

Scope of Technological Intervention in the Sector of Traditional Indian Milk Products Industry for Sustainable Rural Development

Shakeel Asgar* & Manorama Chauhan

Department of Dairy Technology, College of Dairy Science & Food Technology, Raipur 492 012, Chhattisgarh, India

Received 20 May 2021; revised 11 February 2023; accepted 22 February 2023

The entrepreneurial activities related to the vast sector of traditional Indian milk products and milk sweets effectuate the holistic development module fulfilling the concept of economic viability, technological feasibility, social obligation, cultural necessity and above all ecological balance. Despite robust growth and plenteous milk production, this informal sector of dairy products and sweetmeats is facing unprecedented challenges on multiple fronts. The major identified problems include non-availability of the packaging system, lack of proper handling and processing of raw material and finished products, inconsistent product quality, shortage of modern equipment, and inadequate arrangement of effluent handling. Milk and traditional Indian milk products are extremely perishable. With the ever-increasing cost of production, this sector being vast and unorganized has become increasingly vulnerable and can have far-reaching prejudicial consequences if protective technological measures are not employed at grassroots level. The pressure driven membrane processing system can bring a sea change to this industry from higher yields to a reduction in the cost of handling, storage and transportation. Modified Atmosphere Packaging (MAP), solar energy and business digitization are ready to open new vistas. The urgent necessity indicates concentrated efforts to pool, evaluate, preserve and motivate traditional practices, knowledge and wisdom coupled with selective uses of modern technological advancement in order to bring paradigm shift and inclusive growth.

Keywords: Inclusive growth, Membrane system, Milk sweets, Packaging, Traditional milk products

Introduction

Over the years, the livestock sector has been playing an important role to strengthen the economy and has unremittingly served as the bulwark for the welfare of agrarian society by providing resilience to ward off frequent socio-economic shocks and disparities. The livestock sector makes the agricultural system sustainable. The over dependence on monsoon and lack of irrigation facilities often result in crop failure and low agricultural productivity facing farmers to distress. Agriculture needs diversification. Dairying is one of the best options for diversification of agriculture as it is not a seasonal occupation, like agriculture. India has a long tradition of keeping animals as an integral aspect of agriculture dependent society. According to the recently conducted nationwide 20th livestock census (2019), India has again remained the world leader as far as the resources of livestock are to be considered. The phenomenal contribution of dairying is more inclusive as its share remains about 27% of the agricultural gross domestic product. The structural transformation

of dairying related to milk production and processing is more attributed to small and marginal land owning farm households. Small and uneconomic land holding may be considered as one of the major stumbling blocks on the way of agricultural growth and development, but the notable contribution of small and marginal farmers has positioned India as the largest milk producing country on the map of the world.^{1,2} With 209.96 million tons annually (2021), India is contributing around 60% of total milk output in Asia and nearly 20% of total milk production of the world. For the last five years India's milk production has maintained a sustainable growth rate above 6% annually in contrast to the global growth rate of 1.7%.³ This boom in milk production has come to stay in subsequent coming years also as India will produce 300 million tons of milk by 2033.⁽⁴⁾

Notwithstanding an accelerated pace of urbanization, 98% of milk production in India is still taking place in rural areas which considerably indicate the deployment of a significant workforce in this sector. The involvement of masses is an exhibit to the role of this business activity in promoting contribution to inclusive progress as well as generation of income, particularly in rural, backward, hilly and semi-urban

* Author for Correspondence
E-mail: shakeelasgar@rediffmail.com

areas where true infrastructure development still awaits.⁵ Cooperative and private dairies still procure only 20% of milk produced while 34% is sold in the unorganized sector and the remaining 46% is retained for household consumption.⁶ The milk utilization pattern further reveals that around 46% of the milk is consumed in the form of liquid milk, 47% as traditional Indian dairy products and 7% in manufacturing of western dairy products.⁷ Besides the unmatched mass appeal another significant reason for the popularity of indigenous milk products and milk-based sweets is huge profit margin far exceeds that of milk powder, butter, cheese, dairy whiteners, ice-cream and other western dairy products. The business prospect based on traditional Indian milk products and milk-based sweets brings the remarkable scope of the value addition up to 200% as compared to only 50% in the case of western milk products.⁸ However, activities linked with conversion of surplus milk into various value-added milk products are more about generation of effective means of livelihoods for millions of small farmers, milk producers, vendors and sweetmeat makers at their native place in a familiar environment than simply a business.

In spite of humongous amount of milk utilization, immense opportunity for value addition and good prospect, this sector of indigenous milk products and milk-based sweetmeats has been subjected to certain constraints also. The most notable barriers are poor shelf life, menace of adulteration, lack of specific packaging system, irregular demand, the fluctuation in sale price, allegation of adoption of unsanitary and unhygienic practices, inadequate infrastructure and equipments restrict processing operations to the level of batch method and lack of skilled manpower for manufacturing. In an Indian scenario where population is ever-growing and where poverty, unemployment and hunger stalk at every step there is no better solution than keeping alive this 'well tried' weapon-development and strengthening of sustainable business activities of traditional Indian milk products and milk-based sweets. In order to make the dairy value chain stronger, it is necessary to adopt emerging technologies for better handling and processing of milk and milk products.

