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REVIEW ARTICLE **OPEN ACCESS**

Commercial Production Scenario of Traditional Indian Dairy Products: A Review

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ABSTRACT
India is the largest milk producing nation in the world. India is also the largest dairy products consumer in the global because traditional dairy products have played a significant role in the economic, social, religious and nutritional well-being of our people. These traditional dairy products account for over 90% of all dairy products consumed in the country. Many traditional milk products such as khoa and khoa based sweets, chhana, paneer, shrikhand, rabri, kheer, halwa, basudi, doodhpak, fermented products and many region-specific traditional ethnic products are being manufactured in India. These products need to be enhanced in terms of quality and hygiene such are not possible by the batch type making machines. So traditional dairy products have acquired an interest in large scale production using continuous manufacturing equipments to meet consumer demands. Thereby many of equipment for continuous manufacturing of traditional Indian dairy products were developed and some they were successfully installed in dairy plants. The design specifications and applications of these equipment are discussed briefly in this review.
Keywords: Traditional Indian dairy products, Continuous methods, *Khoa* and *Chhana* based products

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INTRODUCTION

Dairying in India has played a predominant role in up-gradation of the socio-economic altitude of the people. The milk revolution in India reveals an exceptional prosperity story as reflected by increased milk production from 17 million tonnes in 1950-51 to 138 million tonnes in 2013-2014 [28]. India has maintained the first position in milk engenderment since 1998 with milk production of 74.1 million tonnes per annum, overtaking the United States of America. The milk production of India in the year 2015-16 has reached to 155.5 million tons accounting for about 18 per cent of world total milk production and that too growing at a rate of 6.26 per cent per annum. India's estimated demand for milk is likely to be around 200 million tons in 2021-22. About 50-55% of milk produced in India is converted into a variety of milk products through processes such as heat desiccation, heat acid coagulation and fermentation [8]. As growth rate of dairy industry in India is increasing, the demand of energy efficient and the need for highly sophisticated mechanized systems are also growing. Besides higher profitability, traditional dairy products have acquired an interest in large scale production to meet consumer demands. Therefore, the large scale manufacturing of traditional milk products is economically viable due to higher profitability and export potential.

IMPORTANCE OF INDIGENOUS DAIRY PRODUCTS

In early Buddhist and Jain work also, there is a mention about the sweets prepared from inspissated milk designated as Sihakesara and Morandeka. In Maurya period (75-300 A.D.), the sweets were prepared from concentrated milk with the addition of honey, jaggery or sugar [36]. This clearly exhibiting, those

traditional milk products are an integral part of Indian heritage and have great social, religious, cultural, nutritional, medicinal and economic importance.

MARKET GROWTH, DEMAND AND VALUE OF TRADITIONAL DAIRY PRODUCTS

The consumption of traditional dairy products is liable to grow at annual magnification rate of more than 20%, while the growth rate for western dairy products is much lower i.e. 5-10% [30]. According to a survey, the demand of *ghee, paneer, shrikhand, rasogolla* and *gulabjamun* was 200, 16, 5.7, 6 and 5.9 thousand metric tonnes respectively in the year 2009 [26]. Potentially traditional Indian dairy products add about 200% value to milk [7]. The market value for traditional dairy products is estimated at more than 1000 billion INR with an annual growth at 50 billion INR [4], the share of *chhana* and *khoa* based sweets is Rs. 520 billion; *ghee/makkhan*, Rs. 310 billion; fermented products (dahi, *chakka* and *shrikhand*), Rs. 180 billion and *paneer*, Rs. 20 billion [20].

NEED FOR MECHANIZED PRODUCTION OF TRADITIONAL DAIRY PRODUCTS

In order to overcome the inherent disadvantages associated with the conventional manufacturing of traditional dairy products such as in efficient use of energy, poor hygiene and sanitation, non-uniform product quality, fatigue on the operator, etc. some many attempts have been made to develop semi-continuous and continuous equipments for the manufacture of these products. The mechanized production of traditional dairy products present a unique opportunity to the organised dairy sector in India, even many minuscule scale dairy entrepreneurs are intrigued to adopt mechanization in engenderment of many traditional dairy products in order to get uniform and ameliorated product quality and to gain more profit. Thus, expanding traditional Indian dairy products business through mechanization helps in large scale manufacture of traditional dairy products to meet consumer demands.

