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Research Article

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Comparison of Traditional and Mechanized Manufacture Rawa Burfi: Research Article

Suresh Velpula[1*], Bhadania A. G.[2], Pinto S. V.[3], Aravind T.[4] and Umapathy K. S.[5]

[1*]M.Tech Scholar, Department of Dairy Engineering,

[2]Professor and Head, Department of Dairy Engineering, [3]Professor, Department of Dairy Technology, S.M.C. College of Dairy Science, AAU, Anand (G.J), India

[4]M.Tech Scholar, Department of Dairy Engineering, College of Dairy Science and Food Technology, C.G.K.V., Raipur (C.G), India

[5]Assistant Professor & Head, Department of Dairy Engineering, College of Dairy Technology, PVNRTVU, Kamareddy, (T.S), India

*Corresponding Author E-mail: sureshvelpula72@gmail.com

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ABSTRACT

The present investigation was intended to evaluate the performance of open type scraped surface heat exchanger (SSHE) during manufacture of rawa burfi prepared using skim milk powder (SMP) and compared with traditional made delicacy. The performance of open type SSHE in terms of heat transfer characteristics and electrical power consumption was evaluated at 30 rpm of process vat and 10 kg batch size. The overall heat transfer coefficients (U-values) of open type SSHE obtained at selected operating conditions was 453.05 W/m^{2}K. The LPG fuel consumption and thermal efficiency of open type SSHE during manufacture of rawa burfi was 0.22 kg fuel/batch and 31.00% respectively. The manufacture of rawa burfi in open type SSHE has consumed 251Wh electrical power. Sensory attributes of rawa burfi manufactured using SMP in open type SSHE at 30 rpm of process vat and 10 kg batch size were at par (P > 0.05) with control product prepared by the traditional method. Cost estimated for manufacture of rawa burfi/kg in SSHE was Rs 168.37 in which the raw material cost was 96.54% and processing cost was 3.64%.

Key words: *Open type SSHE, Rawa burfi, Skim milk powder, Sensory analysis, Cost structure.*

INTRODUCTION

Dairying in India has played a predominant role in up-gradation of socio-economic conditions of the people. The milk revolution in India reveals an exceptional success story as reflected by maintaining the first position in milk production since 1998 overtaking the United States of America. The milk production of India in the year 2015-16 has reached to 155.5 million tons and estimated demand for milk is likely to be around 200 million tons in 2021-22[1].

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Milk utilization pattern reveals that indigenous dairy products are India's largest selling and most profitable segment after liquid milk accounting for 50-55 per cent of milk produced in the country[4], while 5-6 per cent of total milk produced is used for the manufacturing of western dairy products such as ice cream, butter, cheese, powder, etc.[5]In recent years, a lot of interest has been gained in the development of composite food and milk based sweets prepared by combining one or more dairy products with appropriate non-dairy ingredients. These products have higher demand and profit margin[2] and having the nutritional value of both milk and non-dairy ingredients such as fruits, vegetables or cereals. Amongst them, *khoa* based sweets like rawa burfi is very popular.The mechanized production of traditional dairy products present unique opportunity to the organized dairy sector in India, even many minuscule scale dairy entrepreneurs are intrigued to adopt mechanization in manufacture of many traditional dairy products in order to get uniform and ameliorated product quality. Thus, expanding traditional Indian dairy products business through mechanization for large scale production will enable the dairy plant more economically viable due to their higher profitability and export potential.Scraped surface heat exchanger (SSHE) is the most suitable heat exchanger for handling high viscosity and heat sensitive products, which tend to foam and foul heat transfer surface. The SSHE consists of jacketed cylinder in which a rotor carrying scraper blades rotate during preparation of the products. Because of its potential in manufacturing of traditional dairy products, several attempts have been made to design SSHE depending on the type of the process. Therefore, the present investigation is aimed to evaluate the performance of open type SSHE during manufacture of rawa burfi and comparison with traditional made product.

MATERIALS AND METHODS

The work was carried out at Department of Dairy Engineering of Sheth M. C. College of Dairy Science, Anand Agricultural University (G.J.).