Exquisite Heritage Products

India is a land of celebration. Several ceremonial occasions appear in day to day life of people through magnificent feasts, fairs, festivals, rituals and custom gathering. In this prodigious rich diversity and

linguistic variability traditional Indian milk products and milk sweets occupy a place of pride. Occasions and sweets are two inseparable part of tradition. Not only in India but all over this vast subcontinent of South Asia, people make, share and sale varieties of indigenous milk products and milk sweetmeats on different social events and personal achievements.^{9,10} A sumptuous Indian meal always remains incomplete without milk-based items and sweets. Offering milk based sweets to visiting guests is a highly revered custom. Even offering of milk and milk products to different god and goddess is considered significant purely and pertinent. Lord *Krishn* is linked with *makkhan* so as lord *Ganesh* with *modak* and *laddoo*. The *peda* is one of the most popular sweet, always distributed as *prasad* after worship of lord *Hanuman*. In central eastern part of India *tilkodombo* is commonly offered as *prasad* during *Sarswati puja*. The role of *ghee* in performing *hawan* or *yagya* can never be undermined.¹¹ The auspicious *diyas* are preferably brightened in *ghee* for extreme providential favor. Indian sweets are very commonly used for *bhog*, *abhishek* and *naivedyam*. *Panchamrit* or *charamrit* is regarded as one of the most important *prasad* in *Hindu* worship. The constituents of milk, curd, ghee along with sugar and honey make it to be healthy drink.¹² The festival of lights *Dipawali* is synonymous with sweets. *Shor bhaja* is prepared mainly in festivity of *Durga puja* in Bengal. In the vast land of western India *shrikhand* is a must served delicacy on the occasion of *Gudi padwa*. There is an age old tradition of exchanging sweets or *mithai* at the time of festivals and for commencement of new social relations. The demand of indigenous milk products and milk sweets increases manifold at the time of *Holi*, *Eid* and *Rakshabandhan* also. These valuable food delicacies are having unlimited popularity and strongly connected to economic, social, cultural, religious life and health of people.¹³

India's regional and cultural symbolism perfectly reflects in different types of traditional milk products and milk sweetmeats. Every state and region in India has something unique to offer. The popularity of *shrikhand* has been remained in the western part of the country whereas the eastern region is known for the likeness of *chhana* and *chhana* based sweets. It is a very popular phrase that you can keep sweets away from a *Bengali*, but you cannot keep a *Bengali* away from sweets. About 65% of total milk production presently taking place in Bengal is used for making sweets. In the emergent condition of lockdown due to

Corona virus pandemic, it were the sweet shops that remained open every day for a notified time hours in Bengal. The north India is a home for numerous *khoa* based sweets whereas the popularity of *payasam* and its variants are very much persist in nearly all states of south India. Sweets enjoy a legendry reputation across India. At Lakhimpur district in Uttar Pradesh, the national highway 24 stretch is known as “*gulabjamun* highway” due to more than a hundred shops selling mouth watering fluffy *gulabjamun* along the side of road. The similar kind of popularity has been gained by Mohamadabad area in Farrukhabad district of Uttar Pradesh. The regional variant of the *gulabjamun* in Tamil Nadu is *kumbakonam*. These *jamuns* have a typical dust of sugar on surface with more crisp in crust. *Mathura peda* is one of the most famous milk product delicacies. Obviously the place of origin is Mathura district in Uttar Pradesh.¹⁴ In Karnataka the place, Dharwad and Kunthalgiri are also very famous for unique *peda* variants. *Lal peda* is another class of heat desiccated traditional milk delicacy having its origin in Banaras but hugely popular in all over the eastern India.^{15, 16} The unforgettable melt-in-your-mouth texture is an unprecedented characteristic of *malaiyo*, a foaming and fizzing sweet of Banaras. Another very special indigenous milk product is *rabri*. It is obtained from milk by direct heating in a shallow pan. The *rabri* is characterized with a viscous body along with distinct presence of layers of clotted cream imparting a chewy texture unparallel to any other milk products. The concept of the clotted cream is though more linked to denatured whey protein than mere fat content of milk. During manufacturing of *rabri*, formed thin layers on milk surface are placed on the edge of pan one over the other. The clotted cream or *malai* has a matchless feature of smaller unsweetened thickened mass of milk solids which delightfully melt in mouth. In the process of milk concentration removal of moisture also takes place from piled layers of denatured milk whey protein and fat, giving slight stiff, rich and dried mouthful which overall generate chewy texture of product.^{17,18}

Ghee is produced mainly by indigenous method in Asia, the Middle-East and Africa. Nearly 30% of milk produced in India is utilized for the preparation of *ghee*.^{9,19} No other food item on this earth has such a superior aroma matching to well prepared *desi ghee*. Although *ghee* is popular all over India, but the variation in regional preference of *ghee* on the basis of sensory characteristics represent a true picture of unity in diversity.²⁰ On the basis of place of origin, regional specificity and sensory attributes of sweets, Geographical Indicator (GI) tag is awarded to

different states of country. Bengal was granted GI tag for *Banglar Rasogulla* while Odisha got the GI tag for its version of *rasgulla* i.e. *Odisha Rasogola*.

