yield. Sharma and Reuter (1992) developed a process for production of Chakka and Shrikhand using ultra filtration technique. The process consisted of agitation of Dahi at slow speed, heating to 60-62ºC for 5 min., ultrafiltration at 50ºC, pressing of retentate to get Chakka and then mixing with sugar in planetary mixer. Sachdeva et al. (1994) attempted the manufacture of Chakka by reverse osmosis which involved heat treatment (90ºC for 5 min.) to RO concentrate, cooling to 22ºC, inoculation with 20% mixed lactic culture, incubation for 18 hrs and then removal of whey by filtration to get Chakka. Increased yield, higher solid recovery, reduced processing time, access to mechanization and alleviation of whey disposal problem were claimed as major advantages of the process. Kumar et al. (2005) reported manufacture of improved quality of chhana from diafiltered UF cow milk. An innovative new approach of adding coagulant to the retentate followed by heating to 60ºC produced soft chhana suitable for manufacture of chhana based sweets.

2.3 Developments in preservation of traditional dairy products.

The short shelf life of the traditional dairy products is the major limitation in organized marketing of these products. The conventional preservation techniques such as sterilization, freezing, etc. cannot be used for traditional dairy products due to their adverse effects on sensory and textural quality. This calls for application of newer concepts of food preservation such as hurdle technology, biopreservation, modified atmospheric storage, etc.

2.3.1. Hurdle Technology:

The microbial stability and safety of most traditional foods is based on a combination of several preservation factors, called hurdles, which microorganisms present in food are unable to overcome. These "hurdles" include water activity, pH, heat treatment, sugar, salt, redox potential, preservatives, etc. Hurdle technology involves optimization of 3 or more hurdles so that shelf life and the microbial safety is extended without adversely affecting overall quality of the product. The advantages of hurdle technology are: (i) the sensory and nutritional characteristics of food remain close to fresh/natural ones (ii) less energy consumption (iii) autosterilization of foods is observed during storage, and (iv) less susceptible to non-enzymatic browning and lipid oxidation. The first ever-successful application of hurdle technology in India was made in author's laboratory for preservation of ready-to-eat Paneer curry (Rao and Patil, 1999). It involved optimization of water activity, pH, extent of heat treatment and level of preservatives to obtain shelf-stable product. The product has a shelf life of one month. Recently, application of hurdle technology in preservation of Paneer (Yadav and Sanyal, 1999) and heat coagulated colostrum milk (Premaralli, et al. 1999) has also been reported. The work on

preservation to Burfi and milk cake using hurdle technology is in progress at NDRI.

2.3.2 Bio-preservation:

Another emerging technology for preservation of perishable foods is "biopreservation". It refers to extended shelf life and enhanced safety of foods using their natural or controlled microflora and/or their antimicrobial products. The lactic acid bacteria synthesize variety of inhibitory substances including bacteriocins or bacteriocidal proteins. Currently large-scale attempts on application of natural antimicrobials for food preservation are being carried out. Nisin was the first recognized antimicrobial substance produced by lactic streptococci that has realized commercial application in food preservation. Use of nisin in extension of shelf life of Khoa, Lassi, and sterilized Kheer has been reported (Salahuddin, 2002).

Many other bacteriocins produced by Lactobacillus spp. such as lactocin 27, helveticin J, Lactocidin, Plantaricin A & B, Sakacin – A, Brevicin, Pediocin PA-I, Pediocin AcH, Pediocin-A, Leucocin demonstrate broad range of antagonistic activity against many spoilage organisms. These bacteriocins need to be exploited for preservation of traditional dairy products. They will be particularly effective when used in combination with hurdle technology.

2.3.3 Osmotic dehydration:

The concentration of food products by means of product immersion in a hypertonic solution is known as osmotic dehydration. This process has received considerable attention in recent years because of potential industrial application. Compared to air drying or freeze drying, osmotic dehydration is easier as less energy consuming because of removal of water occurs without a phase change. As the food product dehydrated by osmosis is not subjected to high temperatures for extended periods, the heat damage is also minimized. The technology has great potential in near future for dehydration of indigenous dairy products. Successful attempts have been made at author's laboratory to dehydrate rasogolla and paneer using this technology.

2.3.4 Individual quick freezing (IQF) process:

IQF process is another technology, which can be used for extending the shelf life of the traditional dairy products. IQF is a continuous process in which the product moving on the belt is exposed to a blast of extremely cold air freezing it in a matter of seconds. This serves two purposes – there is no time for the product to deteriorate and because it is frozen instantly the pieces do not stick to each other. Thus there are no clumps or blocks and one can take out even one individual piece without having to defrost or cut the frozen product. The great advantage of IQF is that the product reverts practically to its original fresh state when used for consumption. The technology will be useful for preservation of paneer, rasogulla, gulabjamun, etc.

2.3.5 Intermediate moisture products:

Reducing water activity of the food product to the intermediate moisture range is a well-known method of food preservation. This technique has recently been applied successfully at NDRI to preserve paneer cubes (Surinder Kumar, 2003). The intermediate moisture paneer has a shelf life of 4 months at room temperature and can be reconstituted within five minutes.

2.4 CONVENIENCE TRADITIONAL DAIRY PRODUCTS

The changing life-styles and increased purchasing power especially among urban population has necessitated the research efforts for formulating ready-to use traditional milk products with added convenience, enhanced shelf life, added nutritive value, and with attractive packaging. Recently, number of such convenience products viz. Khoa powder, Kulfi mix, Gulabjamun mix, Rasogolla mix, Burfi mix, Chhana powder, instant rice Kheer mix, Makhana kheer mix, Shrikhand powder, Lassi powder, dried carrot milk food mix, ready-to-eat Paneer curry, Chakka powder, Kadhi mix, Palada mix, Rasmalai mix, Basundi mix, long life paneer, long-life milk cake, etc. have been developed at NDRI and elsewhere, some of which are already being manufactured commercially.

2.5 FUNCTIONAL TRADITIONAL DAIRY PRODUCTS:

Probiotic Traditional Dairy Products:

Probiotic food products in general and probiotic organism in particular are in the center of current R & D activities all over the world. Functional foods segment that is registering a steady and consistent growth at present, among processed food products, gathered the momentum primarily from the scientific investigations based on probiotic food products.

Industrial interest in developing probiotics and probiotic functional foods is thriving, driven largely by the market potential for foods that target general health or well being. NDRI has made some progress in this area by developing probiotic dahi, lassi, probiotic aloe vera lassi, and probiotic cheese. There is possibility of developing other milk based fermented traditional dairy products such as probiotic shrikand and Rabadi – a milk-cereal based fermented product.

FAT-REPLACEMENT IN INDIGENOUS DAIRY PRODUCTS:

High fat consumption has been linked to several chronic diseases including cardiovascular diseases, obesity and certain forms of cancer. Nutrition experts recommend a total fat intake of less than 30 per cent of total daily calories. These dietary recommendations are one reason for the increasing demand for lower fat food products of the world market has been flooded with the food products carrying the labels "low fat", 'no fat' or 'reduced fat'. Fat mimics or fat substitutes are normally used to produce low-fat foods, fat mimics are substances that help replace the mouthfeel of fat but cannot substitute for fat on a gram for gram basis and cannot be used for applications involving frying. Substances whose physical or thermal properties resemble fat are termed as fat substitutes and can replace fat on a gram-for gram basis and can also be used for frying applications.

Low-fat cheese, processed cheese, cultured products, frozen desserts, butters and spreads have been successfully developed using commercially available fat mimics/replacers. Using similar technique several low fat varieties of traditional dairy products can be developed. An attempt has been made to develop low fat burfi at NDRI, Karnal (Prabha, 2006).

A HEART-HEALTHY OPPORTUNITY

With the functional food market abuzz about the heart-health benefits of plant sterols, dairy foods formulators have excellent

opportunity to develop variety of TDP with heart healthy benefit. Recently, a low cholesterol ghee has been developed at NDRI. The product has been commercialized and is now available in the market.

Arjuna ghee, with functionalities like resistance against heart diseases and blood pressure regulating properties was developed at NDRI, Karnal. The developed ghee was found sensorily similar to the market ghee. It had overall acceptability score of 85.1 compared to the control (90.84). The Arjuna ghee was found to be 4 times more stable to oxidative deterioration as compared to control ghee. This is due to the fact that Arjuna extract contains several antioxidants like polyphenols, terpenoids in addition to phytosterol, which are beneficial in case of Cardio-vascular Diseases (CVD), high blood pressure and to boost up our immune system.

DIETETIC INDIGENOUS DAIRY PRODUCTS

The dairy industry has responded to the growing needs of health conscious consumers for low-calorie foods. Consequently, a large number of dairy products made with low-calorie and nonnutritive sweeteners have been witnessed in the market. Low calorie sweeteners have become sugar alternatives to replace sucrose in a wide variety of dairy products. Kumar (2000) developed a low calorie lassi by using aspartame and reported that aspartame at a level of 0.08 % was required to replace 15 % of cane sugar in lassi. The technology for the production of rasogolla, the most popular channa based Indian sweetmeat, was developed by Jayaprakash (2003) using sorbitol (40 %) and aspartame (0.08 %). Chetana, et al. (2004) developed gulabjamun, a popular khoa based sweet, using sorbitol. Burfi, another khoa based sweet delicacy was developed by completely replacing sugar using acesulfame-K (Yarrakula, 2006), aspartame (Muralidhar, 2006), saccharin (Narendra, 2006), sucralose (Singh, 2006), and sucralose and bulking agents (Prabha, 2006). Kalakand and flavored milk were developed using acesulfame-K (Yarrakula, 2006), aspartame (Muralidhar, 2006), saccharin (Narendra, 2006), and sucralose (Singh, 2006). The Indian counterpart for ice cream, kulfi was developed by Pandit (2004) using sorbitol (5.5 %), maltodextrin (4.26 %) and aspartame (742 ppm).

INDIGENOUS DAIRY PRODUCTS FORTIFIED WITH DIETARY FIBER

Milk and most dairy products are devoid of dietary fiber. With the growing interest in dietary fiber and its health benefits, dairy industry has geared up for fortifying the dairy products with fiber. In India, there are few traditional dairy products that contain significant quantities of fiber e.g., Gajar-pak (carrot halwa), Giya-ka-halwa (bottle gourd halwa), Doda-burfi, and Kaju-burfi. Traditionally made cereals-based milk desserts like kheer and dalia-dessert are other dairy food sources of dietary fiber in Indian diets (Patel and Arora, 2005). Recently, dahi (Chandrakant, 2002), lassi and other dairy products have been fortified with fruits and commercial dietary fibers to give the benefits of dietary fiber. Kantha (2005) developed a low fat paneer using soy fiber and inulin and reported that milk with 2.5 % fat and 0.56 % soy fiber or 1.8 % fat and 4.5 % inulin yielded a paneer similar to that prepared from full cream milk (6 % fat) in respect to sensory quality. Amul has launched a new variety of isabgol-enriched ice cream. Isabgol is the seed derived from Plantago ovata. Being a 'true dietary fibre', the isabgol husk is considered to be a natural laxative that aids easy bowel movement. Besides it is also known to possess serum cholesterol reducing properties (Mann and Singh, 2005)

3.0 ISSUES, STRATEGIES AND VISION

3.1 Production of indigenous milk products by organized sector:

Large-scale manufacture of these products in a hygienically safe manner with assured quality control and proper packaging will certainly do wonders for this sector not only in India but also abroad. Lead has initially been taken in this regard by NDDB's Sugam dairy and since has been followed by Sabar and Rajkot dairies in Gujarat; Warna dairy, Maharashtra; dairies in Madras, Bangalore, Hyderabad and Chittoor in South India, Mother dairy, Calcutta; KCMF, Trivendrum, COMFED, Patna; and many others. This organised production of indigenous dairy products, however, is miniscule as compared to total volume traded in the market. By 2020, we should shift at least 25 % of production of Indigenous dairy products to the organized sector.

In spite of several innovative efforts made in the mechanization of manufacture of indigenous dairy products, adoption of these innovations by the industry is very limited. There may be several reasons for this. One reason may be our typical mindset. We appear to have lost faith in our abilities and ourselves. We seem to have a blind admiration of anything done outside our country and blindly believe whatever is foreign. We are by and large reluctant to adopt technologies developed locally.

It would also be pertinent at this stage to ask whether we need continuous systems or batch system when only a fraction of total ethnic products are processed in organized sector. Will it not be more appropriate to develop and promote batch type units so that mechanization of production in the small size units in the unorganized sector is effected thereby improving the hygienic quality of the products marketed by this sector?

The organized production does not necessarily mean large-scale production. We cannot afford to forget a large number of small and tiny manufacturing units, which are in the unorganized sector. A number of them have people with great innovative capabilities and basic skills. These talents need to be properly organized for hygienic production and marketing.

There is also a need to facilitate formation of consortia of dairy industry to fund research to (i) develop mechanized and energy efficient systems for manufacture and packaging of indigenous dairy products and (ii) develop value added indigenous dairy products for the future.

3.2 PACKAGING OF TRADITIONAL DAIRY PRODUCTS:

Poor packaging of traditional dairy products is another big area, which should be strengthened. Most of these products particularly sweets are sold in open condition which is great source of contamination. Even products prepared by organized/large dairies, for example khoa and paneer are not properly packaged. No packaging system/machine is available for traditional milk sweets and the units available for non-dairy sweets are unsuitable for milk sweets. The methods of manufacture of many sweets also do not commensurate with the continuous packaging system. The appropriate and environmental friendly packaging materials are to be identified. Complete packaging systems that are in harmony with the production line will have to be adopted.

3.3 TRAINING OF SMALL-SCALE OPERATORS:

Most of the trade of Indian milk sweets is with the halwais and the small-scale operators. Most of them have art and skill of manufacturing varieties of indigenous dairy products. However, no attention is paid by them on quality of milk, hygienic handling, proper packaging and storage due to ignorance. The training of operators in this sector in hygienic handling and quality control aspects will go a long way in improving the quality of these products. The regional Agricultural Universities and Krishi Vigyan Kendras will have to play active role in training of small entreprenuers.

3.4 UNDERSTANDING BASIC CHARACTERISTICS OF INDIGENOUS DAIRY PRODUCTS:

In order to modernize the Indian milk sweets sector, it is necessary to understand the basic characteristics of these products. The knowledge of these characteristics would contribute a great deal in design of equipment and standardizing scaled-up methods for manufacture of these products.

A variety of traditional dairy products are produced in India, most of which are region specific. Most of these products have been characterized for their chemical composition, sensory attributes and rheological and microbiological characteristics. Wide variation in composition of these products is observed due to variation to the method of manufacture, concentration ratio used, sugar level, type of milk (i.e cow, buffalo or mixed). There is a need to determine the consumers' preference about the most desirable attribute of these products in different regions of the country so that the organized dairies may adopt the same. Similarly, characterization of various food products on the basis of their rheology and microstructure forms the backbone of the scientific approach to product/ process development and of quality assurance in modern industrial practices. The current trends round the globe favour such studies to facilitate product description/specification for promoting process control and for international trade. At a juncture when the need for modernizing the manufacturing and marketing of traditional milk products is being emphasized in India, such rheological and electron microscopic studies would be sine qua non to obtain much needed information for product/process/equipment development. In the past few years, some work has been directed to study the rheology and microstructure of selected indigenous dairy products such as Paneer, Khoa, Rasogolla and Sandesh. It is also necessary to understand the kinetics of texture formation during manufacture of these products and the molecular level changes in the constituents of milk during processing. Any equipment designed without taking into consideration these basic aspects is less likely to be accepted by the industry as the product obtained using such equipment would lack the desirable texture.

3.5 ESTABLISHING NATIONAL STANDARDS FOR INDIGENOUS DAIRY PRODUCTS:

Lack of quality/legal standards and quality assurance systems is one of the bottlenecks in improving the quality of these products. While legal standards for some of the milk sweets have been laid down, there is an urgent need to formulate the national standards for all the Indian sweets marketed in the country. There is also need to evolve the quality assurance system to meet the international standards of food hygiene and food safety.

3.6 INNOVATION IN VALUE ADDED INDIGENOUS DAIRY PRODUCTS:

The markets of conventional indigenous products are increasingly getting overcrowded and our future success will depend on our ability to provide innovative products, which consumers want and need. Whatever the innovation - products, processing method or packaging - it should meet the real consumer need. We know today's families want "grab-and-go" convenience. They are also concerned about nutrition and health. Different ages and demographics want different things. Therefore, investment at this level is essential if we are to respond rapidly to customers who are increasingly demanding new and different taste experiences from products that are also competitively priced. New variants of sweets can be developed. Indigenous dairy products containing health-promoting ingredients may be developed and promoted. Host of ingredients such as dietary fibre, cholesterol reducing phytosterols & phytostanols, minerals and vitamins, berries and cherries with its anthocyanins that prevent cancer etc. are available for value addition of traditional dairy products. Development of dietetic sweets is another area needing attention.

3.7 INNOVATION IN MARKETING:

Innovation in marketing is equally important. It is possible to popularize indigenous dairy delicacies through the fast food chains or franchising of some popular brands of Indian dairy delicacies may be promoted. Collecting market intelligence to inspire confidence among prospective entrepreneurs to take commercial production of traditional dairy products in India and abroad is also essential.

4.0 EPILOGUE

The Indian milk products enjoy mass appeal, give high profit margins and have high export potential. There is an urgent need to modernize this sector to produce high quality products with long shelf life. We need to generate basic data on these products which will help for designing of new equipment or for intelligent selection of existing food processing and packaging lines. Great scope also exists for improving the shelf life of milk sweets by employing newer preservation techniques. While lots of innovations have taken place recently, these innovations have not percolated to the actual users. Industry-R & D organization links need to be strengthened. Collaborative efforts of industry, unorganized sector, equipment manufacture and R & D institutions are required for all round development of this sector.

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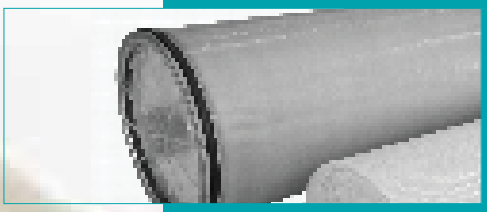

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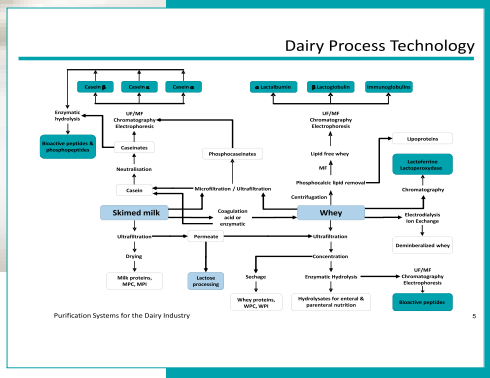

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Technical Session-II

Mechanization of PANEER Production Process

Józef Żuraw, PhD, Maciej Raczyński MSc
Obram Ltd., Poland

INTRODUCTION

Annual production of Paneer in Asia (India, Pakistan, Bangladesh, Iran and other) was estimated at approximately 1 500 000 tonnes in the year 2010. Paneer has many uses starting from its consumption in raw form, to preparation of several varieties of culinary dishes and snacks. The demand of the value added products with paneer as the base material is growing at a very fast rate particularly in the urban areas. There is a further need to tap the marker potential of paneer both for domestic consumption as well as export.

PRINCIPLE OF PANEER MAKING

Paneer is obtained by heating milk to about 900C, acidifying the hot milk by adding citric acid solution followed by removal of whey and pressing of the curd before cooling the pressed mass in chilled water. Chemical and physical changes in casein and whey proteins, brought about by the combined influence of heat and acid treatment, form the basis of paneer making.

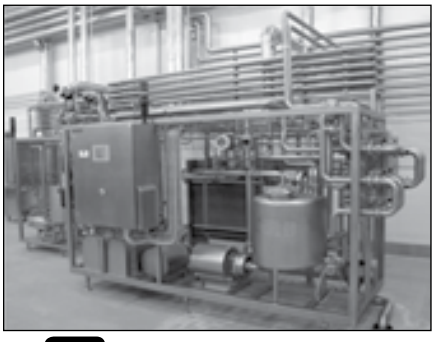
When milk is heated to a temperature required for paneer making (900C), the native configuration of whey proteins is disrupted, they loose calcium-caseinate-phosphate micelles.

The gelation / aggregation occurs more rapidly and at a higher pH (pH 5.4 – 5.7) in heated milk (900C) than in unheated milk. Paneer manufacture thus essentially involves the formation of coprecipitates due to complexing of heat-denatured whey proteins with the casein followed by their acid coagulation. The higher the degree of coprecipitation, the grater will be the total solids recovery and yield of paneer.

TYPE OF MILK

Use of buffalo milk produces best quality paneer. Cow milk product is criticized to be too compact, fragile and unsuitable for frying and cooking. Irrespective of the type, milk should be standardized to a fat & SNF ratio of 1:1,65. Paneer of most desirable texture attributes and maximum yield (about 22%) can be prepared from buffalo milk wherein fat and SNF are adjusted to 5.8 and 9.5%, respectively.

HEAT TREATMENT



High heat of milk improves the solids recovery, yield, flavour and body and texture characteristics of paneer. Milk heating up to 900C with holding, is more widely used by dairy industry. Coagulation 70-80 0C and higher produces the desirable body and texture characteristics in paneer. Higher temperatures of coagulation induce greater solids recovery, but lower yield due to increased moisture expulsion. Such product has also very hard body. But a higher temperature of coagulation (850C) should be used when making paneer from cow milk.

Pasteurization of milk is done on Pasteurization Unit based on PHE (plate heat exchanger) with 10 minutes holding time. Heat from whey drained after coagulation process can be recovered here and used for pre-heating of milk.

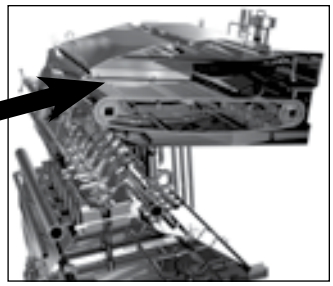
COAGULATION OF MILK

The optimum pH of coagulation of Buffalo milk at 70-75°C is between 5.35-5.45 and that for cow milk at 80-82°C is in the range of 5.25-5.35. The concentration of citric acid solution that results in the best product is 1-1.5%. Stronger solutions impart hardness and graininess and cause greater solids loss in whey. About 2.0-2.5g of citric acid is required for coagulation 1kg of buffalo milk, and 1.7-2.0g of cow milk.

Closed Coagulation Vats can be used for coagulation of milk. Its construction prevents evaporation of steam inside the production room. The body of vat is insulated. Preheated citric acid is provided via flow meter to dosing nozzles installed inside the vat. Citric acid is spread evenly on milk surface. Gentle treatment of coagulated mass is possible with use of special designed shovels which break the curd (not cut).

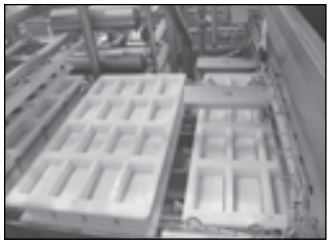
DRAINAGE OF WHEY AND PRESSING OF CURD

After coagulation, curd is allowed to settle for about 5 min to achieve a final consistency and then whey is allowed to drain through the strainer (traditional) or mechanical belt curd drainer. It is desirable to maintain temperature of curd at temperature not lower than 63°C during drainage of whey , what can be

achieved by accelerating of the process on OBRAM Paneer line.

Curd together with whey is transported on the draining belt by membrane pump, where the whey is drained. Curd is moved to perforated tubes by special dispenser. In the tubes a final drainage of whey from the curd takes place and it ends with initial forming. Proper size of paneer cheese block is than placed into multimoulds and pressed for approx. 15 min (up to 1,0 kg /cm²) to obtain a product with desired texture.



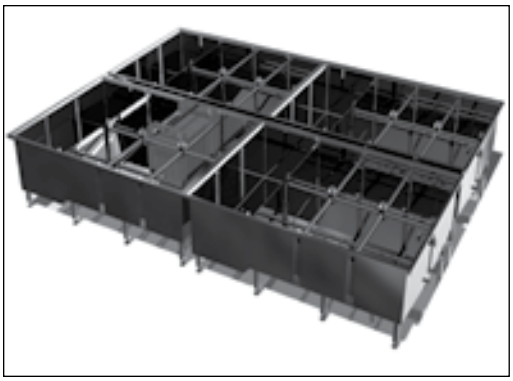
Paneer in multimoulds after Columnar Forming Unit

Paneer in multimoulds located under pressing station

Individual pressing of Paneer in the multimoulds

CHILLING OF PANEER

Paneer block taken out of the multimould, using pneumatic pressure (blow-out system), can be cut into pieces of the desired size and transferred to a chilled water tank (temperature must be lower than 10°C) for 1-3 hours depending on size of Paneer block. Chilling of paneer brings down temperature and helps in developing desired texture. Technological chilled water must be pasteurized and very good quality, particularly from bacteriological point of view.



Water inside the cooling vats is in continuous circulation. The system consists of filtration system and automatic temperature control.

PACKAGING

Paneer cheese can be packaged in high hygienic conditions in polyethylene pouches, heat sealed and stored under refrigerated conditions or frozen. Vacuum packaging in laminated or co-extruded films is recommended. Some dairy companies use polyethylene pouches filled with natural gas, which is also a proper way of packaging.

YIELD OF PANEER

The yield of paneer depends on the total solids in the milk and the retention of milk solids and moisture in it. Moisture and solid retention contribute to paneer yield. Generally a yield of 20-22% of paneer for buffalo milk and 15-17% for cow milk is obtained under optimum conditions of manufacture.

Table 1

Recommended parameters of Paneer made from buffalo or cow milk using OBRAM mechanized Paneer production line.

Process	Buffalo milk	Cow milk
Standardization	Fat : SNF 1: 1,65	Fat : SNF 1: 1,65
Heating	90^{0}C / 7-10 min	95^{0}C / 10-15 min
Coagulation (temperature)	70-74 ^{0}C	80-82 ^{0}C
Coagulant	Citric acid (1 % solution)	Citric acid (1-1.5 % solution)
pH of coagulation	5.35-5.45	5.25-5.35
Curd	Prepressing in tubes (OBRAM Solution)	Prepressing in tubes (OBRAM Solution)
Final pressing	0.5-1.0 kg/cm^2	0.5-1.0 kg/cm^2
Chilling	Chilling water 6-10^{0}C	Chilling water 6-10^{0}C
Time of chilling	Depend on size: 1-3 h	Depend on size: 1-3 h
Packaging	Vacuum system	Vacuum system
Storage - refrigerated	< 10^{0}C	< 10^{0}C
Storage - frozen	≥ - 18^{0}C	≥ - 18^{0}C

UF PROCESS IN PANEER MANUFACTURING

Membrane processing has a potential in applications for the manufacture of Paneer. Ultrafiltration (UF) brings the advantages to mechanization, uniform quality, improved shelf life, increased yield and nutritionally better product. The process involved standardization and heating of milk followed by UF whereby much of lactose, water and some minerals were

removed along with this permeate. UF of milk and the removal of permeate is equivalent to removal of whey by coagulation in conventional method. The concentrated mass, which had about 40% total solids, can be acidified as in traditional process to get the desired pH, moisture and texture. UF process can be applied to mechanized OBRAM Paneer production line.

VARIANTS OF PANEER

Under certain conditions as, for example, for reduction of cost, in case of non-availability of fresh milk, for the reason of health benefits and improvement of nutritive value, modification of the normal paneer or a new type of products similar to paneer in sensory quality, may become desirable. Such products developed so far are discussed below.

LOW FAT PANEER – FROM MILK 3% FAT

The conventional paneer is quite rich in fat, which not only increases the price but also makes it unsuitable to those consumers who are conscious of high fat and want to have a low-fat paneer. Therefore, attempts were made to develop low-fat paneer. Paneer of quite good quality could be manufactured from milk with fat content as low as 3,0%.

RECOMBINED AND RECONSTITUTED MILK PANEER (FROM LH MILK POWDER)

Suitable technologies have been developed for the manufacture of acceptable-quality paneer from reconstituted whole milk powder and recombined milk. Paneer made from reconstituted milk did not conform to the PFA requirements in respect of the minimum 50% fat content on dry basis.

FILLED MILK PANEER (VEGETABLE OIL)

Studies showed that paneer of an acceptable quality could be prepared using buffalo skim milk and groundnut oil. A fat level of 5.5% in the filled milk and heating to 900C were found to be the most suitable conditions. The paneer thus obtained contained 16-18% protein, 22-23% vegetable fat and 55-56% moisture. The process developed is relatively simple and permits the use of commonly available equipment for manufacture of paneer on both small and industrial scale and the cost of production is considerably reduced. Standardized process for manufacturing of paneer from skim milk incorporated with coconut milk of 25% fat gave positive results. Sensory quality of the product made from filled milk having 10% coconut milk was highly acceptable.

PROTEIN ENRICHED FILLED PANEER (VEGETABLE PROTEINS)

A new process has been developed for preparing protein-enriched filled milk paneer. The process involves supplementation of vegetable proteins in the form of calcium soy isolates or calcium groundnut isolates to the skim milk and vegetable fat mixture. Such product would be nutritionally rich (protein increased by 50%) and economically superior to the conventional paneer and thus ideally suited to dietary management of consumers suffering from protein-energy malnutrition. This product is similar to tofu.

Milk fat (%)	Constituents in Paneer (%)					References
	Moisture	Fat	Protein	Lactose	Ash	
Buffalo milk						
3.5	56.99	18.10	18.43	–	–	Chawla et al. (1987)
5.0	56.77	22.30	–	–	–	Bhattacharya et al. (1971)1)
5.0	56.43	22.50	–	–	–	Shukla et al. (1984)
5.5	55.19	23.80	17.99	–	–	Chawla et al. (1987)
5.8	50.72	27.13	17.99	2.29	1.87	Rajorhia et al. (1984)
5.8	54.10	23.50	18.20	2.40	1.80	Sachdeva and Singh (1987)
5.9	51.12	26.86	17.38	–	2.00	Pal and Garg (1989)
5.9	55.10	23.47	19.92	3.09	2.43	Pal et al. (1999)
6.0	54.76	25.98	–	–	–	Bhattacharya et al. (1971)
6.0	53.51	24.12	16.44	2.60	1.88	Pal and Kapoor (2000)
6.0	47.05	23.00	19.77	–	2.75	Masud et al. (2007)
7.57	51.93	26.17	15.74	2.71	1.80	Pal and Yadav (1991)
Cow milk						
3.5	55.97	18.98	20.93	2.01	1.45	Mistry et al. (1992)
4.4	56.0	22.0	18.5	2.1	1.4	Sachdeva et al. (1991)
4.5	55.26	24.15	18.43	–	–	Syed et al. (1992)
4.57	59.31	17.9	17.34	2.43	1.38	Pal and Yadav (1991)
5.0	53.90	24.80	17.60	–	–	Sachdeva and Singh (1988b)
Mixed cow and buffalo						
3.5	55.06	18.40	20.75	2.43	1.90	Pal et al. (1991)
5.0	57.14	22.32	–	–	–	Shukla et al. (1984)
Skim milk						
0.1	62.14	4.0	27.48	–	–	Syed et al. (1992)
–	62.47	1.96	28.64	–	2.55	Sivakumar et al. (2005)
Goat/Ewe's milk						
Goat milk (4.86% fat)	46.94	26.95	19.99	–	1.93	Agnihotri and Pal (1996)
Ewe milk						
(6.94%)	55.08	23.50	15.75	2.73	2.93	Pal et al. (2008)
Reconstituted/Recombined milk						
Reconstituted WMP (15%TS)	57.30	17.40	22.80	–	–	Singh and Kanawjia (1992)
Recombined cow milk	57.40	22.92	16.16	–	–	Singh and Kanawjia (1991)

Innovation in Small Scale Manufacture of Desiccated Milk Based Products

Uday N Khare – Proprietor
Malhar Industrial Associates

- Today India is largest producer of Milk in the world having share of 16% of the total production of Milk in the world as per data generated in the year 2011-12.
- About 50% of India's total Milk Production is utilized for making different Dairy Products.
- Desiccation means process of removing moisture for preserving foods. Desiccation of milk gives a product which in India is called as Khoa OR Mawa which is a major constituent of Milk based Indian Sweets, viz – ***Khoa, Peda, Burfi , Kalakand, Milk Cake, Rabri, Khurchan, Basundi, Kunda, Dharwad Pedha, Gulabjamum etc.***
- It is estimated that 8% of country's 110 million Ton of milk is used for making Khoa(Mawa) which gives 88 Lac Ton of Khoa valued at Rs.1,58,400/- Crores @ Rs.180 per Kg. As such Khoa is of great commercial importance in India.
- The most widely used old traditional method in India for small scale manufacture of Desiccated Milk based Products (Khoa based products & sweets) uses open fire burner Bhattis operating on Diesel/Kerosene/ LDO on which a Mild Steel Kadhai (Mild Steel Pan/ Cauldron) is mounted in an unfixed manner, so that one operator can stir the milk continuously using a Zaara/ palta/Khrcha for scraping of inner surface of Pan to facilitate evaporation and avoid sticking & burning of milk fat and protein to the inner surface of the pan under heating. The process being batch process, 4-5 Ltrs of milk is taken in the pan and heated vigorously for 7 – 8 minutes and stirred and scraped continuously. Then the pan is removed from fire for removal of Khoa from the pan. Immediately one empty pan is kept on Bhatti fire and next batch of milk is added for processing. There is a series of such Kadhai Bhatti set up in a small scale Khoa manufacturing unit which mostly handles 400 Ltrs. to 2000 Ltrs of milk in a day of 8-10 operating hours.
- Such Khoa produced in batches differ in quality due to varying temperature profile, uncontrolled heat input, irregular scraping of heat transfer surface and irregular speed of agitation. Further the fuel efficiency of the traditional method is only 40% and as such it consumes lot of fuel leading to light cost of manufacturing.
- During last 25 years lot of work has been done to improve the manufacturing process of desiccated Milk (Khoa) using modern techniques of fuel conservation, indirect heating of milk by steam OR by Thermic Fluid. Standardisation of process equipment, estimation of energy requirement of batch type process equipment using steam OR Thermic Fluid as heating media, condensate recovery system and hot water generation by waste heat recovery, is made regular part of the operating system.
- ***Two major innovations in small scale manufacturing of Desiccated Milk based products ; which are time tested and commercially exploited on all India basis are***

I Steam Heated, Non IBR Boiler based Khoa making plant for 400 – 2000 Ltrs/day of Milk Conversion in 10 hours using Diesel/LDO/fired wood / Bio mass Briquettes as fuel.

II Thermic Fluid Heated, T.F. Heater based Khoa making Plant for 400 – 2000 Ltrs./day of milk in 10 operating hours using Diesel/ LDO/ Firewood/ Biomass Briquettes as fuel.

INNOVATION (I):

Non IBR Boiler based Khoa making plant consists of a Non-IBR Vertical type Automatic Steam Generator which uses Liquid Or Gaseous fuel e.g. LDO, Diesel/ LPG, Natural Gas or Solid Fuel e.g. Coal, Firewood, Biomass Briquettes. Such Steam Generators are automatic and they generate 100 Kg to 600 Kg/hr. of Steam depending on selected model of a specific size and design. The Steam generated is transported through an insulated pipeline to the Khoa making machine. This machine is Stainless Steel AISI 304 Grade open top dished bottom jacketed and insulated Vessel having a bottom driven stirrer with PTFE lined scraper blades which rotates at two different speeds as selected by a selector switch for changing the speed of geared motor of stirrer. (Variable speed drive is operational) The machines is mounted on a heavy stainless steel frame & fitted with hand tilting turning assembly (Geared motor for turning is optional). The machine is fitted with all required steam line fittings like valves, steam trap, pressure gauge, safety valve etc for efficient and trouble free working.

The machine is designed to process max. 20 Ltrs. of milk per batch and using steam evaporates milk in 20 minutes to get Khoa/Mawa of desired texture. On completion of batch, steam supply to machine is stopped and the finished product is decanted by tilting the machine using tilting gear. Immediately on full removal of finished product the machine is taken back to initial vertical position for loading the next batch of 20 Ltrs. of milk. In one hour one machine would process minimum 40 Ltrs. of milk and number of machines required could be decided on the basis of quantity of milk to be processed to get Khoa/ Mawa.

THE MAIN BENEFITS OF THIS INNOVATION ARE :

1 40% Fuel saving over traditional setup of Bhatti – Kadhai
2 Zero wastage of milk during process.
3 Hygienic set up and clean environment benefits the product and operator.
4 Consistent desired quality of finished product and no batch to batch variation.
5 No need for highly experienced operator as any workman can easily operate the machine and plant and heavy physical exertion is eliminated.

INNOVATION (II):

The First innovation even though commercially successful and widely accepted all over India, since last eight years, there emerged a need for further work as the steam based operating system required soft water of less than 5ppm. Over a period of last 5-6 years making available good quality water in required quantity has become increasingly difficult and due to this small scale manufactures faced maintenance problems. To handle this problem instead of Steam Heating System, closed loop Thermic Fluid System is designed and developed. The Khoa Making Machine has also undergone design changes in heating jacket etc. to suit Thermic Fluid Heating.

Even though initial cost of this Thermic Fluid based heating system is higher than that of Steam based system it is worth to consider this, where availability of water is difficult and/or large heat generator which is out of purview of IBR is desired.

Now Work is being done to **design and develope a Khoa Making Machine** which has **loaded software to select a set of operating instructions** to get a specifically desired finished product without depending on human effort. Such Automation will give Audio Visual signals and make announcement at various process stages of machine during a batch. Hopefully, Industry will find these innovations customer friendly, and commercially and practically beneficial to the Industry.

EMERGING REQUIREMENTS IN DAIRY INDUSTRY

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ABSTRACT

India's Dairy Industry has significantly progressed since seventies consequent to implementation of 25 yearlong Operation Flood Programs that concluded in 1996. India changed its position from a milk short state and importer of powdered milk /butter oil to now as world's sustaining top milk producer with an expanding range of milk products.

The objective of making available adequate, affordable and reasonable quality milk and milk product to consumers of all ages yet ensuring improvement in socio economic condition of rural producer is still vital. With all round Globalization, the industry is at a cross road now. It needs a complete strategic manoeuvre covering cattle management, milk production and handling, milk processing, milk product manufacturing, packaging and distribution.

The lowest productivity level and improvement in management of India's milk cattle have to be tackled. The milk production has to be made proficient to sustain attraction to the rural enterprise for whom this is undoubtedly the best living means under all conditions be it draught, floods or any other calamity.

The importance of milk in Indian diet is to be sustained the least, if not increased by redefining nutrition in milk and transform all the negatives to vantage, given the ever increasing disease spectrum and the encroachment of junk, unhealthy and imitation foods in the new generation. Formulations in milk and milk products should be innovated that attract all ages and make the milk consumption compulsive in a way. Research should focus on ways to quickly check and monitor quality at all levels to ensure safe product to the milk consumer

Thanks to spirited support to cooperatives and the enterprising private sector, the share of processed milk is continuously rising from the present level of 20%.The local Dairy Engineering Industry has also grown in the process reasonably to support the emerging requirements of improved plants and processes.

However, the indigenous milk products in the traditional palate is still far from industrialization. The dairy processors, academia, the technologists and engineers have to integrate their efforts in this endeavour and make innovations to meet the needs of the industry. The challenges posed by rapidly diminishing energy resources and most importantly water in the entire dairy spectrum is also to be tackled.

Cattle and farm management, Milk Procurement, Bulking and transportation, Processing and Product manufacturing, formulation of safe and appropriate products for all ages, Milk Packaging and distribution, means of making milk and milk products available safe to the consumer by employing environmentally sustainable technologies are the target areas to work upon.

This note is written in the personal capacity of the author and addresses each of the above segments and underlines areas of concerns and remedies. More importantly author searches for an enabling platform to execute a time based plan to achieve them. The dream is to make a system that that is fail safe and is sustainable under the political and country environment on a continual basis.

CATTLE MANAGEMENT:

It can be proved that Cattle reared together in numbers of 50 and above and connected through a cluster can make cost of milk at the dock substantially cheaper than it is today. Bigger farms could be more rewarding and if size is 1000 and above, we could derive further mileage in quality and processing cost by processing milk at the farm itself. This is a significant variant from present day approach but has relevance from the point of view of village hygiene, non -availability of land to producers and so on. We need to look into the experiments of animal hostels outside village boundaries, incentives for big size farms and similar initiatives. This could be effectively clubbed with community milking with an aim to slowly and slowly withdraw animal from the producer's house to a hostel.