Rawa materials

"SAGAR" brand skim milk powder manufactured by AmulFed Dairy (Mother Dairy, Gandhinagar) was procured from the local market of Anand, Gujarat. Fresh *khoa* and *ghee* were procured from the Department of Dairy Processing Operations (Anubhav Dairy), Sheth M. C. College of Dairy Science, Anand Agricultural University, Anand. A white fine crystalline sugar (sucrose) of commercial grade was obtained from the local market of Anand, Gujarat. The packaged *rawa* of reputed brand was procured from the local market of Anand, Gujarat. The composition of major raw materials required for preparation of rawa burfi are given in Table 1, Table 2, Table 3 for *khoa*, skim milk powder and rawa respectively.

Open Type SSHE

Open type SSHE (Make: Milk Tech Engineers, Bengaluru) was used for manufacture of rawa burfi. The SSHE consists of (i) process vat (ii) scraper assembly (iii) drive arrangement for process vat and (iv) measuring instruments. It is also equipped with LPG fuel burners for supply of thermal energy which makes it suitable for manufacturing of these products by small scale manufacturers. The process vat of the open type SSHE was fabricated from 6 mm thick AISI 304 grade S.S. plate. It has volumetric capacity of 60 liter. The SSHE is used for multi-purpose application such as heating of milk, concentration of milk, preparation of *khoa,* etc. Spring loaded scrapers having Teflon blades are provided on the bottom and on the side of the vat. These scrapers remain stationary while the vat containing product rotates which scrapes the product from bottom as well as from the sides. The process vat rotates at 30 rpm by providing a drive arrangement from the bottom of the vat using single phase 0.5 HP electric motor. Two LPG burners are provided at the bottom of the vat for supply of heat energy for the product. The photograph of the SSHE is depicted in Figure 1.

Preparation of Experimental Rawa *Burfi* in Open Type SSHE

The flow diagram of the method followed for manufacture of rawa burfi in the SSHE is depicted in Figure 2. Initially *ghee* weighing 1.66 kg was taken in thoroughly cleaned SSHE, then motor drive and LPG fuel supply were started. *Rawa* weighing 2.38 kg was added and roasted in *ghee* for 10-12 min. After the roasting of *rawa*, SMP weighing 2.38 kg was added and contents were stirred until the whole mass mixed properly. Then total mass was transferred to a big tray. The crystalline sugar weighing 2.14 kg and equal amount of water to dissolve sugar was taken in the SSHE. Intermittently sugar syrup concentration was measured using refractometer by taking the sample from top of the SSHE. When sugar syrup concentration was reached to a 60 ^{o}brix, a mixture of SMP and roasted *rawa* was added in the sugar syrup. Then contents were continuously stirred and scraped for 4-5 min until it attains *burfi* consistency, finally cardamom was added and LPG fuel supply was stopped at this stage. *Rawa burfi* mass was unloaded from the SSHE followed by transferring to a greased (with *ghee*) stainless steel plate, spread evenly and kept 3-4 h for setting. Control product (rawa burfi prepared using *khoa*) was prepared according to the method reported by Aparna[7].

Determination of Overall Heat Transfer Coefficients (U-Values)

$$M * CPm * (Ti - Tp) + E * L = U * A * (Ts - Tp)$$

Where M= Mass of mixture, kg, Specific heat of mixture, kJ/kgK, T_i = Temperature of feed mixture, K, T_p = Temperature of the product, K, E= Rate of evaporation, kg/h, L= Latent heat of evaporation kJ/kg, U= Overall heat transfer co-efficient, W/m^2 K, A= Effective area of SSHE, T_s = Temperature of surface contact with LPG fuel, K, T_p = Temperature of the product, K

Energy Analysis of SSHE

Heat energy with the feed material	+	Heat energy of LPG fuel	=	Heat energy of evaporated water	+	Energy leaving with the product	+	Energy losses