The traditional Indian dairy products business majorly covers heat and acid coagulated milk products, heat desiccated milk delicacy, fermented products, fat rich milk products, frozen dairy products, cereal based milk desserts and a large number of sweets obtained from these products.²¹ Some luscious milk products like *sarpuriya* and *chhana podo* are obtained by meticulously utilizing baking operation.²² A series of traditional milk delicacies are obtained from judicious utilization of different types of vegetables, fruits and legumes.^{23,24} Numerous culinary items are prepared by using indigenous milk products and milk sweets as a necessary ingredient and these are also used for garnishing and decoration. Fat concentrated traditional milk products and milk sweets are found to be used as one of the best mediums for frying.¹⁹ Enough literatures are widely available signifying the therapeutic advantages of these valuable products.²⁵ Indigenous milk products and sweetmeats have long been remained part and parcel of daily life of people from all over the area of South Asia due to their nutritional, therapeutic, palatability, accessibility and convenience.²⁶

A Disconnected Paradigm

Products are identified with its package. A package contains, preserves and communicates what it sells and sell what it packaged. Packaging is necessary for enhancing the value and life span of the product. In spite of huge potential there is clear evidence that the sector of traditional dairy products and milk sweets have remained completely untouched with packaging technology intervention (Fig. 1). Product specific packaging is a miss for most commercially viable traditional milk products and milk sweetmeats. Existing scenario of packaging of some sugar dipped products having feasibility of canning, availabilities of some dried version of indigenous dairy products and mixes in flexible laminates, smaller paper cardboard handling of sweets prepared either from dry fruits or fried in *ghee* and vegetable oils are some exemplary minuscule representation of vast packaging sphere which still awaits increased participation in the peripheral horizon of traditional Indian milk products and milk sweets.^{27,28} Changing lifestyle, growing health awareness, convenience of carrying and opportunity of advertisement are certainly major

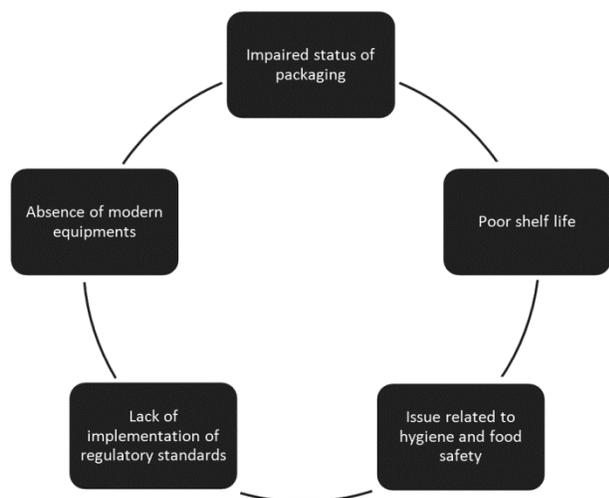


Fig. 1 — Unprecedented challenges of the sector of Indigenous Milk Products

factors which can improve the growth of packaging for this informal sector of traditional Indian milk products and milk sweets.²⁹ The overall bleak situation of packaging as far as the indigenous milk products and milk sweetmeat are to be concerned makes this sector highly vulnerable and non-commercial. Whatever packaging measures are there most of them are techno economic infeasible. Even the standard norms to sale low fat *chhana* only permissible in hermetically sealed package with a maximum limit of 15% fat content on dry matter basis is not so rational as packaging materials, storage period and storage temperature have varied influence on product quality.³⁰ In an industrial segment there is always a need for providing guidance note for recommendation of packaging materials as per the characteristics of specific product, if product is to be commercialized effectively.³¹ In this subcontinent traditional milk products and milk sweets are usually displayed on trays and sold in loose. The evolution of packaging system requires a comprehensive understanding of the heterogeneities in the physical, chemical, sensory and rheological characteristics of these Indian milk products and milk sweets. Clearly, the transition from a situation of nothing to all things as far as packaging of indigenous milk products and milk sweets are to be considered is a complex and long term process, one that cannot be achieved overnight. While there is growing consensus around the need of packaging system for these ready to eat food products, but there is little agreement on how this is to be conceptualized as there is no specific product wise identified available packaging system.

Whatever packaging solutions are there, these are not providing protection and consequently products soon lose their typical sensory appeal. On the other hand sweet makers or *halwais* are mainly using traditional packaging techniques such manual packaging, pouch packaging and heat seal packaging. These types of package handling do not control the environmental and microbial effects, resulting in decrease in shelf life of the food items. In existing packaging techniques of indigenous milk products and sweets minimal technology is used, and no procedures are used to enhance the shelf life of the food items through packaging. Due to this the storage and long distance transportation of these food delicacies in its natural state is very difficult.

Imposition of regulations and standards concerning to pollution control was never so necessary than it is today. Effluent treatment of indigenous milk products and milk sweetmeats can no longer be ignored. Discharging untreated effluent as such is an offence under the laws of existing pollution control. Due to the highly diversified nature of this industry, a wide variety of value added products are prepared which generate wastes of different quality and quantity. The dairy effluents from traditional Indian milk products and various milk sweets have high organic contents, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS). For the dairy industry in typical Indian conditions COD range generally remains from 800 to 5000 mg/l.³² The running cost of effluent treatment system is also very high. Being the nature of cottage and small scale industry many manufacturing units cannot afford its own to commission a waste treatment plant due to –

- High land cost
- Inadequate quantity of discharge
- Absence of standard for specific effluent and treated waste
- High cost of equipments and measuring instruments
- Non availability of energy efficient equipments
- Shortage of knowledgeable staff
- Lack of facility for pretreatment of effluent

The scarcity of sewage treatment plants in the vicinity of traditional Indian milk products and milk sweets manufacturing units aggravates the problem of non handling of effluent. The big gap between the amount of waste generated and treated will keep on

increasing due to the complete absence of such facilities particularly in remote, hilly and rural areas. The entrepreneurial activity under indigenous milk product and milk sweet sector is constantly facing dilemma of non viability, due to astringent pollution control regulation effluent cannot be discharged untreated, on the other hand there is virtually no infrastructural facility for adequate effluent treatment.

