

Mechanized Production of Traditional Indian Dairy Products: Present Status, Opportunities and Challenges

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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 small scale techniques used at present for the preparation of value added Traditional Indian Dairy Products (TIDP) can not be adopted for industrial production. The current method 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 suffers 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. This has necessitated the need for innovations in designing of equipment for the manufacture of value added dairy products.

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 has developed various innovative indigenous technologies over the centuries, to preserve milk in the form of value added products. 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.

Present Status of Mechanized Manufacture of 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.

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.

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.

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. 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. More (1987) developed an equipment which consists of a stationary jacketed drum having steam inlet, condensate outlet through steam trap and pressure gauge. A prototype khoa making machine of mild steel working on the principle of SSHE has been successfully developed by Christie and Shah (1988). Sunil Patel (1990) has studied heat transfer performance of scraped surface heat exchanger during khoa making.

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. 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. Punjraath *et al.* (1990) have developed an inclined scraped surface heat exchanger for continuous khoa making. Dodeja *et al.* (1990) have described a continuous khoa making equipment operating on the principle of thin film scraped surface heat exchanger. 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.

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. A mechanized method of manufacture of burfi was developed by Palit and Pal (2005). Khojare and Kumar (2003) standardized the parameters for *Burfi* making in Conical Process Vat (CPV) from Khoa. Pre-weight khoa obtained from Thin Film SSHE was loaded in the CPV.

A mechanized semi-continuous system is adopted for the manufacture of gulabjamun from khoa at Sugam Dairy, Baroda (Banerjee, 1997). 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). Jain (2010) manufactured '*Kheer*' using batch type multi purpose SSHE, and studied its heat transfer performance. The Industrial mechanized method of converting khoa into *Kesar Peda* had been developed at National Dairy Development Board (NDDB), Anand.

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). 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. Batch type *Halwasan* making Machine (BHM) is designed at SMC College of Dairy Science, Anand Agricultural University, Anand.

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. 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. Recently, Karunanithy *et al.* (2007a,b & c) also tried to mechanize these unit operations in *rasogolla* making for its continuous production. 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. 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.

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. Many organized dairies are now preparing *dahi* adopting mechanized and standardized method (Singh, 2005). 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. The technology for the manufacture of *misti dahi* in an organized manner was developed by Ghosh and Rajorhia (1990). 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. Kumar (2000) developed *lassi* for calorie-conscious and diabetic people using an artificial sweeteners. Recently, Khurana (2006) developed suitable technologies for the manufacture of mango, banana and pineapple *lassi* along with their low-calorie counterparts using artificial sweeteners. A fully mechanized/continuous process has also been developed for industrial production of *Shrikhand* (Aneja and Vyas, 1983). 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*.

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

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

(A) Continuous 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 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 making 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 develop with mechanization would benefit both the milk producer and consumers and will promote entrepreneurial development by fetching the higher price of value added products.

Commercialization of Machines Developed

AAU BPD Unit is commercializing equipments 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.

Opportunities

India's traditional dairy sector is poised to have rapid expansion hopefully with the innovations in technology, equipments for mechanized production, packaging and storage. The major strength of the TIDP is the mass appeal enjoyed by such a wide



variety of products. The operating margins are also much higher, mainly due to lower raw material cost. They can do wonders for organized sector to have better financial stability and steady growth

Challenges

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. Development of new equipments for a variety of traditional milk products is a time consuming exercise involving huge expenditure and scaling up is also cumbersome exercise. Further, commercial equipment manufacturers in India are reluctant to invest in new equipment development.

Another major area to be strengthened is packaging of TIDP. The appropriate and environmental friendly packaging materials are to be identified with complete packaging systems. The training of skilled operators in this sector in hygienic handling, proper packaging, quality control, and storage is required. Characterization and standardization of TIDP is another challenge to have consistent quality of mechanized production of indigenous products. Lack of legal standards and quality assurance system for TIDP is one of the major challenge. New variants of TIDP can be developed with health promoting ingredients, such as dietary fibres, cholesterol reducing phytosterols, minerals and vitamins, berries and cherries with its anthocyanins that prevents cancer etc. Innovations in marketing of TIDP is also required. It is possible to popularize indigenous dairy products through the fast food chains or franchising of some of popular brands. Collecting the market intelligence to inspire confidence among prospective entrepreneurs to take commercial production of traditional dairy products in India and abroad is also necessary.

Conclusion

Traditional Indian Dairy Products has mass appeal with high profit margins and high export potential. There is urgent need to modernize this sector with innovations, mechanizations and automations to have large scale commercial production of high quality products with long shelf life. We need

to develop energy efficient new equipment for manufacture of various TIDP. The possibilities of utilizing alternative sources of energy in manufacture of TIDP should be exploited, wherever possible. Great scope also exist for improving the shelf life of TIDP by employing newer preservation techniques. Industry and R & D organizations links need to be strengthened. Collaborative efforts of industry, unorganized sector, equipment manufacturer and R & D institutions are required for all round development of this sector.

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