MECHANIZED METHOD FOR CONTINUOUS MANUFACTURE OF *KHOA*

The increasing demand of *khoa* based indigenous sweets has created a need for large scale industrial production of *khoa*. Earlier several attempts have been made to develop batch type *khoa* making equipments by many scientists [39] but their limited capacity and non uniform product quality are not suitable for large volume production. In order to overcome the disadvantages by batch type *khoa* equipments. [2] designed a horizontal thin film scraped surface heat exchanger (SSHE) for the continuous production of *khoa*. [18] extended application of thin film SSHE for continuous production of *khoa.* It is reported that rotor speed of 150 rpm gave the desirable quality *khoa* [19]. [34] developed an inclined SSHE to the manufacture *khoa* continuously with a capacity of 40-55 kg/h. This unit has been successfully employed at the Sugam Dairy, Vadodara and Sabar Dairy, Himatnagar (Gujarat) for production of *khoa*. [13] designed three stages unit for the continuous manufacture of *khoa* from whole milk. [17] developed a thin film SSHE system of mild steel for continuous manufacturing of *khoa* by arranging two SSHE in a cascade fashion. The capacity of this unit was about 50 kg/h. [10] developed a continuous *khoa* making unit of mild steel by arranging three identical SSHE one over another in inclined fashion for controlling the product flow under gravity with a capacity of 55-58 kg milk/h. [27] studied the feasibility on manufacturing of *khoa* from low fat milk using three stage SSHE by keeping milk flow rate of 200 kg/h. [31] carried out a study on feasibility of integrated SSHE with conical process vat (CPV) for the continuous production of *khoa*. It was demonstrated that such integrated system could be used to process *khoa* with better sensory and textural quality in a continuous manner. [16] explored the feasibility of three stage SSHE for the manufacture of *danedar khoa* by using standardized milk with 0.18 % LA.

CONTINUOUS MANUFACTURE OF *BURFI*

Increasing demand of *burfi* has created a need for large scale industrial production which ensuring uniform product quality, product safety, energy conservation, etc. [24] investigated the acceptability of three stage SSHE for the continuous manufacture of *burfi*. The optimum parameters for the best quality *burfi* were found out at a rotor speed of 150 rpm and 4 blades in the third stage. [11] studied the performance of thin film SSHE for the continuous manufacturing of *burfi*. The combination of scraper speed of the first, second and third stage are 200, 175 and 15, respectively with adding crystalline sugar into the third stage found best for satisfying overall criteria i.e. quality of *burfi*, energy consumption, production and operation. [43] investigated the inline production of *burfi* by integrating SSHE with conical process vat and mechanized cooling system. On the basis of texture analysis and sensory attributes, the operational parameters were optimized by using RSM (Response surface methodology). 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 speed of rotor for continuous cooling system gave maximum sensory and textural score among all combinations. The process time taken for *burfi*

production in the integrated system was significantly low in comparison to *burfi* produced in the jacketed steam kettle.

LARGE SCALE SYSTEMS FOR PRODUCTION OF *PEDA, KALAKAND AND GULABJAMUN*

Now a day's *peda* has gained much of commercialization and manufactured by several organized dairy plants also. In Sugam Dairy, Baroda, kesar *peda* is prepared by adopting large scale mechanized process using continuous *khoa* making machine, planetary mixer, *peda* shaping machine [29]. [14] investigated the continuous manufacturing of *kalakand* using three stage thin film SSHE. The best quality of *kalakand* was prepared by standardizing the milk with 0.19% LA acidity and keeping scraper speed 175, 125 and 15 rpm for first, second and third stage of SSHE with a flow rate of 195 kg/h. A commercialized semi continuous system is adopted for the manufacture of *gulabjamun* from *khoa* at Sugam Dairy, Baroda [9].

CONTINUOUS MANUFACTURING OF *BASUNDI* AND *RABRI*

[32] developed a continuous *basundi* making machine based on the principle of thin film SSHE. He claimed that this machine was energy efficient and under optimum operating conditions gave a lower cost of processing i.e. 50% less than the conventional method. It gave uniform and hygienic quality, better sensory attributes and higher profit margin compared to other methods. [40] explored the three stage SSHE for manufacturing of *basundi*. The best quality of *basundi* was prepared by keeping scraper speed of both the SSHE at 2.461 m/s and flow rate of 165 kg/h and by using caramelized sugar syrup solution. The third stage of SSHE was not used for *basundi* manufacture as two stages gave the product of required consistency.

Rabri is characterized as sweetened concentrated whole milk product contains thickened *malai* layer obtained by milk evaporation and concentration. [37] evaluated the performance of three stage thin film SSHE for continuous manufacturing of *rabri*. The best quality of *rabri* was prepared by keeping 127, 121 and 15 rpm in first, second and third stage of SSHE respectively with a flow rate of milk at 151 kg/h and acidity of milk at 0.17% LA. [12] optimized the process parameter of SSHE and CPV for in line production of *rabri* and recommended that most acceptable quality of *rabri* can be prepared by keeping initial concentration of milk to 29.9% TS in SSHE and final concentration of milk to 39% TS in CPV before sugar addition.