The Way Forward

The sector of traditional Indian milk products and milk sweets is truly based on the concept of self-reliance. The typical feature is use of local resources and local workforce for the production of commodities for local and regional consumption with minimal dependence on the outside world. On the way of turning milk pocket area into manufacturing hub, strengthening of ongoing entrepreneurial activity is very pertinent along with the creation of favorable environment for better survival of upcoming ventures. The characteristic of milk production in India is popularly defined as the production of masses not by mass production. Milk procurement model of private dairies and cooperative plants leave some milk production area unattended due to scattered nature of milk production and small quantity of milk produced in that belt particularly in remote, hilly and forest zone. The cost of milk production, handling and marketing are quite high in India. One of the most successful states of India as far as milk business is concerned is Gujrat. Even in Gujrat, cooperative dairies are selling processed milk to consumers at the rate of just double what procurement price milk producers or farmers are receiving.³³ The problems associated with milk collection and its economic handling further increases at the time of flush season when there is abundant availability of milk and milk collection infrastructure is remained to be quite bleak. Milk if not handled properly vitiates fast. Long chains of milk handling especially before its processing amid adverse tropical conditions always result in a very high microbial load. Emphasis should be put on the establishment of new units in the milk production catchment to reduce cost transportation. Manufacturing traditional milk products and milk based sweet items serve millions of milk producers, small dairies, *halwais* and tones of milk that may go to waste. Conversion of milk to value added indigenous milk products and sweets is one of the simplest way of milk solids conservation as well as income generation.³⁴ As milk is supplied from

producers to village cooperative society for its further transportation and processing, similarly semi-solid indigenous milk products like *khoa*, *chhana* and *chakka* can be prepared at a village and block levels for its supply to dairy plant also. Formation indigenous milk products producer's organization and self-help group like structure in potential milk shed area will certainly go to provide ways for better milk utilization if privates and cooperative dairies are not yielding better economic outcome. The rising trend of healthy eating, growing acceptability of organic products, aspiration for natural products and overall preference for fresh nutrition have notably increased the consumer demand for chemical free, preservative free and synthetic additive free food products. The sector of indigenous milk products and milk sweets can easily fulfill these emerging requirements of consumers as these delicacies are prepared with natural raw material without any chemical additives. Even the coagulating agent used for making of *chhana* and *paneer* is usually the drained whey recovered from the previous operations.

Infallible Packaging Solutions

Appropriate packaging of multifarious milk sweets and indigenous milk products is without any doubt is one of the most important concerns of this informal sector. Traditional milk products and milk sweets of Indian sub-continent have a limited shelf life as many deteriorating changes take place during handling and storage.³⁵ The technique of Modified Atmosphere Packaging (MAP) is going to be seen as one of the best solution for storage of traditional milk products and milk sweets as it gives preservation without any chemical additives. The better stability of *rabri* was observed when samples were packed in 100% N₂ than air and 50% CO₂: 50% N₂ combinations, whereas the MAP of *kalakand* at the ratio of 50% CO₂: 50% N₂ at 10°C was found as the most suitable preservation up to 60 days.^{21,36} The most popular heat desiccated milk products *khoa* was also observed nearly 50% reduction in deterioration prone changes during storage at 27 ± 2°C and 65% RH when packed with modified atmosphere technology than ordinary packaging.³⁷ Presence of oxygen in packet has been proved as one of the most important reason for deterioration of indigenous milk products and milk sweets. Vacuum packaging is having potential to arrest the oxidative spoilage and microbial growth by eliminating oxygen.³⁸ Vacuum packaging system although a good mechanism to retard microbial

growth was also found to affect sensory characteristics adversely mainly texture of milk sweets.³⁹ The comparison of better performance between MAP and vacuum packaging (VP) indicated that samples of *paneer* when subjected to MAP condition resulted in less deterioration during storage at $7 \pm 1^\circ\text{C}$ than VP.⁴⁰ Modified atmosphere packaging when coupled with the concept of hurdle technology (HT) had found to extend the shelf life from 1 to 2 days at $30 \pm 1^\circ\text{C}$ and 6 to 20 days at $7 \pm 1^\circ\text{C}$.⁴¹ Besides types of packaging system facilitated to indigenous milk products and milk sweetmeats, their shelf life get affected by the presence of moisture, availability of major constituents, transformation of constituents undergone during processing, types of packaging materials and conditions of post-processing operation. With the changing times the most commonly used packaging materials, papers and plastics have a major snag due to economic and environmental concern. The entire industry of indigenous milk products and milk sweets is seeing possibilities of natural packaging materials. The rich biodiversity of this region of South Asia is ready to provide natural vegetative sources for effective handling and packaging solutions. Banana leaves and bamboo have been traditionally proven materials in this regard.⁴² Various successful efforts were made for enhancement of shelf life of traditional Indian milk products and milk sweets with natural preservatives also.^{43,44} The benefits of developed technology are yet to be explored at grass root level by stakeholders of the industry.

Approach to Integrated Membrane System

Membrane technology has revolutionized the water industry. The milk is also a liquid for membrane filtration. The utilization of membranes in the sector of traditional Indian dairy products and milk sweets can be a suitable and economic alternative to various time taking and energy consuming batch methods. Membrane filtration process like reverse osmosis, ultrafiltration, microfiltration, nanofiltration, difiltration and hyperfiltration may have multifarious application as below-

- The enormous challenge of effective effluent treatment faced by this sector can be effectively handled without involving higher cost and energy.
- Production of *shrikhand*, *paneer*, *chhana*, *makhan*, *ghee* and other popular traditional milk products generate huge amount of valuable by

products. With the help of specific membrane operation, these by products can be effectively utilized in the form of value added, commercial items.