Cattle feed; cost effective location specific formulations to improve the availability and reduce cost of feed is important. Machine milking needs to be carefully introduced. An exclusive model of milking parlours and cattle management gadgets should be devised that does not ignore the requirement of rural employment and engagement of producer's family members

There is a need to treat cattle on input output basis and we should be concentrating on outputs other than milk like urine, cow dung, beef and uses of cattle remains like leather etc. We have to put a pragmatic approach and learn from our own mythology as well as European experience

MILK BULKING, CHILLING AND TRANSPORTATION:

The existing practices should be revisited to identify deficiencies and look for innovative solutions. Methods of chilling at production level like Eutectic pads, dipstick cooling, small capacity bulk milk coolers, mobile coolers, Optimized efficient cooling systems, bigger transport vehicles, quick and reliable milk measurement methods at all levels have to be looked at. Clean milk practices at Production level, improving CIP at collection centre levels, self- generation of hot water, improved and more effective detergents, safe and complete cleaning, appropriate Effluent Treatment means at collection Centre level, power conservation systems, effective use of non-conventional energy are areas to look at. We have to connect this segment with the carbon foot print.

MILK RECEPTION AND PROCESSING:

Can reception is fading. Bulk Milk reception in tankers in India suffers from proper CIP cleaning discipline. CIP rinse recovery and a regime of proper CIP cleaning in case of tankers is required. The design of tankers have to be made uniform and their manholes compatible to suitable gadgets to make tanker clean. External cleaning due to plying on dusty roads and even rainy mud has to be handled. Rapid and reliable lab testing of milk of necessary parameters is also a requirement.

MILK PROCESSING:

Safe and secure milk pasteurization, Extending thermophile concept to pasteurization process, elongated production time between two

cleanings, improved standardization techniques, just adequate homogenization pressures and partial homogenization process, clarification and bactofugation, alternative processes for milk with flexibility are some of the areas of work.

PRODUCT MANUFACTURING & PACKAGING

MARKET MILK:

ESL milk processing and clean milk pouch packaging, aseptic milk and double milk and other cost effective UHT milk processing technology and packaging solutions need to be looked at.

Revisiting of SNF composition of all grades of market milk thereby avoiding SMP addition, identifying and declaring reconstituted and recombined milk, Right reconstitution and recombination processes that keep the product milk within consumer preference criteria, modifying pouch configuration to wide seal and pilferage proof design, secondary packaging, improved crate washing, crate handling and automation in pouch filling lines are also significant areas of work. Package less distribution, bulk vending, Any Time Milk (ATM) formats that reduce the cost of dispensing besides being environment friendly are the need of the hour.

TABLE BUTTER:

Innovative butter manufacturing system, low capital and hygienic butter packing systems, alternate table butter processing and packaging systems with flexibility to manufacture low fat and flavoured butter varieties. Cholesterol stripping, low cholesterol butter would become the requirement of the day.

MILK POWDERS:

One step technology without intermediate pasteurization and storage , Processes to add sugar in the middle of the process to manufacture high sugared powders like, Infant food, Dairy Whiteners, Ice cream Mix Powders, Energy efficiency in Evaporation and spray drying processes, Cold concentration, Clubbing up of Mechanical Vapour Recovery (MVR) and Thermal Vapour Recovery (TVR) systems, Cold addition of vitamins and other nutrients at safe temperature.

Improving recoveries, minimizing stack losses, product losses, safe processing, advanced fire extinguishing and explosion suppression systems, wet/dry cleaning

TRADITIONAL & INDIGENOUS PRODUCTS

Ghee: Improved ghee manufacturing through alternate methods, continuous ghee manufacturing, bringing energy efficiency, innovative packaging formats, ghee including box cartons, clarification, serum separation and solids recovery are topics of active discussions and work. Lactic acid butter for flavoured ghee and similar ideas.

CURD AND DERIVATIVE PRODUCTS:

Improving curd manufacturing process with logistics, innovative culture propagation systems, simplifying equipment and systems, Both flexible and rigid curd packaging initiatives.

Initiatives for butter milk, Lassi processes and packaging systems. New innovations in Extended Shelf Life (ESL) format for cultured products, Technology and engineering in product formulations.

Paneer, Cheeses and Whey Disposal: Revisiting brought in Continuous Paneer Manufacturing technology, removing lacunas and improving product. Conceiving a small scale Paneer Manufacturing gadget and implementation Processing Paneer whey for use as whey Powder and other product formulations, recycling whey back to Paneer processing and generating permeates that are benign, revisiting work done on whey drinks and devising industry applications Conceiving multi product lines to manufacture Mozzarella, Cheddar and other varieties of cheese, Conceiving real UHT cheese process, work to extend the shelf life of Paneer and cheeses Indigenous Sweetmeat Technology: Khoa, Peda, Burfi, Milk Cake, Srikhand, Basundi/Rabri Large scale processes and equipment modules. Conceiving and setting up new generation installations on lines of Sugam experiment.

SERVICES AND MISCELLANEOUS:

Reengineering the utilities on steam, water ,compressed air, Refrigeration, solids and liquid fuel handling and electricity with a special eye to energy conservation and environment.

Inducting and evaluating renewable energy sources and regeneration/ cogeneration of energy Upgrading the effluent treatment systems, smoke and exhaust stack pollution, creating HACCP awareness and designs in all processes, Introducing effective ERP management system, fixing requirements on phased automation and modernization, carbon foot print criteria formulation and implementation.

THE APPROACH:

This is a big dream aspiration but undoubtedly the need of the hour for the industry. The value disciplines to focus are summarized into Improving energy efficiency and carbon foot print of existing processes Innovating appropriate technology, processes and equipment to suit our requirements and changing needs. This should include product improvement. Handling and catering to the need of our industry requirements that is varied given our geographic and cultural diversity Take on our global social responsibility of disseminating our experience within the country and outside to other needy countries and maintaining synergy to globalization needs

The first requirement is to tackle and accentuate the political and professional will. The traditional mind set of resistance to change, fear of failure in introducing new products and processes and taking an overall view is next on line to be handled by creating system to support an idea and go about it systematically involving all stake holders and taking challenges head on to conclusive success.

A cell empowered with various stakeholders as taskforce team members need to be enacted. Experts in each area starting cattle management till packaging shall be the capital of the cell. The cell should also carry the responsibility of coordination with international and national level bodies. In order to maintain effective contact with the industry, the cell should steer the requirements of

1. New projects and/or expansion
2. Refurbish and modernize existing plant installations to induct efficiency, environment friendly technologies and systems. The Cell should be taking the lead role in this venture.

This could be done in coordination with Premier Research Institution, Academia and Dairy and Process Engineering enterprises to strengthen the collective image and heighten the contribution to clients.

The proposed cell would take the accountability of identifying relevant ideas and implementing from concept to commissioning. The success shall be measured from intensity of adoption by the industry. The vision is that the cell should emerge as an effective technical face of the country in application research and product development. Creating first installations as demonstration units and supporting them to success obviously is the key. Financial support from National Dairy Project or other Project Schemes is a must at least initially; Successful examples would power the system to be self-sustaining.

The author would like to throw this proposal in open to national and international institutions, governmental bodies, Associations and even Private enterprises to find takers. Alternative thoughts can also be accommodated.

Energy requirements for the manufacture of Traditional Indian Dairy Products

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INTRODUCTION

India is the largest milk producing country in the world since 1997 and in the year 2011-12 the annual milk production of India reached to 127.9 million metric tonnes amounting around 16% of total world milk production. The milk utilization pattern of India reveals that 50%, 47% and 5% of the total milk produced is used as liquid milk, in manufacture of Traditional Indian Dairy Products (TIDPs) and western products respectively. Thermal and electrical energy are mainly required in various dairy processing operations. Energy requirement for processing of liquid milk is relatively less as compared to manufacture of different dairy products. The manufacture of traditional Indian dairy products involves heating and concentration of milk which requires considerable amount of energy. Moreover, these indigenous milk products are being manufactured by unorganized sectors using traditional methods. These unorganized sectors do not focus on efficient use of energy and there is limited scope of energy conservation. Mechanization of TIDPs is required to meet the demand for quality milk products with improved technology having potential of energy conservation.

Mechanization of TIDPs is a basic need for the commercialization of many products irrespective of energy requirement. Many *halwais* and organized dairy sectors are interested to adopt improved technology for the manufacture of these products. However, non-availability of improved mechanized system is one of the constrains for the large scale commercial manufacture of many TIDPs. Once the technology is made available for small as well as medium scale manufacturers, improvement in terms of the product attributes, scale of production and energy efficiency of the process can be easily evaluated and improved.

ENERGY REQUIREMENTS IN DAIRY INDUSTRY

Energy is one of the very vital requirements for the development and progress of any nation. Indian economy is growing at the sustained GDP of around 7.8 % and livestock sector contributes 5.59% in national GDP and 28% in agricultural GDP. Two forms of energy namely electrical and thermal energy are required in dairy industry for various unit operations. There has been an increasing consciousness regarding relationship between economic development, enhanced use of energy and adverse environmental implications due to emission of Green House Gases (GHGs). In this regard, many national, international and intergovernmental bodies across the world have been working to formulate program to reduce the energy use in various sectors to combat the phenomena leading to global warming. It has become exceptionally critical to manage the use of energy and to adopt all possible measures to conserve it in order to boost the profitability and to reduce emission of GHGs.

Electrical power is required for the operation of pumps and electrical motors for the refrigeration plant and other equipments. Thermal energy required for organized dairy industry is mainly obtained from coal, natural gas, furnace oil etc. It is observed that 80 % of the world's population of the developing countries consume only 40 % of the world total energy consumption and the rest is consumed by developed nations. India is 4th largest energy consumer after USA, China and Russia, accounting for 3.4% of global energy consumption. The installed electrical power generation capacity of India is 205.3 GW as on June, 2012 and rank 5th in power generation capacity. The total demand for electricity in India is expected to cross 950,000 MW by 2030.

Energy requirement for dairy industry depends on several factors such as capacity, product mix, technology adopted in supply of utilities, source of thermal energy, etc. Some of the processing operations such as pasteurization, heating, cooling, refrigeration etc. are common for the manufacture of TIDPs or western products. Many western products such as milk powders, ice-cream, cheese etc. have also become the basic part of organized Indian dairy industry.

ENERGY CONSUMPTION IN PROCESSING OF MILK

The cooling of milk immediately after the production of milk, cold chain of milk transportation and subsequent pasteurization are the basic requirements in order to achieve good quality milk either to manufacture TIDPs or western products. The electrical energy required for bulk milk cooler varies depending upon the capacity of bulk milk cooler, capacity utilization of the bulk milk cooler, ambient temperature, maintenance etc. The rated energy required

for milk bulk coolers of 500, 1000, 2000, and 5000 liters capacity were 1.6, 2.48, 4.96, and 13.04 kWh respectively (Anon., 2010d). The cost of chilling in bulk milk cooler using diesel generator set has been reported (Anon., 2010c). The steam and electrical power consumption of milk pasteurizer having different level of regeneration efficiency have been reported (Harris, 1978). The values of steam and electrical power requirements reported by various workers vary considerably on account of capacity of the pasteurizer, regeneration efficiency, temperature of pasteurization etc. Garrett and Reay (1978) reported energy requirements of for 12.5 MJ per 100 gallons of milk for pasteurization of milk in HTST plant having 90 % regeneration efficiency. Varshney and Patil (1978) reported that the steam consumption of different make HTST pasteurizer ranged between 1.77 and 2.02 kg steam per 100 kg of milk processed. The energy audit carried out in recent years reveals that steam consumption varies from 1.5 to 1.6 kg steam and 0.39 kWh electricity per 100 kg of milk processed in HTST plant. The comparison of values of energy consumption reported by various workers is difficult as the regeneration efficiency, pasteurizing temperature, make of pasteurizer etc. are different.

Cream separation and homogenization may also be required in processing of milk. Garrett and Reay (1978) reported energy requirements of 2.0 and 10.0 MJ per 100 gallons of milk for separation and homogenization process. Cream separator requires 1 kW power for a flow rate of 1000 kg/hr while power requirement for homogenization is directly proportional to homogenization pressure and flow rate of the product.

ENERGY REQUIREMENT IN MANUFACTURE OF TRADITIONAL INDIAN DAIRY PRODUCTS

The traditional method adopted in unorganized sectors for the manufacture of TIDPs such as *khoa*, *khoa* based sweets, *basundi, chhanna, chhanna* based sweets, *paneer, shrikhand, makhan*, ghee, butter milk etc. mainly requires thermal energy in the manufacturing process. When mechanized systems are developed for commercial manufacture of these products, in addition to thermal energy mechanical energy is also required for various unit operations involved in the process. The literature on production technology of TIDPs followed in different parts of the country, chemical composition, sensory attributes microbiological quality etc. is quite well documented. However, as these products are manufactured in rural and urban unorganized sectors, the information published on energy requirement is very scanty except for those products which are mechanized and adopted in organized dairy plants. In commercial scale manufacture of TIDPs, processing of milk is a part of the production line. It will not be possible to use raw milk directly for the manufacture of some of the traditional region specific milk products. Therefore, energy required for processing of milk together with specific energy requirements in manufacture of TIDPs is presented in this paper.

HEAT DESICCATED MILK PRODUCTS

Heat desiccated dairy products mainly include *khoa* and *khoa* based sweets. The traditional method of manufacture of *khoa* involves concentration of milk in open vessel with continuous stirring using wood, LPG or gas/diesel fired furnace till the semisolid consistency is achieved. The preparation of *khoa* requires considerable amount of water to be evaporated at atmospheric pressure. It is estimated that preparation of one kg of *khoa* requires to evaporate 4 kg of water from the milk which consumes theoretically 9.032 MJ of heat. The efficiency of such furnaces employed for *khoa* making process is relatively poor in the order of around 50 % which requires two times higher thermal energy input as compared to theoretical energy requirement. The mechanized SSHE developed by different workers requires steam as source of heat and electrical power for the operation of scrapper assembly. The reported values of energy consumption of *khoa* making machine varies from 1.2 to 1.4 kg steam and 0.10 to 0.25 kWh electrical energy per kg water evaporated from milk. The steam requirement of *khoa* making machine developed by Banerjee et al. (1968) having rated milk capacity of 50 litre/h was 50 kg of steam per hour and electric power requirement was 4 kWh. Singh and Verma (1985) studied the energy consumption and losses in *khoa* making process using a jacketed steam vat of 15 litre capacity. The steam consumption was found to increase from 1.224 to 1.320 kg/kg of milk with increase in pressure from 0.5 to 1.5 kg /cm^2 (49.05 to 147.15 kPa) pressure for a batch of 5 kg milk. The steam consumption/kg milk was observed to be 1.31, 1.27 and 1.24 kg when quantity of milk processed was 5, 18 and 24 kg respectively. It was observed that when steam pressure was varied from 0.5 to 1.5 kg/cm^2 (49.05 to 147.25 kPa), the heat utilization in processing of milk into *khoa* reduced from 65.64 to 56.62 % for a bath of 5 kg milk. Verma and Lal (1989) reported energy requirement of 825.23 Kcal /kg milk for preparation of *khoa* and thermal losses were 32.03 %. Dodeja et. al. (1989) studied the power consumption of thin film SSHE used for the manufacture of *khoa*. Cuevas et al. (1982) indicated that the contribution of electric power required for driving the rotor is very small (< 0.5 %) as compared to steam required for evaporation of water. The electrical power consumption of batch type *khoa* making machine developed by More (1987) was 0.093 kWh per kg of milk handled.

Burfi, peda, thabdi etc. are prepared either using *khoa* as a raw material or directly from milk. As these products are manufactured mostly in unorganized sectors, energy consumption of such processes is not published and it depends on the type of the furnace and heat exchanger employed in the preparation of these products. Chauhan et al.

(2009) reported steam consumption of 0.93 to 1.12 kg steam per kg milk processed and electricity consumption from 6.0 to 8.34 kWh per 1000 kg of milk processed for three stage scraped surface heat exchanger. The steam consumption of continuous *basundi* making machine was1.2 kg steam per kg water evaporated (Sunil Patel, 2007).

ACID COAGULATED MILK PRODUCTS:

Paneer is one of the most important products in the category of acid coagulated milk products. Thermal energy is required in raising the temperature of milk to about 90^0C. The values of thermal energy requirement vary from 70 to 100 kg steam per 100 kg product depending on the initial temperature of milk and type of equipment used.

FERMENTED MILK PRODUCTS:

Dahi, chhass and *shrikhand* are the main fermented TIDPs. Thermal energy is required to increase the temperature of milk to incubation temperature depending upon the type of starter culture used for preparation of *dahi/ chakka*. This process requires around 10 to 12 kg of steam per 100 kg of milk as per the type of equipment used. For *shrikhand* manufacturing, basket centrifuge is used for removal of whey from curd to prepare *chakka*. Thermization is done after mixing of *chakka,* sugar and other ingredients using a SSHE vat. The reported values of LPG consumption for thermization of *shrikhand* ranged between 0.5 to 1.25 kg/h for a thermization machine operating capacity ranging between 85 to 150 kg/h.

FAT RICH DAIRY PRODUCTS
MAKHAN AND GHEE:

Makhan is prepared by agitating the whole milk curd by either by manual or power driven agitator. Ghee is very popular premium indigenous milk product and it is traditionally prepared from *makhan* by evaporation of water in open pan using direct fired stove/furnace. In organized dairy plants, ghee is prepared from white butter in ghee boiler having power operated scrapers and steam as a source of heat. Lakshmi kanth (2003) found steam and electricity consumption 42 kg and 1.302 kWh per 100 kg ghee respectively. Pandya et al. (1987) found that cream with 40%, 50% and 60% fat when converted into ghee by direct cream method, required 1951 kcal, 1325 kcal and 896 kcal of energy per kg of ghee respectively. Abhichandani et al. (1978) developed continuous ghee making machine using creamery butter as raw material. The steam and electricity consumption were found as 0.35 kg at 2.0 kg/cm^2 steam pressure and 0.01 kWh per kg of butter.

DAIRY PLANT UTILITIES

The supply of steam, water, electricity and compressed air supply are very essential for dairy plants. The cost of steam produced in organized dairy plant varies from Rs. 2.0 to 4.0 per kg of steam produced depending on the type and capacity of boiler installed and the type of fuel used for steam generation. The cost of water pumping and distribution depends on the rate of flow as well as head of the water. The electrical power requirements for supply of air for operation of pneumatic controls depends on the type of compressor, pressure of the air required and the temperature of the air. It is reported that 0.5 – 0.75 kWh energy needed for removal of 1 kg of COD by aerobic process, while 1.2 kWh energy can be generated from 1 kg of COD removed by anaerobic process. Refrigeration is very important for processing of milk and storage of some of the products. It is reported that 50 to 60 % of electrical cost incurred for the operation of ice bank refrigeration system and cold storage. It is found that electrical energy in order of 0.8 to 1 kWh per ton of cooling effect depending upon the operating conditions of the plant.

SCOPE OF NON-CONVENTIONAL SOURCES OF ENERGY:

As the use of non-conventional sources of energy is eco-friendly, there is a scope to use solar energy in dairy plants to conserve energy as well to contribute in the carbon foot print cutback. The use of solar water heating system is an established practice for heating of water required for boiler feed water, cleaning application etc. However, due to certain economical, operational and maintenance problems, it is not exploited to its fullest extend. A solar water heating system of 50,000 liter capacity designed to heat water from 30 ºC to 75 ºC can collect 9,418,500 kJ per day which is equivalent to about 205 kg of furnace oil resulting into saving of about Rs. 25.8 lakh every year. As a result of advancement in solar collectors and related technology, it is prudent to use solar energy. Similarly, solar lighting, wind power, bio-gas etc. can be considered for conservation of energy.

CONCLUSION:

Thermal and electrical energy are the basic requirement for the manufacture of various traditional Indian dairy products. The efficient use of energy is not only important for reducing the cost of manufacture of the products, but also helps in reduction of GHGs in the environment. The conservation of energy in different unit operations involved in production of traditional Indian dairy products is one of the essential requirements for reducing production cost. The adoption of newer technology having potential of energy conservation in the area of mechanization of TIDPs is one of the essential requirements for the entrepreneurs. The possibilities of utilizing solar energy in the manufacture of TIDPs should be exploited wherever possible.

Design and Development of in-line System for Manufacture of Multiple Indian Traditional Dairy Products

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ABSTRACT

An in-line system for manufacture of multiple traditional milk products has been conceptualized to overcome the problems associated with processing of these products by providing a better control over the processing parameters. For design and development of in-line system, a number of equipment were identified, selected and integrated on the basis of unit operation and processing parameters required for production of Indian dairy products. The developed in-line system consists of milk feed tank, milk pump, scraped surface heat exchanger (SSHE), intermediate concentrated milk tank, product conveying mechanism, conical process vat (CPV) and continuous product cooling system. Variable parameters considered for in-line production system were steam pressures and speed of the scrapping mechanisms in different processing equipment. The above process parameters were optimized for different products, viz., *khoa, burfi, basundi, rabri* and *ghee,* on the basis of product quality and the sensory scores. The product obtained by the optimized parameter were comparable ($p<0.05$) with that of product prepared conventionally and it could thus be concluded that in-line system can be successfully employed for manufacture of multiple Indian traditional dairy products.

KEYWORDS:

Indian traditional dairy products, in-line system, process mechanization

INTRODUCTION

Agricultural development is crucial to India's overall progress and this can be achieved by intensifying the agricultural and allied activities as well as by diversification and commercialization of agriculture. A strong and effective food processing sector plays a significant role in diversification of agricultural activities, improving value addition opportunities and creating a surplus for export of agro-food products. With the implementation of various dairy development programmes, the dairy industry in India has made remarkable progress in the last three decades. Significant increase in the milk production has been achieved and the white revolution has ended our foreign dependency for dairy products. India holds first rank in respect of total milk production in the world and dairying in India has ushered in an era of surplus milk resulting in diversion of substantial quantities of milk for the commercial production of several value added milk products including indigenous milk based sweets. The Indian market for dairy processing machinery has been growing steadily with domestic demand for milk, milk products and milk beverages growing significantly in the last few years. This pattern is likely to continue as more milk processing units are commissioned in India.

The flavour of the new millennium is India's ethnic milk-based sweets, desserts and puddings. Each product has its distinctive characteristics and unique processing techniques which have been evolved through the ages. Milk and milk products are highly valued in Indian society as a source of nutrition (Aneja et al., 2002). The market for Indian milk products is estimated to be of the order of Rs. 250 billion. This fact underlines the significance of traditional dairy products in the national economy. In spite of such a great importance of traditional dairy products in our country, these products are still produced manually in the small sectors with variable quality depending on the skill of the *halwais*. The current methods of manufacture of these products are primitive and based on techniques that essentially remain unchanged over ages. The small scale operations are associated with inefficient use of energy, poor hygiene and non uniform product quality (Patil, 2002). Systematic efforts have been made by various researchers to standardize the production of Indian dairy products

(Gaikwad and Hembade, 2011; Patel and Upadhyay, 2004, Kumawat et al., 2012, Gayen and Pal, 1991).

Design of equipment for a given product processing is based on its process description. Usually the process description is provided in the form of product recipe which is developed for a small scale product manufacture. Preparation of product by continuous processing equipment is an accelerated procedure. Many a times the process parameters of the recipe do not suit to the machine parameters. In such circumstances even though the equipment is optimized for the given process, the product prepared by machine does not match the recipe product. The specific processing requirements for equipment development for traditional Indian milk products are diversified. The requisite engineering design inputs could be delineated as preheating, concentration, scrapping of heating surfaces, mixing and blending of ingredients and milk-metal-air contact for producing characteristic mild cooked flavor in indigenous dairy products. Sometimes several of these unit operations are to be carried out simultaneously and in the same processing vessel. Taste and texture continue to be the major market force in the development of dairy foods. Texture formation in traditional dairy products is one important characteristic for process mechanization as product with pasty consistency and poor grainy texture has low acceptability.

The processing of traditional Indian milk products require several unit operations which are difficult to carry in one piece of equipment. Based on all these facts, an in-line system for manufacture multiple traditional milk products has therefore been conceptualized and developed to overcome the problems associated with processing of products like *khoa*, *burfi*, *rabri, basundi* and *ghee* by providing a better control over the processing parameters.

MATERIALS AND METHODS

The concept of in-line production of milk products involves the integration of different equipment, wherein, each of the equipment would contribute to specific unit operation requirement. The approach for mechanization is based on simulation of unit operations which are essential to Indian dairy products for development of proper texture and flavour. Several unit operation based equipment have been successfully developed and tested at Dairy Engineering Division of National Dairy Research Institute, Karnal in the recent past for the process mechanization of Indian milk products. This equipment include mechanized conical process vat (CPV), scraped surface heat exchanger (SSHE), and mechanized system for continuous cooling of milk products and continuous transfer mechanism for concentrated milk products. Each of the equipment has its advantages and disadvantages associated with the equipment, different processing parameters, capacities and suitability for integration into in-line system for a particular unit operation.

2.1 DEVELOPMENT OF MECHANIZED CPV

A mechanized process vat with conical configuration offering a straight line scrapping profile with a scrapping mechanism has been developed. The vat has a cone angle of 60o and a steam jacket partitioned in to four independent segments for efficient use of thermal energy and less heat loss. The scrapping mechanism consists of three equidistant arms supported at two points in the shaft and each arm having independent spring loaded Teflon blades. A backward raked 3-vaned impeller for continuous product discharge has been mounted on the central shaft. The unit has a positive displacement screw pump for recirculation and spreading of product on heat transfer surface during processing for texture control and increased heat transfer. This equipment simulates the ordinary *karahi* of the *halwai* or a steam jacketed vessel. The equipment can process the milk product up to very high concentrations and is very useful in product texture formation and cooked flavour development in the product by aloowing the required milk-metal-air contact. (Agrawala, et. al. 1987, Kumar and Sawhney 2004).

2.2 DEVELOPMENT OF THIN FILM SSHE

In thin film SSHE, the working fluid is spread in the form of film over the surface by rotating blades. Each film scoops a certain amount of fluid from the pool and accelerates it along the heat exchanger surface. At any given instant the fluid picked up by blades is partly in the form of a film behind the blade and partly in the form of fillet in the front of blade. The blade action is that of a plough that causes part of the fluid mix with that of the fillet. The unique characteristic of thin film scraped surface heat exchanger are, high heat transfer coefficient, narrow residence time distribution, short residence time, minimum surface fouling and wide viscosity range. This equipment can conveniently be used for concentration of product up to 45% product concentrations with very high heat transfer coefficients (Dodeja et al 1990a).

2.3 DEVELOPMENT OF MECHANIZED SYSTEM FOR CONTINUOUS COOLING OF MILK PRODUCTS

Khoa and other base materials for various indigenous dairy products, *rabri* etc after their preparation are cooled in trays in open atmosphere for 3-4 hrs. Slow cooling results in more browning effect due to interaction of milk sugars and amines at higher temperature. Use of modern mechanized vacuum coolers, employed for rapid cooling of khoa in trays, is not feasible in continuous system. A mechanized system for continuous cooling has been developed that could be integrated inline production system. A fully enclosed jacketed tubular screw conveyor was designed to cool the product to the desired temperature without affecting physical, chemical and sensory attributes. This system was fabricated using food grade stainless steel with the angle adjustment viz. 0,5,10 degree inclination and variable RPM viz. 3, 6, 9 of screw shaft. The operating parameters have been optimized for different products for obtaining optimal performance with regard to heat transfer coefficient (U-value), cooling rate, and cooling efficiency (Gurjar and Sawhney , 2009, Avijit and Sawhney 2010).

2.5 DEVELOPMENT OF MECHANISM FOR PRODUCT TRANSFER FROM MANUFACTURING TO COOLING SYSTEM

Most of the indigenous dairy products are viscous, semi solid and sticky in nature. The conveying of these products poses practical difficulties and has been limited to manual methods only. A fully enclosed tubular type screw conveyor has been designed and fabricated for this purpose. The system has an angle adjustment mechanism for varying the angle of inclination of the screw. The system also has the provision for varying the rpm of the screw by using the variable frequency drive. The operating parameters of the system, viz. rpm of screw, angle of inclination of the screw with the conveyor axis and conveying temperature of the product have been optimized for different products and their concentrations using response surface methodology (Mohit and Sawhney 2011).

2.5 PROCESS OPTIMIZATION OF INTEGRATED IN LINE SYSTEM

The SSHE with variable frequency drive (VFD) motor, conical process vat (CPV) with agitator (fixed rpm), product transfer mechanism with variable drive and product cooling system were integrated through suitable piping, pumps and intermediate balance tanks.. Operational parameters of the equipment were optimized by Response Surface Methodology (RSM) and general factorial design using 'Design Expert software 8.0 Statease Inc'. The machine parameters considered were SSHE rpm (50-200), SSHE steam pressure (2-5 kg/cm^2) and CPV steam pressure (1-3 kg/cm^2). Preliminary trials were conducted to find the range of these parameters for mechanized production of *khoa*, *burfi*, *rabri, basundi* and *ghee*. Various responses were total solids (%), fat (%), textural attribute and sensory scores (flavour, body and texture, colour and appearance and overall acceptability). Texture profile analysis was done using Texture Analyzer TA-XT2i (Stable Microsystems, UK).

KHOA

For production of khoa, milk was first concentrated to 35-45% total solids in SSHE. Concentrated milk was transferred to CPV using screw pump where texture formation and final working of khoa was done. The process variables were: SSHE steam pressure (3-5 kg/cm^2), SSHE scraper speed (100-200 rpm), concentration (35-45% TS) along with steam pressure of CPV (1-2 kg/cm^2). Cooling of khoa was done in a cooling system operating at 9 rpm with 10^o angle of inclination.

BURFI

Three variables viz. CPV steam pressure (1.0-1.5 kg/cm^2), stage of sugar addition (45-50%TS concentration of milk) and rotor speed of continuous cooling system were considered for in-line production of *burfi*.

RABRI

Parameters selected for process optimization of *rabri* production were: initial concentration in SSHE (25-31% TS), final concentration in CPV before addition of sugar (35-45%) TS), clotted cream layer to sweetened condensed milk (CCL/SCM) ratio (0.10-0.25) and steam pressure in CPV during removal of CCL (0.5-1.5 kg/cm^2).

BASUNDI

For in-line production of basundi, milk was preheated to 90^{o}C for 10 min in SSHE and was concentrated upto 20% TS. Concentrated milk was transferred to CPV and sugar was added. Heating was continued till concentration of 2.5 times of initial milk solids (including sugar) was achieved. Variable parameters were SSHE speed (50 to 200 rpm), SSHE steam pressure (2-4 kg/cm^2) and CPV steam pressure (0.5 to 3 kg/cm^2).

GHEE

Ghee from cream: Buffalo milk cream (40% fat) was used for manufacture of ghee. Cream was heated in SSHE and was re-circulated until entire moisture was removed. When the product attained the temperature of about 105°C it was transferred to CPV for slow heating and heat clarification.

GHEE FROM BUTTER:

Butter (84 % fat) was used for manufacture of ghee. Butter was melted in CPV and was pumped to feed tank. Molten butter was heated in SSHE and was re-circulated until entire moisture was removed. When the product attained the temperature of about 105°C it was transferred to CPV for slow heating and heat clarification.

RESULTS AND DISCUSSION

KHOA

Optimum parameters for khoa production were predicted as 4.96 kg/cm^2 steam pressure, 200 rpm scraper speed of SSHE, 45% TS concentration along with 1 kg/cm^2 steam pressure of CPV. Sensory score viz. flavour (50), body and texture (35), colour and appearance (15) were 44.63, 32.10, and 12.60 respectively. Average textural attributes like hardness, gumminess, chewiness, adhesiveness, springiness, cohesiveness value were 3.415N, 0.808 N, 0.234 Nmm, 0.534 Nmm, 0.257 mm and 0.241 respectively. The TS of the product was 62-64% with 19-21 % fat.

BURFI

Using RSM optimum parameters for *burfi* production were predicted as 1.5 kg/cm^2 steam pressure (after sugar addition), 50%TS concentration of milk for sugar addition stage and 8 rpm of rotor of continuous cooling system which will give maximum sensory and textural score among all combinations. The TS of *burfi* was in range of 72-75% having 17-18.5 % fat. It was observed that *burfi* produced by optimized parameters had average textural attributes score for hardness (3.86 N), gumminess (0.54 N), chewiness (0.108 Nmm), adhesiveness (0.652 Nmm), springiness (0.152 mm), cohesiveness (0.344). Average sensory score for flavour (50), body & texture (35), colour & appearance (15) were 37.76, 29.09 and 12.27 respectively.

RABRI

Optimum parameters for rabri production were predicted as 29.90% TS initial concentration, 39.41% TS final concentration before addition of sugar, CCL/SCM ratio 0.16 along with 0.75 kg/cm^2 steam pressure in CPV during removal of CCL. Rabri produced by using optimized operating parameters gave average 9 point hedonic sensory score viz. flavour, body and texture, colour and appearance and overall acceptability as 7.97, 7.93, 8.23 and 8.067 respectively. The TS and fat content of the optimized sample was 44% and 14.4% respectively. The average textural attributes score for firmness and stickiness value were 0.354 N and -0.0528 N respectively.

BASUNDI

Optimized parameters were SSHE speed 165 rpm, SSHE steam pressure 4 kg/cm^2 and CPV steam pressure 3 kg/cm^2. Predicted sensory score viz. flavour (45), body and texture (35), colour and appearance (15) and packaging (5) were 42.97, 33.6, 13.24 and 4.87 respectively. Viscosity, TS and fat content of the optimum sample were 67.58 mPas, 31.4% and 11.5% respectively.

GHEE

The optimized parameters for ghee from butter were SSHE 200 rpm, 2.5 kg/cm^2 SSHE steam pressure and 3 kg/cm^2 CPV steam pressure. Sensory score viz., flavour (45), body and texture (10), colour (10), and freedom from suspended particles (5) were 42.2, 8.44, 9.25 and 3.49 respectively. Moisture content, BR reading and FFA were 0.28 %, 40.5 and 0.69 respectively. The optimum operating parameters for making ghee from cream were SSHE 100 rpm, 4 kg/cm^2 SSHE steam pressure and 2.5 kg/cm^2 CPV steam pressure. Sensory score viz., flavour (45), body and texture (10), colour (10), and freedom from suspended particles (5) were 40.9, 8.2, 8.0 and 4.76 respectively. Moisture content, BR reading and FFA were 0.31 %, 40.8 and 0.77 respectively.

CONCLUSION

The developed in-line system can be used for manufacture of multiple products like *khoa*, *burfi*, *rabri, basundi* and *ghee*. The product obtained by the optimized parameter were comparable ($p<0.05$) with that of product prepared conventionally. It meets the requirement of small and medium entrepreneurs handling 500 to 2000 litres of milk per day for manufacture of various Indian dairy products with the same set of equipments. The integrated in-line system has been designed to take advantage of each equipment for production of Indian dairy products.

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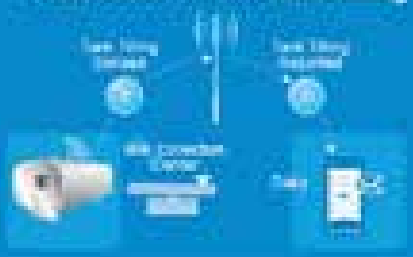

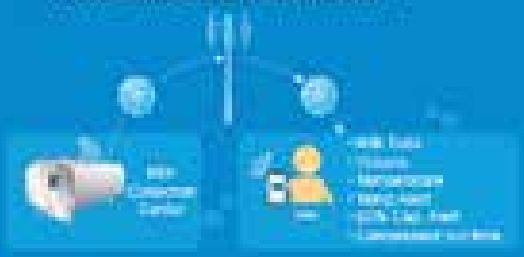

Auto Flush System

Flushing of residual milk by using water

Flushing of residual milk by using Auto Flush System

Advantages of Auto Flush System

- Overcome contamination of milk by flush water hence improvement in microbial quality of milk
- Improve milk quality in terms of %Fat and %SNF in milk as air is used to Flush the milk in the milk tanker
- Very easy to install in available set up
- Compact design and easy of operations
- In line Air filter to ensure high quality of air in the system to flush the milk
- Energy efficient

Auto CIP (Cleaning in Place)

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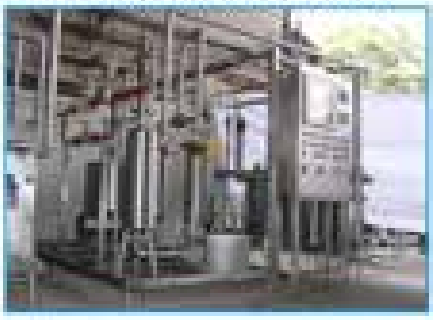

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Technical Session-III

Dahi Processing Equipment and their Design

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INTRODUCTION

Dahi is a popular Indian fermented milk product known since Vedic times. Similar types of products have also emerged from various parts of the world and are known by different names, yoghurt being the most popular. The art of fermentation was developed by man kind for preservation of food, but soon they realized number of other benefits of fermenting milk and became very popular. Today, market for fermented milks has tremendously increased, mainly because of their functional, nutritional and health attributes. Fermented milks are also the best dispensing media for probiotics.

Dahi is traditionally made in homes, but as the demand is increasing, its industrial production has become mandatory. Manufacture of dahi and fermented milks involve special care because they are live and are very sensitive. The quality of the product depends largely on the culture behavior and is greatly affected by environmental, mechanical and physical factors. As they are in the form of very fragile and sensitive gel, they need utmost care during processing and handling. Hence, we need special type of equipment and machinery for production of dahi and related products. Further, as live organisms are desired in the product, we cannot use harsh treatments to control unwanted or spoilage bacteria. Looking to these two special issues, the equipment and processing lines designed for handling dahi and fermented milks must have two specific features; (i) hygienic design for effective cleaning, sanitation and contamination control and (ii) gentle handling appliances that do not give stress and strain to the gel.

Apart from main processing lines, manufacture of dahi may require starter culture production facilities, especially when Direct-Vat-Set (DVS) cultures are not used/not available. Starter culture propagation and bulk starter culture production facilities are available with unique features of contamination control.

Following discussion shall highlight requirements of dahi and fermented milk processing equipment and their design.

DAHI PRODUCTION LINE

While travelling through the dahi production line, it could be noted that the process is simple and requires less complicated equipment. However, process flow for set type product and stirred type product is entirely different. Probably the quality requirement of product may also be different. The most important steps in the process involve a set of specially designed equipment for (i) raw material mixings (ii) heat processing (iii) starter propagation and production (iv) incubation (v) cooling and stirring and (vi) packaging.

SYSTEMS FOR STARTER CULTURE PRODUCTION

As the use of concentrated DVS cultures has become popular, the need for propagation of culture at dairy factory has become unnecessary. However, if a dairy plant wishes to have the culture propagation and bulk starter production, different systems are available. The most important is aseptic handling of starters. In order to prevent the entry of the outside air, it is important to heat the growth medium and cool down in a completely enclosed system of a fermentation tank. It is normally recommended that two tanks should be used in rotation; one contains ready-made starter for use and the other is for preparing starter for the following day. The bulk starter tank should of an aseptic design (i.e. hermetically sealed and triple jacketed) and preferably equipped with HEPA filters. It should be capable of withstanding negative and positive pressures up to 30 and 100 kPa, respectively. The shaft of the agitator should be double sealed.

Different types of mechanically protected systems have been developed in last 50 years. The most important are; (a) The Lewis system and (b) Alfa Laval system, both working on different principles. The Lewis system involves the use of squeezable plastic bottles with two-way hypodermic needles to carry out starter propagation from stock-mother-feeder to bulk culture. The culture remains under completely closed system and hence there is no scope for contaminant to enter. The bulk starter tank is pressured and it does not permit entry of air during heating and cooling of medium inside. The vessel is totally submerged within an insulated water tank, which provides maximum protection from aerial contamination as well as maintaining a constant temperature during incubation. The agitator shaft is fitted with a double mechanical seal, and water under pressure is fed to the seal housing to ensure efficient protection against contamination, cooling and lubrication.

The Alfa Laval system uses glass bottles for the culture propagation and the transfer is affected through pressurized filtered air. The bulk starter tank is not pressurized but the air enters through a special sterilization assembly that prevents contamination especially with phages. The bottom of the tank is slanting for easier drainage. Similar systems with some modifications in air sterilization systems are also available.

SYSTEM FOR RAW MATERIAL MIXING

It is well known that best quality yoghurt can be made with milk having 14.5 to 15.0% total solids. This is the optimum concentration of milk solids to make dahi also. This demands the system to raise milk solids in the milk. The level of milk solids in the milk base can be raised by adding different high total solids preparations of milk either in dried or in a liquid form,

although skimmed milk powder is used most widely. The dried ingredients are incorporated into the aqueous phase using sifter for delivery into the mixing unit in order to ensure the complete dispersion of the dried ingredients, complete hydration of the dried particles with no residual lumps, minimal incorporation of air in order to reduce the problems of foaming, and easy cleaning and sanitization of the unit. In a large scale production, generally, closed circuit system is used for reconstitution which consists of a tank, pipe connection, centrifugal pump and the funnel/hopper assembly. In this circuit, arrangement of the hopper with regard to the centrifugal pump affects the process. Hopper assembled on the suction side of the centrifugal pump, for instance, offers an advantage of rapid dispersal and adequate dissolution of the powder owing to the action of the pump, however frequent blockages may occur. On the other hand, hopper on the outlet side of the centrifugal pump could avoid the problem of blockage but full dispersal of powder may be a little slower.