COMMERCIAL MANUFACTURE OF *GHEE*

Ghee occupies a very significant place in the 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. However, *ghee* is manufactured in steam jacketed kettles even today, which inherently suffers from several disadvantages so continuous manufacturing of *ghee* may overcome many of the problems associated with conventional and other methods.

[33] developed a prototype continuous *ghee* making machine using pressurized SSHE coupled with vapour separator from cream or butter as a base material. [1] designed a continuous *ghee* making plant on the principle of flash evaporation to produce 100 kg *ghee*/hr by taking creamery butter as raw material. [35] worked on a continuous *ghee* making machine using the principle of hydrodynamics and heat transfer in a horizontal straight-sided thin film SSHE having a capacity of 500 kg/h *ghee*.

[3] designed a continuous *ghee* making system working on the concept of thin film SSHE using plastic butter. [38] investigated the three stage thin film SSHE for mechanized manufacturing of *ghee* using butter as a base material with a feed rate of 240 kg/h. [42] studied the feasibility of the in line system for *ghee* manufacturing using cream based on SSHE and CPV.

CONTINUOUS MANUFACTURING OF *PANEER*

Batch production of *paneer* at a small scale employing the traditional process often results in an in consistent quality and poor hygienic conditions. A proto type machine for the continuous manufacture of *paneer* has been developed at NDRI, Karnal [5]. This machine is designed to manufacture 80 kg *paneer*/h by employing a twin flanged apron conveyor cum filtering system for obtaining the desired moisture content and texture attributes.

CONTINUOUS PRODUCTION SYSTEMS FOR *CHHANA* AND *CHHANA* BASED SWEETS

To overcome the problems of small scale, attempts have been made to mechanize *chhana* and its based sweets production. A proto type continuous machine with 40kg *chhana*/h capacity has been developed at NDRI, involving tubular heat exchanger acid injector, hold and strainer [6]. *Chhana* with 55-65 % moisture is discharged through the outlet and collected in the basket. [41] obtained a patent on the mechanized production of *Channa*. The process involves indirect heating of milk in a tubular heat

exchanger to 95°C, cooling to 70°C, continuous coagulation with hot citric acid (70°C), 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 4°C, by directly spraying chilled water on the layer of *Channa*. [25] developed a single screw vented extruder for cooking mixture of *chhana* and sugar that paved the way for the mechanized continuous production of *sandesh*. With some of necessary modifications, this existed technology may also be suitable for the continuous *sandesh* production from buffalo milk. [22, 23] also tried to mechanize the unit operations in *rasogolla* making for its continuous production by developing *chhana* kneader and *chhana* ball former.

COMMERCIALIZED *SHRIKHAND* MAKING MACHINE

Shrikhand is an Indigenous fermented and sweetened milk product of Indian origin. Although *shrikhand* is largely produced on small scale manufacturers by adopting traditional methods, with the increase in demand, nowadays *shrikhand* is commercially produced in the organized sectors. A fully mechanized/continuous process for industrial production of *shrikhand* was developed and patented. In this process, *chakka* is prepared by separating the whey from skim milk dahi employing basket centrifuge at 1100 rpm. The resultant *chakka*, sugar and plastic cream are then mixed in a planetary mixer. [15] developed a continuous *shrikhand* thermization system based on SSHE.

CONTINUOUS SYSTEMS FOR *KHEER* AND *GAJARPAK* PRODUCTION

In order overcome the disadvantages such as time consumption and improper quality in terms of consistency by batch *kheer* making system, [21] optimized the process parameters for continuous *kheer* making machine. Based on the sensory analysis, the operating pressure of 0.27 MPa and cooking time of 7.5 min was chosen for design of pressurized cooking section of the continuous *kheer* manufacturing machine. Recently NDRI, Karnal evaluated the performance of three stage SSHE for continuous manufacturing of *gajarpak*.

CONCLUSIONS

The commercial production of traditional dairy products has been identified as one of the important priority areas by the government and other policy makers. In the view, these criteria many organized dairy plants have shown interest in venturing into the manufacture of different traditional dairy products through mechanization because those products have great demand in and out of the country. Even though research and development involvement is required to make the some of the traditional products by continuous systems to meet quality similar to the conventional process. So all efforts must therefore be made by adopting more efficient designs of equipment and better technologies for the improvement and up-gradation of the traditional Indian dairy product industry.

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