- The matchless benefits of membrane processing can procreate better yield for a series of conventional milk products and milk sweetmeats without consuming much energy.
- Being located in remote, hilly, forest and non-industrial area mainly, the sector of indigenous milk products faces a lot of problems concerning the availability of clean and safe water for cleaning, sanitization and product manufacturing operations. The technique of membrane filtration can solve all water related issues of this informal sector up to a greater extent.
- As pressure driven membrane system involves the separation of bio molecules and insoluble compounds on the basis of pore sizes, therefore it can be helpful in recovery of total solid materials by avoiding losses during manufacture of various indigenous milk products and sweetmeats based on it.
- Membrane filtration process is widely applied for bulk reduction. In this way it can be helpful in better handling and minimization of storage space.

Microfiltration is a specific membrane process that can be effectively employed in reduction of initial microbial load in milk, whey and other fluid material. The process of ultrafiltration found helpful to increase the yield of *paneer* by 25% along with 95% total solids recovery.⁴⁵ The sensory characteristics of various samples of *paneer* obtained with the help of membrane processing were quit comparable.⁴⁶ Attempt was also made to improve system of *chhana* production with the help of ultrafiltration.⁴⁷ The reported research investigation had indicated that there is good opportunity in making of *khoa* and other dairy products with the help of membrane processing.¹⁴ Membrane processing can also be successfully utilized for preparation of *shrikhand* where water content of milk is going to be reduced along with simultaneous reduction in lactose.⁴⁸ In this way integrated membrane processing can be efficiently utilized in making of three major Indian dairy products i.e. *chhana*, *khoa* and *chakka* which are utilized as base material in preparation of varieties of sweets. Utilization of whey, buttermilk and all other by products of this informal sector can be utilized in

form of different types of whey beverages, energy drinks and fermented beverages which will generate good revenue in existing market of dense population.^{49,50} Fixation of processing parameters during manufacturing of different types of value added conventional milk products like standardization of milk, adjustment of mineral content, reduction in lactose content etc. can be achieved efficaciously.⁵¹

Business Digitization

Now-a-days information technology is very much crucial to build and grow the commerce and business sector. Accessibility of necessary information is a catalyst for empowerment of business. Information technology is very powerful and considered as the backbone of the economy.⁵² The sector of traditional milk products cannot be remained isolated from the multidimensional benefits of growing information technology and digitization. India, as many of its South Asian neighbouring countries will has more rural internet users than urban. The information and communication technologies can be very much helpful to all stakeholders of the sector for keeping the record of financial status, standardization of product mix, making decision of supply chain and distribution channel, inventory management, up-to-date knowledge of prevailing price of ingredients, selling price of commodities and maintenance of plant utensils.⁵³ The necessary information associated with business of conventional milk products and milk sweets like text message, video call, photograph etc. can be transferred to any location in remote and rural area effectively.

With the help of vibrant communication technologies, business operators can improve networking for the success of the business to manifold. The business of traditional Indian milk products is highly unorganized and dominated mainly by local and regional operators. Most stakeholders are traditional retailers who do cash transaction and have no standard pricing policy. Digital payment may be cost saving and also assure better transparency, security and accessibility of tracking. The main advantage of digital payment is the simplicity and ease of completing the business transactions. The database of different rural milk shed area can be designed for better availability of raw milk at low cost. All relevant information may be made available to the hub of milk products manufacturing units which again time to time be expanded by including a wide variety of information for the use as per the

necessity of the local situation. With all necessary information and feedback it is necessary to keep operators aware about the changing market scenario so that they always remain well geared up to produce as per market demands only.¹

Exploring the Scope of Mechanization

In the present scenario manufacturing of conventional milk products and milk sweets uses little or no machinery. Existing continuous processing substitutes for batch operations radically alter the physicochemical and sensory properties of indigenous milk products and milk based sweets. As per the requirement of typical features of these milk delicacies, there is tremendous scope of suitable up scaling and continuous process intervention in this informal sector.²⁶ The available in line operation of mass production which is quite a few though enhances capacity and speed tremendously but noted to have the following drawbacks-

- The closed shell or chamber of continuous process is not able to provide enough means of atmospheric evaporation of water from milk during the process of heating and concentration.
- In continuous operation the longer period of heat at simmering temperature is not effectively carried out.
- Holding of milk at a high temperature is needed to develop better network of coagulum especially in making of fermented milk and milk products. In continuous methods of manufacturing holding of heated milk for further processing is usually difficult for effective process synchronization.
- In making of traditional Indian milk products and milk sweets moderate level of stirring and scrapping are needed at different stages of processing for better interaction between milk constituents to constituents and constituents to elements of ingredients which are not feasible in continuous method of operation.
- The design of equipments generally used in continuous method of product manufacturing does not allow post-processing and slow cooling effectively.
- For unique sensory quality of products, the batch method is widely preferred in the making of traditional Indian milk products and numerous sweets.
- Business operators usually complain about the continuous processing which requires high initial

investment and the demand of a higher working capital.