Similar system can be useful for mixing other raw materials too, especially sugar or sugar syrup for making sweetened dahi.

HEATING AND COOLING SYSTEMS

Heating of milk base is essential to make it suitable for growth of starters, to make it safe and also improve some of the technological properties of the dahi. Two types of equipment that could be used for heat treatment of milk include; (a) batch pasteurizers or multi-purpose tanks and (b) plate or tubular heat exchangers. Batch or multi-purpose tanks (series of tanks for large scale plant) are normally water jacketed. Steam is injected into the water during the heating stage of the milk base and chilled water is circulated during the cooling of the milk.

In continuous system, plate heat exchanger is most widely used and it consists of a series of corrugated stainless steel plates held together in a frame, and a rubber gasket is fitted to prevent leakage. The necessary size and configuration of any type of heat exchanger are mainly dependent on product flow rate, physical properties of the coagulum gel to be processed, temperature programme, permitted pressure drops, heat exchanger design, cleaning requirements, required running or operation time.

Usually it is done in the range of 80-95C for 5 to 30 min. Holding is essential to get hundred per cent denaturation of whey proteins, which help in giving firm coagulum and minimize problem of whey separation from dahi. Hence, heating in batch pasteurizer or multi-purpose fermentation tank is desirable. In conventional heat exchangers, the provision of holding is too short and hence for making good quality dahi, it is required to design heat exchangers with long holding tube. Depending on the plant capacity, the holding time and maximum temperature could be optimized. Homogenization is a desirable process in the pasteurization line for getting better quality dahi.

INCUBATION SYSTEMS

There is a great difference in the incubation system during production of set dahi and stirred dahi. It should always be kept in mind that for set dahi, the incubation is done while the product is in final retail container and hence the system must be very gentle. For stirred type product, like lassi or butter milk, the incubation can be done in bulk tanks, but extreme care is required while stitting and cooling the coagulum.

CABINETS (BATCH SYSTEM)

In the cabinet system, incubation takes place in small insulated chambers with average capacities ranging from 250 to 750 l. Forced hot air is circulated during the fermentation stage and later it is replaced by chilled air to cool the coagulum. All units of this type are electrically operated and some incubator/cooler cabinets are fitted with a pH controller so that the fermentation/cooling cycle can be automated. However, care should be taken to circulate the air uniformly and provision for accurate and reliable temperature control in the cabinet is necessary. The disadvantage of this approach is that the coagulum is in motion while it is still warm and hence may suffer some structural damage and/or whey separation.

TUNNEL (CONTINUOUS SYSTEM)

Large quantities of set product could be produced in batteries of individual cabinets, but the process can be mechanized for continuous production by adopting a tunnel system. The pallets containing the dahi pots are placed on smooth rollers/conveyor belt and travel through a tunnel consisting of two sections. Warm air is circulated in the incubation part of the tunnel and the speed of the pallet is governed by the speed of the conveyor belt, which in turn is regulated by the rate of lactic acid production in the milk. At the end of the fermentation period (sensed by pH probe), the pallets pass through the cooling section and the hot air is replaced by a blast of chilled air. The product is partially cooled in this section and final cooling takes place in the cold store. Vibrations and mechanical disturbances during the entire process of incubation are detrimental to get stability.

FERMENTATION TANKS

Special fermentation or multi purpose tanks could be designed to obtain standards of aseptic conditions by equipping insulated tank with pH electrode and resistant thermometer, air filter and agitator with double shaft seal with steam barrier which would eventually minimize the contamination. Tank could be permanently pressurized (0.01 ± 0.005MPa) under sterile air.

COOLING SYSTEMS

The basic objective of the cooling is, of course, to slow down the metabolic activity of starter cultures and control acidity. The rate of cooling is extremely important and as thumb rule, faster cooling contracts gel and release more whey separation, while slower cooling give better gel strength. Increase in acidity of the product during cooling period should be considered while deciding the end of incubation period. For example, expected acidity in dahi is 1.0% LA and the rise in acidity during cooling period is expected to be 0.3%LA, then the incubation should be terminated when the coagulum show 0.7% acidity.

The sensitivity of coagulum is higher at higher temperature and hence it should be very gently handled, when it is at higher temperature. Therefore, in thermophilic products or stirred products, two stage cooling is advisable. The gel may be gently stirred to cooling to about 15C and then it can be packed and finally cooled in cold store to 4C. The recommended temperature for fermented milks during storage, distribution and retailing is below 4 ºC, otherwise the keeping quality of the product will be severely impaired.

Chilled air is circulated in cabinets and tunnels to cool set type of fermented milk and usually circulated in the jacket for stirred types of fermented milk at the end of the fermentation period. It is also circulated in the cold store, transport vehicles and retail stores. Rate of cooling of coagulum from 37-42 ºC to 20 ºC or <7 ºC is greatly dependent on area of the speed of agitation, contact surface, temperature differential between the cooling medium and the product, mass flow rate of the cooling agent, contact time between the product and the cooling surface. Another way is cooling of fermented milks by using heat exchanger (preferably plate) into the coagulum at the end of the fermentation stage. However, this type of apparatus could not be used for set type of fermented milks.

Continuous coolers, on the other hand, provide more rapid cooling of fermented milks. The plate cooler is similar in design to the conventional plate heat exchanger described earlier, except that the gap between the plates is much larger (e.g. up to 6mm compared with 2.5 mm), so minimizing the risk of structural damage to the coagulum. In addition, because of the tendency of back pressure to build up in a plate cooler, either the passage of fermented milk has to be restricted, or alternatively the gap between the plates is increased progressively across the unit.

PUMPS

Different pumps are used in the dairy industry, depending on their intended function. For simplicity the production line can be divided into the following sections:

- liquid milk handling and processing
- coagulum production and handling
- fruit/fermented base blending and packaging

In large plants the fermented milk, the finished or semi finished product pumped through long pipelines with many valves, and through heat exchangers, filters and other equipment may result in high pressure drops. Therefore, pumps are used in different parts of the processing plants and it is important that the right type of pump is installed at the right place in order to avoid problems.

Centrifugal pumps could be used for milk handling lines but not the fermented milk as they produce high shear. Positive displacement pumps, either rotary or reciprocal type, are good for pumping fermented milks. Another type of positive displacement pump is known as the eccentric screw, helical or screw pump, widely used for pumping fermented milks containing fruits preparations. Lobe-type rotary pumps, or the rotating displacement pumps are the most widely used for fermented milks. The design of the rotor lobes makes them suitable for pumping fermented milks containing delicate solids (e.g. large fruit pieces). In general, each rotor is independently driven by a timing gear located at the back of the pump; however, the rotors do not touch each other or the pump casing even though the clearances between all parts in the pump are very small. Air-operated diaphragm pumps are also used in the yoghurt industry to transport a product including fruit pieces without any damage.

MISCELLANEOUS FITTINGS

Different items of equipment in a yoghurt processing line are linked together by a series of pipes, valves and sometimes strainers, and the passage of the fermented milks through these miscellaneous parts of the plant can cause some structural damage to the coagulum.

PIPES

Fermented milks are pumped at considerably low velocity therefore it could be assumed that the flow pattern through the pipes would be laminar. However, length and diameter of the pipe, internal roughness of the pipe surface, and fluctuations in fluid velocity could also affect the flow of the product. It has been reported that if the velocity and diameter of pipe are kept constant, reduction in the viscosity of yoghurt is proportional to the length of the pipe, and if the velocity and length of pipe are kept constant, the larger the diameter of the pipe, the least structural damage occurs to the coagulum. It is recommended that large diameter pipes should be installed between the fermentation tanks and the filling machines, and that at the same time the connections should be as short as possible.

FRUIT HANDLING AND MIXING UNITS

Different types of continuous mixer are available primarily for proper mixing, minimal structural damage, accurate blending of fruit and coagulum. Static in line mixer is most widely used in dairy industry which consists of a stainless steel pipe into which a number of helical blades are welded. The flow of coagulum/ fruit through the twisted blades in the mixer ensures uniform distribution of the fruit throughout the coagulum.

PACKAGING

Different types of packaging machines available for liquid, semi solid and gel filling can be employed, but the most important aspects is hygienic design. When set dahi is desired, it involves only filling of inoculated milk in cups. However, for stirred dahi packaging in bottles, positive displacement or piston pump which are volumetric are universal.

CONCLUSION

Dahi manufacturing equipment should be designed to handle very sensitive gel. The whole processing line must be centered at the care of culture and care of coagulum to get the best quality product.

Mechanization of Manufacture of Traditional Dairy Products

By Mr. Jayesh Gosrani (Jt. Managing Director)
Goma Engg. Pvt. Ltd.

GOMA INTRODUCTION:

GOMA ENGINEERING, a company more than 30 years old, provides Turnkey solutions from concept to commissioning of Dairy & Food Processing projects, such as building layout, machinery layout, erection of the plant and machinery, formulation of the products, packaging development, setting up laboratory, training to manpower, etc.

GOMA manufactures dairy equipment like Homogeniser, Pasteuriser, Skid Mounted Process modules, Crate Washers, Cup Filling & Sealing machine, Centrifugal Pump, Continuous Freezers.

GOMA undertakes turnkey projects for Dairy, Ice-cream, Yoghurt, Fruit Juice, Pulp, Tomato Ketchup Processing lines.

Goma, an ISO 9001-2008 company, headquartered at Majiwada, Thane, near Mumbai (India), owns office building of 7,000 sq.ft. area with all modern amenities with SAP program installed.

Goma's manufacturing facility (1st Unit) 50 k.m. away from Thane, sprawls on 5 acre land with more than 60,000 sq.ft. built up factory building with modern amenities for material handling, machining, assembling, testing, storing etc. 2nd Unit is situated at Pune for SS fabrication Job.

Goma has a very well developed service network to provide after-sales service to its customers. Customer support is very strong, with ready stock of each and every sub-assembly, all kinds of spares available off-shelf, and instant availability of technicians.

Goma has regional offices all over India i.e, at Kolkata, Bangalore, Chennai, and Delhi, with technically sound regional heads.

INTRODUCTION

India today produces 130 million MT of milk. India is the biggest milk producing country in the world. Milk and milk products constitute the largest gross agriculture produce of the country. The value of milk and milk products now exceeds Rs.40,000/- million (US$ 930 million) every year. A significant amount of milk produced in India has been traditionally converted into a variety of sweets. The practice seems to have originated because of staggered production in remote areas, regional/ seasonal surpluses, difficulties in transport / marketing and perishable nature of milk.

In spite of the fact that the dairy industry has made rapid strides in the last 3-4 decades, the methods of manufacture of the traditional products have remained essentially unchanged except for a few isolated products. Most of the developments in the dairy sector in India have been directed towards manufacture of western dairy products for which equipments were readily available from industrially advanced countries.

With the increase in availability of liquid milk, development of more competition for the western type dairy products and improvement in per capita income after independence, there is increased pressure for restructuring of the indigenous milk based sweets industry. The organized sector has started showing keen interest in processes and equipment for large scale manufacture of these products in the organized sector. Any innovation which can enable the organized sector to manufacture and market indigenous milk sweets on industrial scale can have far reaching impact on the dairy industry as well as on the social and economic condition of milk producers in the country.

The indigenous milk products of India can be broadly classified into the following three categories, depending upon the method for their manufacture:-

I. Condensed (Heat dessicated) Products:
Ghee, Khoa, Burfi, Gulab Jamun, Peda etc.

II. Cultured Products:
Dahi, Makkhan, Chhas, Lassi, Shrikhand etc.

III. Acid Precipitated Products:
Paneer etc.

1. GHEE

Ghee is one of the most important indigenous milk products of India. It is estimated that India alone produces some 650,000 tons of Ghee a year and more than 90% of Ghee is still produced by the traditional methods.

Traditionally, Ghee has been produced at house-hold level by fermenting the whole milk into curd and churning into indigenous (Dahi) butter, followed by heat clarification.

In the organized sector, Ghee is manufactured by batch processes directly from cream or via cream-butter route or by the prestratification method as shown in Diagram

Ghee Plant, Ap Dairy, Karimnagar : Capacity 1 Ton Per Da

Flow Diagram For Manufacture Of Ghee

↓

Receiving Of Milk

↓

Weighing & Filtration

↓

Standardisation/Separation

↓

Cream

↓

Additives

↓

Ripening

↓

Churning

↓

Butter Making

↓

Melting

↓

Prestratification

↓

Heating

↓

Settling

↓

Clarification

↓

Packing

↓

Storage

↓

Ghee

2. PANEER:

Industrial Process

A considerable amount of research and development work has been conducted on the optimization of the process for manufacture of Paneer. The Paneer process is illustrated in Following Diagram.

Flow Diagram For Manufacture Of Paneer

Milk

↓

Standardised Milk Heated In Phe-85Oc And Cooled To 75Oc

↓

Add Citric Acid @ 0.10%
Coagulum Settles Down. Whey Is Drained Off

↓

Coagulum Removed From Vat. Filled In Ss Hoops.
Placed Under Pressure 3 Kg/Cm2 For 15 Min.

↓

Paneer Blocks Removed From Ss Hops.
Placed In Vat Immersed In Chilled Water At 4Oc For 3 H.

↓

Paneer Blocks Removed From Vat, Cut To 200/500 G Blocks.
Wrapped In Hdpe/Ldpe, Heat Sealed And Stored In Cold Room

Automatic Paneer Plant, G. K. Dairy : Capacity 1 Ton Per Day

3. MISHTI DOI:

Mishti Doi is a highly nutritious, palatable, sweetened, fermented milk product available generally as a set curd product. Mishti Doi is very popular in the Eastern part of India especially in the/• state of West Bengal. \,

The traditional method for manufacture of mishti doi. comprises various steps viz. Preparation of milk concentrate with or without addition of starch, colouring and Flavouring the concentrate with burnt sugar, inoculating the previous day's product, dispensing the cultured mix in earthen bowls, incubating these overnight by keeping the bowls near a chulha without any control over the incubation temperature, acidity development etc.

Flow Diagram For Manufacture Of Mishti Doi

Receiving Of Milk

↓

Standardisation

↓

Adding Sugar & Caramel

↓

Heating Up To 90 Deg. C

↓

Cooling Up To 4245 Deg. C

↓

Inoculating With Starter Culture

↓

Filling In Cups

↓

Incubation At 42 Deg. C

↓

Cold Storage

4. DAHI/ YOGHURT:

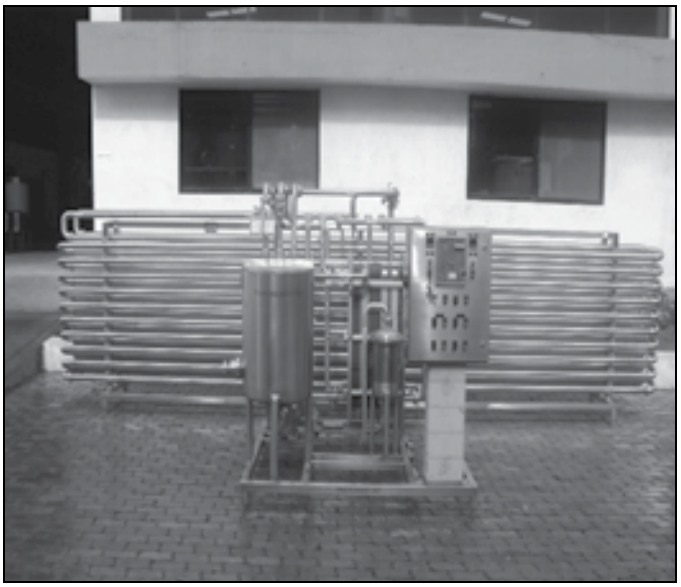
Dahi is a well know fermented milk product consumed throughout India. The conversion of milk into Dahi is an intermediate step in the manufacture of Shrikhand, Makhan and Ghee. There are three types of Dahi –prevalent in the country

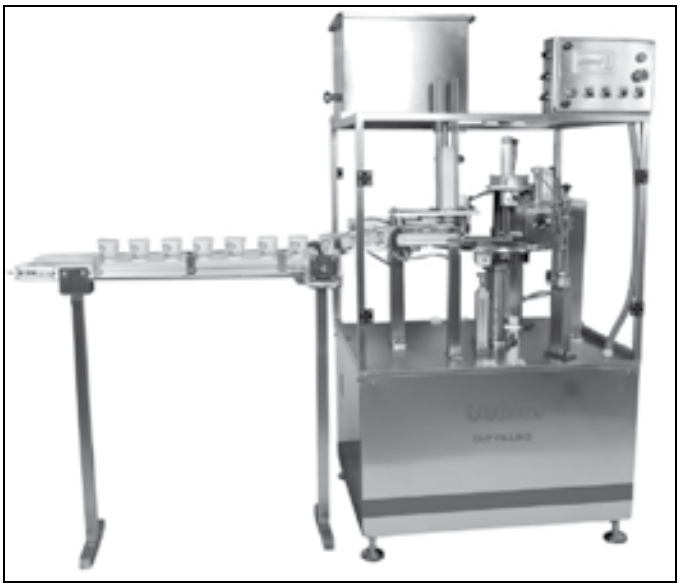
1) Sweet, mildly sour dahi
2) Sour dahi and
3) Sweetened dahi (called misti, lal or payodhii).

Dahi has higher nutritive value as compared to milk. It is palatable, digestive, and assimilable than milk. The product has got nutritive and therapeutic value. Dahi is carbonated to increase its keeping quality up to 15 to 30 days without refrigeration. Thermization is another process in which starter micro-organisms are killed after production of dahi to stop further metabolic degradation of milk constituents. Yoghurt is taken as short of set curd alike to dahi.

Flow Diagram For Manufacture Of Dahi

Receiving Of Milk
↓
Standardisation
↓
Heating In Past. Up To 90 Deg. C
↓
Holding 5-10 Mins
↓
Past. Milk Out At 45 Deg. C
↓
Adding Culture
↓
Packing
↓
Incubation
↓
Cold Storage





Dahi Plant, Matrubhumi Dairy, Gujrat: Capacity 2000 Lph

5. SHRIKHAND

Shrikhand is a Dahi-based product

The Dahi I curd is partially strained' through a muslin cloth to remove the whey and thus produce a solid mass called chakka (basic ingredient for shrikhand). This chakka is mixed with the required amount of sugar. spice or nuts or fruit pulp to make different varieties of shrikhand. A fully mechanized/continuous process has been developed for industrial scale of production of Shrikhand.

Preparation of Curd

Skim milk (9 percent SNF. 0.05 percent fat) is heated to 90°C for! 0 sec. in a HTST pasteurizer cooled to 30°C and inoculated with 0.25-0.50 percent Dahi culture of mixed strains. After 8 hrs of incubation period (0.8 percent as lactic acid), curd is ready for further processing.

Preparation of Chakka

Chakka is prepared by separating the whey from Dahi employing a 28" dia basket centrifuge at 1100 rpm, which permits 80 kg of curd per hour. Alternatively, a horizontal desludging centrifuge (Westphalia SDA 230) may also be satisfactorily employed for separating whey from curd.

Preparation of Shrikhand from Chakka

In the process described here, Shrikhand is prepared by adding sugar at the rate of 80 percent of the amount of Chakka and mixed in a planetary mixer. Predetermined amount of plastic cream (80 percent fat) is added along with sugar to Chakka so as to give at least 8.5 percent fat in the finished product.

Mixing of Maska with Cream and Sugar

The mixing capacity in the earlier process was limited due to use of planetary mixer, which could handle up to 40 kg/batch.

By replacing by a scraped surface heat exchanger (SSHE), handling per batch may be increased up to 500 kg in 10 min. Two such mixers may be installed in the line to facilitate continuity in production. When one mixture was used for production, the other was emptied to Shrikhand cooling tank.

Packaging of Shrikhand

In the earlier process, the use of pre-formed polystyrene cups for packing Shrikhand limited the capacity to 1000 cups/how. By employing a 'Form-fill-seal' machine up to 6000 cups may be filled / packed per hour.

Flow Diagram For Manufacture Of Shrikhand

Receiving Of Milk
↓
Standardisation
↓
Pasteurisation
↓
Cooling
↓
Inoculation With Lactic Culture
↓
Incubation
↓
Breaking The Curd
↓
Draining Of Whey
↓
Chakka
↓
Addition Of Sugar, Additivs Etc.
↓
Storage

Shrikhand Plant, Raja Dairy, Surat: Capacity 1 Ton Per Day

6. CHHANA

a. Mechanization of chhana process

A process has been developed for the mechanized production 01 Chhana at IIT, Kharagpur involving continuous acid coagulation of milk. The process, involves indirect heating of milk in a helical tube heat exchanger to 95°C followed by cooling to 70°C. Citric acid heated to 70°C employing U type heat : exchanger, is continuously mixed in a vertical tube where the milk -acid mixture moves upwards. The residence time is so controlled as to permit complete coagulation of milk. Thereafter coagulum (Chhana) and whey are separated in a continuous flow employing a double walled basket centrifuge. Chhana so prepared may be chilled to 4°C by directly spraying chilled water on the layer of chhana.

Flow Diagram For Manufacture Of Chhana

Receiving Of Milk
↓
Standardisation
↓
Coagulation
↓
Draining Of Whey
↓
Packing
↓
Storage
↓
Chhana

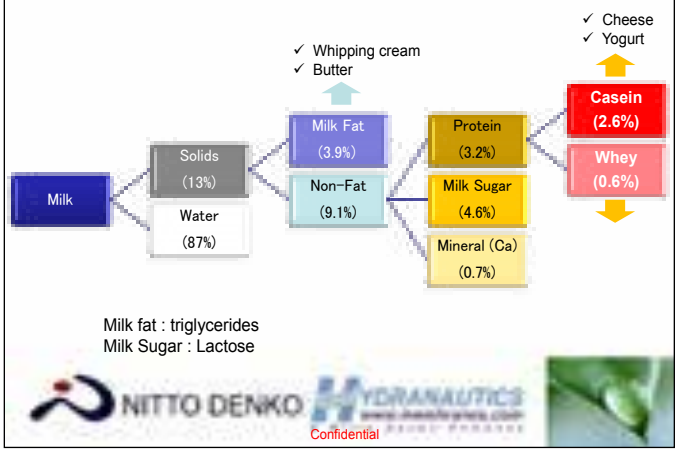
CONCLUSION:

The major strength of the traditional dairy product sector is the mass appeal enjoyed by such a wide variety of products. The market or these products far exceeds that for Western dairy products.' Their operating margins are also much higher than the western dairy products. The increasing demand for these products presents a great opportunity for the organized dairies in the country to modernize and scale up the production. The expanding business prospects provided by these products and their accompanying value-addition call for a thorough study of this sector. This development would also facilities an increased production and marketing of hygienically prepared and properly packed products to meet the demand of growing population.

Dairy Market Application and Products

By : Mr. V. K. Ghoda

About Milk Composition



Milk fat : triglycerides
Milk Sugar : Lactose

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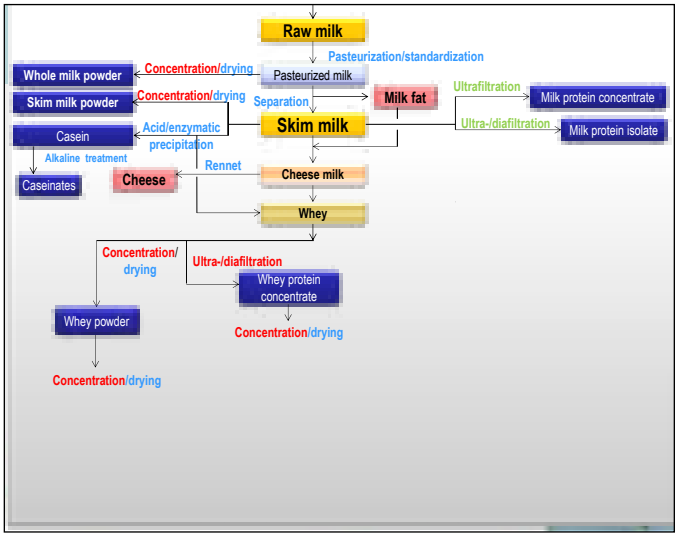

Dairy Applications by Membrane

- MF
  - Defatting of whey
  - Bacteria/spore removal from skim milk, whey, and WPC
  - Protein fractionation
- UF
  - Concentration and fractionation of proteins in milk
  - Whey, WPC, and WPI
  - Protein standardization for cheese, yogurt
  - Brine clarification
- NF
  - Demineralization of whey
  - Demineralization of UF permeate
- RO
  - Lactose concentration
  - Polishing of evaporator condensate

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DairyRO® Series

High Performance Dairy Process Membranes

Hydranautics' 40+ years of reverse osmosis membrane manufacturing experience is incorporated into every DairyRO® membrane and element. ***All DairyRO® elements are automation-rolled for straight and minimally sized glue lines, maximum membrane area, and the highest possible glue line adhesion.***

- **DairyRO®** composite polyamide reverse osmosis elements are of the net-wrapped, full-fit design, intended for daily CIP in the dairy environment.
- All membranes and elements are manufactured using highly controlled, ISO 9001-compliant processes, ensuring the highest quality and most consistent, reliable performance available.
- Hydranautics has set a new industry-standard for the rolling of full-fit membrane modules:
- Hand-rolling of elements has been eliminated by the use of proprietary, robot-based automatic rolling machines, specifically designed by Hydranautics for fabricating membrane modules of the highest quality.

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DairyRO

Applications

- Pre-concentrating milk or whey for reducing product transport costs
- Lactose production
- Sweet/acid whey concentration
- Concentration of UF permeate
- Milk and juice concentrations

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DairyUF ™ Series

High Performance Dairy Process Membranes

- **DairyUF 10K : USDA-Accepted High-Flux, 10,000 Dalton,**
- **DairyUF 5K : USDA-Accepted High-Flux, 5,000 Dalton,**

Polyethersulfone Ultrafiltration Crossflow Membrane Elements in "Full-Fit",Net-Wrapped Configuration for Use in Dairy, BioPharm, Beverage and Other Applications

Hydranautics PES membranes are always constructed with polypropylene backing for maximum chemical-resistance and longevity in service.
Hydranautics has set a new industry-standard for the rolling of full-fit membrane modules: Hand-rolling of elements has been eliminated by the use of proprietary, ***robot-based automatic rolling machines***, specifically designed by Hydranautics for fabricating membrane modules of the highest quality. The result is a higher level of filtration and separations performance

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Applications

- Sweet/acid whey concentration before evaporation and spray-drying
- Enzyme and protein concentrations
- Pre-concentrating milk or whey for reducing product transport costs

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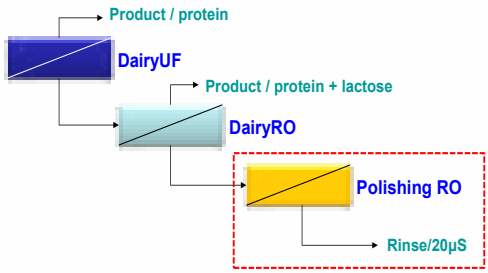
Polishing application



<Water Recovery>

✓Water Recovery and "Polishing"

Permeates originating from RO or NF processes as well as condensates from evaporators are practically water. With an additional RO treatment normally referred to as "Polishing", this water can be purified and re-used for cleaning purposes.

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Hydrapolish

- ✓ **Sanitary, net-wrapped 8040 elements with PSF ATDs, brine seals and interconnectors**
- ✓ **99.6% NaCl rejection**
- ✓ **Water polishing applications**
- ✓ **BOD and COD reduction**
- ✓ **USDA-accepted, FDA-compliant**
- ✓ **100% NaCl and flow-tested**

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Applications

- Whey and milk concentration
- De-salting (de-mineralization) of whey and other streams
- DP1/DP2 sugar fractionation
- Recovery of hydrolyzed proteins and enzymes

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Cage wrapped elements

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How to prevent the Blistering ?

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Key technology is how to achieve the best glue penetration

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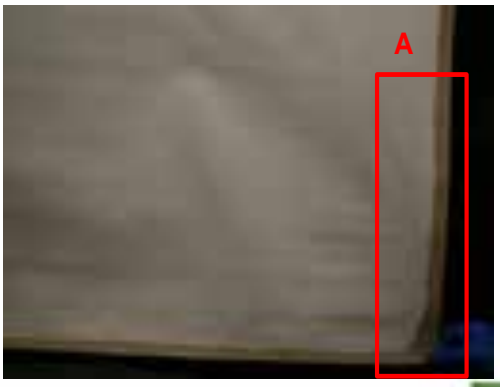
Glue penetration by Automated Production



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Advantage of HYD products

These improvements are anticipated to result in:

- ❖ Maximum element longevity for less expensive membrane-based processing
- ❖ Fewer maintenance costs and lower element replacement costs due to longer-lasting elements
- ❖ Highest possible flux and lowest possible pressure resistance due to maximum "effective membrane area" (5-7% increase in active area)
- ❖ Lowest possible potential of glue "voids/Blistering" which can result in blister formation
- ❖ Maximum confidence in element integrity during USDA inspections

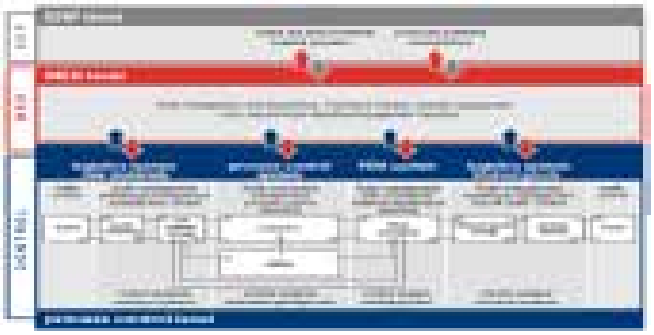
NITTO DENKO HYDRANAUTICS

Automation for Improvising Productivity, Quality & Quality

By : Shri Vimlesh Kumar

ABSTRACT :: ***" Today's dairy processing plants face enormous challenges. Many facilities still using outdated dairy automation systems must now make major upgrades in spite of difficult economic circumstances. And as dairy processing regulations tighten and profit margins narrow, consumers are demanding a broader selection of healthy, grab-and-go dairy products. Dairy processing plants must develop a sustainable approach to innovation in order to succeed in this environment , BUT HOW??? "***

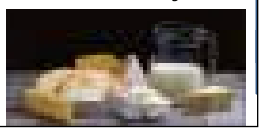
The Key is to adopt integrated advance process approach. After all, if all processes are perfectly coordinated with each other and reliable communications have been established between all parts of the manufacturing plant, it is much easier to address the big challenges. Today and tomorrow. Ranging from higher flexibility for customization to cost savings through leaner and more efficient processes. Our Advance Automation Process act as a catalyst to achieve excellent deliverable.



Profitability in the dairy foods and juice industries depends on a host of variables: the cost of milk and juice inputs as well as the costs of production, packaging, distribution, marketing and overhead, especially labor. Some costs, like milk, juice and energy, are at the market's mercy, while the others need tight controls to keep them within predictable limits. In all, they're enough to keep plant operators awake at night and to give them fits by day. Dairy and juice food profits – typically slim – can leak from any one of ***hundreds of operational points across large, complex dairy plants capable of processing thousands of*** *gallons of milk or juice a day:*

- *Milk and juice loss at any point from receiving, during vessel transfers, CIP cycles and on its way to packaging*
- *Wasted power in the 100-plus motors that typically drive production through large dairy and juice plants*
- *Excessive energy use at various production stages – evaporator, dryer, boiler, refrigeration and pasteurization – as well as in the facility itself*
- ***Unused capacity that still must be depreciated, maintained and kept in repair***
- ***Downtime due to recipe changeovers, cleaning operations and other maintenance and repairs***
- ***Latency between finished output and packaging, time that can also increase chances of spoilage***
- *Costly errors due to time-consuming, manual recordkeeping*
- *Excessive water consumption during clean-in-place (CIP) operations*
- *Unnecessary wastewater treatment or municipal fines due to untreated or under treated biological oxygen demand (BOD) releases*

Often what can further compound the downstream effects of operating goblins like these is a lack of real-time information about them. Hours, days and weeks can pass before one is discovered, if it's discovered at all. Some of these unaddressed issues can also undermine quality, leading to contamination, wiping out valuable inventory or triggering a shockingly



understanding requires systemic plant knowledge and experience to drive relevant insights. Also helpful are proven process improvement methodologies like Lean, Six Sigma and other techniques

In general, these methods break processes down into discrete measurable parts, analyze them for potential improvements, determine key metrics, make the needed changes, gauge results and fine-tune changes. They also can help address issues of cost accounting, variation, waste and what key performance indicators. With an understanding of the ends plus clear insights into measurable process improvements, technology can then help dairy and juice plant operators realize significant efficiency gains, better controls and new-found flexibility.

Milk or juice loss, for example, can be a big cost for dairy and juice plants. Most losses are small amounts that add up and can occur during loading or changeovers. Other causes can be human errors, carelessness or poor operating procedures. Plant accounting can inadvertently mask these losses without the right data to reveal where, when, why and how they occur.

Manufacturing Execution System (MES) can automatically collect and transfer all production data to higher-level plant systems including all major Enterprise Resource Planning (ERP) systems such as Oracle and SAP as well as warehouse and inventory management systems. This can save the time and cost associated with error-prone manual recordkeeping. It can also help operators determine optimal production line utilization and product mix, then have the flexibility to quickly execute changes to production lines with little or no latencies or downtime.

Importantly, operators gain real-time and historical visibility into every plant process that provides the needed intelligence for process optimization and alarms to respond faster and more effectively to almost any situation. They also can remotely access this intelligence 24x7 through the web and mobile devices. Multiple plant sites can also be networked to provide enterprise wide visibility and oversight virtually worldwide.

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TRAINING PROGRAMME SCHEDULE FROM SEP 2013 TO JUN 2014

Vidya Dairy a Student training Institute imparts hands-on experience to the B. Tech (Dairy Technology) students of SMC college of Dairy Science-Anand. Besides imparting regular training to B. Tech (DT) students, the dairy also organizes Short-Term Training Programmes for the benefit of the industry in association with the Faculty of Dairy Science, Anand. These programmes are aimed at giving broad orientation of technological and analytical aspects of milk and major milk products along with hands – on – experience of the operations to the dairy / non-dairy personnel working in plant and laboratory areas. This helps the organization to improve efficiency, reduce cycle time and cost.

Month	Schedule	Course Name	*Fees (Rs)
Sep-13	09.09.2013 to 14.09.2013 (6 Day)	Technological and Engineering Aspects of Ice cream Plant	10000/-
	10.09.2013 to 11.09.2013 (2 Day)	Advances in Automation in Dairy Industry	4000/-
	16.09.2013 to 21.09.2013 (6 Day)	Technology of Fermented and Probiotic Dairy Products	5500/-
Oct-13	07.10.2013 to 12.10.2013 (6 Day)	Dairy Technology for Non Dairy Technologists (English)	9000/-
	21.10.2013 to26.10.2013 (6 Day)	Laboratory Practices in Dairy and Food Plant	9000/-
Nov-13	11.11.2013 to13.11.2013 (3 Day)	Management of Bulk Milk Cooling Systems (Gujarati)	4500/-
	18.11.2013 to22.11.2013 (5 Day)	Sensory Evaluation of Milk and Milk Products	6500/-
Dec-13	02.12.2013 to07.12.2013 (6 Day)	Dairy Technology for Non Dairy Technologists (Gujarati)	8000/-
	09.12.2013 to14.12.2013 (6 Day)	Technological and Engineering Aspects of Ice cream Plant	10000/-
Jan-14	06.01.2014 to 11.01.2014 (6 Day)	Dairy Technology for Non Dairy Technologists (English)	10000/-
	20.01.2014 to 22.01.2014 (3 Day)	Technology of Fermented and Probiotic Dairy Products	6500/-
	25.01.2014 (1 Day)	Pest Management for Food Industry	3000/-
Feb-14	03.02.2014 to 08.02.2014 (6 Day)	Laboratory Practices in Dairy and Food Plant	10000/-
	10.02.2014 to 12.02.2014 (3 Day)	Management of Bulk Milk Cooling Systems (Gujarati)	4500/-
	14.02.2014 to 15.02.2014 (2 day)	Internal Auditor Course on ISO-22000 : 2005	6000/-
Mar-14	03.03.2014 to 06.03.2014 (4 Day)	Sensory Evaluation of Milk and Milk Products	7000/-
	10.03.2014 to 15.03.2014 (6 Day)	Dairy Technology for Non Dairy Technologists (English)	10000/-
Apr-14	14.04.2014 to 16.04.2014 (3 Day)	Management of Bulk Milk Cooling Systems (Hindi)	4500/-
	21.04.2014 to 26.04.2014 (6 Day)	Dairy Technology for Non Dairy Technologists (Gujarati)	9000/-
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Technical Session-IV

ADOPTION OF ADVANCED PROCESS TECHNOLOGIES FOR UPGRADATION OF TRADITIONAL DAIRY PRODUCTS

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1.0 INTRODUCTION

Increasing demand for traditional dairy products among both rural and growing urban populations offers a great scope for commercial production throughout the country.

Large scale manufacture of indigenous milk products in a hygienically safe manner with assured quality and proper packaging will yield huge dividends. An organized production of indigenous products has already been initiated by some private and cooperative sector dairy plants. The main products include ghee, paneer, dahi, rice curd, misti dahi, rasogolla varieties, peda, gulabjamun and chhana kheer. Per day production may vary from quintals to tons. The total market share of traditional products in the organized sector is insignificant compared with the total volumes traded by Halwaiis. In spite of many innovations made in the mechanized production of some of the indigenous products, the industry has been slow in their adoption because of lack of appreciation of potential application of these techniques. Any technology that is imported to this country is believed to do wonders. Indian dairy sector is generally reluctant to adopt locally developed technologies due to lack of faith. Innovators of new technologies have made limited efforts for marketing their own creations.

2.0 PRESENT STATUS OF PROCESS DEVELOPMENT

2.1 Mechanized Systems

Many mechanized systems such as inclined scrapped surface heat exchanger, three stage thin film scrapped surface heat exchanger, convap-contherm, scraped surface falling film evaporator and conical vat have been developed for khoa making. Some of these units are efficient in production of all varieties of khoa, burfi, basundi and rabri.

A tubular heat exchanger with Venturi mixing device was used to design and develop a continuous chhana and paneer making equipment. Heated whey was employed as a coagulant and mixed in the Venturi to facilitate coagulation in a holding section continuously. The contents were passed through a screen filter to collect the coagulum and delivered into a basket centrifuge to obtain the desired moisture and texture in chhana and paneer.

2.2 Application of Drum Driers

Successful attempts were made in using the idle roller dryers in the production of khoa and khoa powder by manipulating feed rate of concentrated milk, roller speed, steam pressure and adjusting scraper blades.

2.3 Ready to Reconstitute Formulations

The formulation of ready to use mixes for instant preparation of milk based sweets has received great attention of scientists. There are several milk based convenience mixes which are produced by dry blending of ingredients, spray drying, crystallization, etc. The author was responsible for formulation of Gulabjamun mix, rasogolla mix powder, instant kulfi mix powder, khoa powder, kheer mix and rasomalai mix, carrot halwa and mango milk powder. Some of these technologies have been commercialized and others may soon get adopted.

2.4 Use of Alternate Sources of Milk Solids

In past, it was reported that good quality traditional milk products can be produced only from fresh milk. Attempts to use pre concentrated milk in khoa making and use of recombination process and spray dried milk were found successful especially in milk products prepared from alternate milk solids were comparable in flavour with conventionally produced products.

3.0 SCOPE FOR MODERNIZATION

India's traditional dairy sector is poised for rapid expansion, hopefully with the application of modern technologies in production, packaging and storage.

The major strength of Indian milk sweets is their mass appeal, taste and texture enjoyed by a wide spectrum of population of all the ages. The margins of profit offered by milk sweets are lucrative and high because of low raw material costs, least wastages, remarkable value addition and least marketing efforts. The small scale producers and tiny traders neither follow food safety precautions nor adhere to standards in the preparation and distribution of traditional sweets. Sweets are often packed in paper board cartons for carry home purposes. The consumption of sweets with contaminants and hazardous substances is a cause of great worry knowing fully well that our children are the biggest consumers.

Dairy industry has a responsibility, therefore, to ensure the production and distribution of safe milk based sweets. This effort will save consumers from health risks and diminish long term impact of ill health in our economy.

Indian dairy industry for long has been demanding from research scientists' innovative processing technologies for traditional products suitable for meeting the requirements of small and large scale operators. Successful efforts have been made to develop batch, semi-continuous and continuous equipment for khoa, chhana, paneer, ghee and khoa /chhana based sweets.

Initiatives have to come from the industry for scaling up these equipment.

The traditional dairy products need to be processed and packaged in new form with guaranteed shelf-life, chemical composition and microbiological safety. Consumers always demand milk foods with good flavour and texture. Statutory and regulatory provisions require that consumers receive foods of known standards and safety. Process to be developed must reduce or completely eliminate the potential hazards commonly found in milk products.