These are the reasons why the sector of traditional Indian milk products has been thrived upon batch method of operation successfully without any threat of automation and mechanization. Even private milk plants and cooperative dairies engaged in business of indigenous milk products and milk sweets rely upon batch or traditional method of processing. Convenience in manufacturing operation, product consistency, cost minimization, increased yield and feasibility of continuous processing are possible in the field of traditional Indian milk products where the optimum mechanization takes place. In order to enhance efficiency of products making in the sector of conventional milk products and milk sweetmeats, a series of modern equipments and accessories must be integrated with manufacturing activity (Table 1).

With modern advancement, prototype instant boiler for generation of steam and walk-in-cooler for maintenance of effective cold chain are available on subsidized rate for the benefits of operators.

Solar Energy as Priceless Resource

As there is power crunch in many regions of South Asia, similarly India is facing enormous challenges to maintain the balance between the power generation and demand. In order to fulfill the ever-increasing demand of power, moving from conventional sources to non-conventional sources is the only solution. Due to abundant availability of sunlight in India, using solar energy can be one of the most significant ways

to achieve energy reliability with due consideration of ecological balance and economic profitability.⁵⁴ Availability of regular supply of electricity particularly in remote, hilly, forest and in the area of low density population is difficult due to poor development of infrastructure facilities and extreme adverse socio-geographical conditions. Under such circumstances effective use of solar system for generation of adequate power will certainly transform the villages of India in the self-reliant industrial hub of indigenous milk products and milk sweetmeats. These valuable conventional milk products have tremendous demand in market, but demand is not fully exploited due to lack of cold chain and storage. Milk products are highly perishable in nature therefore cold chains have to be established. Either community based or in individual ownership low-cost solar system based cold storage facility will be certainly a boon to operators. At the time of festivals and wedding seasons the demand of indigenous milk products and milk sweets increases up to a considerable extent. *Hariyali khoa* is widely prepared in winter season and stored for use at the time of *Basant* or in summer. Beside *khoa*, *chakka*, *shrikhand wadi* and many other products can be preserved effectively in solar system based cold storage. *Batti khoa* is mainly used as the base material for manufacturing of different *khoa* based sweets. This variety of *khoa* can also be stored safely in cold storage due to low content of moisture in it.¹⁶

In the industrial unit of traditional Indian milk products and milk sweets there is need for consistent availability of power for generation of adequate utilities (water, steam, cold water, soft water etc.) and electricity supply for running of motor, equipments, fan, light, air purifier, fly repellent, cooler and other essential items. The low cost of solar system based cold storage and electricity will make the sector of indigenous milk products and sweetmeats more viable and affordable for many stakeholders.⁵⁵

Conclusions

The traditional Indian milk products industry provides livelihood opportunities for a large section of the population. In order to bring sustainability in this sector, it is important to ensure that milk producers, suppliers, processors and product distributors must get better return of inputs. The sector of traditional Indian milk products and milk sweets currently aspire to technological intervention in order to increase efficiency and productivity. The optimum technology

Table 1 — Ancillary machines and handling tools for the industry of traditional Indian milk products and milk sweets

Name of equipments	Application/ products
Conveyor system	Transport ingredients, products, utensils etc.
Precision cutter	<i>Burfi, kalakand, milk cake, milk roll, chhana podo</i> etc.
Ball portioning machine	<i>Laddoo, gulabjamun, langcha, moa</i> etc.
Ball forming machine	<i>Gulabjamun, modak, rasgulla, pantua, rajbhog, peda</i> etc.
Oven	Roasting, mild heating and baking
Basket centrifuge	<i>Shrikhand, chhana, paneer</i> etc.
Pulverizer/multi mill	Mixing, crushing etc.
Moulder	<i>Peda, sandesh, kachagulla, laddoo milk cake</i> etc.
Frying unit with temperature indicator	<i>Gulabjamun, pantua, khoa jalebi</i> etc.
Dough maker / kneader	<i>Shrikhand, sandesh, rasgulla</i> etc.
<i>Rasgulla</i> kettle with temperature indicator	<i>Rasgulla, rasmalai, cham cham</i> etc.

and its proper application at different stages of milk procurement, handling, processing, storage and marketing are needed to rejuvenate this unorganized sector. The multi-pronged approach of scientific technological intervention would go a long way in ensuring better income and capacity building.

Acknowledgement

The authors are grateful to the College of Dairy Science and Food Technology, Chhattisgarh Kamdhenu Vishwavidyalaya, Durg (CG), India.

References

- Kumar A, Mishra A K, Parappurathu S & Jha G K, Farmers' choice of milk-marketing channels in India, *Eco Pol Weekly*, **53** (2018) 58–67.
- Singh R S, Thakar K P, Soumya C & Datta K K, Future of smallholders in the dairy sector: A macro study of Gujarat, *Indian J Dairy Sci*, **72** (2019) 534–541, <https://doi.org/10.33785/IJDS.2019.v72i05.011>
- NDDB (2019), www.nddb.coop/information/stats
- Niti Aayog (2018) www.niti.gov.in/sites/default/files/WG-Report-for-printing
- Kumar A, Kumar R & Rao K H, Enabling efficient supply chain in dairying using GIS: A case of private dairy industry in andhra pradesh state, *Ind J Agri Econ*, **67** (2012) 395–404.
- Deshmukh M S, Growth and performance of dairy sector in India, *Voice Res*, **3** (2014) 39–44.
- Mishra S, Kunwar N & Prakash V, Effect of dairy enterprise on women's and Indian economy and demand of mode of utilization of milk and milk product at household level, *Int J Home Sci*, **3** (2017) 231–233.
- Arora S, Patel S S, Gurditta H, Yadav U & Mahajan S, Estimation of production cost for hard-variant of chhanamurki (Indian cottage cheese based dessert), *Haryana Vet*, **58** (2019) 174–180.
- Kumar M, Pandya H B, Dodiya K K, Batt R & Mangukiya M, Advancement in industrial method of ghee making process at Sarvottam dairy, Bhavnagar, Gujrat (India), *Int J Sci Envi Technol*, **6** (2017) 1727–1736.
- Alam M M, Huq A K O, Jahan I & Ahmed E, Calorie density and nutrient content of commonly consumed sweetmeats of Jashore district in Bangladesh, *EPRA Int J Mult Res*, **6** (2020) 174–179, <https://doi.org/10.36713/epra4035>
- Bansal P, Kaur R, Gupta V, Kumar S & Kaur R, Is there any scientific basis of *Hawan* to be used in Epilepsy-Prevention/Cure?, *J Epilepsy Res*, **5** (2015) 33–45, <https://doi.org/10.14581/jer.15009>
- Sen D J, *Panchamrita*: The five nectors of god, *WJPLS*, **4** (2018) 73–75.
- Kumar A, Patil G R, Singh R R B, Gupta H R, Swarnita K & Shahi N C, A comparative study on the quality of laboratory-made and market samples of *milkcake* - a traditional Indian sweet, *J Hill Agri*, **7** (2016) 139–148, DOI 10.5958/2230-7338.2016.00025.2
- Aggarwal D, Raju P N, Alam T, Sabikhi L & Arora B, Advances in processing of heat desiccated traditional dairy foods of Indian sub-continent and their marketing potential, *Food Nutr J*, **3** (2018) 172, DOI: 10.29011/2575-7091.100072
- Jha A, Kumar A, Jain P, Om H, Singh R & Bunkar D S, Physico-chemical and sensory changes during the storage of *lal peda*, *J Food Sci Technol*, **51** (2014) 1173–1178, <https://doi.org/10.1007/s13197-012-0613-3>
- Rasane P, Tanwar B & Dey A, *Khoa*: A heat desiccated indigenous indian dairy product, *Res J Pharm Bio Chem Sci*, **6** (2015) 39–48.
- Khaskheli M, Jamali A, Arain M A, Nizamani A H, Soomro A K & Arain H H, Chemical and Sensory Quality of Indigenous Milk Based Product 'Rabri', *Pak J Nutri*, **7** (2008) 133–136.
- Chopde S, Kumar B & Minz P, Process optimization for in-line production of *rabri*, *Asian J Dairy Food Res*, **35** (2016) 10–16, DOI: 10.18805/ajdfr.v35i1.9245
- Ahmad N & Saleem M, Studying heating effects on *desi ghee* obtained from buffalo milk using fluorescence spectroscopy, *PloS one*, **13** (2018) e0197340, <https://doi.org/10.1371/journal.pone.0197340>
- Kapadiya D B & Aparnathi K D, Comparison of physicochemical, nutritional and sensory aspects of *ghee* obtained from different species, *Int J Trend Sci Res Dev*, **1** (2017) 1231–1236.
- Jain V, Rasane P, Jha A, Sharma N & Gautam A, Effect of modified atmospheric packaging on the shelf life of Kalakand and its influence on microbial, textural, sensory and physico-chemical properties, *J Food Sci Techno*, **52** (2015) 4090–4101, <https://doi.org/10.1007/s13197-014-1501-9>
- Pal U S, Das M, Nayak R N, Sahoo N R, Panda M K & Dash S K, Development and evaluation of retort pouch processed *chhena poda* (cheese based baked sweet), *J Food Sci Technol*, **56** (2019) 302–309, <https://doi.org/10.1007/s13197-018-3490-6>
- Mathpal R, Kulshrestha K & Kushwaha A, Quality and safety of market vs home made carrot *halwa*: designing a safe process, *Int J Food Sci*, **7** (2017) 1–12.
- Mukhekar A, Desale R J & Shelke M, Studies on sensory evaluation and cost of production of rice kheer, *Pharma Innov J*, **8** (2019) 65–67.
- Debnath P P & Ghosh B C, Enzyme modified ghee flavour: Application and shelf life studies, *Int J Pure App Biosci*, **6** (2018) 822–826, doi: <http://dx.doi.org/10.18782/2320-7051.7032>
- Asgar S & Chauhan M, Contextualization of traditional dairy products of India by exploring multidimensional benefits of heating, *Trends Food Sci Technol*, **88** (2019) 243–250.
- Dhaka S S & Choudhary U, Assessment of the brand image of Bikaji Foods International Limited in Bikaner City, *Adv Eco Buss Manag*, **1** (2014) 119–123, <https://ssrn.com/abstract=2532433>
- Altaf U, Kanojia V & Rouf A, Novel packaging technology for food industry, *J Pharma Phytochem*, **7** (2018) 1618–1625.
- Gupta A K, World packaged food market-Opportunities and Forecasts, 2014–2020, *Allied Market Research Report*, (2015) 1–123, <https://www.alliedmarketresearch.com/packaged-food-market>
- Dhage R D, Shelke R R, Chavan S D, Bidwe K U & Gubbawar S G, Effect of various packaging materials and storage temperatures on chemical quality of cow milk *chhana*, *Res J Animal Hus Dairy Sci*, **2(1&2)** (2011) 24–26.