4.0 LIMITATIONS IN DESIGNING AND DEVELOPMENT OF NEW EQUIPMENT

Development of new prototypes for a variety of traditional milk products is a resource and time consuming exercise involving huge expenditure. Scaling up of successful prototypes will also remain cumbersome. The equipment manufacturers in India do not wish to invest in new equipment development unless they are assured of confirmed work orders from sizeable number of product factories. Not much headway has, therefore, been made by equipment manufacturers in adopting even the time tested innovations reported by research institutes and the universities.

A variety of traditional dairy products are produced in India, many of which are region specific. Although most of these products have been characterized for sensory attributes, chemical composition and microbiological quality, information on rheology and micro structure is inadequate which essentially form the backbone for process development. The current trends round the globe favour basic studies on flow or viscous properties and textural profiling of new product/processes to facilitate prototype development and process controls. It will be necessary to understand the kinetics of texture formation and flavour production during the manufacture of these products at molecular levels. Any equipment designed without taking into account the basic aspects is less likely to be accepted by the industry.

5.0 ADVANCED PROCESS TECHNOLOGIES

In view of the above problems, it may be useful to look at suitable process equipment being used by other food industries anywhere and evaluate them for adoption by traditional milk sweets manufacturers in India. Some of the common and popular technologies are described hereunder.

5.1 Membrane Technology

The pressure driven membrane processes usually discriminate between molecules primarily on the basis of size and shape and chemical composition of a product. The membrane systems in ascending order of pore size are: Reverse Osmosis (RO), Nano Filtration (NF), Ultra Filtration (UF) and Micro Filtration (MF). In essence, RO is a dewatering technique; NF is a demineralization process; UF a fractionation method and MF a clarification technique.

Membrane processes offer many applications in traditional milk products. Membrane separation can be carried out at ambient temperature to avoid thermal degradation problems commonly encountered in thermal concentration resulting in improved nutritional and functional properties of milk constituents. The continuous molecular sieving processes do not involve a phase change or inter-phase mass transfer. The energy requirements of membrane processes are lower than those in evaporation, freeze concentration, freeze drying, etc. Because of increased recovery of constituents, higher yields of products are obtained.

RO process has been used in the production of khoa, basundi, kheer, rabri, chhaka and shrikhand. The problem of salty taste in khoa prepared from cow milk and sandy texture was overcome by 1.5 fold NF before khoa making. UF produces permeate containing water, lactose, soluble minerals, non protein nitrogen and water soluble vitamins in proportion of permeate removed. The retentate is rich in proteins, fat and colloidal salts. UF can be used in chhana, rasogolla, rasogolla mix powder, chakka, shrikhand and long life paneer.

5.2 Osmotic Dehydration

Traditional dairy products are perishable due to their high moisture content. In general, drying is energy consuming. Moreover, the product's quality notably depends on its texture, colour and flavour which are often deteriorated by thermal drying. The products are placed in a hypertonic sugar solution presenting a high osmotic pressure and a low water activity. It is a counter-current mass transfer process, in which water is drained from the interior of the product to the hypertonic solution and the solute flows into the food depending on the permeability of cell membranes and cell architecture. This method has been tried for dewatering chhana murki, rasogolla, sandesh and other sugary products to increase shelf life and reduce packaging cost. The speed of osmotic dehydration can be enhanced by the application of high pressure, ultra sound or a pulsed electric field, gamma irradiation and by applying vacuum or centrifugal force. Osmotic dehydration can be achieved by using solutes like fructose, corn syrup, glucose, starch solutions and sorbitol.

5.3 Retort Processing

Retort processing involves in-package heating of Ready to Eat (RTE) foods above boiling point of water at 2-3 atmospheric pressures in special vessels called retort. The retorts deliver sterilized products like basundi, payasam and kheer equipped with product handling trays, trolleys and other material handling devices for loading and unloading. Modern retorts are supplied within built PLC based controls for operation, monitoring and recording of critical process parameters like temperature, steam and air pressure, product heat treatment history inside the pouches. Automatic and continuous filling lines for retort pouches are available for heterogeneous products. Dairy plants may easily adopt this technology for mass production.

5.4 High Pressure Super Critical Carbon Di Oxide

High pressure or super critical CO2 processing is an alternative method for acid precipitation for isolation of proteins as in case of chhana making. When CO2 is dissolved in milk, it hydrolyzes

to form carbonic acid. The pH is reduced to 5.4 and casein precipitates above its iso-electric point of 4.8. This process has been demonstrated at temperatures in the range from 40 to 70OC and pressures up to 14 MPa. The major advantage of using CO2 as a substitute for mineral acids is elimination of the precipitant from the product upon release of pressure. Washing steps are not needed to remove the precipitant from the product and neutralization of whey is not required. This results in less particle breakage and less wastage water generation.

Super critical processing offers a feasible approach to customized fractionation of milk fat by the phenomenon of selective distillation and extraction simultaneously. It allows concentration of milk fat flavours (δ-lactones) by more than five times the amount in milk fat. This technique has successfully been applied in removal of cholesterol, extraction of food additives and bioactive compounds besides fractionation of milk fat in 3-4 distinct fractions with varying physical and chemical characteristics.

5.5 Microwave Processing

Microwave cooking is an exciting and novel form of food preparation. The speed and ease of preparation it offers fits well in heating operations. Foods electronically cooked are heated throughout at the same time up to the limit of depth of microwave penetration in contrast to conventional heating where foods are heated by hot air or water by conduction. Microwave energy is used in pasteurization and sterilization of milk, thermization, in pack paneer making, ghee and cooking of curd for cheese making. Investigations need to be planned to explore the possible uses of microwave energy in indigenous milk products.

5.6 Extrusion Technology

At present, snack foods, breakfast cereals and confectioneries are produced by extrusion process. It basically involves the principle of compressing food ingredients into a semi-solid mass and then forcing it through a small aperture to produce a variety of textures, shapes and dimensions in the cooked and extruded product. An extruder consists of a power supply to operate the main screw, a feeder with metered supply of raw ingredients, and a barrel which surrounds the screw. The die shapes the product under high temperature and pressure. Temperatures in the cooking zone may range from 80 to 150OC and barrel temperatures in the forming zone will range between 65 to 90OC.

Processors are exploring newer applications of extrusion technology in new product development combining the milk solids with cereals, fruits and vegetables, starch and fibers using twin-screw extruders. The system can produce a variety of surfaces, colours, shapes, texture and flavours. Extrusion processing can be helpful in designing balanced snack foods for school feeding programme and military field rations. The use of extrusion to produce new and innovative traditional milk products holds much for future needs.

6.o INNOVATIVE PACKAGING

The conventional packages do not provide adequate protection to traditional milk products from atmospheric contamination. Sweets become dry, hard, mouldy, de-colourized and develop off flavours. Pre sterilized polyester tubs or cans may be used for packaging in multilayer co-extruded nylon high barrier pouches. Tin cans, lacquered or unlacquered, of different sizes continue to enjoy popularity inspite of their high cost. Semi rigid plastics are replacing tin cans. In many countries abroad, most of the dairy products are packaged in composite paper cartons, retortable pouches, microwavable containers, laminated and single service molded packages using continuous packaging systems. Several shelf-life extension methods have been adopted using modified atmospheric packaging, active packaging and use of edible coatings. These interactive packages perform the functions of food preservation, provide inert barriers to outside reactants. Interestingly, pouch packaging, PET bottles, light weight metallic cans, transparent tubs and cups and laminated flexible pouches offer most attractive packaging solutions for meeting special need for individual traditional products.

6.1 Modified Atmospheric Packaging (MAP)

MAP provides an enclosure with gas barrier properties in which gaseous environment has been changed with a mixture of gases above normal atmospheric pressure. MAP slows down respiration rate and microbial growth and retards enzymatic spoilage during storage. Aerobic bacteria and oxidation require the presence of oxygen. Absence of oxygen in MAP thus inhibits spoilage and enhances shelf life. Product deterioration may be caused by anaerobic or micro aerophilic organisms and non oxidative reactions. These problems can be controlled by storing the product at low temperatures. Gas pressure above the atmosphere is achieved using horizontal or vertical form-fill-seal machines, thermo form-fill-seal or a vacuum machine with gas injection. Efforts made by many research groups to improve shelf life of paneer, peda and rabri have showed significant benefits of MAP.

High barrier laminates based on polyester/ethylene vinyl alcohol/polythene can be used for bulk packaging of khoa for long storage in refrigerated rooms. Peda can be packed under MAP (80% nitrogen+20% CO2) in bags made from high barrier multilayer film.

6.2 Active Packaging

Active packaging delays oxidation and controls respiration rate, microbial growth and moisture migration. Active packaging may include oxygen or carbon dioxide absorbers or CO2 emitters, odour absorbers, ethylene removers and aroma releasers. The permeability of gases through the packages can be controlled by lamination, coating, co extrusion, polymer blending and micro perforation relative to oxidation or respiration kinetics of milk sweets. A certain number of nano-composite materials are reported to prevent ingress or egress of oxygen, CO2 and moisture from foods.

Industrial Method of Ghee Making at Panchmahal Dairy, Godhara

"The quality of ghee made by the new method was studied with respect to marketability. All were found to be at par with Agmark standards. The team of sensory panelists also carried out the organoleptic evaluation and no difference in comparison with earlier method of ghee manufacture was observed."

Dr. R.S. Patel, Managing Director – AMR Dairy, Amreli

INTRODUCTION:

Ghee occupies a very significant place in Indian diet. The nutritional value of ghee is known since Vedic time in ancient India. Ghee is an indispensable part of religious and ceremonial functions. The major markets for ghee are located in south Asian countries. Ghee is also consumed in Australia, Arabian countries, USA, UK, Belgium, New Zealand, Netherlands and many other African and Asian countries.

Table 1 : Regional Preference for ghee flavor and texture

Northern	Flavour	Slight acidic, mildly curdy
	Texture	Fine to medium size grains
Western	Flavour	Mildly curdy (Strongly curdy in Suurashra)
	Texture	Coarse grains of 0.3 to 0.6 mm size
Southern	Flavour	Mildly to high cooked, aromatic. Higher level of free fatty (butyric) acid (preference for special herb flavours in Tamil Nadu & Karnataka)
	Texture	Midum sized grains (Tamil Nadu), coarse grains (Andhra Pradesh and Karnataka)
Eastern	Flavour	Slightly to definitely cooked flavour
	Texture	Medium grains
Source : Rajorhia, 1980		

Traditionally in Indian households, ghee is made first by converting milk in to dahi, churning it at room temperature to obtain makkhan or desi butter, clarifying the desi butter accumulated over a period of time and conversion in to ghee by boiling it continuously at temperature upto 100-120 C depending upon the regional flavor preferences. Ghee made traditionally contains as high as 5 times CLAs as compared to original milk fat in milk. CLAs are also known to be antioxidants and are responsible for higher shelf life of ghee at ambient temperature (Aneja and Murthi, 1990)

The quality of ghee is described in terms of flavour, texture and colour. The consumers of ghee always look for most desirable sensory attributes and freedom from suspended serum residues. They also want an assurance of purity, freshness and wholesomeness.

Rajorhia (1980) reported that consumer's preferences for ghee in India vary from region to region. The findings have been given in Table 1. Ghee manufacturer should be able to use this information for commercial applications.

Post WTO scenario presents a big challenge before the Indian fairy industry where competition from overseas manufacturer in global market has become unavoidable. Although ghee is our indigenous product, besides meeting the international standards, it should be manufactured in a manner that is cost effective with considerable savings in energy and without affecting the sensory and shelf life attributes.

Table 2 : A comparison of various ghee manufacturing methods

Particulars	Indigenous	Cream – Butter	Direct Cream	Pre-stratification	Continuous
Fat Recovery %	88-99	88-92	92	93	93
Aroma	Strong nutty	Pleasantly rich	Mild & milky	Pleasantly rich	Mild
Flavour	Acidic	Normal	Cooked	Normal	Flat
Texture	Packed coarse grain	Slushy fine grain (Cow) paked fine grain (Buffalo)	Mostly liquid with slight granulation	Fine grains	Greasy
Clarification using heat	Easy, economic, pre-stratification possible	Easy, economic, pre-stratification possible	Difficult slow, pre-stratification not possible	Easy and economic	Easy and economic
Essential equipments	Butter churn	Cream separator & butter churn	Cream separator	Cream separator & butter churn	Scraped surface heat exchanger
By-product produced	Butter milk and ghee residue	Skim milk, butter milk and ghee residue	Skim milk, butter milk and ghee residue	Skim milk, butter milk and ghee residue	Skim milk, butter milk and ghee residue
Adaptability	Small scale	Large scale	Large scale	Large scale	Large scale
Source : Rajorhia (1993) and Aneja et al (2002)					

For manufacture of ghee, there are many methods, such as desi (indigenous or traditional method), creamery butter method, Direct cream method, Pre-stratification method and continuous method (Rajorhia, 1993). Comparison of these method is given in Table 2.

Nearly, 90 per cent of the ghee produced in the country is made by traditional method. Increased awareness about energy management in past motivated the research workers to develop energy efficient and continuous method for ghee manufacture (Punjrath, 1974), which include either an oil separator (Bhatia, 1978) to separate serum and fat phase OR use of scrapped surface heat exchangers (Abhichandani, et al, 1995). Both the processes save energy and yield a comparable product.

CONTINUOUS METHOD OF GHEE MAKING:

Dairy plants have tried to modify, scale up and adopt the traditional batch process for commercial production. Although large quantities of ghee are made by this process, there is a long felt need of a continuous plant. One of the ways is to adopt the established process for producing butter oil involving centrifugal separation of moisture followed by final dehydration under vacuum. However, the product would lack typical ghee flavor. (Pandya and Sharma, 2002)

As an alternate to such system, a scraped surface falling film heat exchanger along with auxiliary equipment such as a melting vat and mechanical clarifier has been developed to serve as a continuous ghee making plant.

Various approaches made for continuous ghee making were directed to achieve the following salient features in process viz (1) high heat transfer coefficient and hence compact design (2) better control on quality of product (3) only small holdup of raw material in the plant at any given time and hence no chances of whole batch getting spoiled (4) no spillage loss (5) simple, robust and hygienic design (6) minimum strain on the operator (7) facilitate cleaning in place (8) high degree of automation possible (9) no surface fouling and hence heat transfer coefficient can be maintained throughout the run of system (10) easy capacity control (11) no foaming problem, cream can be handled conveniently and (12) economic operation.

IMPROVED METHOD OF GHEE MAKING DEVELOPED BY PANCHMAHAL DAIRY:

Under Total Quality Management Programme at Panchmahal Dairy, Godhra, a small Group Activity (SGA) team was constituted which worked on the improvement in production of ghee making with a special focus on reducing fat and SNF losses.

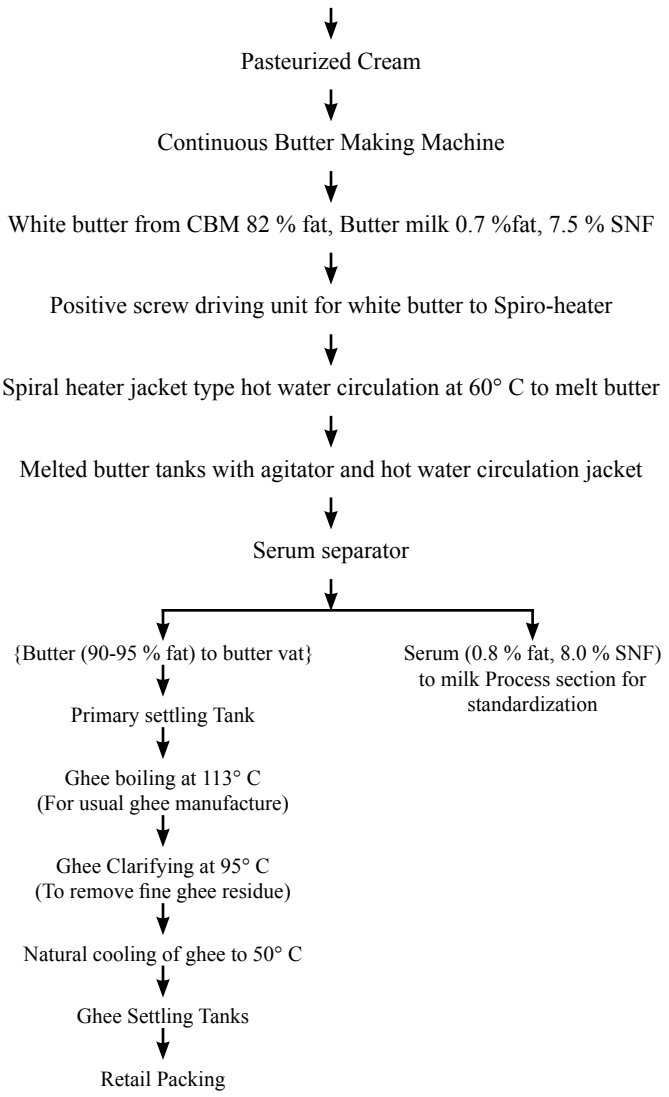
Firstly, data analysis was done to identify the losses area, which occurred in ghee manufacture on the big scale. A brainstorming session was conducted on saving the serum solids since fermentation of milk was not carried out and only sweet serum separated out of stratification tank.

It was decided that a modification in normal procedure has to be done to recover fat and SNF from sweet serum. To collect fat and SNF from serum, a serum separator was installed for melted fresh butter so that SNF can be directly used in market milk for standardization and fat percentage in butter br increased and sent to butter melting vat and Primary Settling Tank (PST) and thereafter to ghee kettle.

The procedure was finalized with the inclusion of a serum separator and a spiro heater in the process as summarized below.

At first, fresh raw milk is received at raw milk receiving dock (RMRD) of the main diary plant, chilled and store. This milk is subjected to cream separation after necessary filtration and warming to 55-60 C in regeneration section of pasteurizer. Resultant cream is pasteurized in a high temperature short time (HTST) plant at 90-92 C for 15 seconds, chilled to 10-12 C and stored in insulated, jacketed, cream storage tanks. This cream is then pumped in continuous butter making machine (CBMM) wherein white butter is obtained. Resultant buttermilk along with serum from serum separator is chilled in a plant chiller and diverted for use in standardization of fresh milk.

Fig. 1 Process steps of a New, Modified Method of Ghee Making



White butter is pumped via screw conveyor to Spiro-heater where it is melted by circulating hot water. Melted butter is conveyed to tanks provided with agitator and hot water circulation jacket from where it is subjected to serum separation. Serum is separated, chilled in a plate chiller and pooled with sweet butter milk for use in milk standardization. Melted butter with low moisture and high fat and serum solids is collected in butter melting vat from where it is pumped to Primary Settling Tanks (PST) and then continuously to different ghee kettles (boilers) for ghee manufacturing in normal way during which residual moisture is evaporated at 113° C.

After some holding, ghee clarification is done at 95° C through a ghee clarifier to remove fine particles of residue. Clarified ghee is pumped to ghee settling tanks where ghee is cooled with water circulation to 50° C. At this stage, a sample is withdrawn for analysis with respect to chemical constants and physical attributes before allowing it for packing into retail containers.

The ghee made by this process is fetching premium price in the market. Last year ghee export was worth Rs. 50 million.

ADVANTAGE OF MODIFIED METHOD OF GHEE MANUFACTURE

The quality of ghee made by this new method was studied with respect to marketability involving the tests like colour, flavor, texture and other chemical constants. All were found to be at par with Agmark standards. The team of sensory panelists also carried out the organoleptic evaluation and no difference in comparison with earlier method of ghee manufacture was observed. Hence, it was decided to adopt the new manufacturing process.

The benefits obtained by adopting the new method commercially are listed as under:

- **Steam Saving:**
  Due to implementation of hot water circulation in spiral heater to melt white butter at 60°C, 250-300 per cent steam was saved. Secondly, in ghee boiler, water to be evaporated reduced drastically as serum solids were removed by serum separator and percentage of fat in melted butter increased to as high as 95 per cent.
- **Increased Ghee production:**
  Using traditional method for ghee making one batch of ghee making takes about 4-30 hours whereas by using this method it takes 1-30 hours. Thus the same ghee vessels can be used for more number of batch making.
- **Saving in Fat and SNF:**
  Serum separator from fresh white butter having 0.8 per cent fat and 8.0 per cent SNF was used in milk processing for standardization.
- **Reduced load on ETP:**
  Because of serum separation, SNF in melted butter was reduced; so quantity of serum residue in effluent also decreased to great extent.
- **Hygienic condition:**
  As the circuit for heating through Plate heat exchanger and conveying melted butter is totally closed and a continuous one, the hygienic condition in the ghee section was dramatically improved.
- **Delight in working condition:**
  There was visible delight in the operators and workers of the section because less scraping in ghee boilers was to be done due to less ghee residue. Ghee filtration was also fast and efficient and ghee batch gets ready in half the times as compared to earlier method. Work of shop floor got reduced, as section does not get that much soiled as earlier.
- **Overall Savings:**
  As per this estimate, an annual saving amounting to Rs. 190 lakhs could be obtained by way of saving fat / SNF, steam, electricity, man power, water, hygiene, house- keeping etc. the saving was calculated by considering 12000 kg. of ghee per day made in all 365 days of the year (Table 3)

Table 3 : Savings obtained by Innovated Method per Tonne of Ghee

Steps where saving achieved	Traditional Method	Innovated Method	Saving in Rupees per tonne / day
Steam consumption	Rs. 900	Rs. 300	Rs. 600
SNF recovery	Nil	Rs. 750	Rs. 750
Fat Loss	Rs. 3000	Nil	Rs. 3000
Total Savings			Rs. 4350
Savings per year / tonne			Rs. 15.88 Lakhs
Saving to the plant per annum (12 tonne per day capacity)			Rs. 190.56 Lakkhs

- Ghee made by this process has no residue other than ghee fat. Since last five years the Panchmahal Dairy is making ghee using this innovated process.
- The average test parameters of ghee made by this process were: Moisture 0.18 per cent, free fatty acids 0.16 per cent as oleic acid, Reichert Meissl (RM) value 32, Polenske (P V) value 1.6, Butyrorefractometer (BR) reading at 40° C is 41-42 and Baudouin's test negative.

Modified methods for manufacture of Ghee and its Nutrition

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The moment word 'Ghee' is heard it strikes to the mind something that is rich, flavourful, wholesome, good for health and one that is going to leave long cherished memories. The history of ghee is very old. Our old classical books - "Vedas" approximately third century B.C. describe ghee. It occupies a unique place in our life and is so closely woven that practically it is inseparable. Life begins and ends with ghee. With the advent of civilization, man started domesticating cattle. Search for food taught him to make use of milk. His ingeniousness led to preservation of food, but for milk. Excellent nutritional quality supporting all forms of life, higher ambient temperature and lack of development of proper technology for preservation of milk – a highly perishable commodity posed problems.

It was visualised that only one constituent of milk i.e. fat could be preserved for longer time without appreciable deterioration. This could also be due to ease with which fat can be separated from other milk constituents. This very fact led to the development of products viz. makkhan, ghee etc. which were concentrated forms of milk fat. Originally milk was allowed to sour; the curd thus obtained was churned to get butter, which upon boiling yielded ghee. Subsequently several such methods came into being.

Among all the fat rich dairy products from buffalo milk, ghee occupies a prominent position. About 28 % of the milk produced in India is utilized for ghee manufacture. Many workers, Srinivasan and Ananthakrishnan (1964), Rangappa and Achaya (1971), Srinivasan (1976), Sharma (1981), Pandya (1990), Pandya and Sharma (2002) and Pandya and Khan (2004) aptly covered the literature on ghee. Factors affecting the composition, flavour and textural properties of ghee have been also discussed by Ramamurthy (1980) and Pandya (1998). Indian Dairy Association organized a ghee conference and brought out a special issue of Indian Dairyman on the conference in October 1980. Gujarat Chapter of the Indian Dairy Association in 2002 organized a National Seminar on "Role of pure ghee in Health and Nutrition – Exploding Myths".

METHODS OF GHEE MAKING:

For manufacture of ghee there are many methods, however, ~ 80 – 90 % of the ghee produced in the country is made by traditional method. The different methods of ghee manufacture are (1) Traditional or indigenous method (2) Creamery-butter method (3) Direct cream method (4) Pre-stratification method and (5) Continuous methods. Pandya (1990) provided a detailed write-up related to different methods of ghee making.

Increased awareness about energy management has led to development of energy efficient and continuous methods (Punjrath, 1974) for ghee manufacture, which include either an oil separator (Bhatia, 1978) to separate serum and fat phase or use of scraped surface heat exchangers (Abichandani *et al*. 1995). Both the processes save energy and yield a comparable product. Energy consumption in ghee making by different methods was studied by Pandya (1978). Use of microwaves for ghee making has also been reported (Sahai, 1996). The ghee so prepared had higher vitamin A and E contents and appreciably lower levels of cholesterol. Chemical quality of ghee prepared by microwave heating has been studied by Mehta and Wadhwa (1999). Ghee prepared from curdled buffaloes' milk by direct churning and reprocessing (neutralization, boiling, filtration and cream separation) method. Direct churning of curdled buffaloes' milk gave better sensory score when compared with the reprocessing method and control ghee sample (Gupta *et al*. 1986).

TRADITIONAL METHOD

Of all the methods, ghee produced by the traditional method has still a major share in ghee production in India. Simple technology, inexpensive equipment, small scale of operation and superior organoleptic quality of ghee could be some of the reasons for this. The principle of ghee manufacture by this method entails (1) fermentation of primary raw material i.e. milk (2) a mechanical process to gather milk fat in a concentrated form and (3) heating of the fat concentrate at a specified range of temperatures to remove moisture and induce interaction of milk fat with fermented residue of milk SNF. The characteristic aroma, flavour and taste of ghee depend on the first and third steps.

Unfortunately, owing to the basic lack of control in the technique, ghee produced by the traditional method may not have desirable quality attributes. The reasons for this could be (1) lack of cleanliness in handling of milk for ghee manufacture (2) uncontrolled fermentation during curdling of milk (3) inherent defects in country churns and inefficient working (4) improper storage of butter prior to clarification into ghee (5) uncontrolled heating at the time of clarification and (6) unsanitary and undesirable pots used for production and storage

of butter and ghee. Further, the very fact that to prepare 1 kg of ghee one has to start with ~ 15-20 kg milk which makes the process unsuitable for large scale industrial application.

To overcome the problems / limitations narrated above; several suggestions in the original traditional method have been made and are summarized below.

Improvements in traditional method of ghee making

Steps	Recommendations
Milk	Use clean, fresh strained milk. Boil once for 10 min or 5 % volume reduction and cool quickly.
Fermentation	Use mixed starter of right type. Use 2-2.5 % in winter and 1 % in summer. Sour upto 12-15 h in winter and 8-10 h in summer.
Curd	Do not accumulate beyond 1 day.
Churning	Perform in gear driven wooden beater fixed on a vessel with a draining device at the bottom. Cary out churning in cold. Add cold water if desired, but not exceeding the volume of the curd taken. After butter granules are formed, drain buttermilk, add cold water and gently churn again to wash butter.
Butter	Do not store before melting. If unavoidable float in 1 % salt solution in an enamel or porcelain vessel.
Clarification	Heat to 80 C and hold for 30 min. Remove lower most water layer. Clarify upper layers of curd and fat by heating in an enamel, glass or stainless steel vessel. When cracking due to water removal stops, heat for a few minutes without burning.
Ghee	Store in an earthenware, porcelain or enamel jars filled to the top, store in a cool place. Withdraw small quantities for use into a smaller container

CREAMERY BUTTER METHOD

The ghee making by creamery butter method is the usual industrial practice. In this process, the milk is first heated to around 40 C and separated through a centrifugal cream separator. The cream thus obtained is pasteurized, cooled, aged and converted into butter. Sometimes, when butter made is immediately converted into ghee, the pasteurization of cream is eliminated. In order to further improve the flavour of the final product the cream is sometimes ripened using lactose fermenting starter culture and then churning is carried out in usual manner. Butter is then heat clarified at temperatures ranging from 110 to 140 C. The ghee residue is removed either by filtration or through a ghee clarifier.

Baring the limitation that one needs to have a butter churn, this process offers several advantages like (i) reduction in bulk of the volume to be handled, (ii) highest fat recovery, (iii) relatively good flavour, (iv) economy of operation and (v) possibilities of employing pre-stratification.

DIRECT CREAM METHOD

The direct cream method is another way of obtaining ghee from milk. As the name suggests, the ghee is obtained by directly heat clarifying the cream. Since the whole process is just a two-step procedure, it has attracted the attention of many research workers. The modifications suggested by these workers include (i) dilution of cream to the original volume of milk with water and re-separating the same, (ii) washing the cream with ordinary or acidified water, (iii) use of cream with high fat percentage and (iv) ripening of cream. All these attempts were mainly aimed to increase the recovery of fat in ghee and improve the flavour, which otherwise is mild and milky in case of direct cream ghee.

PRE-STRATIFICATION METHOD

When the butterfat is heated to around 80 C and left undisturbed, it leads to the formation of distinct layers. The lower most layer has the highest specific gravity and is made up of serum portion of butter. The other layer is largely fat and the curd particles generally form an intermediate stratum. Keeping this information in mind, the pre-stratification method was developed. Apart from the shortening the period of clarification with saving in energy, the yield of ghee also increases by about 8% by this method.

CONTINUOUS METHODS OF GHEE MAKING

Dairy plants have tried to modify, scale up, and adopt the traditional batch process for commercial production. Although large quantities of ghee are made by this process, attempts have been made for development of continuous methods for ghee making. Increased awareness about energy management has led to the development of energy efficient and continuous methods. (Punjrath, 1974) for ghee manufacture, which include either an oil separator (Bhatia, 1978) to separate serum and fat phase or use of scrapped surface heat exchangers (Abichandani *et al*., 1995). Both the processes save energy and yield a comparable product. Use of microwaves for ghee making has also been reported (Sahai, 1996). The ghee so prepared had higher vitamin A and E contents and appreciably lower levels of cholesterol.

Various approaches made for continuous ghee making are due to the following salient features of the process viz. (1) Very high heat transfer coefficient and hence compact design (2) Better control on quality of product (3) Only small hold-up of raw material in the plant at any time and hence no chances of whole batch getting spoiled (4) No spillage loss (5) Simple, robust and hygienic design (6) Minimum strain on the operator (7) Can be cleaned in place (8) High degree of automation possible (9) No surface fouling and hence heat transfer coefficient can be maintained throughout the run of the system (10) Easy capacity control (11) No foaming problem. Cream can be handled conveniently and (12) Economic operation.

IMPROVED METHOD OF PANCHMAHAL DAIRY

At Panchmahal Dairy, Godhra, an innovative method of ghee manufacture with a special focus on reducing fat and SNF losses from the largest section of the dairy which handles costliest ingredient of milk, i.e. milk fat was developed. Different methods of ghee manufacture so far discussed are compared in table below.

Comparison of Different Ghee making Processes

Particulars	Indigenous process	Cream butter process	Direct cream process	Pre-stratification process	Continuous process
% Fat recovery (maximum)	88-90	88-92	92	93	93
Aroma	Strong, nutty	Pleasantly rich	Mild and milky	-	Mild
Flavour	Acid	Normal	Rather flat	-	Flat
Texture	Packed coarse grain	Slushy fine grain (cow) packed fine grain (buffalo)	Mostly liquid with slight granulation	Fine grains	Greasy
Aroma retention on storage	Taken as 100	140	233	-	-
Flavour retention on storage	-Do-	150	160		
No. of stages Involved	3	2	2	3	3
Clarification using heat	Easy economic Pre-stratification possible	Easy economic Pre-stratification possible	Difficult Slow Pre-stratification not possible	Easy and economic	Easy and economic
Essential equipment	Butter churn	Cream separator and butter churn	Cream separator	Cream separator and butter churn	Scraped surface heat exchanger
By product Produced	Butter milk, ghee residue	Skim milk, butter milk, ghee residue	Skim milk, ghee residue	Skim milk, butter milk, ghee residue	Skim milk, butter milk, ghee residue
Acceptability	Small scale	Large scale	Large scale	Large scale	Very large scale
Domestic Advantages	Full traditional characteristics. Clarification by stratification technique. Economical and easy. Cheap butter churn required. Useful consumable by products.	High fat yield. Clarification by pre-stratification. Easy and economical.	Max. fat yield, Very high keeping quality. Rapid process.	Reduced energy requirement.	
Industrial Advantages	-do-	-do- By products can be usefully processed.	-do- By products can be usefully processed. Phase reversal possible, making subsequent clarification economic and processing time reduced	-do-	CIP possible. Very rapid process. Economic Efficient Simple Hygienic, Robust design. By products can be used fruitfully
Domestic Disadvantages	Poor yield of fat. Low keeping quality.	Sensory quality. Medium keeping quality. Expensive cream separator needed.	Sensory quality. Expensive cream separator required. Slow clarification.	-	Expensive as installation cost are high. Cannot be used on small scale.
Industrial Disadvantages	All the above. Slow three stage process. Requires careful control. Large scale production not possible.	The first two, process requires careful control	Sensory quality	Preciseness required in removing bottom layer of serum	In addition to above, careful control is required.

Rearranged from Rangappa and Achaya (1964) and De (1980)

GHEE AND HUMAN HEALTH

Chemically ghee is nothing but ~ 99.5 % milk fat. It is a complex lipid of glycerides, free fatty acids, phospholipids, sterols, sterol esters, fat soluble vitamins, tocopherol, carbonyls, hydrocarbons, carotenoids, small amounts of charred casein, traces of minerals like calcium, phosphorous, iron, copper, etc.

The role of milk fat in human nutrition does not need any elaborate justification. Our ancestors were rather drinking pure ghee and maintaining good health. In addition to its contribution to the flavour and textural characteristics to almost all the dairy products, the fat also plays a vital role in providing requisite calories, acts as a carrier of many fat-soluble vitamins, makes food less bulky, gives the feeling of satisfaction and prevents hunger from reappearing quickly. It also provides essential fatty acids (linoleic acid and arachidonic acid) the deficiency of which will lead to drying of skin of the young babies and problems with the reproduction process both in the male and female, which our body is not able to synthesize. In absence of Vitamin A, which is mainly supplied to our food by ghee, the growth rate of the children is hampered, moist areas near eyes, nose and throat become dry and hard, and ability of the eye to adapt to dim light reduces – night blindness. Vitamin D is essential for laying down of calcium and phosphorous in the bone and in the greater absorption of these elements from the diet. Thus, it has major role to play for children and expecting mothers. Vitamin E (tocopherol), the daily body requirement can be completely obtained by consuming recommended quantity of ghee in our condition, is essential for normal pregnancy, birth and breast milk production.

Within the body, Vitamins A and E are only bio-available when taken with fats. Beyond ghee, only one other edible fat contains Vitamin A in the form of fish oil. Ghee is thus an ideal delivery vehicle, especially for lacto-vegetarians. It serves to take anti-oxidants to cell membrane and cell structures made of fat, protecting against free radical damage.

Scientists at the University of Texas medical branch in Galveston found that drinking whole milk after lifting weights boosted muscle protein synthesis - an indicator of muscle growth - 2.8 times more than drinking skim did.

With regard to the digestibility, absorption and growth in relation to ghee it has been found that ghee falls in the fully digestible class of fats putting relatively little strain on the body. It can therefore be an important dietary constituent for the patients having disease of stomach, intestinal tract, liver, kidney and gall bladder. Ghee passes unchanged to the small intestine, where it is split into fatty acids and partial (mono and di) glycerides by pancreatic lipases. The mono and di glycerides are altered and esterified again with the fatty acids present to give Triglycerides, which of course differ from the original fat. Assisted by the bile salt, free fatty acids, glycerol and mono glycerides present, such tri glycerides are emulsified into fine droplets, cross the wall of the intestine and are collected in the lymphatic vessels which empty them into the blood. The unique presence of glycerides of lower fatty acids in ghee lead to rapid initial hydrolysis of these glycerides, faster absorption, rather than re-esterification of the liberated short-chain fatty acids and easy absorption of residual partial glycerides (which still contain lower acids) after re-esterification. Ghee is tolerated in greater amount compared to other fats. Peak absorption of ghee occurs in 2-3 h compared to 3-5 h for sesame oil and 4 h for groundnut oil.

GHEE AND CORONARY HEART DISEASE:

A common belief prevails that if you eat foods which are rich in fat the chances that you have heart related problems are more. Until recently, many heart problems such as angina, thrombosis and coronary heart disease were thought to be caused by excess cholesterol, a term that encompasses both dietary and blood cholesterol. It is now established fact that while former can influence health, the latter type – whose levels are often hereditary – is the main threat. It is therefore essential that cholesterol is viewed differently. Kansal (2002) and Latha (2002) dealt the subject with these background. Certain information is reproduced below.

The cholesterol content of milk fat is very low (2.8 mg/g and 1.9 mg/g fat for cow and buffalo milk respectively). The body itself synthesizes higher amounts of cholesterol than what is absorbed from the diet. Cholesterol (1-4 g per day) is mainly formed in liver from acetyl CoA and 10-14 g is constantly present in the blood and 10-150 g in the body.

A high cholesterol diet led to hypercholesterolaemia and arteriosclerosis in the experimental animals. But the same cannot be transferred to human as cholesterol metabolism is different in different animals. The experimental animals have low serum cholesterol and absorb much more of the cholesterol supplied by the feed. Humans absorb 10-14 % of the dietary cholesterol whereas figures for monkeys, dogs and rabbits are respectively 50-80 %, 40-75 % and upto 90 %. Based on body weight the cholesterol absorption capacity of human is only 1 % of that of the animals stated above.

A common belief is that ghee because of its SFAs increases the serum cholesterol. Therefore there should be more of PUFA in the diet. Studies have shown that reduction in the serum cholesterol levels by PUFA was attributed partly to a redistribution of cholesterol into other body tissues. An increased excretion of cholesterol in the form of bile acids may accelerate the formation of gall stones. (Renner, 1983). A high intake of PUFA reduces the conversion of linoleic acid to arachidonic acid and hence to growth factors. Excessive intake of PUFA increases the vitamin E requirements. Oxidation products of PUFA such as peroxides may cause alteration in the membrane of blood corpuscles. Further, the diet containing predominantly either oleic or linoleic acid result in LDL enriched with these fatty acids and thus more susceptible to oxidation. According to Hodgson *et al* (1993) the chances of atherosclerosis are higher when the linoleic acid content of adipose tissue is higher. The increased excretion of bile acids due to PUFA rich diet may lead to increased colonization of bile degrading bacteria in the intestine – which are thought to be carcinogenic.

While saturated fat was villainized for decades, a 2010 analysis published in the American Journal of Clinical Nutrition concluded that ***"there is no significant evidence for concluding that dietary saturated fat is associated with an increased risk of [coronary heart disease or cardiovascular disease]."***
Further, there are numerous benefits to drinking full-fat dairy products. In its most pure state (raw, organic, and coming from grass-fed cows), full-fat dairy has been found in research to potentially promote heart health, control diabetes, aid in vitamin absorption, lower bowel cancer risk, and even aid in weight loss. But while pure dairy could promote your health, conventional dairy may prove damaging.

CONJUGATED LINOLEIC ACID (CLA):

Pariza (1991) in IDF bulletin 257 described CLA as a new cancer inhibitor in dairy products and gave its mode of action.
Parodi (1994) in a review "Conjugated linoleic acid: An anticarcinogenic fatty acid present in milk fat" discussed various aspects related to CLA. He indicated the anticarcinogenic activity of this fatty acid and added that the dairy products are the richest dietary source of CLA, whereas vegetable oils and margarines contain only small amounts of CLA. Depending upon pasture conditions milk fat may contain upto 30 mg CLA per g fat.
Szakaly *et al* (2002) published a review listing certain bioactive components in milk fat. Pandya and Haenlein (2009) discussed different bioactive components of buffalo milk including the milk fat.