- 31 Cruz A G da, Faria A F J de & Dender V G F A, Packaging system and probiotic dairy foods, *Food Res Int*, **40** (2007) 951–956.
- 32 Mehrotra R, Trivedi A & Mazumdar S K, Study on characterization of Indian dairy wastewater, *Int J Engg App Sci Technol*, **1** (2016) 77–88.
- 33 Jadawala R, Patel S, Challenges of indian dairy industry (In the aspects of Cattle Farms), *Ind J App Res*, **7** (2017) 516–517, doi: 10.36106/ijar
- 34 Mariselvi B & Mathuravalli V, Work culture of milk producers, *Our Heritage*, **68** (2020) 3632–3636.
- 35 Jha A, Kumar A, Jain P, Gautam A K & Rasane P, Effect of modified atmosphere packaging on the shelf life of lal peda, *J Food Sci Technol*, **52** (2015) 1068–1074, <https://doi.org/10.1007/s13197-013-1064-1>
- 36 Ghayal G, Jha A, Kumar A, Gautam A K & Rasane P, Effect of modified atmospheric packaging on chemical and microbial changes in dietetic rabri during storage, *J Food Sci Technol*, **52** (2015) 1825–1829, doi:10.1007/s13197-013-1171-z
- 37 Chowdhury T, Chattopadhyay S K & Saha N C, Modified atmosphere packaging (MAP) and the effect of chemical preservative to enhance shelf life of *khoa* (heat desiccated milk product), *J Package Technol Res*, **1** (2017) 25–31, <https://doi.org/10.1007/s41783-017-0004-3>
- 38 Ahuja K K & Goyal G K, Combined effect of vacuum packaging and refrigerated storage on the chemical quality of *paneer tikka*, *J Food Sci Technol*, **50** (2013) 620–623, <https://doi.org/10.1007/s13197-012-0688-x>
- 39 Narasimhachar S, Vijayalakshmi, Ambuga R, Indiramma, Prema V, Anupama D & Kumar K R, Extension of the shelf-life of *burfi* by packaging, *J Food Qual*, **28** (2005) 121–136.
- 40 Rai S, Goyal G K & Rai G K, Effect of modified atmosphere packaging (MAP) and storage on the chemical quality of *paneer*, *J Dairyin Food H S*, **27** (2008) 33–37.
- 41 Thippeswamy L, Venkateshaiah B V & Patil S B, Effect of modified atmospheric packaging on the shelf stability of *paneer* prepared by adopting hurdle technology, *J Food Sci Technol*, **48** (2011) 230–235, <https://doi.org/10.1007/s13197-010-0155-5>
- 42 Zakariah M A, Malaka R, Laga A & Ako A, Effect of banana leaf and plastic material packaging on microbial contamination dangke fresh white cheese, *Int J Eng Adv Technol*, **8** (2019) 204–206.
- 43 Prasad W, Khamrui K & Sheshgiri S, Effect of packaging materials and essential oils on the storage stability of *Burfi*, a dairy dessert, *J Package Technol Res*, **1** (2017) 181–192, <https://doi.org/10.1007/s41783-017-0018-x>
- 44 Badola R, Panjagari N R, Singh R R B, Singh A K & Parsad W G, Effect of clove bud and curry leaf essential oils on the anti-oxidative and anti-microbial activity of *burfi*, a milk-based confection, *J Food Sci Technol*, **55** (2018) 4802–4810, <https://doi.org/10.1007/s13197-018-3413-6>
- 45 Khan S U & Pal M A, *Paneer* production: A review, *J Food Sci Technol*, **48** (2011) 645–660, <https://doi.org/10.1007/s13197-011-0247-x>
- 46 Kanawjia S K & Singh S, Technological advances in *paneer* making, *Indian Dairyman*, **52** (2000) 45–50.
- 47 Kumar J, Gupta V K & Patil G, Studies on improvement of *chhana* production using ultra filtration process, *Indian J Dairy Sci*, **50** (2005) 162–168.
- 48 Shukla K K, Gupta V K, Patil G R & Shivkumar, Studies on the production of *shrikhand* using ultra filtration process, *Indian J Dairy Sci*, **60** (2007) 393–398.
- 49 Dhineshkumar V & Ramasamy D, Review on membrane technology applications in food and dairy processing, *J Appl Biotechnol Bioeng*, **3** (2017) 399–407, DOI: 10.15406/jabb.2017.03.00077
- 50 Asgar S & Manorama, What pressure driven membrane processing has to do with butter milk and whey for sustainable income generation in India, *Indian J Econ Dev*, **7** (2019) 1–10.
- 51 Kumar P, Sharma N, Ranjan R, Kumar S, Bhat Z F & Jeong D K, Perspective of membrane technology in dairy industry: A review, *Asian-Australas J Anim Sci*, **26** (2013) 1347–1358, <https://doi.org/10.5713/ajas.2013.13082>
- 52 Kumar M P, Information technology: roles, advantages and disadvantages, *Int J Adv Res Comput Sci Softw Eng*, **4** (2014) 1020–1024.
- 53 Deshmukh M A, Chopde S S, Kalyankar S D & Kele V D, Computer applications in dairy industry, *Ori J Com Sci Technol*, **8** (2015) 24–34.
- 54 Dawn S, Tiwari P K, Goswami A K & Mishra M K, Recent developments of solar energy in India: Perspectives, strategies and future goals, *Renew Sust Energy Rev*, **62** (2016) 215–235, <https://doi.org/10.1016/j.rser.2016.04.040>
- 55 Kumar J C R & Majid M A, Renewable energy for sustainable development in India: current status, future prospects, challenges, employment, and investment opportunities, *Energ Sustain Soc*, **10** (2020) 2, <https://doi.org/10.1186/s13705-019-0232-1>