Bioactive and physiologically beneficial milk components

Bioactive material	Effect
Rich conjugated linoleic acid CLA content	Anticarcinogenic Antiatherogenic Immunomodulatory Making body muscle fibrous
Rich sphingomyeline content	Tumour suppressor
Rich butyric acid content Different etherlipids	Prevention of tumor formation
Vitamin A and Beta carotene	Due to their antioxidant effect they prevent cancer formation and atherosclerosis and delay ageing
Small amount but beneficial trans fatty acids	Antiatherogenic
Ideal Omega-6/n-6/ and Omega-3 / n-3 / fatty acid ratio	Antiatherogenic, Antihypertensive, Antithrombic, Antiallergenic Migraine alleviation, Antiarhythmic Prevention of premature birth Prevention of menstruation pains

OMEGA FATTY ACIDS IN GHEE

Despite the potential health problems associated with poor quality PUFAs, they are also vital in providing the essential Omega fatty acids now famed for their health giving anti-oxidant properties. Ghee contains linoleic acid, an Omega-6 oil and alpha-Linoleic acid, an Omega-3 EFA. Both are also found in another nectar like substance, breast milk. EFAs are only used for energy if present in excess; generally play the role of stimulating metabolism. Correlations with ghee's effects of increasing *agni* are of great interest in this regard. Despite their benefits, there are dangers associated eating the wrong ratio of Omega-6 to Omega-3. These include CVD, mental disorders (ADHD, depression, MS and Schizophrenia), and inflammatory diseases. Most of us eat more Omega-6 than 3 but ghee provides both in an ideal ratio of 1:1. In his groundbreaking book 'Fats that heal fats that kill', Erasmus dismisses all dairy products as a poor source of EFAs due to them raising triglyceride and cholesterol levels and increasing platelet stickiness. He adds 'the cholesterol in dairy products, combined with sticky fatty acids, create a burden that must be carried by fat dispersing Omega 3 and Omega 6, which must come from another source" Although human breast milk contains cholesterol, its EFA content keeps it from oxidizing and damaging arteries. Erasmus concludes human milk is better adapted for human health than cow and other types of milk. Unfortunately, ghee is not included in his research on dairy products. Studies are needed into whether ghee is a good enough source of EFAs to help prevent cholesterol damage. (A 21st Century look at ghee - Ayurvedic nectar or heart disease risk factor? *June 29, 2009)*
To conclude the role of pure ghee in health and nutrition need not be overemphasized. The role is understood fully but needs to be consolidated. Certain findings are well described but clinical evidences are missing. Future is as bright as "ghee" itself.

ENERGY CONSERVATION IN DAIRY INDUSTRY

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IMPORTANCE OF ENERGY CONSERUATION:

Though energy is an integral part of industrial and economic growth, it is very important to conserve it because of the following reasons:

- Energy scarcity (global energy stocks are depleting at a very fast rate, which may result in non- availability of energy at all in future for the industries.)
- Due to energy scarcity its cost is increasing day by day, resulting into increasing the production cost. In a competitive market, it is very essential to keep the cost of production to the minimum possible levels.
- Most importantly, its harmful effect on environment (environmental pollution due to increased industrial emission, global warming, acid rain, sea level rise, ozone layer depletion etc.,)

Due to the above mentioned harmful effects of energy use on environment, its scarcity and rising energy cost, the issue of "Energy Conservation" has become a global issue, and rising energy use is a matter of grave concern to human being /civilization. Looking at the present scenario and harmful effect of energy use on the environment, there is strong immediate need to reduce the energy consumption to minimum possible levels. This can easily be achieved by incorporating and implementing energy conservation measures at all the levels judiciously.

ENERGY USE IN DAIRY INDUSTRY:

- Thermal Energy (Heat Energy)- for milk pasteurization, milk evaporation/drying, ghee and khoa making , indigenous milk products manufacturing, etc. Source of Energy - Fuel oil (furnace oil, LDO, diesel , etc), Coal, Natural Gas etc.
- Refrigeration (Electrical Energy) - for milk pre - chilling and chilling of milk after pasteurization, cold storage for packed milk and milk products, reconstitution of milk , butter and ice crème storage, etc.
- Compressed Air (Electrical energy) for pneumatic milk packaging machine operations , process plant controls, etc.
- ELECTRICAL ENERGY: For milk pasteurization, homogenization , clarification, separation , milk evaporation and drying etc.

ENERGY INTENSIVE OPERATIONS:

- Milk pre chilling and chilling of milk after pasteurization.
- Milk pasteurization, homogenization, clarification/separation.
- Milk evaporation and drying .
- Milk packaging and cold storage, deep freeze operation .
- Milk reconstitution.
- Ghee and khoa manufacturing.
- Effluent treatment.

As dairy industry consumes huge amount of thermal and electrical energy , there is strong and urgent need of adopting energy conservation techniques. .

POTENTIAL AREAS FOR ENERGY CONSERVATION IN DAIRY INDUSTRY

- Steam generation , distribution and utilization .
- Refrigeration generation , distribution and utilization.
- Compressed air generation , distribution and utilization.
- Electrical energy utilization.
- Efficient effluent treatment.
- Use of solar energy as a partial substitute of thermal energy (milk pasteurization hot water generation, khoa and paneer manufacturing etc.)
- General Energy Conservation measures.

EFFICIENT STEAM GENERATION, DISTRIBUTION AND UTILISATION:

- ***Proper fuel selection:*** Fuel selected should be easily available, with minimum impurities and should be environment friendly. Also, while selecting the fuel, impact of transportation cost should also be in mind. In fact, the cost comparison of various fuels available should be done on the basis of NCV (Nel Calarific Value in kcal) with respect to fuel cost. Also periodic tests (fuel analysis) should be carried out at reputed laboratory to know the level of impurities, available effective energy (KCAL) etc, so as to avoid initial energy losses . The best fuel is, which gives maximum kcal/steam output with minimum cost input and minimum environmental pollution/ emission.
- ***Stack temperature control -*** Stack temperature should be maintained as low as possible (around 200 degree c) .
- Higher stack temperature indicates wastage of heat energy/scaling of heat transfer area.
- Periodic clearing of fire - side/water - side is very important as 2 to 3 mm thick soot deposition reduces efficiency by around 5 percent and 0.5 mm thick scale formation reduces efficiency be around 2-3 percent.
- Feed water pre- heating/combustion air pre- heating by using flue-gases as per techno economic feasibility.
- The proper and adequate feed water treatment should be done with commercially zero hardness i.e less than 5 ppm.
- Proper feed water temperature (around 85^0c) should be maintained so as to drive out free oxygen , which is harmful from corrosion point of view.
- ***Efficient Combustion of Fuels:*** By regulating and periodic monitoring of various combustion efficiency parameters the combustion efficiency can be improved to maximum possible attainable level. (80-85 Percent)

Ideal combustion parameters (furnace oil) :
Carbon dioxide level (C02) : 12-13 percent.
Oxygen level (02) : 1-4 percent .
Excess air level : 5-20 percent .
Stack temperature : 180-200^0 C

- Adequate insulation of heat transfer surface/steam line to reduce heat losses (a bare steam pipe of 150 mm diameter and 100 m length carrying saturated steam at 8 kg /cm2 would result into wastage of 25,000 litre of furnace oil in a year).
- Proper and periodic blow down .T D S should not exceed more than 3000 ppm.
- Proper operation and maintenance of steam traps,so as to improve steam distribution and utilization efficiency.
- Timely and promptly arresting the steam leakages (3 mm diameter hole in steam distribution line carrying steam at 7 kg /cm2 pressure would result into wastage of 3000 liter of fuel per year .
- Dry saturated steam should be used to meet process heat requirement. Wet steam reduces total heat content in the steam.
- Wet steam (water) forms a wet film on heat transfer surface/area and reduces heat transfer efficiency .

- Heat transfer surfaces should be cleaned periodically (process equipment, milk pasteurizer, plate heat exchangers).
- Periodic and proper air purging from the process equipment
- Adopt suitable condensate recovery system to recover waste heat.
- Incorporate the use of solar hot water system as per techno economic feasibility.
- Substitution of conventional fuel with low cost fuel such as baggasse, rice husk, briquette, etc as per availability and techno economic feasibility.
- Use of hot water generator as per feasibility.

EFFICIENT REFRIGERATION, GENERATION, DISTRIBUTION AND UTILIZATION

- Efficient running of refrigeration compressors by carefully monitoring desired parameters, so as to produce refrigeration effect efficiently .
- Periodic cleaning of heat transfer surfaces (evaporator / condenser) [0.8 mm scale built upon condenser tube can increase energy consumption by 30-35 percent].
- By maintaining proper suction pressure proper liquid level in the receiver , and reducing head (discharge pressure) to lowest possible level, refrigeration efficiency can be improved considerably.
- Timely and periodic air and oil purging should be carried out from the system.
- Proper insulation of chilled water lines, and storage, ice- bank tanks.
- By segregation of chilled water tank (IBI), cold storage and deep-freeze suction line and connecting the same to separate refrigeration compressor, wherever possible with provision of interchangeability, refrigeration efficiency could be improved considerably and better refrigeration effect could be produced with reduced compressor running hours. The individual refrigeration compressors should be loaded/ operated to their full capacity.
- ***Efficient utilization of Refrigeration effect:-***

The refrigeration effect produced must be utilized efficiently, so as to achieve maximum savings. This can be achieved by proper maintenance and cleaning of chilled water tank coils, and other heat transfer surfaces, reduction of chilled water losses from different equipments, valve, lines etc.

- ***Efficient Running of cold storage:***

By reducing cold air losses from cold stores better cold storage temperature can be maintained at increased milk load , with reduced refrigeration compressor running hours. Cold air losses can be reduced by sealing main door properly, controlling door openings, reducing the open area of milk crates loading and unloading windows etc.

- ***Proper maintenance of refrigeration system:***

Proper and timely preventive maintenance of compressor, compressor motors, chilled water pumps, condenser pumps, chilled water valves, etc help in improving the efficiency of refrigeration system. The heat transfer surface (condenser coil surface) must be very clean and free from scale algae etc for efficient refrigeration operation. Defrosting operation should be conducted periodically and efficiently.

- ***Proper scheduling of refrigeration compressor operational timings as per environmental conditions.***

MINIMIZING REPROCESSING LOAD

It is observed that reprocessing of milk puts additional load on refrigeration systems, which directly affects the refrigeration and processing costs. Joint efforts should be made to minimize the reprocessing load, by efficient control of pasteurization temperature, chilled milk temperature and incorporating effective cleaning schedule. Top management should periodically review the reprocessing load carefully and try to bring it to zero level.

EFFICIENT COMPRESSED AIR GENERATION, DISTRIBUTION AND UTILIZATION

- Air intake (suction to compressor) should be cool clean and dry.
- Adequate cooling of compressed air and compressor.
- Segregation of low and high pressure air requirement.
- Minimum pressure drops in air liners.
- Avoid air leaks.
- Proper removal of moisture from compressed air and air lines.

CONSERVATION OF ELECTRICAL ENERGY :

- Maximum demand should be controlled and monitored properly, so as to keep it to minimum.
- Power factor (PF) should be controlled to near unity (use adequate capacitors). For effective control of power factor automatic power factor controller should be installed.
- Use energy efficient motors and transformers .
- Use soft starters for heavy duty motors, which offers advantages such as:

Less mechanical stress, and maintenance.
Improved power factor.
Lower minimum demand.
Increased motor life/ machine life.

- Use mechanical milk packaging machine instead of conventional electro pneumatic milk packaging machines.
- Use plant and machinery with maximum level of efficiently and install energy efficient equipments only. Use electronic ballast, CFL/ LED lighting devices.

EFFICIENT EFFLUENT TREATMENT;-

- Effluent treatment in the dairy industry is one of the area, which consumes considerable amount of electrical energy. Generally this area gets less attention from energy conservation point of view. In fact there is considerable scope of energy conservation, if effluent generation and treatment are paid maximum due attention.
- In large milk processing daries, efforts should be made to segregate low BOD streams from the high BOD streams, so as it reduce the hydrological load of effluent treatment plants. In fact there are many areas in the dairy industry which have very low BOD and do not require any treatment at all. For identifying low and high BOD streams, samples from various sections should be studied and accordingly segregation plan should be implemented as per techno-economic feasibility.
- Use of "anaerobic effluent treatment system" instead of conventional "aerobic effluent treatment system" give considerable amount of savings. In fact, where plant BOD is on higher side (specially product manufacturing plants) combination of anaerobic cum aerobic treatment plants are found to be feasible. Such units not only reduces electrical consumption but also give useful bio- gas, which can be utilized for electricity/ hot water generation. This aspect should be examined and studied carefully and implemented based on techno-economic feasibility.
- As country is facing acute water shortage, concept of water recycling should be studied and concept of tertiary treatment, which gives extremely good equality water (even at potable level) should be adopted. Effluent treatment system of Mahanand Dairy has given huge monetary savings.
- Effective water conservation efforts should be made so as to bring consumption level to minimum possible. By making sincere efforts and adopting effective water conservation measures, water consumption level of less than one liter per liter milk handling are achievable. This will not only reduces the water consumption cost

but also help in reducing the effluent treatment costs considerably due to reduced hydrological load on the treatment plant .

- Milk and milk product losses (Fat / SNF losses) should be controlled and minimized as these directly affect BOD/COD levels. Top management should review BOD/COD level of the plant various sections and efforts should be made to minimize these levels.

APPLICATION OF SOLAR ENERGY IN DAIRY INDUSTRY :-

- In fact, dairy industry is an ideal industry where there is great potential of solar energy use.
  Dairy industry extensively uses hot water for cleaning operations (CIP), milk pasteurization, boiler feed water, tanker cleaning, crate washing etc.
- Looking at the energy crisis, its harmful effect on environment and its increasing cost, efforts must be made to use solar energy in dairy industry, as per techno-economic feasibility, so as to substitute thermal energy to maximum possible extent.
- Among various dairies Mahanand Dairy is one of dairy where solar energy is used successfully for hot water generation since 1990. The hot water (25,000 LPD) is generated from ambient temperature to 85^0 C by using flat plate solar collectors. The system comprises feed water storage tank, flat plate solar collectors, insulated hot water storage tank, water circulation pumps, valves, pipes and fitting, temperature controller, etc, Hot water generated is being used for boiter feed water, cleaning of milk pouch crates and general purpose cleaning operations Appx. 200 liters of furnace oil saving per day are achieved.

ADVANCED SOLAR HOT WATER GENERATING SYSTEM :-

- Looking at the potential of fuel saving for milk pasteurization activity by developing solar water heater, for generating high temperature hot water (90 to 95^0c), so as to run milk pasteurizer, without using boiler/ without fuel an advance solar concentrator –Arun 160" was installed and commissioned at Mahanand Dairy, Latur Unit, The project was undertaken as R & D project with technical assistance from I I T , Mumbai and financial assistance from M N E S, New Delhi and same was completed during the year 2005-2006.
- To meet milk pasteurizer (5000 LPH capacity) heat requirement, system gives hot water at 160 to 180^0c (total heat output 3,80,000 kcal par day) with heat storage arrangement (50 to 70 percent heat generated) so as to pasteurize Appx 20000 to 25,000 liter of milk per day during any time of the day or night. This definitely will be proved a boon to the dairy industry in future.
- The system comprises parabolic self tracking solar concentrator, pressurized hot water storage tank, heat exchanger ,so as to deliver hot water at 90-93^0c to meet milk pasteurizer requirement.
- During initial trials, appx 65 to 75 liters of furnace oil per day could be saved, which is quite encouraging.
- In addition to above the system helps in reducing Co 2 emission in the environment, which is a matter of global concern.
- In our opinion the system developed is unique, which make possible to pasteurize the milk without using boiler/ fuel. In the future, this will prove as a trend setter for the dairy industry.
- In addition to above application, solar energy can successfully be used for khoa making (solar khoa maker similar on the line of solar pressure cooker), Rabadi manufacturing, milk heating for product manufacturing such as paneer, cheese etc., However for commercial application/ industrial use further R & D work needs to be undertaken so as to use the technology based on techno economic feasibility.

General Energy Conservation Measures:

- By promoting general energy consciousness and awareness among the staff at shop floor level to use energy judiciously.
- Adaptation of proper coordination measures among various energy intensive departments (production , engineering and quality control).
- Use of advanced energy efficient equipments.
- By adopting effective preventive maintenance programmer and utilizing plant machinery to full capacity.
- Proper measurement and recording the energy consumption data and comparing the efficiency level with well managed energy efficient plant.
- By comparing the energy consumption level with theoretical energy requirement/ National level norms for individual activity so as corrective measures can be adopted well in time.

SOME AREAS FOR FUTURE R & D:-

- As properties of milk and water are almost identical work may be initiated develop a " solar milk pasteurizer" so as to heat the milk at a required milk pasteurization temperature, by using self tracking solar collector fitted with stainless steel tubes at the centre parabolic collector with arrangement of S . S milk pump for milk circulations.
- R & D work should be initiated for developing solar khoa making, rabadi making units based on solar cooker technology.
- As dairy industry needs quite a significant amount of heat energy for milk drying plants there is strong need to undertake R & D projects based on the use of solar energy for developing a solar milk concentrator/ evaporator, so as to remove some water before milk enters in multi stage conventional milk evaporating plants, developing solar hot air generator for heating the air required in spray drying plants.
- Development of hot water heating system from waste heat (boiler exhaust, generator exhaust refrigeration discharge line, etc,)

SUGGESTION

- For effective implementation of energy conservation techniques in the industry, independent senior executive should be appointed and separate energy conservation /research and development cell should be started.
- Energy conservation laws should be finalized and norms for energy consumption should be finalized and fixed for various operations (Bench Marking).
- Strong commitment and support from the top management should be there, which is very essential for a successful conservation programme.
- Strong and burning desire should be developed for implementing energy conservation techniques.
- National and State level bodies such as NDRI , NDDB, IIT, NPC, State Level Energy Development Agency, etc should work vigorously for implementing energy conservation programme and to assist in implementation of the suggestions made.
- Lastly every citizen should understand the gravity of the situation, spare some time to think about the energy crisis and its adverse impact on environment and act for adopting the energy conservation measures.

CONCLUSION:-

It is strongly felt that there is scope of at least 25- 30 percent energy saving in the industry (which is quite a sizeable amount) by adopting simple and general energy conservation technique. For getting better results strong inner will and whole- hearted commitment from the top management must be there. If things are taken in right sprit, with well defined objectives and correct approach in right direction, no power on earth can prevent to achieve unbelievable results.

BIOTECH INTERVENTION
GHEE WITH 85% LESS CHOLESTEROL

Dr. R. S. KHANNA
Director, Kwality Dairy (India) Limited, New Delhi.

INTRODUCTION

Despite the fact that ghee has been revered for thousands of years by Ayurveda, it is now under a severe threat of being dumped in favour of low-fat, supposedly heart-friendly oils. ''Fat is bad, ghee is the pits, lean is in'', we are told. Notwithstanding such critics, modern science is looking at the benefits of ghee with renewed interest. In a TV series presentation on health, Dr B S Raheja, the then Director of the All India Institute of Diabetes, categorically pointed out that ''the present epidemics of diabetes, heart disease and some cancers'' is due to ghee not being present on the food scene. ''There is considerable evidence to show that this rise was due to change in dietary cooking fat and increased consumption of fast, fatty, and preserved foods,'' he said.

All kinds of allegations about villainous qualities of ghee are being countered. Kathryn Feldenkreis, in her book, Ghee, A Guide to the Royal Oil, explains, ''Cholesterol itself is not harmful but becomes harmful when it is partly broken down or oxidised by unstable chemicals called free radicals. Ghee, and particularly organic ghee, has no oxidised cholesterol or trans-fatty acid and is very stable at higher cooking temperatures.''

Our ancient Ayurvedic texts gave ghee the cherished title of rasayana— food that helps overall health, longevity and well-being. They attribute many benefits to it:

Digestion:
Ghee helps balance excess stomach acid, and helps repair the mucus lining of the stomach.

Preservative:
Since ghee doesn't spoil easily, it preserves the original freshness of herbs and foods.

External use:
Ghee is said to prevent blisters and scarring if applied quickly to affected skin.

Mind:
It is said to promote all three aspects of mental functioning— learning, memory and recall.

Fertility:
Ghee enhances the quantity and quality of semen and ovum for increased fertility and healthier children.

Anti-Ageing:
Ghee is an anti-ageing ingredient and enhances the quality and quantity of Ojas, the master coordinator of the mind and body.

TYPES OF GHEE

There are eight types of ghee described in Ayurved.

Cow's Ghee:
Out of the eight types of ghee mentioned in Ayurveda cow's ghee is considered best for therapeutic actions as well as for daily use as diet. It is sweet in taste and Vipaka (post digestive taste), cold in action and pacifies Vata and Pitta. It promotes body strength and eyesight and specifically useful in the treatment of poisoning. Milk of the cow is sweet in taste and has cold, soft, unctuous, thick, smooth, slimly, heavy, slow and pleasing properties. All these ten properties of milk are similar to that of Oja. Therefore it increases Oja and is Jivaniya i. e. it provides all the benefits of Rasyana.

Buffalo's Ghee:
It is sweet both in taste and Vipaka, cold in action and heavy to digest. It pacifies Vata and Pitta but increases Kapha and is useful for the treatment of bleeding disorders. Vijayarakshita, the commentator of Madhava Nidana, while describing the role of Anshansha Kalapana in pathogenesis mentions that buffalo's ghee and Kapha have all the properties similar to each other, so ghee causes maximum increase in Kapha. Charaka has advised to use buffalo's Ghee for the treatment of jaundice particularly for the preparation of medicated ghee for this disease. Buffalo's milk in comparison to cow's milk is more heavy and cold and possesses more fat. It induces sleep and useful for such persons who have excessive digestive power.

Goat's Ghee:
Ghee of goat is light to digest, promotes digestive power and body strength and increases eyesight. It is Pathya for the diseases such as cough, dyspnoea and tuberculosis. The milk of goat is astringent and sweet in taste, cold in potency, light in digestion and solidifies the faeces. It is useful in the treatment of bleeding disorders, diarrhoea, tuberculosis, cough and fever.

Sheep's Ghee:
Ghee of sheep is light to digest. It is useful in the treatment of disorders of Vata and Kapha, tuberculosis, gynaecological

disorders (Yoni Dosha) and tremors. The milk of sheep is hot in potency and increases Pitta and Kapha. It may produce hiccup and dyspnoea.

Camel's Ghee:
Ghee of camel is pungent in Vipaka (post digestion taste), promotes the digestive power and relieves the vitiation of Kapha and Vata. It is useful in the treatment of chronic skin diseases (Kushtha), localized swelling in abdomen (Gulma), generalized enlargement of abdomen (Udara Roga), swelling, poisoning and worm infestation. The milk of camel has slight saline taste, light in digestion, hot in potency and is dry. It pacifies the disorders caused by Vata and Kapha, distension of abdomen, swelling, piles and worm infestation. It is specially indicated for the treatment of Udara Roga such as ascites.

Mare's Ghee:
Ghee of mare is astringent (Kashaya) in taste, light in digestion, hot in potency (Ushna Virya) and promotes digestion power. It relieves Kapha disorders and decreases the quantity of urine. Hence it may be useful in polyuria and diabetes mellitus. The milk of mare is slightly saline and sour in taste, hot in potency, light and dry in action. It promotes body strength, provides firmness to body organs and cures the Vata situated in Shakha.

Elephant's Ghee:
Ghee of elephant is astringent (Kashaya) and bitter in taste, light in digestion, promotes digestive power, pacifies Kapha, makes the feces formed and causes decrease in urine. It is useful in the treatment of chronic skin diseases (Kushtha), poisoning and worm infestation. The milk of elephant is heavy in digestion, promotes the body strength and provides maximum firmness to body parts.

Woman's Ghee:
Ghee obtained from woman's milk cannot be used for common practice. However, it is light in digestion, promotes growth of child and digestive power and it useful like nectar. It provides relief in eye disease and poisoning. It may not be ethically right to use the woman's milk for common practice but due to its unique properties, it may be very useful in emergency. For instance few drops of woman's milk put in the nostrils in the form of Nasya may stop the bleeding from nose immediately. Mother's milk provides all the properties of Rasayana to the child. It increases weight and is wholesome for the child. It is used for effusion of eyes in eye diseases.

TRADITIONAL MANUFACTURE OF (AYURVED) GHEE

This history of ghee is not properly recorded but it is very old. Our old classical books – "Vedas" approximately third century B. C. describe ghee. It occupies a unique place in the life of a human and is so closely woven in life that practically it is inseparable. Life begins and ends with ghee. With the advent of civilization, man started domesticating cattle. His search for food, taught him to make use of milk. His ingeniousness led to preservation of food, but for milk. Excellent nutritional quality supporting all forms of life, higher ambient temperatures and lack of development of proper technology for preservation of milk – a highly perishable commodity posed problems.
It was visualized that only one constituent of milk i. e. fat could be preserved for longer time without appreciable deterioration. This could also be due to ease with which fat can be separated from other milk constituents. This very fact led to the development of products viz. makkhan, ghee etc. which were concentrated forms of milk fat. Originally milk was allowed to sour, the curd thus obtained was churned to get butter, which upon boiling yielded ghee. Subsequently several such methods came into being. All the above-mentioned properties of various types of ghee are of that which is obtained through the process of churning of curd of respective milk. The properties of ghee directly obtained from milk i.e. cream are mentioned separately. Similarly the properties of ghee and butter are also separate. For instances ghee relieves constipation due to its Sara properties, while butter may cause constipation due to its Grahi (astringent) properties.

Technology for Processed Ghee
For manufacturer of ghee there are many methods, however, 80-90% of the ghee produced in the country is made by traditional method. Increased awareness about energy management has led to development of energy efficient and continuous methods for ghee manufacture, which include either an oil separator to separate serum and fat phase or use of scraped surface heat exchangers. Both the processes save energy and yield a comparable product. Ghee made through microwaving process has been shown to have higher vitamin A and E contents and appreciably lower levels of cholesterol. The different methods of ghee manufacture are:
Desi or indigenous or traditional method
Creamery-butter method
Direct cream method
Pre-stratification method
Continuous method
Of all the methods, ghee produced by the traditional method still has a major share in ghee production. Simple technology, inexpensive equipment, small scale of operation and superior organoleptic quality of ghee could be some of the reasons for this. The principle of ghee manufacturer by this method entails: Fermentation of milk Mechanical process to gather milk fat in a concentrated form, and Heating of the fat concentrate at a specified range of temperatures to remove moisture and induce interaction of milk fat with fermented residue of milk SNF. The characteristic aroma, flavour and taste of ghee depend on the first and third steps.
Owing to the basic lack in adoption of standard operational procedures and controls ghee produced by the traditional method lacks repeatable quality attributes. The reasons for this could be: unhygienic handling of milk; uncontrolled fermentation during curdling of milk; inherent defects in country churns and inefficient working; improper storage of

butter prior to clarification into ghee; uncontrolled heating at the time of clarification; and unsanitary and undesirable pots used for production and storage of butter and ghee. The process has been found unsuitable for large scale processing by the dairy plants on an industrial scale.

TECHNOLOGY FOR LOW CHOLESTEROL GHEE

Biotechnological interventions are latest in producing innovative foods for human consumption. Kwality Dairy (India) Limited (KDIL), under a license agreement with the National Research Development Corporation, has been manufacturing India's first 85% less Cholesterol Pure Ghee in their brand "DairyBest LivLite".

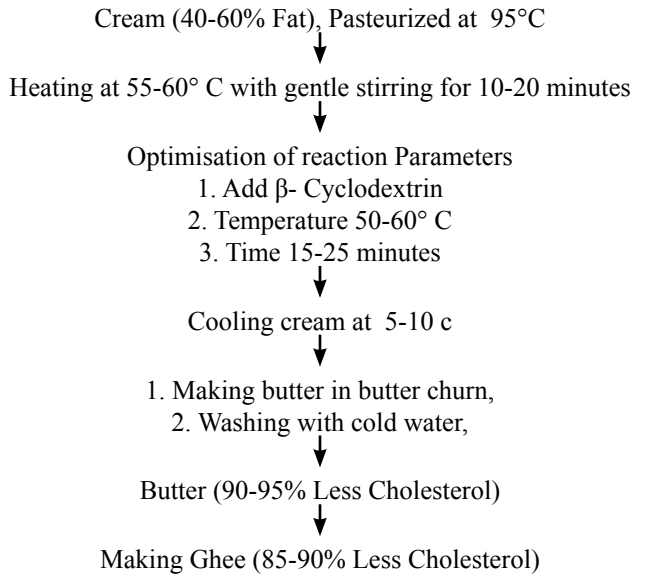
Technology to produce pure ghee with very low cholesterol in it has been stabilised by the National Dairy Research Institute, Karnal -- an institute of the Indian Council of Agricultural Research dedicated to undertake applied research in the dairy field. The Karnal institute had stabilised the technique (Fig 1) for close to five years and had handed over the technology for commercial application to the Government owned company the National Research Development Corporation.

What, perhaps prompted the National Dairy Research Institute to conduct research for producing low cholesterol ghee is because fat is an essential dietary component of all foods fit for human consumption. Inclusion of Ghee in a balanced diet is extremely relevant and has been recommended since the ancient dietary recommendations made by Ayurveda. Ghee has exceptional sensory and nutritional elements. Ghee is the most widely used milk product in the Indian sub-continent and is considered as the supreme cooking and frying medium. Being an excellent source of fat-soluble vitamins (A, D, E) and essential fatty acids, Ghee holds the potential to make major contribution towards nourishment of people of all age groups. Most important bioactive components in milk fat may be cited as Butyric acid (anti-carcinogenic), Conjugated Linoleic acid (CLA), Vaccenic acid (anti-atherogenic and anti-carcinogenic, muscle builders, and immunity boosters), Short chain fatty acids, Vitamins etc.

It is common knowledge that the modern medicine has been cautioning usage of ghee mainly because, it contains 0.2–0.4% cholesterol, in both free as well as in esterified form. Although necessary for biological processes, high levels of cholesterol in the blood have been linked to damage to arteries and cardiovascular diseases. This is the reason research worldwide has been conducted to reduce cholesterol in butter and ghee. Various physical, chemical and biological methods have been proposed for reducing cholesterol in foods especially dairy products, most of which has practical and economic restrictions. Success of research by the NDRI prompted the Kwality Dairy (India) Ltd., to use the unique biotechnological intervention in producing "DairyBest LivLite" Ghee through use of a cyclic oligosaccharide that selectively separated the cholesterol complex. It is the only pure ghee available with 85% Less Cholesterol as compared to the commonly produced Ghee. "DairyBest Livlite" keeps intact the traditional form, colour, aroma, consistency, texture, flavour, nutritious value of ghee and has a shelf life of twelve months. The physico-chemical properties such as Reichert-Meissel (RM) value, Polenske value, Butyro-refractometer reading, Iodine value and free fatty acids of low-cholesterol ghee remain almost unaltered as compared to normal ghee. Fat soluble vitamins such as beta-carotene, A and E, which are present in milk fat as unsaponifiable constituents and have significance in human nutrition, as they play an important physiological role in growth, development and maintenance of life also remain unaffected.

"DairyBest LivLite" Ghee from the house of Kwality, in a nutshell has 85% Less Cholesterol, with all the qualities intact.

Fig 1: Diagrammatic Presentation for Processing of Low Cholesterol Butter/Ghee



हरियाणा की पावन धरती से

।। वीटा का संदेश ।।

1- कंसीव्स करें कि दुकानों से दूध न लें क्योंकि उसमें कई तरह की बीमारी के बैक्टीरीयू होते हैं जो सभी आँखों से नजर नहीं आते।

2- यहां तक कि अपने सामने निकलवाये हुए दूध में भी कई तरह के बैक्टीरीयू होते हैं जो कि पशु के शरीर से दूध में आते हैं तथा हमें से नजर नहीं आते।

3- जिस दूध को दूधिये आप के घर घर दे जाते हैं तथा महीने के बाद आपसे पैसे लेते हैं यह आपके बच्चों के लिए हानिकारक पड़ता है क्योंकि यह दूध घटिया किस्म का होता है, साथ में उसमें फैट की मात्रा तथा प्रोटीन आदि की सही मात्रा निश्चित नहीं होती।

4- वीटा के दूध व दुग्ध पदार्थों की क्वालिटी होने से आपके समय व पैसे की बचत भी होती है।

5- वीटा का ठण्डा दूध बिना चीनी के भी पीने में बहुत स्वादिष्ट होता है अवश्य पीकर देखें।

6- वीटा के दूध व अन्य दुग्ध पदार्थों का प्रयोग करें ये आपके स्वास्थ्य के लिए लाभप्रद हैं।

7- मिनरल वाटर अथवा बोतल में पैक पानी पीने की बजाए उसी मूल्य में दूध पिएं जो सूखे वीटा से कैल्शियम आपकी प्यास बुझाता है बल्कि स्वास्थ्यवर्धक भी है।

''हरियाणा की शान - वीटा से बने पकवान''

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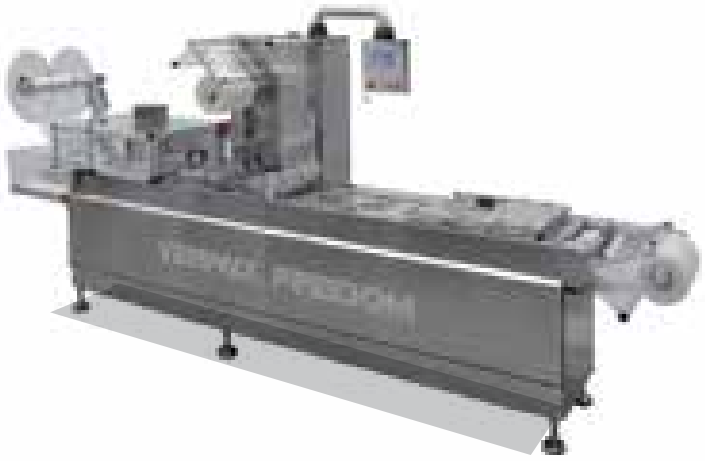

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Technical Session-V

ENTREPRENEURSHIP OPPORTUNITIES FOR LARGE SCALE MANUFACTURERS OF TRADITIONAL MILK PRODUCTS

Mayur N Vyas
Past Managing Director
Sabar Dairy, Himmatnagar

The Dairy industry in India has been going through a productive metamorphosis almost every decade. During 60's & 70's the dairy industry in India was in its infancy. We had very few dairies in the organised sector. We were dependent on imported milk powder and butter oil. The Operation Flood – the largest dairy development programme in the world was started with the inception of the National Dairy Development Board. Gradually the scenario started changing in the 80's. The Operation Flood programme in Phase I made milk available in four metro cities followed by Phase II & Phase III, making liquid milk available throughout the country and also transporting milk from surplus areas to deficit areas by establishing milk drying plants in surplus areas. Milk was transferred to urban dairies in powder form. Excess milk in winter was converted into powder and stored for summer months, thereby balancing well between seasons. In the late 90's there was a gradual shift towards value added products.

Today India is the largest milk producing country in the world. The price that farmers get in the country is also the highest in the world. Organised dairies pay 80 paise of the consumer's rupee to the farmers. To maintain global competition and also to pay high price to the milk producers, milk products like SMP, WMP, Partially Skimmed Milk Powder and Butter no longer remained attractive due to high investments in dairies and cheaper imports. With high investment in dairy industry and cheaper imports of milk products like milk powder, butter oil and cheese, it is time to concentrate more on indigenous and traditional products. Manufacturing of traditional milk products on a large scale as well as manufacturing plant and machinery is very attractive and will remain in demand for a long time.

It should be well understood that the role of the dairy industry now is not just to produce products that go into the kitchen. But their role has changed with time. It has now been transformed into a National Kitchen so that products directly go on dining tables. Today more and more women are working and they find it difficult to cook at home as it consumes a lot of their valuable time.

TRADITIONAL PRODUCTS :

Both fermented and non-fermented traditional products have now become a necessary part of our life. There are sizeable number of traditional milk based products which can be produced on a large scale like :

Fermented	Non Fermented
Shrikhand	Ghee
Dahi	Khoa
Buttermilk	Peda
Lassi	Gulabjamun
Paneer	Basundi
Rasgulla	Halvasan
Kadhi	Paranthas
	Palak Paneer
	Mutter Paneer

(These are all traditional ready-to-eat foods.)

OPPORTUNITIES :

India is a country of 1300 million people. Out of which nearly 50 % people are middle class whose purchasing power is considerably rising and form the consumer base for safe ready-to-eat traditional dairy based products. Since consumers are now ready to pay little more, it is now profitable to set up facilities with considerably lower investment for milk based traditional ready–to-eat food products. Opportunities are rising for manufacturers of both equipment and plant as well as manufacturing of traditional milk products.

It has to be noted that demand for our traditional milk products is rising in international market as well. It should be well understood that mechanisations of traditional milk product manufacturing have many limitations and also need hard work to innovate.

Major requirement for large scale production of plant & machinery:

- Green technology i.e. plant and machinery consuming less electricity, water & energy
- Bare minimum Effluent generation
- Reduction of manpower
- More automation to eliminate manual failures as well as consistent quality manufacturing
- Easy to " add on " to expand capacity
- Hygienic design of dairy equipment i.e. pore free welding joints, no sharp corners and easy to clean and sterilise
- Less requirement of space
- Easy to dismantle & assemble
- Line production i.e. from production to despatch every operation mechanised

- Instead of cost cutting, better to design equipment with ease of operation and convenience of production
- Aerial contamination proof i.e. production equipment must be housed in an enclosure
- Skid mounted design easy to install
- One point service connection
- Modular design for various combinations of product mix

REQUIREMENT FOR TRADITIONAL MILK PRODUCTS:

- Products to have typical Indian taste
- Minimum waste generation
- Product mix to complement each product with another i.e. If one wants to manufacture dahi , one should also have butter milk manufacturing.
- Must have good shelf life
- Should be safe from microbiological point of view
- Good quality assurance programme
- Perfect cold chain
- Attractive packaging
- Availability in a variety of sizes
- Enough storage facilities

LIMITATIONS:

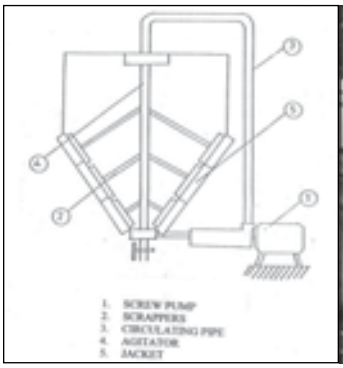
- Innovation of process engineering for traditional milk products
- Availability and collection of milk and it's quality
- Availability of funds
- Marketing network for products
- Cost of transportation
- Effluent treatment & disposal

CONCLUSION:

There is a great opportunity to put up large scale manufacturing facilities for traditional milk products as well as designing and fabrication of equipment, plant & machinery. Today technology is available for Dahi, Buttermilk, Shrikhand, Gulabjamun and Paneer. We need to innovate more to achieve perfection and automation.

We have to look into the limitations but assured quality milk supply like having own large cattle farms combined with collaboration with milk farmers can make investments extremely profitable.

Steam Jacketed Kettle for Heat Desiccated Milk Products



Conical Process Vat

Two Stage Thin Film SSHE

Continuous Basundi making Machine (CBM)

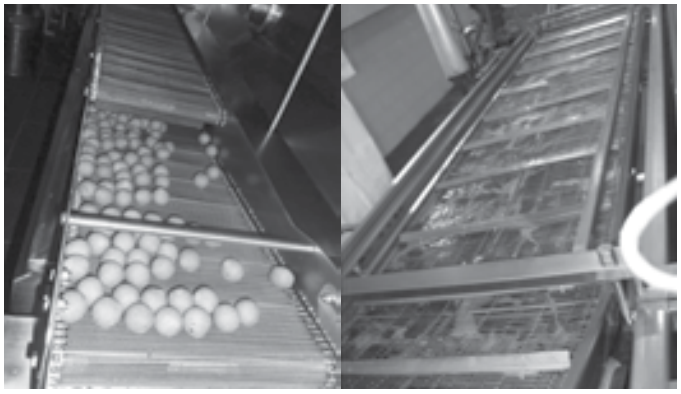
Batch Type Khoa Making Machine

Continuous Khoa Making Plant

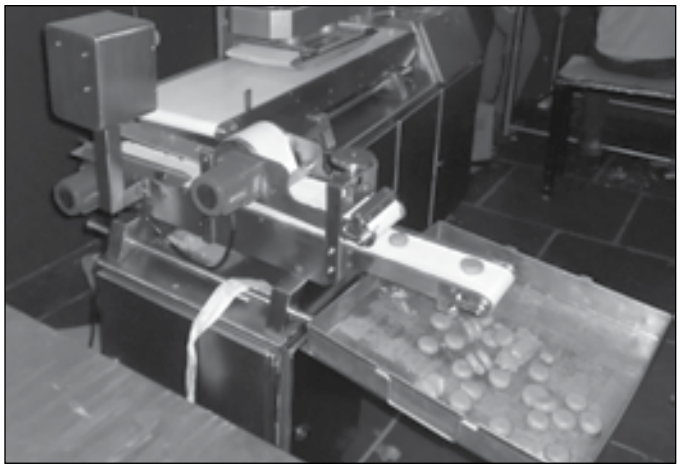
Ball Shaping Machine for Rasgulla & Gulabjamun

Manual Process for Rasgulla making

Manuall process for Gulab Jamun Frying



Continuous Gulabjamun Fryer

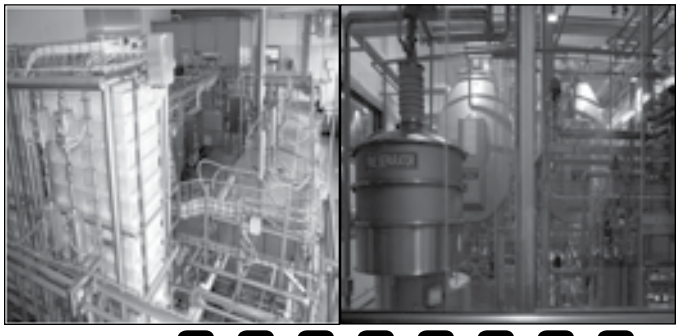


Peda Shaping Machine

Batch Type of Halwasan Making Machine (BHM)

Paneer block dryer

Coagulation Vat



Advances in Testing Methods for Traditional Indian Dairy Products

RAKESH CHOPRA,
ADDL.GENERAL MANAGER
RAJASTHAN ELECTRONICS & INSTRUMENTS LIMITED,
JAIPUR

Company Profile...

- Established in 1981
- A Joint Venture between Government of India and Government of Rajasthan.
- Shareholding Pattern:
  1. **Government of India – 51% holding**
  2. **Government of Rajasthan – 49% holding**
- Formation of REIL came into existence at the initiative of NDDB, DoE, DHI & RIICO
- Accorded the Status of *"MINI RATNA"* by the Government of India in 1997
- ISO 9001 & ISO 14001:2004 organization.
- A Schedule 'C' Organization
- An Energy Efficiency Four Star Rating Awarded Organization

Company activities ...

- In service for dairy sector since 1981
- Contributing in :
  - Qualitative analysis of milk
  - Quantitative measurement of milk
  - Data acquisition, processing & business intelligent systems.
- Variants to fulfill the need of value chain for Indian Dairy sector
- Regular upgradation for maximum ROI
- Nation wide field support network.

PERFORMANCE HIGHLIGHTS
MoU Rating

S.No	Financial Year	MoU Rating
1	2004-2005	"Excellent"
2	2005-2006	"Excellent"
3	2006-2007	"Excellent"
4	2007-2008	"Excellent"
5	2008-2009	"Good *"
6	2009-2010	"Very Good *"
7	2010-2011	"Excellent"
8	2011-2012	"Excellent"
9	2012-2013	"Excellent**"

* Pay Revision Liability, ** Provisional

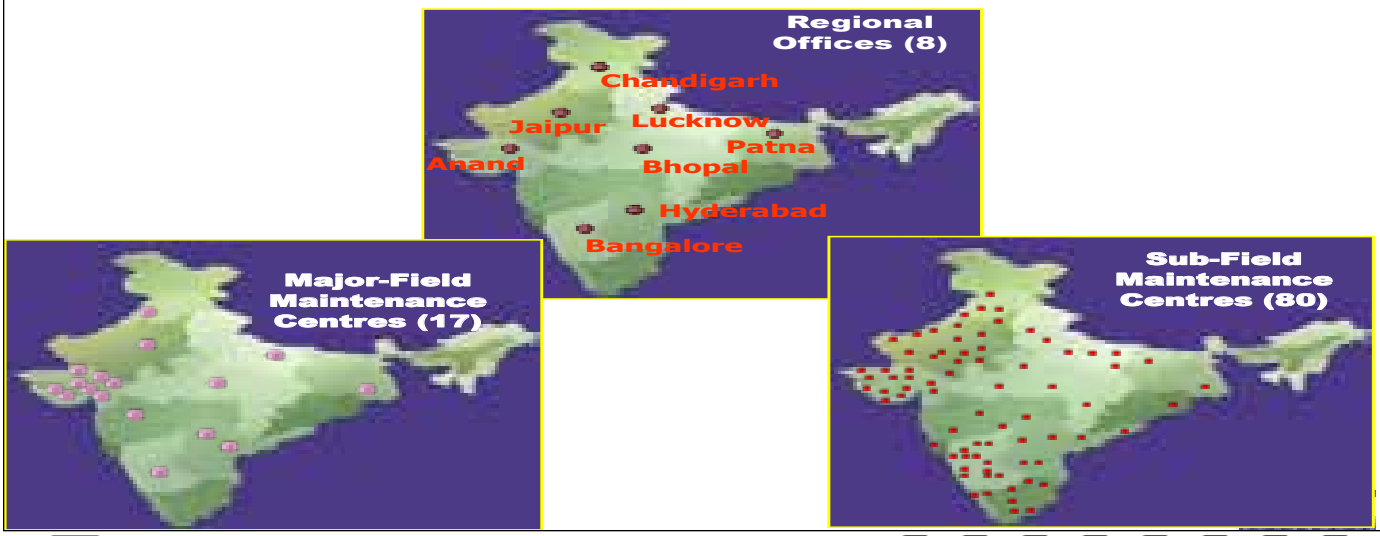
Vision

Strive To Be Leader In The Area Of Rural Electronics, Non Conventional Energy Systems And Information Technology By Developing, Manufacturing And Marketing Quality Products In These And Other Emerging Areas By Offering Quality Services.

Mission

Commitment To Total Customer Satisfaction By Identifying Their Specific Needs, Translating Them Into Quality Products, Providing Dependable After Sales Service And To Work For Continual Improvement Of Quality Management System By Developing/Marketing Quality Products.

Distribution & After Sales Network



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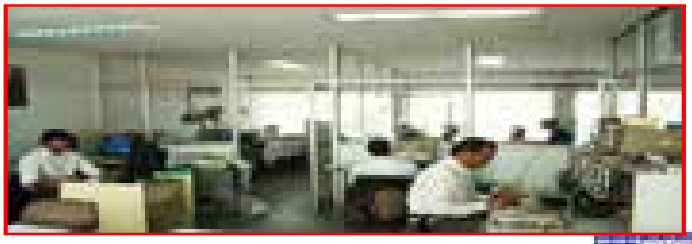
(* - Provisional)

Area of operation

- Product Upgradation
- Milk analysis
- Data Processing & automation
- Milk weighing
- Non conventional systems



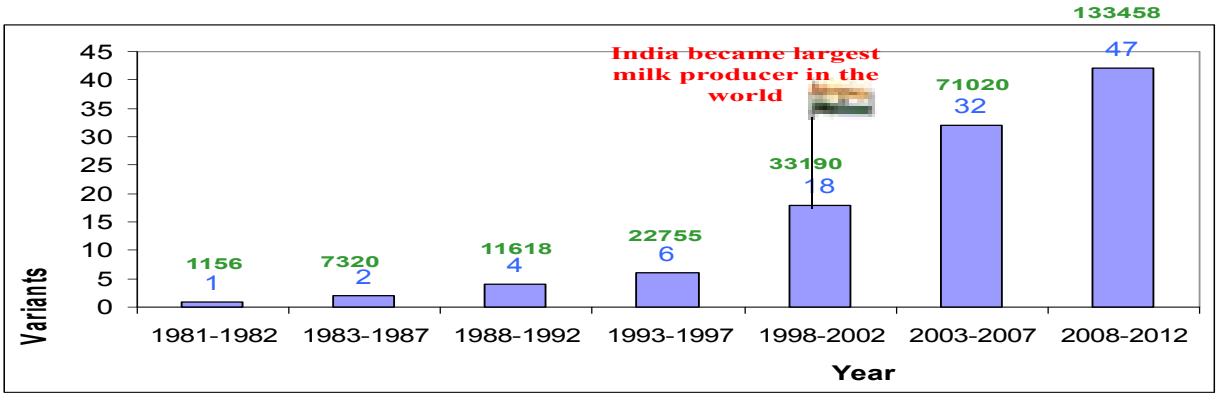
Prestigious Awards ...

Year		Award
National Awards		
2012	:	"National Energy Conservation Award –2012", by Ministry of Power, GoI.
2006/07	:	SCOPE Award for Excellence and Outstanding Contribution to the Public Sector Management
2004	:	DSIR National R&D Award
1991/2000-01	:	Excellence in Electronics Award, by then DoE Now MoIT&C,GoI
National Level Awards		
2013	:	"Governance Now PSU Award 2013" for Asset Utilization & Utilization of Human Resource, by Minister of Heavy Industries and Public Enterprises, GoI.
2013	:	" e-India Award" for Financial Resource Management through ICT, by Minister for Information Technology & Communications, Government of Andhra Pradesh
2012	:	"SKOCH Digital Inclusion Award 2012", in ICT category
2012	:	"eWorld Forum Award – 2012" for the Best ICT G2G Initiative
2012	:	BT Star PSU Excellence Award -2012 (Best PSU) for outstanding performance in Mini Ratna Category
2011	:	"eWorld Forum Award – 2011" for the Best Rural e-Governance Initiative.
2011	:	Energy Efficiency Four Star Rating Award for REIL Premises
2002/2008	:	First Prize from Indian Dairy Association
State Awards		
2011/2012	:	State Award: First Prize in Rajasthan Energy Conservation Awards.
2008/2009 2010/2011	:	Best Employer Award (4 times)
2008	:	State Award for Export Excellence

REIL, IN STEP, WITH DAIRY DEVELOPMENT

Year	Programme	Products	Benefit
1981-1982	Thought of Anand Pattern	Electronic Milk Tester (EMT)	Replaced the subjective GERBER method and Electronic milk Fat testing
1983-1987	Operation Flood-I	Auto Zero EMT	Transparent Electronic milk Fat testing
1988-1992	Operation Flood-II & spread of Anand Pattern	Auto Zero EMT, Upgradation of EMT to AZ-EMT, Milk Collection Station, Milko Scan	Transparent automation of test and measurement and payment at Village and plant level
1993-1997	Automation of Dairy Co-op.	Milk Collection Stations, RMRD Automation System	Bridged the gap among producers, Village milk collection centers, milk chilling centers & dairy dock.
1998-2005	NDDB QPM Programme	PC-AMCS-SAMS, DP-EMT, Upgradation of AZ-EMT, DP-EMT	Implemented the E-governance initiative of NDDB through SAMS and provided low cost solutions for village milk collection centers.
2006-2012	New Generation Co-ops. (NGC), Corporate business houses	Advance DPMCU, Ultrasonic Milk Analyzers, IMMS, Mini Dairy ERP	Advance version to fulfill the modern need of data validation and central level consolidation.
2013	**Second White Revolution; Food safety Act**	DPMCU, AMCU-NDP, MIR- Milk component Analyzer, RFID Cattle Identification and life cycle management system, Electronic Milk Adulteration system	Customized products to meet long term need of Indian Dairy Industry.

Solutions deployed & in operation



- Total Nos. of equipments deployed : 1,33,458
- Variants : 47
- All the products & variants deployed so far in 32 years are being supported by the company

REIL efforts recognized ...

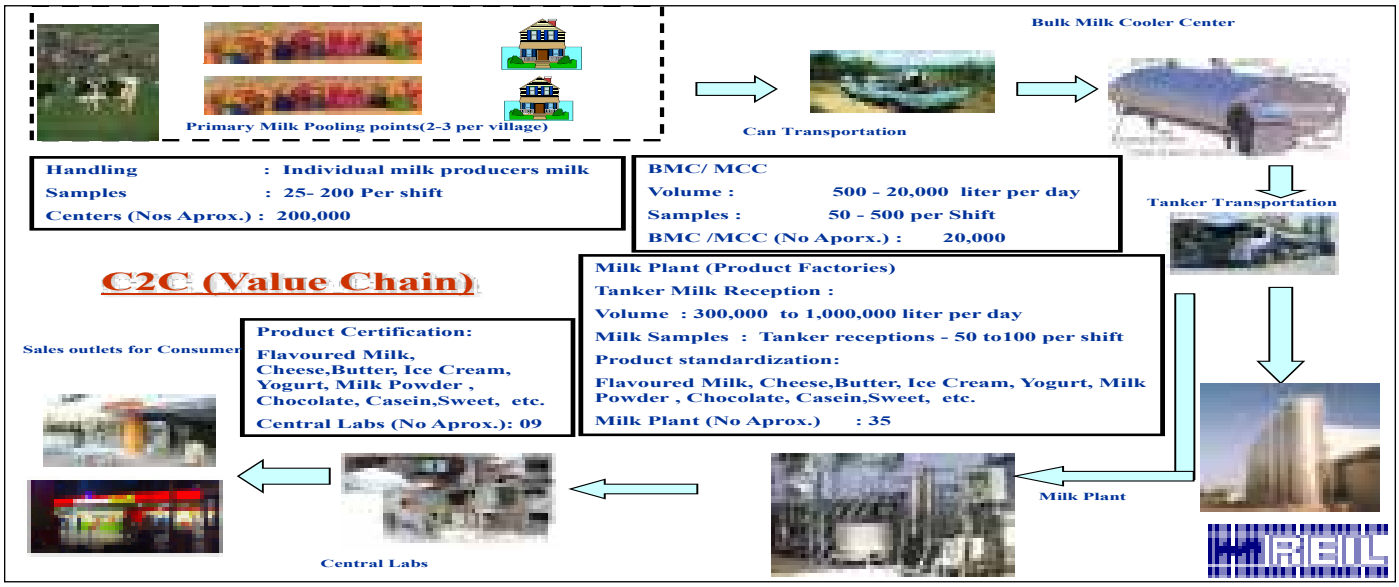
Electronic Milk Tester (EMT)..Photometric technology

- EMT from Foss, Denmark was costing around Rs.3.00 Lacs.
- Under guidance of NDDB, REIL worked out to bring down the EMT price to Rs. 25,000.
- No competitors of EMT emerged in last 30 years with same quality at this price.
- Repair expenses on EMT is about Rs.1,000 per EMT per year, about 0.01 paisa per test.

REIL efforts recognized...

..Ultrasonic technology

- REIL initiated development of Ultrasonic Milk Analyzer (UMA) in 1997.
- Due to technology limitation REIL slowed down the project in 2003 after consultation with Indian Dairy Industry.
- Reliance entered in dairy business in the year 2006, with milk collection based on Fat & SNF i.e. with UMA. Many organizations used Reliance as model and followed their system.
- Initially these analyzers were sold @ Rs.80,000 in 2006. Later on (Year 2009), REIL entered in this market and could strategically bring down the prices in the range of Rs.30,000-35,000.
- REIL addressed the concern of Indian Dairy Industry on deployment & support of UMA as under:
  - REIL worked and concluded technical issues & limitation of technology.
  - Set up manufacturer guided repair center. Leading to inexpensive repairs independency.
- Despite of late entry in the market, REIL could achieve large market share with its cost effectiveness.



Focus areas for sustainable dairy development in value chain ...

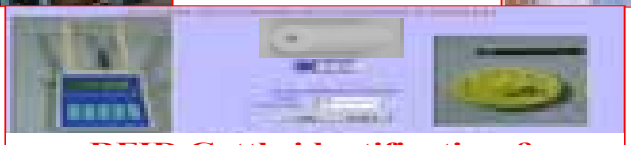
- IT & Electronics for Life cycle management of cattle health.
- Low cost of operation by effective value chain includes:
  - Data validation & secure data communications.
  - Renewable energy for power back up system.
- National database for milk procurements by organized sector.
- Cost effective Hygiene analysis at Dairy Plants
- Adulteration detection at all levels of value chain.

...To cover the value chain from Cattle to Consumer

Automation Solutions .... Cattle

Ear Tagging

Injectiable Tagging



RFID Cattle identification & management System

Bolus Tagging

Scanning

RFID based Animal Identification & Analysis solution .....Comparison of various technologies

Description	Ear Tagging	Injectable Tagging	Bolus Tagging	Remarks
Technology	Plastic Tag (Non Electronics)	RFID Technology	RFID Technology	State-of-art RFID technology.
Identification Number (ID)	Printed & Visible	Embedded in Chip	Embedded in Chip	Secure identification
ID Scanning	Manual, Line of site (No Electronics)	Automatic, from any direction (Dedicated Reader)	Automatic, from any direction (Dedicated Reader)	Scanning subjective in Ear tag.
Detection range	Small	Medium	Long	Long range is essential in cattle identifications
Durability	Less	Possibility of breakage	Permanent	Most important for life cycle management
Multiple identification	No	YES	YES	Reader can detect multiple tags
Life cycle Management	Manual entry	Automatic reading	Automatic reading	Subjectivity in manual entry for data and life cycle management.
Theft protection	No	Semi	Full proof	Possibility of tempering of tag in ear & injectable tag
Standards	Non standard	Compliance with Government standard	Compliance with Government standard	Better for standardization (ISO 11784/85 For Bolus) Tag
Cattle Safety	Possibility of ear injury	Possibility of internal injury if tag broken.	Safe	Most important for cattle health

Automation Solutions .... Villages

Data Processor based Milk Collection Unit (DP-MCU)

- Ideal solution for automation of milk management at Primary milk collection center.

Automatic Milk Collection Station (AMCU)

- Advance solution for complete automation of Primary milk collection center. Covering milk management, inventory, input services and account management , MIS

DPU Milk Collection Unit (DPUMCU)

- Intelligent Data & Milk validation.
- Cost effective secure data communication
- Need of Private and Coop for true automation.

Automation Solutions .... Villages

DPU Milk Collection Unit .....ADVANCE MODEL DPUMCU

Advance features of Data Processor Unit

- Handle 02 year milk collection data
- Dual Keyboard i.e. Membrane & PC type for easy operation
- Data communication through Sr. Pen drive & USB Pen drive
- Runs on Mains & DC
- GPRS enabled

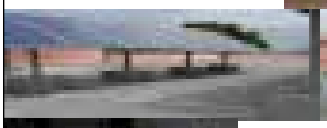
DPUMCU Powered by.....

..... Solar Photovoltaic (SPV)

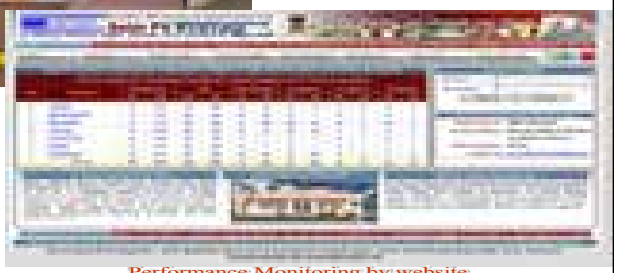
- Input supply GRID, SPV & alone battery
- 3 days back up
- Independent on AC losses
- Increases life of the equipments

SPV FOR BHARAT NIRMAN RAJIV GANDHI SEVA KENDRAS (BNRGSKs) in Rajasthan

REIL executed massive project of Roof top SPV power back up solution at 9100 GRAM PANCHAYAT & 248 PANCHAYAT SAMITI used for computerization of local services & records.



Component of SPV Power Plant for Gram Panchayat/ Panchayat Samiti



Performance Monitoring by website

Similar SPV Power back up solutions are available for Village Milk Collection Centers (AMCU)/ BMC Center/MCCs Value Chain System

Customized Software Solutions .... BMC/MCC/Dairy Plant

SAMS – For Village milk collection centers

- Multilingual Software covering regional language i.e. Hindi, Gujarati, Kannad, Teugu, Marathi, Gurumukhi.
- Society Management
- Milk Management
- Inventory Management
- Service Management
- Accounts Management
- MIS & Various Reports

IMMS – For BMC Centers

- Centrally controlled pricing policy
- Total automation of value chain from Milk procurement to payment
- Fast & secure implementation of pricing policy at Plant, BMC & PP
- Milk data transfer from PP to BMC to Plant.
- Inventory Management at BMC/MCC level.
- Effective Performance Monitoring.
- MSSQL database to handle complex data with better security
- Compatibility with existing Smart AMCU.

RMRD Automation System For MCC/Dairy Dock

- On line Process Automation
- Flexible & Adaptive to up-gradation
- Eliminates Manual Malpractices
- Performance Monitoring
- Instant reports
- Data Validation
- Above 100 installation.

Mini Dairy ERP For MCC/Dairy Dock/Milk Billing

- On line Process Automation for milk reception and input stores.
- Society Billing
- Interface with Tally.
- Hardware independent web based
- Fast & economical
- Data Validation
- One life cycle completed

Umbrella software covering the entire value chain.
Data communications among each stages helps in covering Centralized database

Analyzer on the Infrared (IR) Technology

MILK COMPONENT ANALYZER ...LACTOLYSER

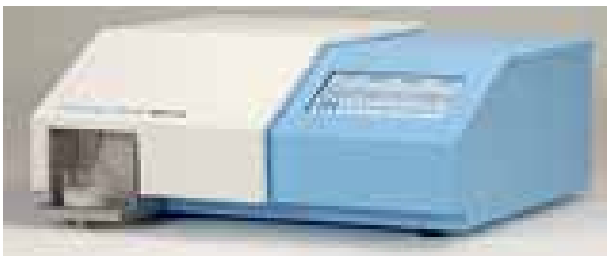
Components:
- Fat/Protein/Lactose/Total solids/Solids non Fat
- Freezing Point Depression (FPD)
- Skim, semi skim and whole milk
- Whey
- Milk powder
- Milk products
- 15 product calibrations

Analytical range
- Fat 0 – 20%, fat in cream 0 – 55%
- Protein 0 – 10%
- Lactose 0 – 15%
- FPD 0.45 – 0.55° C
- SNF 0 - 15%
- TS 0 - 50 %

Standards features
- Smart calibration select
- Sample detection
- High pressure sample homogenization
- Sample heating
- Automatic cleaning
- Automatic zeroing

User input
- Touch screen

Outputs
- 320 x 200 full colour screen
- Sound signal
- RS232 port for printer
- RS232 port for computer
- Lactolyser to PC software for data collection



Conclusion....IR

- IR Technology is stable & accurate available technology
- **Such critical technology & instruments need a fair, reliable & trusted Indian technical partner to keep the check on price and product life cycle in the benefit of Indian Dairy Industry**

REIL role in Product, technology & price – Safety

Safety- concern - Adulteration

- Milk Adulteration is a challenge for Indian Dairy Industry.
- Countries like China, Bangladesh, Sri Lanka etc. faced consequences of Milk Adulteration.
- The better way to address this problem is by preventing at Village level before pouring and then at MCC/Plant before mixing.
- The available lab methods are not being effectively used in villages.

Hence, there is a need of Milk Adulteration Tester .....

- To check harmful known adulterants.
- Should be compatible with present milk collection system
- Cost effective to suit for village societies
- Low maintenance cost.

REIL fulfill this need by introducing...

"ELECTRONIC MILK ADULTERATION TESTER (EMAT)"

REIL role in Product, technology & price – Safety

"ELECTRONIC MILK ADULTERATION TESTER (EMAT)"

EMAT
Milk Adulteration Tester

Features :

- Check harmful adulterants like **UREA, SODA, DETERGENT, LIQUID SOAP, VEGETABLE FAT, SALT.**
- Quick & instant display
- Speed 90-100 tests per hour.
- Low sample volume
- Indigenous Green technology, no hazardous chemicals.
- Runs on Mains & battery
- Data Recording & RS 232 data output
- Supported by REIL far flung after sales service network.
- Variants with inbuilt milk analyzer also to follow
- **FIRST INDEGENOUS ELECTRONIC INSTRUMENTS FOR ADULTERATION TESTING**

Way forward

- Implementation of Adulteration detection at village level.
- Applications of SPV power in Dairy sector
- RFID based cattle Life cycle management system.
- An umbrella system to fulfill the need of National database in line with Census code.

PARAG MILK FOODS: MARKETING OF TRADITIONAL DAIRY PRODUCTS

IDEA SEMINAR 2013

PRITAM SHAH, MANAGING DIRECTOR,
PARAG MILK FOODS PVT. LTD.
Sept. 2013

INTRODUCTION

Growth:

- By 2005, we were one of the largest exporters of dairy commodities from India with around 95% of products manufactured by us, being exported.
- However since 2008, Government started imposing ban on exports of dairy commodities; with the flip-flop continuing till date.
- This was a blessing in disguise, providing us an opportunity to look within India and expand.

INTRODUCTION

Genesis:

- Promoters' family was working with farmers around Manchar area since three generations and providing them farm inputs like Fertilisers, seeds, cattle-feed, etc.
- Manchar is traditionally a milk rich belt and most of the farmers are into dairying.
- Further, the farmers are progressive and have kept good breed of milch animals.
- During 1990s, Government (Aarey) was the only agency collecting milk from the area.
- However, with limited sales in Mumbai, Aarey started restricting milk collection from farmers and declared 'Milk Holidays'.
- With Milk as their only source of daily income and no buyer in sight, farmers were unable to provide cash for cattle-feed purchased from us and instead offered milk in exchange.
- Looking to distress situation of milk producers, promoters started the business to assist milk producers in procuring their excess milk.
- Hence, Parag Milk Foods was founded in 1992, with initial milk procurement of 20 Thousand Litres per Day.

INTRODUCTION

Brand Building:

- With launch of packed milk in market & increasing volumes, 'Gowardhan' brand was developed.

Gowardhan™
LIVE LIFE THE HEALTHY WAY

- This was later made more attractive with the tagline "Live Life the Healthy Way".

INTRODUCTION

Growth:

- With increasing volumes of milk procurement, its growth much larger than the market demand, we were forced to start manufacturing of value-added milk products like Milk Powders, Butter, Ghee, etc.
- Product Introductions over the years:

• 1994:	Cow Milk
• 1998:	Toned Milk
• 1999:	Skim Milk Powder
• 1999:	Ghee
• 2000:	Gulab Jamun Mix
• 2000:	Cheese
• 2000:	Double Toned Milk
• 2000:	Fresh Cream

• 2001:	Dairy Whitener
• 2002:	Cheese Powder
• 2004:	Whole Milk Powder
• 2004:	Butter
• 2005:	Chaas

INTRODUCTION

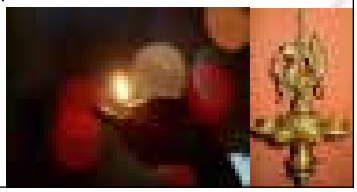
Growth:

- While most of the milk procured from Manchar area was Cow's milk, in order to differentiate ourselves, we created USP of "Made from 100% Pure Cow's Milk".

GOWARDHAN COW GHEE

Brand Building:

- Later, with our foray into product manufacturing, we started marketing "Gowardhan Cow Ghee" into the market.
- While we differentiated ourselves from the competition with our USP of 100% pure Cow's milk Ghee, we also worked upon the manufacturing process to create & develop Ghee which is very close to home-made Ghee in terms of taste & aroma.
- However, marketing this product initially was big challenge. Traders & Retailers refused to stock our Ghee terming it as as a product meant for using it in temples for igniting Diya.



GOWARDHAN GULAB JAMUN MIX

Brand Building:

- Later, we also introduced "Gowardhan Gulab Jamun Mix" again with distinct taste and aroma.
- This established us as a very strong player in ready-to-cook desserts market.
- Even today, we enjoy sizeable consumer loyalty for this dessert.

GOWARDHAN COW GHEE

Brand Building:

- Things started changing, once we opened the container and distinct aroma of Gowardhan Ghee spread like perfume all across.
- The consumers who tried it once, were hooked to the authentic and characteristic flavour of Gowardhan Ghee and are loyal even till date.
- We changed our Gowardhan brand logo and made it much more contemporary as well as included seal of "Made from 100% pure Cow's Milk" to have greater confidence of our consumers.

Gowardhan

Made from FRESH Cow's Milk 100%

GOWARDHAN BUTTERMILK

Brand Building:

- Some more traditional products followed, like "Gowardhan Chhas" in different flavours, which was introduced for the first time in ready-to-drink Plastic Cups.

GOWARDHAN COW GHEE

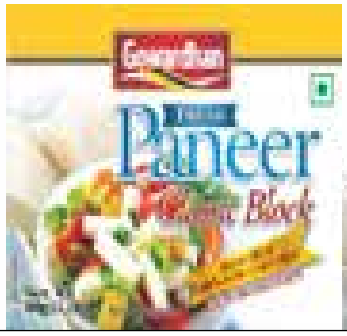
Brand Building:

- We also made another innovation in terms of packaging of Ghee.
- While most of the players selling Ghee at that point were selling it in closed containers like Tins, for the first time in India, we introduced transparent PET Jars with unique shape for Gowardhan Ghee.
- This provided our consumers a chance to see the purity and grains of Ghee before purchase and it also increased their confidence at a time when adulteration in Ghee was rampant.
- This also provided us a distinct place on the stores shelf.

GOWARDHAN PANEER

Brand Building:

- Recently, we have introduced "Gowardhan Fresh Paneer", with following innovations for the first time in India :
  - Paneer made from Cow's Milk
  - Fresh Paneer with shelf-life of 75 days
  - Soft & Creamy Taste
  - Unique packaging



GOWARDHAN PANEER

Brand Building:

- In order to promote further consumption of Paneer and expand the category, recently we had also conducted a promotion of providing "Rasoi Magic Ready-to-eat Paneer dishes" free with our Paneer.

BHAGYALAKSHMI DAIRY FARMS

Equipped with the latest technology for milk processing, packaging and distribution with product traceability and own R&D facility.

OWN FARM - R&D

One of the largest cow farms in India over 35 acres housing ~3,000 cows. Ultra modern farm with the latest rotary parlor for milking (avg. yield of 25 litres per day vs. normal Indian yields between 2-6 litre per day).

The farm doubles up as an R&D unit with continuous work on improving the yield and the quality of milk. The results and benefits are passed on to the farmer to enhance their yield.

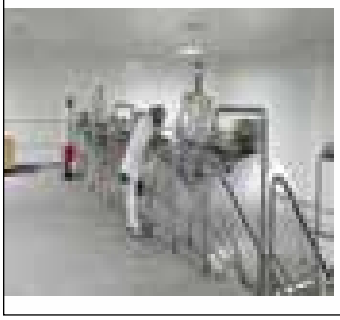
FUTURE PRODUCTS

- We have lined up a range of traditional Indian dairy products like desserts and beverages, to be launched in a phased manner in the market.
- All our products would carry the Gowardhan promise of 100% pure Cow's Milk product, with traditional taste and flavours appealing to the Indian consumers.

The New Cheese Plant

CHEESE PLANT

- Parag has set up one of Asia's largest and one of world's most advanced cheese plant at Manchar Pune with a capacity of 40 TPD.
- The plant uses Ultra High Treatment technology for first time in India, taking care of cold chain and enhancing penetration.



PARAG, A PROFILE

BACKGROUND

Founded by Mr. Devendra Shah and his family in 1992, Parag is strategically located at Manchar and Palamner (in the milk belt of Maharashtra and Andhra Pradesh respectively). **Parag is one of India's largest private dairies.**

100% COW MILK

Parag offers 100% cow's milk. **Cow's milk has superior health benefits.**

PRODUCTS

Products include Fresh Milk, UHT Milk, Milk Powders, Whey Powder, Cheese, Paneer, Butter, Ghee, Butter Oil, Gulab Jamun Mix, Yoghurt, Curd, Lassi and Flavoured Milk.

MILK PROCUREMENT

- Installed milk processing capacity of 20 lakh litre per day (LLPD) (Manchar – 12 LLPD , Palamnar- 8 LLPD).
- Tie-ups with ~4,300+ village level collection centres, 77 Chilling centres (including 37 chilling centres owned by the company), 37 Bulk Cooling units across Manchar / Palamner

DISTRIBUTION

- Strong distribution network of over 70+ super stockists, 1,700+ dealers servicing 140,000 retail counters; having a pan-India presence through both traditional and modern trade.
- Currently has 9 depots and plans to add another 10 depots in this year to have pan-India Distribution coverage.

VISION 2020

- Parag group shall work to serve best interest of all stake holders such as customers, milk produces, investors and employees;
- by creating and marketing top quality milk & value added milk products using state-of-the-art technologies, research & development in areas of
  - – breeding,
  - – procurement,
  - – processing,
  - – marketing and
  - – information technologies.
- Parag group intends to emerge as one of the top five value based modern and rapidly expanding food business of India.

Entrepreneur Opportunity for Traditional Dairy Products

By: Sh. P R Patel,
Executive Director, Mansinhbhai Institute of Dairy & Food Technology, Mehsana

In brief entrepreneur is a person who takes a risk and starts a business venture to satisfy customer and earn profit. In Indian context this mentioned risk should be calculated and the business venture should have ample opportunities. Adding value to an otherwise standard product can provide viable entrepreneurial opportunities. This may be true in many economic sectors but more apparent in traditional dairy products for the reason that India is the largest producer of milk in world and hence there is no question of availability of milk. Altogether, market is available for Traditional Dairy Products (TDP). Further, this segment is traditional and therefore methodology and needs of customer are also known. This all can be simply proven by a single fact that no sweet shop in India had closed after opening.

Before moving further if we look to the history and origin of TDP, these were originated to 1. Preserve milk, i.e: extend shelf life, 2. India is a country of Festivals, and sweets are widely used and are part of every festival & occasion from the ancient times, 3. In due course a call from urban society was generated for making the milk more palatable and more nutritious by value addition.

The TDP can simply be classified as desiccated products like Kulfi, Rabri , Basundi and Khoa based sweets, further acid heat coagulated products like Paneer and Channa based sweets (Sandesh, Rasogolla, Rajbhog, Rasmalai), fat rich products like Ghee, Makkhan, Malai and fermented products like Dahi, Mistidoi, Lassi, Chhach, Srikhand etc (Fig 1). The another TDP segment also includes both RTE/RTS and convenience foods like Instant Kheer Mix, Khoa Powder, Gulabjamun Mix Powder, Rosogulla Mix Powder, Long Life Paneer.

With so much attention on the dairy sector, the entrepreneurs want to make profitable investments. Not only the demand for western dairy products like milk powder, baby food, butter and cheese reaching near-saturation, operating margins in traditional products are also much higher than those for modern dairy products. According to the book on Technology of Indian Milk Products, traditional milk products are the largest selling and most profitable segment of the domestic dairy industry and account for 50% of milk produced and 95% of all milk products consumed in India.

Market for this segment in India is estimated to be Rs. 50,000 Crore, and the annual growth is in-between 10-15%. All together a niche global market has strongly emerged for ethnic Indian Dairy Products in Middle East, Europe and North America to the tune of $ 1.5 billion. The Indian Diaspora presents an exciting avenue for globalization of Dairy mithais. Entrepreneurs across the world are looking into the prospects of manufacturing them. The demand for few traditional products are mentioned in the Table: 1.

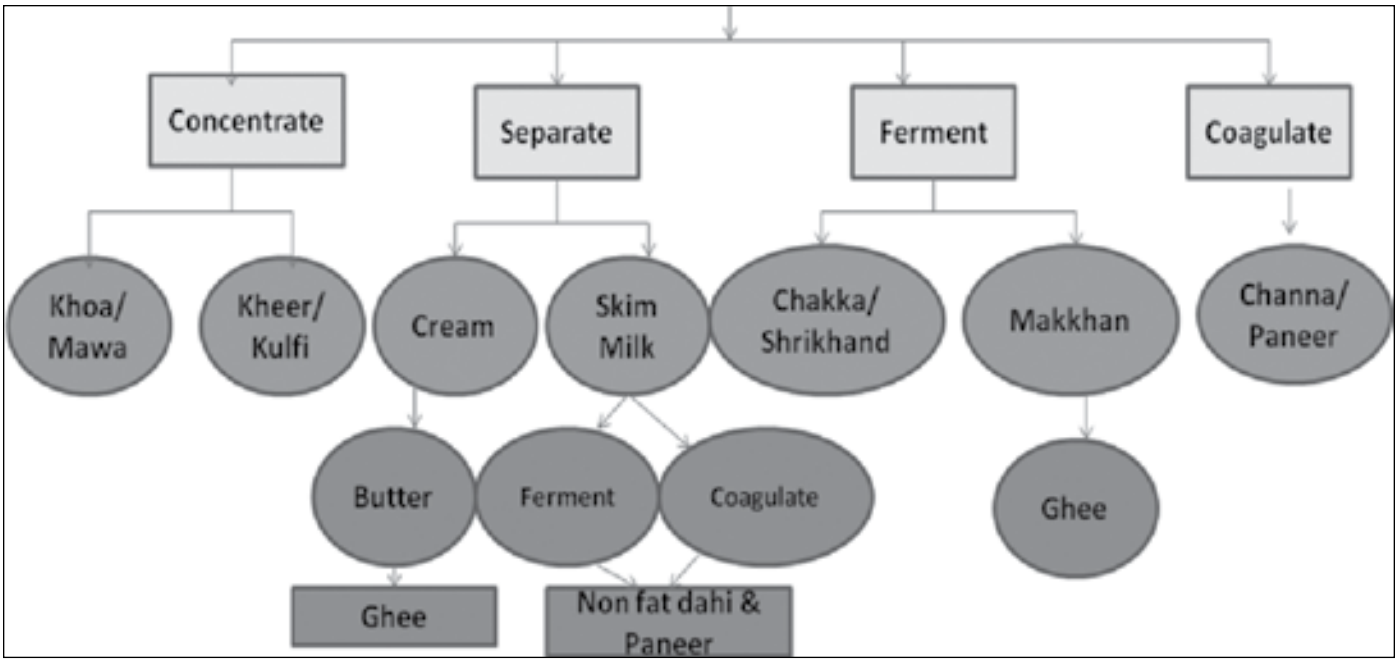


Fig 1: Classification of Traditional Dairy Products

From past as the TDP business remained in hands of few who know the skills for ability to make acceptable quality Indian products, even today also the manufacturing part is more skill based and not science & technology based. Traditional, family-owned business houses like Bikanervala, Haldirams and Bikaji, are making considerable profits by exporting Indian desserts to overseas markets and having monopoly in domestic market as except Haldirams there is no national player in the market. After reviewing the facts few important question arises – whether the monopoly is because of raw material or skilled labour or technology or methodology of preparation or trial & error methods to innovate or geography or because of hidden factors in the name of trade secret, which may lead to even adulteration. More often quality as desired are regional based and consistency in quality are the two key mantras for the existing entrepreneurs.

In last decade the concept of trend setting for better acceptability, protected secret to maintain monopoly and acquiring Geographical Indications came in the business of TDP. The recent example: The tribe of Dangs in Gujarat acquired Geographical Indication for Nagli based foods

Another area of concern in TDP is absence of competition in mithai segment which may lead to provide opportunities to companies like Cadbury India, positioning there cocoa based products- Cadbury Dairy Milk as an Indian dessert, with a 'kuch meetha ho jaaye' tagline. Earlier, it would resort to this positioning only during the festive season but now even campaigning for all time sweet, which not only absorbs the current market share but also changing the eating habits for future.

The full potential of TDP sector can be tapped by involving the entrepreneurs in building the quality and standards required for the global market, product diversification (including synonym products which are as good as traditional products like; Dahi-Yoghurt Probiotic Products, Ice cream – Kulfi- Frozen Yoghurt, Butter milk – Normal/ Probiotic) and value addition. Simultaneously the other area of concern is mechanization in manufacturing of TDP and its cost effective packaging and transportation.

Significant development has been made in the industrial production of TDP like Shrikhand, Gulabjamun, Rosogulla and Peda. Any innovation which can enable the organized sector to manufacture and market indigenous milk products on an industrial scale can have a far reaching impact on the dairy industry as well as on the economic condition of milk producers. A great scope exists for further expansion of the market for indigenous milk products, provided quality and safety are ensured and the shelf life is extended to facilitate distribution over larger areas. Major innovations are needed in standardization of manufacturing, consistency, quality assurance, packaging and process engineering to adapt these products to current marketing and consumer requirements. Some commercial processes have been developed to manufacture Ghee, Khoa, Shrikhand and Gulabjamun, but much is required to be done.

Table 1 : Demand for major milk products in the organized sector in MT

Product	1988	2009
Ghee	100,000	200,000
Cheese	4,200	15,000
Paneer	1,000	16,000
Shrikhand	3,000	5,650
Rasgolla	1,600	6,000
Gulabjamun	3,000	5,850

TRAINING – a tool for change !

In this competitive environment a company has many tools for productivity improvement like Kaizen, 5S, ISO, TQM, TPS etc. The problem is, how does one get people to know and understand these tools ? This is feasible only through TRAINING !

Training is the only tool which can bring about improvements because the improvements happen only after people have understood what is to be done. Company performance is affected by a number of factors. The larger the company, the greater the number of potential variables that can influence company performance. These include the level of competition in the market, the level of investment in new technology, the demand for the products and services of the company, the skills of the management team and so on. In practice, although training may influence the performance of the company, it is difficult to separate the impact of training from the impact of other variables.

Whilst studies may find that it is the successful and more profitable companies that invest more in training, who is to say that it is the training that causes the success of the company rather than the profitability of the company that drives further investments in training ? Is training a determinant of company success or a result of it ?

Industry training is essentially an investment in human capital, the economic benefits of which can be thought of as being shared between:

- The individual trainee, through higher wages (a proxy for labour productivity)
- The firm, through enhanced profitability (a proxy for capital productivity)
- Society as a whole, through ‘‘externalities’’ (returns over and above the private returns to the individual trainee or firm who pays for the training).

These benefits are difficult to measure. However, there is a weight of evidence from the literature relating to the positive wage effects of training. From the literature, we can infer that an industry training qualification is likely to increase the earnings of an individual by between 5% and 20%.

I do not know how many companies in India do really calculate the ROI (return on investment) in training ! Unfortunately, our industry has not given training the importance that it deserves. It is looked at more as an expense rather than an investment !

The benefits of training are rarely tangible in the short-term, but manifest themselves over a period of time. And, the benefits go beyond mere competence building. THOUGH infrastructure, equipment, finances and materials are among the vital resources required for the existence and growth of any organisation, it is the human capital which is the most important.

Operating in an open economy environment, having a competitive edge becomes imperative. Company strategies focus on gaining and sustaining the competitive edge. Often that translates into investments, efficiency of operations, deployment of resources, hard-sell, and so on. But, at some point of time it becomes apparent that competence of the staff is the key differentiator, and the focus shifts to competence development.

And therein lies the dilemma. Should the company find competent persons and then expect them to perform or should they look for appropriately qualified persons and put them through a competence development program. It's the classic case of `fitting the job to the man', versus `fitting the man to the job'.

Experience will bear testimony to the fact that competence is not easily assessed when recruiting new personnel. Also, qualifications do not necessarily equate to high level of competence. Therefore, going the `competence development' way would make more sense in the long-term.

However, there could be a number of constraints: some purely physical. For example, No time/Can't spare the people for training activity/Not enough budget for training etc.

Other reasons are more notional: They're doing okay as it is/We'll train and then he will quit and join elsewhere/Can't see the returns on investment in training, etc.

It has been my experience that best of companies are not able to capitalise on training. This is because there is no periodicity defined. Despite there being training, a large amount of variation remains e.g. different batches of employees give different time/temp. combinations for CIP cleaning, people going to collect samples of milk are not able to give one procedure, there is no idea as regards developing a sampling plan etc.

Further, training need not be restricted to the job functions. There are several other areas such as soft skills, personality development and team-building, which are equally useful and should be explored.

As we go higher up the hierarchy in the organisation, we find that the thinking process changes from `what-to-do' and `how-to-do' towards `why-to-do'.

Internalisation of the company's training policies and acceptance of training programmes as a means for self-development are quite dependent on the attitude of the employees. They are the ones to reap the direct benefits of training, which is passed onto the organisation.

The growth of the individual and the organisation is in tandem — a potentially win-win situation.

Learning is a continuous process and those who think that there is nothing more to know are as good as deadwood. To bring about an improvement, sustainability, consistency in productivity the only tool to enable it is TRAINING !!!

Kailash Ashar,
Principal Thought Leader
Trainer & Consultant,
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AQUACLAVE Applications

Sr. No	Industry	Product		
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2	Indian Sweet	Rasmalai, Shrikhand, Gulabjamun, Basundi, Rasgulla.		
3	Processed Food	Curry Veg.Non-veg dishes, various RTE products, Various Chicken, Lamb, Pork Products.		
4	Beverages	Various Fruits Juices, Coffee and Chocolate Drinks.		
5	Fresh Fruits	Slices, Pulp.		
6	Coconuts	Cream, water, Milk.		
7	Vegetables	Various Beans, Corns etc.		
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Invited Articles

Modern Technology for Ethnic Milk Products

India's traditional dairy product sector is poised for rapid expansion as a result of application of modern process technologies. The demand for packaged ethnic products like peda, burfi, gulabjamun, sandesh as well as fresh products like curds, paneer, lassi and cream is rising fast. These products are expanding the base of the modern dairy sector. Significantly, technological innovations have occurred just as the ethnic milk products are entering the world map.

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The global dairy industry is always in search for dairy products that would help in enlarging its market. The search and the initiatives continue irrespective of changes in the demand and supply of dairy products. There is a shift in the global trade away from commodities — SMP, butter and butter oil — towards value-added products. Both the industry and the consumer look at milk and its products as a means of variation in taste and flavor and as supplement to health and happiness. This is further complicated by the growing competitiveness triggered by the WTO.

Each year, a large number of new food products are being added in the marketplace in response to the consumer's search for delicacies that are novel but natural with a touch of mystery and class. At one end of the spectrum is the high-volume market for low-priced products. At the other end is the niche market for high-priced products that have unique taste and exotic flavour. The dairy exporters from India are continuously identifying such markets as to tap — the low-profit "mass" market or the high-profit "class" market.

Dairy markets in the new millennium are being increasingly shaped by the twin strands of globalization and localization. The spotlight is on the developing world that has shown a remarkable growth in disposable income accompanied by rapid urbanization.

CHANGING MARKET PROFILE

Some of the most important factors that are helping in evolution of the market profile in the developing countries are:

Increased urbanization and income growth:

This global phenomenon has become a major force in the developing world. According to the UN projections, 22 out of 26 urban agglomerations of over 10 million populations in 2015 would be in the developing countries. Already, India and China are witnessing fast urbanisation with large emigration of rural populations. This is further supported by increased disposable income that spurs the demand for variety, and value addition to foods and dairy products are first on the list.

Freshness is the key:

There is growing awareness for fresh products over tinned and dried milk powders. Even though the UHT milk and extended shelf life milk are not truly fresh, both are perceived fresh and preferred over milk powders. The packaged, fresh and fermented dairy products are growing consequent to the expansion of cold chain, refrigerated space, and expanding supermarkets in cities. The growing middle class favours this change and enlarges its kitchen refrigerator.

Health and fitness:

The consumer today demands health benefit in what he eats. On this basis, dairy products rank among the top. They enjoy a positive image in terms of quality and health benefits. For example, the probiotic curds, lassi and yogurts, using live bacteria cultures, are considered health-promoting products. However, another trend that circumvents the fitness concern is a preference for "full-tasting" food products. During the last two years Indian cities have seen a large number of curds, lassi and yogurt brands entering the market.

Pleasure and variety:

More and more consumers are choosing full-fat products such as ice-cream, cheese or desserts for the real pleasure of eating, disregarding the health concern. This change is reflected in the increasing production of full-fat ice-cream since the early 1990s in the United States, reversing the earlier trend in favour of low-fat ice-cream. The summer of 2013 has seen more high-end ice cream brands enter the Indian market than the low priced products.

Eating out and home delivery:

In many countries, the main growth in food expenditure is in the

area of food eaten outside the home and supplemented by the home-delivered meals and foods. There is greater emphasis on convenience provided by instant heat-and-eat dishes and snack foods. The youth are looking for snacks that use one hand to eat while the other is used to maintain the balance in a moving metro train. The rising food consumption outside the home has posed a new challenge to the dairy industry, as its products are so closely linked with the kitchen. Imagine 2013 being a landmark for home delivery of dosa. A highly visible manifestation of the eating-out phenomenon is the rapid growth of the "fast-food" industry. Its secret of success is that it converts a Rs 50-foodstuff into a Rs 500-meal. The growth of this sector has also given a push to the consumption of dairy products like ice cream, milk shakes, and cheese which figure prominently on the fast-food menus.

How does the common man select the food he chooses to eat? A marketing consultant, Mr Xavier Terlet of XTC, a French market intelligence consultancy, has summed up this situation thus: Most people eat for pleasure. It dictates all consumer demands. It implies something different, a shift in habits.

To satisfy the consumer's desire for pleasure, three new trends are emerging as far as taste is concerned in the popular dairy product segments:

Authenticity:

An emphasis on 'tradition', 'real', and 'purity' in tastes that offer a homely appeal (natural tasting, earthenware pots, etc).

Variety: An abundance of new textures, colours and names that never cease to amaze consumers, designed to appeal to different segments. Products for adults are also becoming increasingly sophisticated (with fruits, cereals, creamy, thick textures). Children, meanwhile, prefer colourful and personalized products, small formats rather than refined tastes.

Exoticism:

A constantly evolving trend seeks to supplant 'ordinary' products by emphasising specific tastes, characteristics of faraway, exotic places (Africa, Asia, Latin America, etc). The aim is to stimulate the imagination and whet the consumer's appetite.

TRADITION REINVENTED

Of late, dairymen have realized the need to change the image of milk as only a health/nutritive product that people must consume (a sense of "compulsion") to a mod image of "like to" (a sense of choice) for pure pleasure. This would be possible by widening the choice of dairy products and adding into them authentic, exotic flavours. One exciting area that can tickle the taste buds of the young generation is the wide range of *ethnic* dairy products. Significantly, they have enough variety to serve both the 'class' and 'mass' markets. A FAO publication lists over 300 ethnic products in about 100 developing countries of Asia, Africa, Latin America and the Middle East.

Time is ripe to expand production and marketing of ethnic sweets. Chocolate coated Barfi supplemented with dry fruits is replacing conventional chocolate. Most ethnic sweets are very fragile and delicate to process and handle. The manual skills, not easy to replace, are challenged by the international norms of food safety and hygiene. Thus is born the necessity to bypass manhandling, to enter process automation, and to adopt innovative packaging that help extend the shelf life as well as meet with international food safety norms. Recent advances in dairy technology and innovations in machinery have met with such requirements.

INDIA'S ETHNIC MILK PRODUCTS

The flavour of the new millennium is India's ethnic milk-based sweets, desserts and puddings. Each product has its distinctive wisdom as it evolved through the ages, continuing to surprise the gourmet even today. Milk and milk products are highly valued in Indian society as a source of nutrition. This concept has withstood the test of time, notwithstanding the cholesterol scare in the West.

In India, milk sweets are an inseparable part of wedding ceremonies, feasts, festivals, and social and religious occasions. Boxes of sweets are a harbinger of good news, be it the celebration of a birth or a betrothal in the family, anniversaries, success in examination, landing the first job, promotion and the like. The expression to convey the good news says it all: "Sweeten your mouth." In fact, one of the most popular and oldest Bengali sweets is named "sandesh" meant to convey the message of goodwill. A box of it accompanies the good news that a family wishes to announce in its social circle.

The products developed, either for direct consumption or as an intermediate base material, have followed age-old methods of preservation and conservation through heat desiccation, fermentation, coagulation and clarification. The aim is to recover the total solids to the maximum extent through tiny scale/ household level processes and technologies that are adequate and appropriate to local situations, resources and food habits.

Indian mithais (traditional sweets) have been developed to preserve the nutritional goodness of milk and to extend its shelf life under high ambient temperatures. Sweets are mainly prepared from three intermediate product bases: khoa (partiallly heat-desiccated milk), chhana (coagulated milk after draining of whey) and chakka (concentrated curd). Ghee (heat-clarified butter) and makkhan (cottage butter) are traditionally prepared to conserve milk fat in areas where marketing of liquid milk is not organized. Much of the processing of sweets is done on a small-scale by the halwai (traditional confectioner).

Khoa is a major intermediate product base for a variety of sweets. It is obtained by rapidly evaporating milk in shallow pans to a total solids content of about 70 per cent. The product could be preserved for several days and is also used as a base for different kinds of sweets like peda, burfi, gulabjamun, etc. Another important base is chhana. It is obtained by acid coagulation of hot milk and draining out the whey. This product is used as an ingredient in different kinds of sweets, especially in the eastern region of India. Chhana-based sweets are popularly called Bengali sweets. The third major intermediate base is chakka, popular in Western India. It is a fermented product

obtained from curd and is used in a variety of Gujarati and Maharashtrian desserts.

The traditional dairy products of the Indian sub-continent are broadly classified into the following five categories:

Desiccated Milk-based Products:

Khoa/Mawa, Gulabjamun, Kalajamun, Lalmohan, Burfi, Kalakand, Milk Cake, Peda, Rabri, Khurchan, Basundi, and Kulfi.

Heat-Acid Coagulated Products:

Paneer, Chhana, Rasogolla, Rasmalai, Rajbhog, Khirmohan, Sandesh, Pantua, Chhana-Murki, and Chum-chum.

Cultured/Fermented Products:

Dahi, Mishti Doi, Shrikhand, Lassi, Mattha/Chhach/Chhas, Kadhi, Raita, and Dahi Vada.

Fat-Rich Products:

Ghee (Clarified butter), Ghee-residue Chocolate/Burfi Confection, Makkhan (freshly-churned butter), and Malai.

Milk-based Puddings/Desserts:

Kheer, Payasam, Phirni, Sevian, Sabodana Kheer, Lauki Kheer, Sohan Halwa, Gajar-ka-halwa, and Kaju Burfi.

The Bureau of Indian Standards (BIS) has worked out specifications for khoa, paneer, chhana, dahi, shrikhand, burfi, rasogollas, kulfi and gulabjamuns.

SCOPE FOR MODERNIZATION

The Indian dairy industry is poised for a major breakthrough as a result of the application of modern technologies in the production of traditional milk products. Their production and marketing can bring about a remarkable value addition to the extent of 200 per cent, as compared to only 50 per cent obtained by western-type products like butter, cheese and milk powders. They can do wonders for the organized dairy sector. Seeing better prospects of financial stability and steady growth, a number of modern dairies have already taken to the production of popular milk products like *burfi, gulabjamun, rasagolla, shrikhand, kheer, paneer, peda,* curd and *lassi.* Some of these products have registered a high growth rate, ranging from 15 to 20 per cent. This development is also having a trickle-down effect on the traditional dairy sector which has taken up modernization of its age-old mithai-making methods and product formulations in the following ways:

Inducting appropriate technologies for large-scale production;

Using modern packaging systems and labelling to meet the emerging consumer demand for extended shelf life and product information;

Evolving a quality assurance system to meet the international standards of food hygiene and product safety; and

Collecting market intelligence to inspire confidence among prospective entrepreneurs to take to commercial production of traditional products in India and abroad.

Product development should receive high priority to carve a place for milk sweets in the competitive market. The dairy industry must respond to new demands created by consumer consciousness for health and a low cholesterol diet.

R & D CENTRE

There is a continuing felt need for an R&D centre for development of new variants of traditional milk products to provide an interactive link between the researchers and the technology users. Indian products, processes, technologies and machineries need continued innovations as well as the patenting of such processes, equipment and product formulations. The traditional sector can be encouraged to use its research facilities for upgrading products and modernizing process know-how.

New products should meet requirements of both national and international consumers. Paneer sticks are more nutritious than French fries and also more solid than mozzarella sticks, so popular in the west. Some of these products are best made from buffalo milk. That gives India an edge over western countries in their manufacture and opens up possibilities of exporting buffalo milk powder.

Another major function of the proposed centre could be to organize training of entrepreneurs to raise their skill levels and to make them particularly aware of the importance of hygienic handling and quality standards required for milk and milk products. It will also help them market their products under national and international quality standards. Attention should also be paid to the needs of workers at the floor level.

The centre could find newer ways of packaging some of the delicate and fragile products. For example, kullhars (earthen cups/mugs) absorb whey from curd and mishti doi and make these products far more acceptable. The Delhi Milk Scheme (DMS) presently uses over one million of them for packing and marketing curds and yogurt.

Fast food chains are getting increasingly popular in India and traditional products could fit into them. Franchising has done wonders for several food-based products all over the world. It is a viable option for a widespread marketing of our mithais. Traditional milk sweets can be promoted along with non-dairy food products at such outlets. Already this trend has been taken up by leading brands such as Haldiram and Bikanervala in Delhi. They are emerging as the Indian version of McDonald-type fast-food chains.

The full potential of the traditional dairy sector can be tapped by involving entrepreneurs in its development. National agencies such as the NDDB, NDRI, CFTRI and other state-level food and dairy institutions need to work closely with them to modernize the sector.

Opportunities beckon the Indian dairy industry to build on the tremendous growth of the past 30 years that has already made India the world's largest milk producer. And, now, the Indian milk products and sweets provide a platform to take a quantum leap into an exciting future through their production, modernization and globalization.

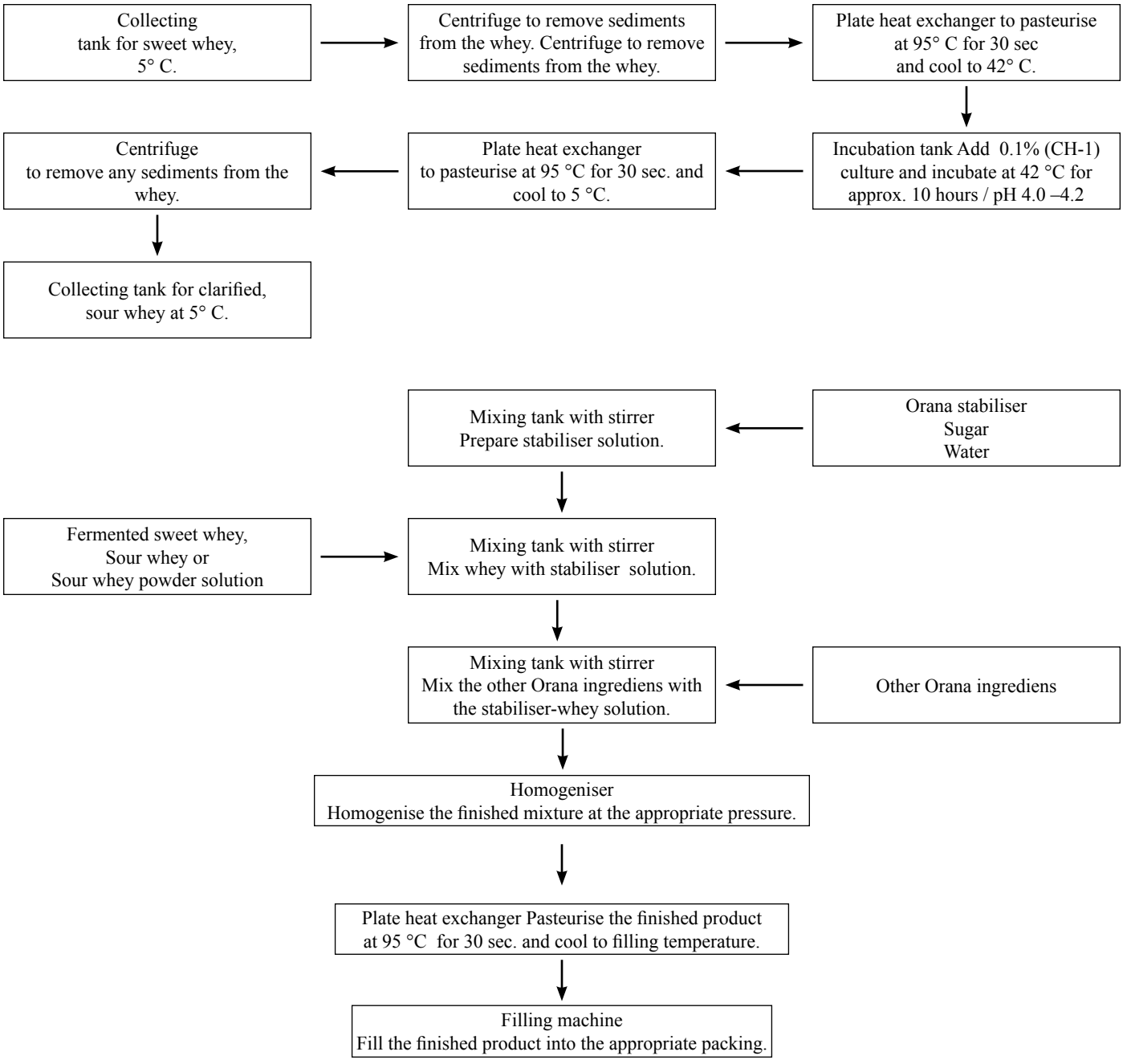
Production of Orana permeate/ Whey Drink.

NECESSARY EQUIPMENT:

- Centrifuge/separator
- Tanks with cooling (5 °C)
- Incubation Tank (42 °C)
- Plate Heat Exchanger (heating 95 °C and cooling 5 °C)
- Mixing Tank with appropriate Stirrer
- Homogeniser (up to 250 bar)
- Plate heat exchanger Heating 95 °C and cooling below 20 °C
- Filling Machine

PRODUCTION STEPS:

1. Fermentation of sweet whey or
2. Centrifugation of sour whey or
3. Dissolving of sour whey powder
4. Preparation of stabiliser – solution
5. Mixing of stabiliser – solution and sour whey
6. Final mixing of whey drink
7. Homogenisation
8. Pasteurisation
9. Filling



WHEY AT A GLANCE

- Milk is used for the manufacturing of cheese, and in this process whey is produced as a by-product. Depending of the type of cheese either sweet whey (from hard cheese like cheddar) or sour whey (from soft cheese like cottage cheese) is produced. They have, however, more or less the same nutritional composition.
- The major differences in nutritional composition between whole milk and whey are in the amount of fat and vitamin C, D and E and to a minor degree protein.. Due to the very low content of fat in whey the content of the fat-soluble vitamins (A, D and E) are low or absent. Most people consider low fat content in a foodstuff as healthy.
- The other good components from the milk such as lactose, protein and the minerals are still largely maintained in the whey, and as such the whey still has good nutritional value. Whey, therefore, is a good nutritional base for producing whey-based fruit drinks, fruit and skimmed milk has a good nutritional value, where especially the vitamin A and C value are high, and the rest of the values are close to 100 % whey.
- Even a whey-based fruit drink with low fruit percentage has a good nutritional value, as it contains a lot of carbohydrate (good for energy), is low in fat and contains milk minerals and vitamins.
- It can therefore be concluded that from a nutritional point of view a whey-based fruit drink can be a good alternative to milk, especially if the whey-based fruit drink is added with extra vitamins such as A, C, D and E.
- Generally whey is regarded as a waste product from cheese production. However, whey can successfully be used for fruit based drinks. Whey contains various nutrients from the milk. Drink products based on whey are therefore value-added products. The nutrients in question are stated on page 3, and various whey types are described on page 4.
- Disposal of whey often creates an environmental problem. This problem can be reduced or even eliminated by using the whey for whey based soft drinks.
- By using the whey for whey drinks, the costs of disposal can be saved, and in addition to this it is possible to produce a tasty, value-added soft drink.
- Depending on the quality, quantity, and taste of the whey, the whey content of the ORANA whey drinks may vary from 10% to 65%. The ORANA assortment of whey drinks consists of several different flavours. In addition to this we can develop tailor made products, which meet the particular market demands.
- The shelf-life of the final whey drink depends on the packaging material. In aseptic packing for instance the shelf-life is 12 months, stored at room temperature max 20°C. For our whey drinks many types of packaging are suitable, e.g. :
- Pure Pak
- Tetra Brik
- Plastic Cup
- Plastic Bag
- Glass Bottle
- Plastic Bottle

PRODUCTION OF ORANA PERMEATE/ WHEY DRINK

- Necessary equipment:
- Centrifuge/separator
- 2 Tanks with cooling (5 °C)
- Incubation Tank (42 °C)
- Plate Heat Exchanger (heating 95 °C and cooling 5 °C)
- Mixing Tank with appropriate Stirrer
- Homogeniser (up to 250 bar)
- Plate heat exchanger Heating 95 °C and cooling below 20 °C
- Filling Machine

PRODUCTION STEPS:

- Fermentation of sweet whey or
- Centrifugation of sour whey or
- Dissolving of sour whey powder
- Preparation of stabiliser – solution
- Mixing of stabiliser – solution and sour whey
- Final mixing of whey drink
- Homogenisation
- Pasteurisation
- Filling

PRODUCTION FLOW:

Potential of machine vision system for process monitoring and manufacturing of Indian dairy products

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ABSTRACT

The traditional Indian dairy products present a great opportunity for the organized dairy sector in the country to modernize and scale up their production. Number of mechanized processing lines has been developed for commercial production. But the visual inspection and quality control is done by human eyes. Human inspection is a slow process, has poor repeatability and result varies from person to person. Recent developments in machine vision system (MVS) and supporting technologies has resulted in general acceptance of the feasibility and profitability of implementing visual inspecting systems in quality assurance operations. Machine vision technology utilizes image processing techniques for the purpose of extracting visual features about an object for a variety of qualitative, quantitative and control applications. MVS can be employed for visual inspection and process monitoring for accurate results. The potential application of MVS in manufacture of Indian dairy products are colour measurement, geometrical analysis, identification of defects, packaging, labelling etc.

INTRODUCTION

The importance of Indian dairy products is underlined by the fact that about 50% of India's milk production is utilized for making these products (Dutta and Bakshi, 2011). The production is carried out basically by sweet manufacturers at small scale. Value addition in the case of production of Indian dairy products may be to the extent of 200%, as compared to only 50% obtained by Western products like butter, cheese and milk powders (Aneja et al., 2002). Looking at the demand and profit margin, many companies have started large scale production. The traditional dairy products present a great opportunity for the organized dairy sector in the country to modernize and scale up their production (Khamrui, 2013). Successful technologies are semi continuous Gulabjamun line, continuous paneer manufacturing lines, continuous khoa making machine, srikand production line etc. Despite of high level of automation, visual inspection and quality control is done by human eyes. Human inspection is a slow process, has poor repeatability and result varies from person to person. Machine vision systems can be employed for visual inspection and process monitoring for accurate results. Machine vision systems can perform repetitive tasks faster, more accurately, and with greater consistency over time than humans. They can reduce labor costs, increase production yields, and eliminate costly errors associated with incomplete or incorrect assembly. They can help automatically identify and correct manufacturing problems on-line by forming part of the factory control network. The net result is greater productivity and improved customer satisfaction through the consistent delivery of quality products (DALSA, 2010).

MACHINE VISION SYSTEM (MVS)

Recent developments in machine vision and supporting technologies has resulted in general acceptance of the feasibility and profitability of implementing visual inspecting systems in quality assurance operations of food producing lines. Machine vision benefited the most from the increase in processing and storage powers of modern chips, and from the emergence of megapixel sensing and imaging devices. Machine vision technology utilizes image processing techniques for the purpose of extracting visual features about an object for a variety of qualitative, quantitative and control applications (Alhusain et al., .2012). The technology is used in a variety of different industries to automate the production, increase production speed and yield, and to improve product quality (Sickivp, 2006). A typical machine vision system consists of several components of the following (Labudzki and Legutko, 2011):

- Digital or analogue camera (black and white or colour) and lens for taking close-ups
- Camera processor interface (the so-called frame grabber) and device I/O (input/output), or communication links
- Processor (this is usually PC or embedded processor)
- Illumination system
- Software to the imaging and detection of features in

common image (image processing algorithm)
- Sync-sensor to detect objects (this is usually an optical or magnetic sensor), which gives the signal for the sampling and processing of image
- Regulations to remove or reject products with defects.

a. Camera: Image capturing devices or sensors are used to view and generate images of the samples. Some of the devices or sensors used in generating images include scanners, ultrasound, X-ray and near infrared spectroscopy. However, in machine vision, image sensors used are the solid state charged coupled device (CCD) (i.e. camera) technology with some applications using thermionic tube devices. Recent technology has seen the adoption of digital camera, which eliminates the additional component required to convert images taken by photographic and CCD cameras or other sensors to readable format by computer processors. Images captured or taken by digital camera maintain the features of the images with little noise due to its variable resolution (Narendra and Hareesh, 2010).

b. Camera processor interface: The most important imaging interfaces are IEEE1394b, Gigabit Ethernet, USB 2.0, USB 3.0 and Camera Link.

c. Illumination system: The lighting system, a critical part of a controlled machine vision system, must be carefully designed. The ultimate purpose of lighting design is to provide a consistent scene eliminate the appearance of variations, and yield appropriate, application-specific lighting. Proper selection of lighting sources (incandescent, fluorescent, halogen, Xenon, LED), lighting arrangements (backlighting, front lighting, side lighting, structured lighting, ring lighting), and lighting geometry (point lighting, diffuse lighting, collimated lighting) is the "key to value" (Zuech 2004). Primary factors that influence the selection is whether the object under inspection is (Patel et al., 2012): 1) flat or curved; 2) absorbing, transmissive or reflective; and 3) the nature of the feature to be imaged in comparison with the background.

d. Processor: Image processing and image analysis are recognized as being the core of computer vision (Krutz et al., 2000). Image processing involves a series of image operations that enhance the quality of an image in order to remove defects such as geometric distortion, improper focus, repetitive noise, non-uniform lighting and camera motion. Image analysis is the process of distinguishing the objects (regions of interest) from the background and producing quantitative information, which is used in the subsequent control systems for decision making (Brosnan and Sun, 2004). Image processing/analysis involves a series of steps, which can be broadly divided into three levels: low level processing, intermediate level processing and high level processing (Gunasekaran and Ding, 1994; Sun, 2000).

POTENTIAL APPLICATIONS OF MVS IN MANUFACTURING OF INDIAN DAIRY PRODUCTS

Colour measurement

Colour is one of main parameters that consumers evaluate and use as an indicator for the acceptance or rejection of foods. Consumers tend to associate colour with flavor, safety, storage time, nutrition and level of satisfaction due to the fact that it correlates well with physical, chemical and sensorial evaluations of food quality. Colour not only makes the any product attractive but also influences the buying decision of the consumer. Machine vision systems can be used for off-line as well as on-line colour measurement. MVS can be employed for colour based process monitoring of manufacture of gulabjamun, rabri, basundi, kheer, ghee etc.

GEOMETRICAL ANALYSIS AND DETECTION OF PHYSICAL DEFECTS

MVS can be programmed to extract dimensional features like size, shape, orientation, texture etc from the acquired image. Vision machine can also be used to know structure in order to quantify the macro and microscopic surface defects of a product or for the characterization and identification of foods (Riva, 1999). Such system can be installed after moulding machine and employed to inspect shape of sweet like peda, channa ball, burfi etc. Physical defects like improper colour development, excessive browning or burning can be identified. It may be integrated with a rejection device to remove the product automatically if it does not meet the set standards.

OTHER APPLICATIONS

a. Bottle thread and cap inspection: MVS can be programmed to verify if cap is threaded onto bottle neck correctly and tightened properly. Presence of safety ring can also be checked

b. Filling inspection: MVS can be used to monitor if product is filled in cup or bottles up the set level before sealing/ capping.

c. Label quality check and packaging: MVS with Optical Character recognition (OCR) capabilities can check required information like weight/volume, ingredients, allergy related information, batch number, manufacture date, best before date, price, bar code etc.

CONCLUSION

Large scale production of Indian dairy products requires high level of mechanization and automation. The visual quality inspection by human eyes may not meet the capacity required by automated processing lines. MVS can solve many of the problems related to human inspection by fast and accurate monitoring of production process. Thus there is a need for development of machine vision system which is specifically designed for quality inspection of Indian dairy products.

INNOVATIVE APPROACH OF GERMICIDAL EFFECT ON AIR USING MULTIPLE REFLECTION OF UV IRRADIATION

(Shah BP[1], Chauhan Divyesh[1], Shah DR[1], Shah RR[2] and Chauhan Paresh[1])
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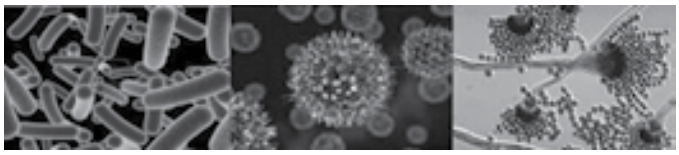
[2]Assistant Professor, Mech. Engg., ADIT College, Vallabh Vidyanagar, Gujarat

INNOVATIVE WORK

Air contains variety of microbes including bacteria, yeast, mold, viruses, spores. These are the potential source of contamination. This may lead to spoilage of the dairy products. It may transfer disease and toxin producing microbes to the dairy products resulting in to health hazards. Therefore, the powerful technology is demanded to protect dairy products from these microbial hazards.



In the present work, Airborne contamination is controlled by using…… Filtration method and UV treatment

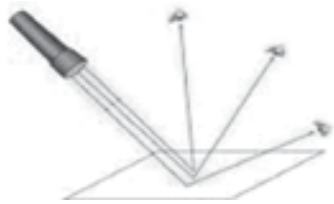
CLASSIFICATION OF ULTRA VIOLET LIGHT UV IRRADIATION

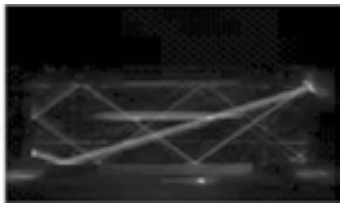
Name	Abbreviation	Wavelength range (in nanometers)	Energy per photon (in electronvolts)
Ultraviolet	UV	400 – 100 nm	3.10 – 12.4 eV
Ultraviolet A	UVA	400 – 315 nm	3.10 – 3.94 eV
Ultraviolet B	UVB	315 – 280 nm	3.94 – 4.43 eV
Ultraviolet C	UVC	280 – 100 nm	4.43 – 12.4 eV

Ultraviolet (UV) light is electromagnetic radiation with a wavelength shorter than that of visible light, but longer than X-rays.It is, in the range between 100 nm to 400 nm. UV radiation has higher frequencies, of violet color. UV rays are mutagenic to human beings.

MULTIPLE REFLECTIONS

Beam of light reflects on a mirror, provides one image. When two mirrors positioned exactly face to face, provides number of images along a conventional line. While, a square of four mirrors employed face to face, provides an endless number of images organized in a plane. The accumulated manifold images obtained amongst four mirrors results in a pyramid.





GERMICIDAL EFFECT BY ULTRA VIOLET IRRADIATION

UV-irradiation at wavelengths less than 200nm is categorized as non-ionizing irradiation. The germicidal properties of UV-irradiation is more effective at wavelengths ranging from 227 to 329nm,with peak at 264nm for majority of microorganisms. It is conformed that destruction of infectious cells by UV-irradiation is mainly due to destruction of deoxyribonucleic acid (DNA) of thebacteria, phages, viruses. UV sterilization has become a practical solution for safe disinfection of air.

WORKING PRINCIPLE

Air for précised contaminant free work was obtained first passing through plenum chamber having UV tubes with reflecting surfaces and then through HEPA filter.

High Efficiency Particulate Airborne filter (having the pore size of less 0.3 micron) made it possible to entrap majority of bacteria, fungi along with the physical and chemical impurities having the size of more than 0.3 micron.

In laminar air flow system, initial circulation of the air may also circulate the tiny microbes in the work place. In this developed system, the viable microbes destroyed by exposing them to UV irradiation. The higher disinfecting efficiency was obtained by forced air circulation by bringing the air in close contact with UV rays, as the cells' destruction is directly related with the contact time.

The provision of reflecting surfaces of the system gave reflection and re-reflection of UV rays on airborne microorganisms in the air duct has further increased the destruction of viable microorganisms. This was achieved by providing reflecting surfaces surrounding the UV tube light.

MULTIPLE REFLECTION OF UV RAYS FOR SUPERB GERMICIDAL EFFECT ON AIRBORNE MICROORGANISM

(Designed and Developed at Vidya Dairy, AAU Campus, Anand, Gujarat)

Table: Performance evaluation of Clear Air Systems

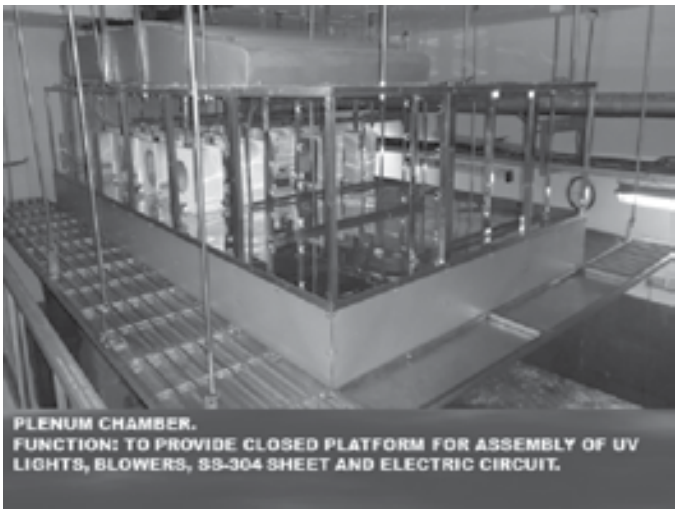
Ambient vs. Clean Air System's microbial flora (SPC & Y&M) average value of 5 Replications.

Time	Total Bacterial Count (cfu/hour)		Y&M (cfu/hour)	
	Ambient	Clean Air Systems	Ambient	Clean Air Systems
00:00-02:00	28	0	32	0.3
02:00-04:00	40	0.1	20	0
04:00-06:00	28	0	24	0
06:00-08:00	56	0	64	0.1
08:00-10:00	112	0	132	0.1
10:00-12:00	136	0	140	0.1
12:00-14:00	40	0	72	0.4
14:00-16:00	88	0	84	0
16:00-18:00	152	0	144	0
18:00-20:00	164	0	172	0
20:00-22:00	100	0	80	0
22:00-00:00	52	0	48	0.3

Note: The developed "**INNOVATIVE APPROACH OF GERMICIDAL EFFECT ON AIR USING MULTIPLE REFLECTION OF UV IRRADIATION" gave nearer to Zero total bacteria as well as yeast and mold count.**

Advantages of Multiple UV Irradiation Effect
(Designed and Developed at Vidya Dairy, AAU Campus, Anand, Gujarat)

- Gives improved quality of air.
- Reduces Risk of microbial contamination.



PLENUM CHAMBER.
FUNCTION: TO PROVIDE CLOSED PLATFORM FOR ASSEMBLY OF UV LIGHTS, BLOWERS, SS-304 SHEET AND ELECTRIC CIRCUIT.

UTILITYOF A CLEAN AIR APPARATUS

Sr. No.	Sector	Area
1.	Dairy	Useful in dairy industry to avoid contamination of airborne microorganisms, where products are exposed to open air. e.g. Manufacturing & Packing area of □ Ice-Cream □ Cheese and Paneer □ Functional food □ UHT Plant, etc.
2.	Hospitals	Operation Theaters and ICU Units.
		Clinical Laboratories.
		Patients of Asthma and other bronchial disease.
		Oncogenic centers where patients are at high risk.
		Maternity sectors where child is at high risk of pathogens.

Sr. No.	Sector	Area
3.	Pharmaceuticals	Drug Formulations and Packing Rooms.
		Capsule and Tablet materialization divisions.
		Research and Development areas.
		Sterile Rooms.
4.	Agricultural & Tissue culture Divisions	Genomics and Proteomics Laboratories.
		Microbiological Laboratories.
		Callus Formulation Sectors.
5.	Food Firms	Pickle Industries
		Bakery Industries
		Pulp and Jam Manufacturing Units.
		Infant Formulations Manufacturing Industries.

WE STRUGGLE AND STRIVE TO GET BEST QUALITY AIR
-VIDYA DAIRY

Excellence is not a destination; it is journey that never ends.

Vidya Dairy was started as an innovative approach to inculcate professional and technical skills among the graduating B.Tech (Dairy Technology) students of SMC college of Dairy Science, Anand Agricultural University, Anand. This was made possible by providing one year of hands - on experience in Dairy Plant Operations & Management Courses I & II.

GENESIS OF VIDYA DAIRY

The SMC College of Dairy Science, Anand is a pioneering dairy education center of international repute at Anand Agricultural University, established in 1961 for imparting quality education to the under graduate students of Dairy Technology. The college is actively engaged in catering technically sound and competent manpower for the Indian Dairy Industry. Till the year 1993 undergraduate Dairy Technology students of the SMC college of Dairy Science, Anand underwent the in plant training in dairies scattered all over the country. This made it difficult for the college authorities / dairy authorities to closely monitor the students' progress during the training, leaving them woefully short of 'hands-on' experience as a result of which the students could not be trained effectively. The lacuna in the dairy education system was churned by the great dairy visionary, Late Dr. V. Kurien into conceiving Vidya Dairy to fulfill the dream of providing excellent training facilities to the students of SMC College of Dairy Science, AAU, Anand. In concurrence with the joint recommendations of National Dairy Development Board, Indian Council of Agricultural Research (NDDB-ICAR) Panel, the programmeme was modified from B.Sc. (Dairy Technology) to B.Tech (Dairy Technology). With this vision, Vidya Dairy was established in 1994 with a financial assistance of ₹ 15 crores from NDDB and it is the first organization in India as well as in Asia to impart such kind of training to undergraduates students.

Being an educational – cum- commercial institute, Vidya Dairy has been awarded the status of a Company under section 25 of the Companies Act (not for profit making company). Its objectives and activities are different than other commercial dairy plants. Thus, the dairy is "***Of the Students, For the Students and By the Students***" and a novel concept of 'Learning by Doing' as

well as an effort Towards Education with a Difference is being practiced. We nurture gen-next dairy technocrats all the way

EXTERNAL TRAINING PROGRAMMES

In view of liberalization, effective and competitive skill enrichment of human resource has assumed a pivotal place. Vidya Dairy is the leading organization in formulating and delivering exemplary training programmes for all key stakeholders of dairy industry from students to working employees to management groups and executives.

Besides imparting regular training to B. Tech (DT) students, the dairy has also forayed into organizing Short-Term Training Programmemes for the benefit of the industry in association with the Faculty of SMC College of Dairy Science, Anand. These programmes are aimed at giving broad orientation of technological and analytical aspects of milk and milk products along with hands-on-experience of the operations to the dairy / non-dairy personnel working in plant and laboratory areas. This aspect refreshes their knowledge and enriches the skills of practicing dairy / non-dairy executives which ultimately helps the organization to improve efficiency, reduce cycle time and cost. The training programmes are designed taking into consideration the recent requirements of the dairy industry. Tailor made training programmes are also designed as per the requirement of an organization, to fulfill the needs of the participants.

From September 2004 to July 2013, Vidya Dairy has offered 262 short-term training programmes and trained 4342 practicing dairy / non-dairy executives of the Dairy Industry. The various training programmes conducted are as under:

DETAILS OF TRAINING PROGRAMME CONDUCTED UPTO JULY 2013

Sr. No	Name of the Programme	Batches	No of participants
1	Dairy Technology for Non Dairy Technologists (in English and Gujarati language)	99	1793
2	Laboratory practices in Dairy and Food Plant.	35	412
3	Technology of Pro-biotic and fermented dairy products.	20	276
4	Technology of Mozzarella Cheese.	1	12
5	Technology of Cheddar Cheese.	1	17
6	Technology of Processed Cheese.	1	8
7	Technological and Engineering Aspects of Dairy and Food Plant.	18	198
8	New Developments in Energy management of dairy and food plant.	3	36
9	Coping with Challenges of Environment in Dairy / Food Plant.	1	12
10	Management of Bulk Milk Cooling System in Gujarati for village level Operators	38	641
11	Clean Milk Production	2	45
12	Sensory Evaluation of Milk and Milk Products.	10	137
13	Technological & Engineering Aspects of Milk Condensing & Drying Plants	3	46
14	ISO-22000-2005 Internal auditor Training	5	122
15	ISO:22000, CIP Principles and GMP	4	153
16	Good Manufacturing Practices & Good Hygiene Practices (In-house)	3	75
17	ISO:14001:2004 Implementation and Management of ETP in Dairy Industry	2	46
18	Technological and Engineering Aspects of Ice Cream Plant	2	54
19	Technology and Engineering Aspects of Cheese Manufacturing	1	33
20	Advances in Fat Rich Dairy Products	3	44
21	Advances in Automation in Dairy Industry	1	29
22	FSSAI Requirements & Pest Management Solution in Food Industry	1	24
23	Outlines of Dairying	4	82
24	**Dairy Plant Operations and Management**		
	A Special Training for Government of Sikkim	1	17
	A Special Training for Institute of Rural Management Anand (IRMA)	1	17
	A Special Training for College of Applied Food & Dairy Technology, Nepal	2	16
	TOTAL NUMBER OF PARTICIPANTS	**262**	**4345**

Achievements...

1. Winner of the Prestigious Rajiv Gandhi National Quality Award – 2003 Commendation Certificate in recognition of the efforts and commitment to quality in the field of Large Scale Manufacturing Industry – Food & Drug Category by BIS, New Delhi.

2. Recipient of "IMC Ram Krishna Bajaj National Quality Award – 2006 – Commendation Certificate" by IMC Ram Krishna Bajaj National Quality Award Trust.

3. Winner of "National Safety Award" by Ministry of Labour & Employment in the year 2004, runners-up in 2005 and winner in the year 2006.

4. Winner of the ICAI Awards for Excellence in Financial Reporting for the year 2008 and Runners up in 2005, 2009 & 2010.

5. SAFA Best Presented Accounts Award – 2008 (1st Runner up -Joint), 2009 & 2010 (Certificate of Merit) in the category of Non-Governmental Organizations by South Asian Federation of Accountants (SAFA).

6. Winner of "National Safety Award – 2009" under Scheme No. V for Lowest Average Frequency Rate & also winner under Scheme No.VI for Accident Free Days in schedule No.06 (Manufacture of food products and beverages).

7. Winner of the Gujarat Safety Award – 2000 and 2002 by Gujarat Safety Council.

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★ *Evaporator Plate especially designed for Indian Summer/winter conditions.*
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Web: www.dairytechequipment.com www.dairytechindia.net

Poster Presentation

SENSORY EVALUATION OF FLAVOURED MILKS USING FUZZY-LOGIC TECHNIQUE

P. Arun Kumar, K.C. Neethu, P.G. Wasnik, Magdaline Eljeeva Emerald and Heartwin A. Pushpadass
Dairy Engineering Section, National Dairy Research Institute, Southern Regional Station, Bangalore

ABSTRACT

Sterilized flavoured milk is one of the highly demanded and value-added milk products. Addition of flavor and other ingredients into milk increases its commercial value and consumer acceptance. In the view of analyzing the consumer preference over different commercially available brands of flavoured milk, a study was undertaken to conduct the sensory evaluation of selected four commercial brands of badam-flavoured milk along with experimentally prepared one through reconstitution process. Fuzzy-logic technique was applied for ranking the samples and also to find out the preference of quality attributes of flavoured milk. It is an important decision-making tool to treat uncertainties in sensory data, mathematically based on the fuzzy set concept. The consumer preference for quality attributes in general were in the order of flavour taste, mouthfeel, colour and presence of clots (undesirable parameter). The experimentally prepared sample scored statistically on par with brand A. The study also observed that none of the selected brands of flavoured milk followed quality attributes as per the above mentioned order. The approach was successfully employed to evaluate the sensory attributes of flavoured milk. The fuzzy-logic tool identified the strong and weak attributes of the individual samples, and gave scope for further product improvement and development.

SORPTION AND TEXTURE STUDIES OF RASOMALAI FOR ITS MECHANIZATION

P G WASNIK, AV DHOTRE#, NM KHODWE#,BD MESHRAM# AND PB NIKAM¥*

ABSTRACT

Mechanization of indigenous dairy products is mainly restricted by the scarcity of data about engineering properties of these products. Hence, such data generation is pre-requisite to initiate their mechanization, which has become imperative for complete Indian TIDP sector and research community in order to keep pace with the changing international market scenario and consumerism. Accordingly, the present study was undertaken to quantify the sorption characteristics and texture profile of Rasomalai. The sorption characteristics are essential for processing, storage, package design and thereby mechanization as it influences; evaporative losses from product, product's micro environment for microbial and biochemical activities, aroma retention and drying potential of a product. The texture profile is essential for knowing product's mechanics, its behavior and energy requirement while handling, chewing and swallowing. The sorption study was done using highly advanced Dynamic Vapour Sorption Analyzer (DVS-Intrinsic, SMS, UK) much precise than conventionally employed static salt method and texture was studies using advanced texture profile analyzer(TAX2Ti,SMS,UK). The results revealed that the initial water activity of Rosomalai at 93.76% DB moisture content ranged from 0.95-0.98 aw at all temperatures(20-40oC) indicating that the product is highly prone to bacterial growth. The representation of GAB, Freundlich, Halsey, Henderson and Oswin models were best fitted for isotherms of Rosomalai at 25oC. Halsey, Henderson and Oswin models were found good to predict the experimental data of Rosomalai at 30oC and 35oC, while GAB, Freundlich and Henderson models were best describe the sorption behavior of Rosomalai at 40oC. The hardness, springiness and gumminess values were found to be 1.566 N, 1.175 mm and 1.071 N respectively while the chewiness and resilience were found to be 1.273 N.mm and 0.232 respectively for the standard composition of the Rasomalai.

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PROCESS MECHANIZATION FOR PRODUCTION OF PEDA

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Peda is popular milk sweet of Indian subcontinent and is the largest produced among the khoa based Indian Dairy products. The process of making peda involves heating of khoa and powdered sugar together for partial removal of moisture when the mixture turns firm, if desired then nuts and flavourings are added. Peda is low in moisture (4-22%) and high in sugar content, that also provides a preservative effect. It has a good shelf life of about 15 days at room temperature, when modified atmospheric packaging is done. In India peda is manufactured mostly by halwais. In order to overcome the disadvantages of the conventional methods of production such as; inefficient use of energy, poor hygiene and sanitation, non-uniform product quality, fatigue on the operator etc, mechanized production of peda is necessary. Their lies a big opportunity in the dairy industry for process mechanization and automation in processing of traditional Indian dairy products.

A mechanized system has been devised for inline production of peda, which involves the preparation of khoa from milk using scraped surface heat exchanger (SSHE), sugar dosing device for appropriate khoa: sugar ratio, barrel type heat exchanger with helical type blade that mixes the contents and moves the product forward along with partial cooking and removal of moisture. At the end of a barrel a die has been fitted, which extrudes a cylindrical mixed peda mass which is cut by the moving knife to form a peda, which is further carried away by the moving belt for packaging. Introduction of sensors for monitoring and control of various process parameters in the production line could help to have a complete automated process.

OPTIMIZATION OF BAKING CONDITIONS OF CHHANA PODO USING RESPONSE SURFACE METHODOLOGY

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ABSTRACT

Baking is the key step in the preparation of chhana podo in which the product undergoes physico-chemical and structural changes due to simultaneous heat and mass transfer. The objective of this study was to optimize the baking conditions of chhana podo using response surface methodology. Chhana podo was prepared by kneading chhana, sugar and semolina (20:6:1) to a homogeneous and smooth dough. Dough weighing 185 g was filled in aluminium casseroles and baked at 120, 135 and 150°C for 120 min. During baking, the core temperature, moisture content, specific volume, crust colour and textural properties were measured at specific intervals. For optimization of baking process, baking time and temperature were taken as independent factors whereas dependent variables were crumb and crust moisture contents, specific volume, hardness and total colour difference. Face-centered central composite response surface design was used for optimization using Design Expert 8.0 software. A quadratic model fitted well, with the independent factors having significant effect ($p<0.001$) on all measured responses. The time-temperature combination for baking of chhana podo was optimized as 135°C for 104 min. The response surface model was validated. The experimental values of the responses at the optimum baking conditions were 55.94 ± 0.41% d.b., 19.71 ± 1.25% d.b., 1.17 ± 0.01cm3/g, 22.66 ± 0.74 N and 45.26± 0.35 for crumb moisture content, crust moisture content, specific volume, hardness and total colour difference. The results of this work would be useful for large scale production of chhana podo.

EVALUATION OF BAKING CONDITIONS ON QUALITY ATTRIBUTES OF CHHANA PODO FOR ITS LARGE SCALE PRODUCTION

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ABSTRACT

Chhana podo is a baked traditional dairy product famous in eastern parts of India. It is light brown in colour and has rich and pleasant flavour. The aim of this was to study the effects of baking conditions on various quality attributes of chhana podo. Chhana, sugar and semolina were kneaded in 20:6:1 ratio, and made to smooth and homogeneous dough, spread into aluminium casseroles and baked for 120 min in a baking oven. Several quality attributes of chhana podo such as crust colour, moisture content, texture, specific volume, oven spring, crumb grain characteristics, weight loss and thermal properties, as influenced by the baking conditions, were determined. The samples were baked at air temperatures of 120, 135 and 150°C. Results showed that higher baking temperatures led to higher moisture loss from the crust and crumb, higher specific volume, lower lightness value with darker crust, lower oven spring, higher mean cell area and increased hardness in the product. The crust and crumb moisture contents decreased from the initial value of 68.35 to 20.85, 16.91 and 10.65% (d.b.) and 55.76, 53.45 and 45.27% d.b. while the specific volume increased from the initial value of 0.94 to 1.09, 1.24 and 1.35 cm3/g, Hardness increased from 4.40±0.32 N to 20.80±3.68, 24.61±8.12 and 31.95±2.33N and total colour difference increased up to 40.59, 50.64 and 58.97 at air temperatures 120, 135 and 150ºC, respectively. After an initial lag period, the product core temperature increased linearly till 100±2°C, thereafter it remained constant. Thermal properties like thermal conductivity, thermal diffusivity and volumetric specific heat decreased with increase in baking time and temperature. The thermal conductivity, thermal diffusivity and volumetric specific heat ranged from 0.359 to 0.223 W/m.K, 0.112 to 0.105 mm2/s and 3.09 to 2.00 MJ/m3k when baked at 120, 135 and 150°C, respectively.and gave scope for further product improvement and development.

MECHANIZATION OF SHRIKHAND THERMIZATION

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ABSTRACT

Shrikhand Thermization is a post production heat treatment given to shrikhand to suppress its undesirable microflora that often include airborne fungi, coliforms from post production contamination and spore formers from sugar. Moreover it enhances the acceptability and shelf life of shrikhand and boosts up its sensory attributes. Nevertheless, owing to non-availability suitably designed equipment, the process of thermization has yet not been widely adopted by most of the pertinent dairy plants with certain exceptions. In the present study a SSHE based machine named as Continuous Shrikhand Thermization Machine was developed to carry out thermization of Shrikhand. The performance of the machine was evaluated at thermization temperatures of 70^{O}C, 75^{O}C and 80^{O}C, at different scraper speeds viz., 20 rpm, 35 rpm and 50 rpm and two levels of TS viz., 20^{O}1 % and 23^{O} 1 %) of chakka. The design of the machine was found suitable for thermization of Shrikhand with simultaneous blending of ingredients. The values of overall heat transfer coefficient (U) under different operating conditions ranged from 267.77 to 487.67 W/m2K. The combination M2S3T3 gave the maximum U-value. The values of ho (Nusselt) and ho (experimental) were found to vary from 10028.15 to 13492.79 W/m2K and 8861.81 to 13739.96 W/m2K respectively under operating conditions studied. The U-values were also found to increase significantly with increase in the scraper speed. The values of product side film heat transfer coefficient (hi) were varied from 278.40 to 535.20 W/m2K. The values of ho and hi increased with increase in scraper speeds and thermization temperatures but decreased with increase in moisture content of chakka. The optimum capacity of Continuous Shrikhand Thermization Machine, was found be 160.71 kg/h for Shrikhand prepared using chakka with 20^{O} 1 % TS while for 23^{O} 1 % TS chakka, the capacity of 124.07 kg/h was optimum. The thermal efficiency based on LPG consumption of the machine obtained at different operating conditions ranged from 50.87 to 65.54 %.

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HURDLE TECHNOLOGY TO ENHANCE SHELF LIFE OF PANEER

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Paneer the indigenous variety of soft cheese is obtained by the acid and heat coagulation of milk at high temperatures. Although paneer manufacture involves heating of milk at near boiling temperature under mild acidic conditions for coagulation of milk the bactericidal advantage so gained from thermal processing of milk, is quickly lost due to direct exposure to the environment during subsequent manual handling, pressing and cooling followed by packaging under unhygienic conditions.

In this way, shelf life of paneer is severely affected and limited down to only a day or two at ambient temperatures and 6-8 days at refrigeration temperature (Bhattacharya et al, 1971). Thus, a relatively shorter shelf life of paneer is a major handicap in commercial adoption of paneer manufacture. A study was planned to apply different dipping treatments to paneer using vinegar, lactic acid and citric acid followed by partial drying under vacuum to reduce its moisture content and converting it to intermediate moisture food.

Paneer was prepared from standardized milk (4.5 % fat and 9.1 % SNF) as per Bhattachrya et al (1971). After pressing it was diced in to approximately 1.5 cm3 size cubes and different dipping treatment was given (Diced paneer was dipped in to three different acids for 30 min) to paneer cubes followed by complete draining and subjected to vacuum drying (4-5 h at 660 – 680 mm hg) in vacuum tray drier. Drying was continued till moisture content reduced to approximately 30 to 35% of the original moisture content of paneer. The paneer samples were packaged in ~ 90 µ LDPE bags and then stored at refrigeration temperature (7 ± 1 OC) till samples became unacceptable. Paneer was rehydrated by dipping dried paneer cubes in warm (~ 75 – 80 OC) water for 10-15 min followed by dipping in chilled water for ~ 15 – 20 min.

The samples of experimental paneer were analysed for physico-chemical (Moisture, Fat, Protein, Acidity, pH, soluble nitrogen, FFA and Rate of Hydration), Rheological (Hardness, Guminess, Chiewness, Springeness, Adhesiveness etc.) and Microbiological analysis (Standard Plate count, Yeast & Mould count and Coliform count).

Shelf life of paneer can be extended by reducing its pH and removing partial moisture by drying the paneer under vacuum. Moisture content of dried paneer varied on account of different uptake rate of different acid solutions employed in the study. Percent fat and protein content of paneer samples varied and this could be because of variation observed in moisture content. Depending upon basicity of acids, pH varied and it showed profound impact on sensory characteristic and rheological parameters. Storageablity of paneer samples were monitored on basis of FFA content, soluble nitrogen content as well microbial analysis. FFA content and soluble nitrogen content increased during storage for paneer samples under study. However, paneer sample treated with vinegar had significantly higher FFA content and soluble nitrogen content. FFA content of other two samples remained statistically at par but soluble nitrogen content of lactic acid treated paneer samples were higher as compared to paneer samples treated with citric acid.

All paneer samples showed increase in SPC and Yeast and Mold count, however the count observed had lower values compared to standards laid down by FSSAI till end of storage period (90 days). Thus microbiologically all paneer samples may be considered safe and acceptable.

Quality of paneer could be judged only after its rehydration as dried paneer is obviously very hard due to reduction in moisture content. Hence rehydration property of dried paneer is an important parameter affecting the sensorial and rheological acceptability of the product.

The rheological properties suggest that hydrated paneer samples treated with vinegar had lower hardness, higher springiness and lower adhesiveness, comparable to that of fresh control sample, closely followed by that treated with lactic acid. Chewiness, Stiffness and Gumminess values were observed to be lowest in hydrated paneer samples treated with lactic acid. This results indicates both Vinegar and Lactic acid can be used successfully for extending the shelf-life of paneer.

Dipping of paneer in vinegar or lactic acid for 30 minutes, followed by partial removal of moisture under vacuum as per AAU protocol and packaging in LDPE bags of 90 µm thickness, could enhance its shelf life up to 90 days under refrigerated (7±2oC) storage. Upon rehydration in warm water, the paneer obtained had similar rheological properties compared to that observed in fresh paneer.

MOISTURE SORPTION CHARACTERISTICS OF SPRAY-DRIED MILK-MALTED FOXTAIL MILLET POWDER

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Milk and malted foxtail millet extract were blended together at 1:1 ratio and spray-dried using a 0.7 mm two-fluid nozzle. The aim of this work was to determine the moisture sorption isotherms of the dried milk-malted foxtail millet food at 25 and 40°C over a range of water activity from 0.11 to 0.96. The moisture adsorption isotherms were obtained using static gravimetric method. The isotherms were of sigmoidal shape, belonging to type II of BDDT classification. The EMC (%, db), at a given water activity, increased as the temperature increased from 25 to 40°C. The sorption data were analysed using several sorption models (BET, Caurie, GAB, Modified Mizrahi, Halsey, Kuhn, etc), which described the relationship between EMC and water activity by giving the best fit to the experimental sorption data. The values of isosteric heat of sorption of water at different moisture contents were determined using the Clausius–Clapeyron equation. The monolayer moisture content, density of sorbed water, number of adsorbed monolayers, percent bound water and surface area of the milk-malted foxtail millet powder were also determined from the experimental data.

"EFFECT OF CONCENTRATION METHOD ON QUALITY ATTRIBUTES OF KULFI"

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ABSTRACT

Concentration is a cumulative process for total solids by evaporating the water content in product. The method of concentration varies with product to product preparation or the facility in the processing plant. Three types of concentration methods such as open pan, vacuum pan and combination of vacuum pan and open pan methods were evaluated to concentrate pre standardized milk (5% fat and 8% SNF) up to two folds. For preparation of kulfi mix the concentration mix was admixed with sugar (13% concentrated weight bases) followed by immediate cooling to ambient temperature to avoid the separation of the cream layer. The freezing of kulfi was achieved by immersion freezing in liquid brine solution. The effect of the concentration method on freezing time, melting rate, hardness and sensory attributes of the kulfi was determined. The combination of open pan and vacuum pan concentration method was ascertained better for hardness (33N), followed by open pan and vacuum pan method at 30.48N and 30.03N respectively, open pan concentration method showed better to other properties such as colour and melting rate as compare to other two methods.

Key words: Concentration, Freezing, and Kulfi

APPLICATION OF RENEWABLE ENERGY SOURCES FOR MECHANIZED PRODUCTION OF TRADITIONAL PRODUCTS

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Traditional dairy products are an integral part of Indian heritage and culture. Traditional dairy products in our country are made manually, handling small quantities. Several limitations are associated with these methods like high energy and labor requirement, hygiene issues, batch to batch variations and low shelf life. To overcome these shortcomings, mechanized manufacture has been developed for many of our traditional products. However, most of these technologies still use considerable amount of energy in the form of steam, electricity etc. The energy that drives these processes now, comes mainly from non-renewable sources like fossil fuels. Hence there is a vast potential in the manufacture of traditional products for utilization of renewable energy sources like wind, solar, geothermal, biogas etc. Heat desiccated milk products such as Khoa, which is the base for a wider range of mithais have great relevance among Indians. Khoa making is a time consuming and energy intensive process involving continuous removal of water which requires large amount of heat. This heat can be supplied using parabolic solar collectors or by burning biomass or biogas. The electricity required can be obtained by solar photovoltaic cells, wind power, micro hydro system etc., thereby reaping the potential environmental and economical benefits.

STUDIES ON MECHANIZED PRODUCTION OF DODA BURFI USING SCRAPED SURFACE HEAT EXCHANGER

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ABSTRACT

Doda Burfi is region specific traditional Indian dairy product popular in northern states. The product has pleasant characteristic nutty flavor. But even today it is manufactured by traditional method, which inherently suffers from various limitations. Scraped surface heat exchanger (SSHE) seems to be most suitable heat exchanger for handling high viscosity products. Therefore, it was planned to study on mechanized production of Doda Burfi using SSHE. Doda Burfi was manufactured by adding germinated wheat flour (GWF), colour, skim milk powder, citric acid solution, sugar at two different intervals. The investigation was carried out to optimize the various process parameter like scrapper speed (100, 125 and 175 RPM), steam pressure (1, 1.5, 2 and 2.5 kg/cm2) and different stages of sugar addition to get the best quality of Doda Burfi. The performance was evaluated on the basis of sensory evaluation and texture profile analysis. The best quality of Doda Burfi was found at scraper speed of 100 RPM, 2 kg/cm2 steam pressure, 0.04% citric acid, 1.2% colour, 4% GWF and 16% sugar. Scrapper speed and steam pressure have shown significant effect ($P<0.05$) on sensory scores and textural characteristics.

Combination of SSHE with Conical Process Vat for continuous production of khoa

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INTRODUCTION

- Indian Dairy Industry is growing annually at 4% rate, where the world milk production is growing at rate of 1.1%, this leads India as status of the "largest milk producing nation" in the world.
- About 50% of India's milk production is utilized for making indigenous products like *khoa*, *khoa* based sweets, *channa*, *paneer*, *dahi*, *shrikhand*, *makkhan*, *lassi*, *basundi*, *rabari*, *ghee*, etc. The market for these products far exceeds than western milk products like butter, cheese and milk powders.
- The consumption of traditional dairy products is likely to grow at an annual growth rate of more than 20%, but for western dairy products the growth rates are relatively much lower varying from 5-10 %.
- *Khoa*, an important indigenous milk product, is used as a base material for a variety of sweet meats. Conventionally it is prepared by continuous boiling of milk in an open kettle until desired concentration (normally 65-72% total solids) and texture is achieved.
- It has been estimated about 5.5% of total milk production is converted into *khoa*. (Banerjee 1997) Total market share of indigenous milk products by unorganised sector had Rs.3658 Billion, among them *Khoa* based sweets contributes Rs375 Billion.
- A conical process vat is suitable for production of desired quality of *khoa* in batch manner, but this equipment suffered from several disadvantages owing to lack of information regarding rheological nature of product at different stages of processing.
- Certain problems like foaming can be overcome by using thin film scraped surface heat exchanger (SSHE) due to its unique performance characteristics, and for handling of high viscosity products that tend to foam and foul the heat exchanger surface, the SSHE (Scraped Surface Heat Exchanger) is most suitable (Abhichandani, 1995).
- Hence *khoa* having better control over desirable texture, produced by integration of thin film SSHE and conical process vat through proper engineering interventions. Based on this operating parameters for formation of desired texture of the product would be investigated and optimized.

OBJECTIVES

- To study the feasibility of integrating SSHE with Conical Process Vat for in-line production of *khoa*.
- Performance evaluation of the system in relation to textural attributes

MATERIAL AND METHODS

Buffalo Milk (4-8°c)
↓
Filtration
↓
Standardization (Fat:SNF=1:1.5,Acidity=0.18%LA)
↓
Balance tank
↓
Concentration in SSHE (30-35% TS)
Steam pressure: 3,4,5 kg/cm²
rpm: 50,100,150 rpm
↓
Collection in Concentrate balance Tank
↓
Pumped to Conical Process Vat
Steam Pressure: 2.5,3.0,3.5 kg/cm²
↓
Collection of *Khoa* in SS trays
↓
Cooling to room temperature
↓
Cover *khoa* with Al foil
↓
Sensory & Textural Analysis

The Central Composite Rotatable Design for three independent Variables: Steam Pressure(SSHE), Scraper speed (SSHE), and Steam pressure (conical process vat)

Sl.NO	RUN	A	B	C	Flavour	B & T	C &A	Hardness	Gumminess	Chewiness
17	1	4	100	3	43	33.2	13	24.76	3.937	0.537
10	2	5.6	100	3	40.25	31.25	11.9	27.51	3.913	0.534
20	3	4	100	3	42.5	32.75	14	25.76	3.937	0.537
9	4	2.3	100	3	36.1	29	10.6	21.37	4.328	0.364
13	5	4	100	2.16	39.5	29.5	10.25	24.36	4.094	0.384
1	6	3	50	2.5	32.7	28	9.5	19.63	4.113	0.542
19	7	4	100	3	42.8	31.54	13.8	24.76	3.937	0.537
11	8	4	15.9	3	32.6	20	8.5	7.87	1.896	0.234
5	9	3	50	3.5	39	28.2	10.08	13.3	2.214	0.095
18	10	4	100	3	42	33	11	26.05	3.937	0.537
15	11	4	100	3	43	32.25	14	24.76	3.937	0.537
4	12	5	150	2.5	42.4	30.75	11.25	21.65	2.664	0.518
3	13	3	150	2.5	38.25	29.75	10.75	24.45	3.974	0.426
12	14	4	184.1	3	39	29.25	11.25	17.65	2.223	0.432
16	15	4	100	3	43.33	33.33	14.2	24.76	3.937	0.537
2	16	5	50	2.5	41	30.75	11.25	23.23	3.528	0.518
14	17	4	100	3.84	38.5	28.3	10	23.42	4.006	0.384
7	18	3	150	3.5	38.66	29.33	10.57	20.43	4.113	0.542
6	19	5	150	3.5	36.2	29.5	10.9	20.9	3.921	0.583
8	20	5	50	3.5	40.7	29.2	11.5	22.24	3.716	0.385

Regression coefficients and ANOVA of fitted quadratic model for effect of various parameters on textural attributes

Parameters	Hardness(N)	Gumminess(mm)	Chewiness(mm)
Intercept	25.11	42.71	0.53
A-SSHE Steam pressure(kg/Cm²)	1.72	0.284	0.048
B-Scraper Speed (rpm)	2.09	0.12	0.05
C-Conical Vat Steam pressure(kg/cm²)	0.076	0.034	0.014
AB	-1.87	-0.3	-0.017
AC	1.44	0.4	0.033
BC	0.71	0.39	0.095
A²	-0.026	0.067	-0.018
B²	-4.56	-0.63	-0.076
C²	-0.26	0.073	-0.018
Model F Value	23.7	52.58	4.26
R²	0.9633	0.9755	0.793
Lack of Fit	NS	NS	NS

Range of SSHE Steam Pressure, Scraper speed of SSHE, and Steam pressure of conical process vat (3-factor CCRD)

Factor	Name	Units	Lower actual	High actual	Low coded	High coded
A	Steam pressure (SSHE)	kg/cm²	3	5	-1.0	1.0
B	Scraper speed (SSHE)	Rpm	[illegible]	[illegible]	-1.0	1.0
C	Steam pressure (Conical Vat)	kg/cm²	[illegible]	[illegible]	-1.0	1.0

Goal set for constraints to optimize the operation parameters for continuous production of khoa by integration of SSHE with Conical process vat.

Constraint Name	Range	Lower limit	Upper limit
SSHE Steam Pressure	is in range	3	5
Scraper Speed	is in range	50	150
CPV Steam Pressure	is in range	2.5	3.5
Flavour	maximize	32.6	43.33
B and T	maximize	28	33.33
C and A	maximize	8.5	14.2
Hardness	is in range	7.87	27.51
Gumminess	is in range	1.896	4.328
Chewiness	is in range	0.095	0.583

Predicted and experimental values of the different sensory attributes of optimal whey protein enriched cranberry whey beverage formulation

Parameter	Predicted value	Observed value	t-test value
Hardness(N)	[illegible]	[illegible]	[illegible]
Gumminess	[illegible]	[illegible]	[illegible]
Chewiness	[illegible]	[illegible]	[illegible]

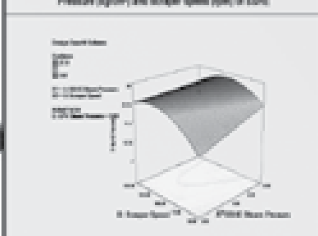
[illegible]

Suggested solutions from the RSM analysis for khoa produced by integrating SSHE with conical process vat.

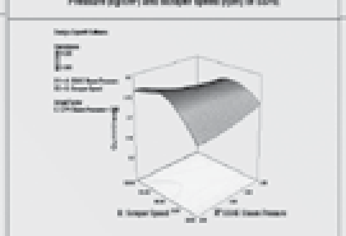
Sr. No.	SSHE Steam Pressure	Scraper Speed	CPV Steam Pressure	Flavour	Body and Texture	Colour and Appearance	Hardness	Gumminess	Chewiness
1	4.40	108.78	2.91	41.300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EXPERIMENT SET UP & OBSERVATIONS

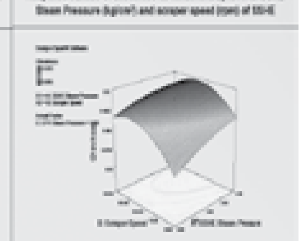
Response surface plot of Hardness as influenced by level of SSHE Steam Pressure (kg/cm²) and scraper speed (rpm) of SSHE



Response surface plot of Gumminess as influenced by level of SSHE Steam Pressure (kg/cm²) and scraper speed (rpm) of SSHE



Response surface of chewiness as influenced by level of SSHE Steam Pressure (kg/cm²) and scraper speed (rpm) of SSHE



SALIENT FINDINGS

- khoa had maximum hardness value when it is manufactured at, SSHE steam pressure of 5.68 Kg/cm²,with scrapper speed 100 rpm and conical vat is having 3 Kg/cm² steam pressure
- The average gumminess scores of complementary food varied from 1.896(mm) to 4.328(mm). The minimum gumminess score obtained for the formulation which had 4 kg/cm² SSHE steam pressure, 15.91 rpm of scraper speed, and 3 kg/cm² steam pressure of conical process vat whereas *khoa* prepared with 2.32 kg/cm² SSHE steam pressure,100 rpm of scraper speed, and 3 kg/cm² steam pressure of conical process vat had a highest gumminess score.
- The average chewiness scores of complementary food varied from 0.095 (mm) to 0.583 (mm).The minimum chewiness score obtained for the formulation which had 3 kg/cm² SSHE steam pressure, 50 rpm of scraper speed, and 3.5 kg/cm² steam pressure of conical process vat whereas *khoa* prepared with 5 kg/cm² SSHE steam pressure, 150 rpm of scraper speed, and 3.5 kg/cm² steam pressure of conical process vat had a highest chewiness score.

CONCLUSION

- The optimized parameters for continuous production of khoa were,
  - SSHE steam pressure of 4.32 Kg/cm²
  - scrapper speed 107.25 rpm
  - conical vat pressure 2.99Kg/cm²
- It was concluded that there is no significant difference between predicted value and observed value, and after applying student's t-test it is significant at p≤0.01and p≤0.05 level of significance.

FEASIBILITY OF MANUFACTURE OF GAJARPAK USING THREE STAGE SSHE

Asari Rashmika Hirabhai and A.K. Dodeja

Indigenous Dairy products are very popular. About 50-55% of Total Indian milk production is converted into traditional milk products. Even today most of the traditional milk products are manufactured by conventional method, which suffers from many limitations. As the growth rate of dairy industry in India is growing, the demand of energy efficient & high sophisticated mechanized system is also growing. Gajarpak is among one of the traditional milk product which is mostly made in north India & also popular in all over India. Feasibility studies & process optimization has also been done for Manufacture of different type of traditional milk products. The three stage SSHE has been designed & fabricated with the state of art technology by incorporating various operating features. It has been proved very successful for continuous manufacture of Khoa, Basundi, Ghee, rabri & Burfi. Therefore it is proposed to study the feasibility of manufacture of Gajarpak in three stage SSHE.

The performance evaluation of three stage SSHE was made for continuous Manufacturing of Gajarpak with fabrication of Screw conveyor. The process & machine parameters were optimized in terms of sensory evaluation & product quality. Trials were conducted by varying Feed rate of shredded carrots, second stage steam pressure & rotor speed. The Steam pressure of second stage SSHE is varied in the range of 2.0-3.0kg/cm2 where as the steam pressure of first & third stage SSHE were kept fixed at 4kg/cm2 & 1kg/cm2 respectively. The rotor Speed of second stage is varied in the range of 150-200rpm & the rotor speed of first & third stage SSHE were kept fixed at 200rpm & 20rpm respectively. The Feeding rate of shredded carrots was kept between 40-60kg/hr. Data indicated that Steam pressure & rotor speed of second stage & feeding rate of shredded carrots have significant effect on flavour, body & texture, Colour & appearance and overall acceptability. The best quality of Gajarpak was prepared by keeping second stage steam pressure & rotor speed at 2.5kg/cm2 & 150rpm respectively, feeding rate of shredded carrots at 50kg/hr. Consumer acceptability of the product indicates that product was graded excellent by half of the consumers. The study indicates that Gajarpak making is possible with three stage SSHE.

STUDY ON ENERGY CONSERVATION DURING KHOA MANUFACTURE IN THREE STAGE SSHE

Dudhe Swapnil Ramdas and A.K. Dodeja

Energy conservation refers to efforts made to reduce energy consumption. Energy conservation can be achieved through increased efficient energy use, in conjunction with decreased energy consumption and/or reduced consumption. Reducing the use of energy reduces costs and may result in financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy efficient technology.

Continuous khoa making machine is developed as three stage thin film scraped surface heat exchange which utilizes around 225 kg/h steam and converts into high temperature condensate which escapes outside the system. Apart from that around 150 kg/h vapours are generated which also escapes into atmosphere and spoils the environment. These condensate and vapors which are having sensible and latent het respectively is utilised as heating medium to preheat the incoming milk and thereby conserve energy .This not only makes the system energy efficient but also keeps the environment neat and clean.

Experiments were conducted to preheat the incoming milk by using condensate in plate heat exchanger and also preheating the milk in jacketed balance tank by utilising the generated vapors .Effects of different operating parameters measured in terms of energy recovered in KJ/h, energy recovered in percentage. Three methods were used to conserve energy i.e. milk preheating at constant volume of balance tank, variable volume in balance tank and generation of hot water. Highest energy which was recovered was in hot water generation quantifying as 112325 KJ/h or 21.1%.

Note

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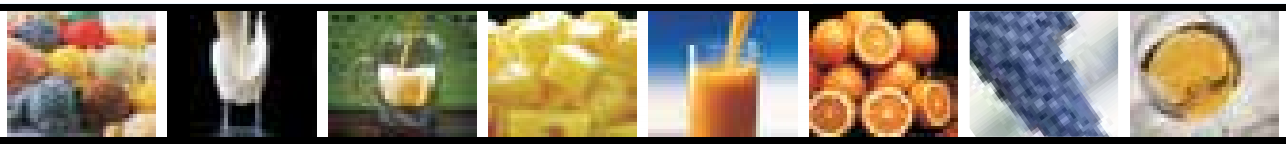

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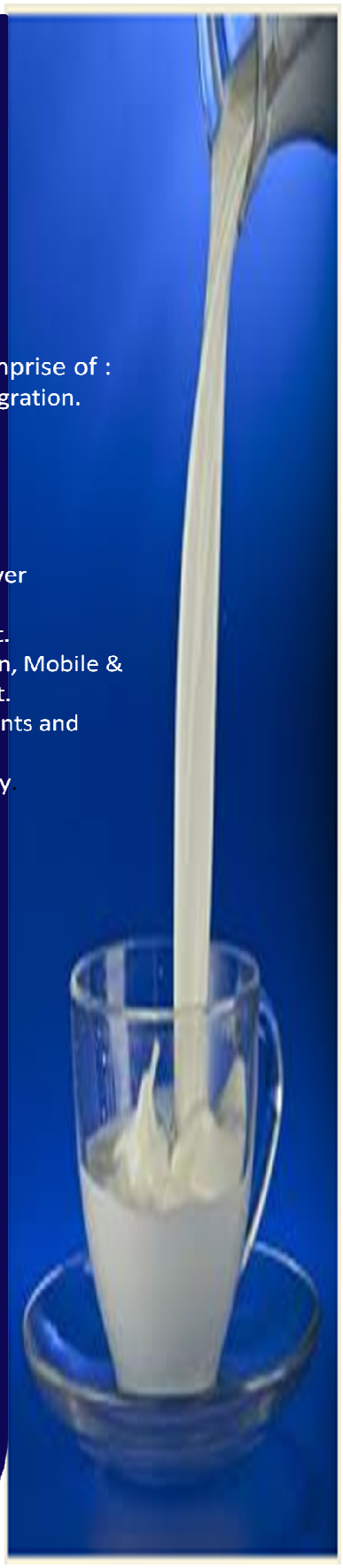

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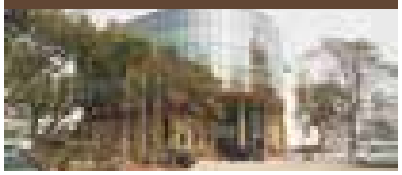
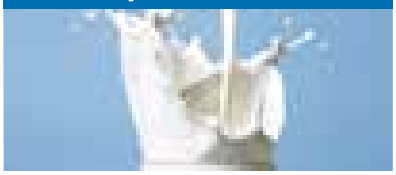


- 'SSP' was founded in 1977.
- The company provides customized turnkey projects & solutions to the industries, pertaining to Food processing sector, Dairy processing sector, Fruit & Vegetable processing sector, Chemical industries and Effluent Treatment Plant for various industries.
- It has client base in 44 countries.
- 'SSP' is an ISO 9001:2008 certified & ASME 'U' stamp holder.
- 'SSP' has FOUR manufacturing units with latest generation fabrication machines.
- 'SSP' has technically sound, highly skilled & experienced work force, numbering to 500+.
- 'SSP' is equipped with state of the art R&D Center which is approved by DSIR, Govt. of India.

Projects for Dairy Industry

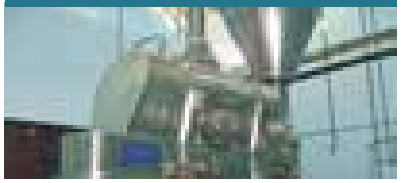
- Milk Powder Plant
- Malted Milk Plant
- Evaporated Milk Plant
- Dairy Whitener Plant
- Liquid Milk Processing Plant
- Baby Food Formulation Plant
- Sweetened Condensed Milk Plant
- Whey, Casein & Lactose Processing Plant

Unique Features of Dairy Based Plants



- Equipment designed and manufactured by 'SSP' complies to international food grade standards (HACCP, FDA, 3A, GMP) and are highly energy efficient, cost effective & operator friendly.
- Equipment designed by 'SSP' handles milk gently thereby minimizing protein denaturation and increasing shelf life.
- SSP provide an integrated CIP system for cleaning the process line thoroughly.

Unique Features of our Powder Plant

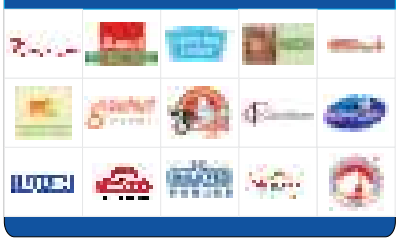


- Highest Steam Economy.
- In 5 effect system with TVR 1 Kg Steam → 8 Kg water evaporation.
- In 7 effect system with TVR 1 Kg Steam → 10 Kg water evaporation.
- Low Power Consumption.
- Maintenance Free Design.
- Lower Δ T ensures gentle heat treatment of the product.
- PLC operator plant available with 100 % automation.
- Production of instant quality powder.
- Flexibility in controlling powder quality.
- Winch driven special cleaning lift.
- Negligible deposition of powder in chamber.
- Stack loss < 0.3%.
- Expandable up to 100 %.

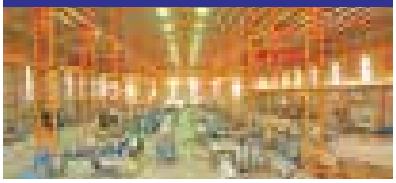
Do You Know?

- 'SSP' has supplied more than 70 powder plants till date.
- Best quality of dairy whitener comes from SSP's installation only.
- Powder from SSP's plants are accepted by **Amul, Nestle, Kraft, Cadbury and Wokhardt Danone** etc.
- 'SSP' is currently executing milk powder plants in India, Turkey, Bolivia and Cuba.

Our Clients...



Why SSP ?



- More than 35 years of experience.
- Supplied projects world over in 44 countries.
- State of the art 4 manufacturing units.
- State of the art R&D Centre.
- 'Proven Technology - Highly Energy Efficient Plants.
- Customized Projects as per client's need.
- On-Time Delivery (Using CCPM Methodology).
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