Sensory evaluation: The nine-point hedonic scale was used for evaluating the sensory qualities of rawa burfi, it includes various scales of grading i.e. liked extremely (9), liked very much (8), liked moderately (7), liked slightly (6), neither liked nor disliked (5), disliked slightly (4), disliked moderately (3), disliked very much (2), disliked extremely (1)[3]

Experimental Design

The data regarding the electrical and thermal energy requirements, etc. were collected during the experimental trials and various calculations were used for the performance of the SSHE. The mean values generated during experimental trials with replications were subjected to statistical analysis using Factorial Completely Randomized Design[6]

RESULTS AND DISCUSSION

Experimental trials were conducted for preparation rawa burfi at 30 rpm process vat and batch size of 10 kg of final product in open type SSHE and traditional product was prepared according to the method suggested by Aparna[7]. The performance evaluation in terms of energy requirement, heat transfer analysis of open type SSHE was carried out during the manufacture of rawa burfi.

PERFORMANCE EVALUATION OF OPEN TYPE SSHE DURING PRODUCTION OF RAWA BURFI

The overall heat transfer coefficient (U-value) of open type SSHE during manufacture of *rawa burfi*

The overall heat transfer coefficient (U-value) of SSHE was determined by the equation given above. The average U-value of the SSHE obtained from the data collected during manufacturing of *rawa burfi* is shown in Table 4. The U-value of the SSHE obtained during manufacturing of *rawa burfi* was 453.05 W/m^{2}K.

Thermal energy requirement of open type SSHE during manufacture of *rawa burfi*

LPG fuel was used as thermal energy source for the open type SSHE during manufacturing of *rawa burfi*. The thermal energy analysis of the SSHE was determined based on the equation give above. Heat losses and thermal energy of the SSHE during manufacture of *rawa burfi* are depicted in Table 5.The average LPG fuel consumption of SSHE for production of *rawa burfi* was 0.22 kg. The total heat losses and thermal efficiency of the SSHE during manufacturing of *rawa burfi* were 61.00 % and 31.00%, respectively.

COMPARISON OF SENSORY ATTRIBUTES OF *RAWA BURFI* PREPARED BY TRADITIONAL AND MECHANIZED METHOD

The average sensory scores of the traditional (T) and mechanized manufactured *rawa burfi* (M) for various sensory attributes are collated in Table 6. There was a non-significant ($P>0.05$) difference in all the sensory attributes viz. flavour, body and texture, colour and appearance and overall acceptability scores of both the products.However flavour score was higher side on mechanized product, it may be due to release of flavour compounds on effective heat transfer surface. Similarly body and texture of mechanized product was superior than traditional product because of close knit of burfi consistency with mechanized method. Similarly colour and appearance and overall acceptability of mechanized made rawa burfi were favour than traditional made delicacy.

COST STRUCTURE OF *RAWA BURFI* MANUFACTURED IN OPEN TYPE SSHE

Cost estimates of *rawa burfi* prepared in open type SSHE and traditionally made is presented in Table 7. The cost analysis is based on 365 days of working in a year and 8 hours of working/day and 14 batches daily.Cost of *rawa burfi* was estimated at operating conditions of 10 batch size and 30 rpm of process vat.

Cost of *rawa burfi*/kg = 1683.71/10 = Rs 168.37

Raw material cost/kg product = 1625.54/10 = Rs 162.55 (i.e. 96.54 % of the total cost)

Processing cost/kg product = 58.17/10 = Rs 5.81 (i.e. 3.46 % of total cost)

It was observed that raw material cost is higher than processing cost, which indicates that economical feasibility of SSHE for manufacture of rawa burfi.

Table 1: Average chemical composition of *khoa*

Sr. No.	Component	Per cent*
1.	Moisture	31.00
2.	Fat	22.20
3.	Protein	16.80
4.	Lactose	26.50
5.	Ash	3.50

n=4

Table 2: Average chemical composition of skim milk powder

Sr. No.	Component	Per cent
1.	Moisture	3.50
2.	Protein	35.50
3.	Fat	1.10
4.	Lactose	52.70
5.	Ash	7.20

n=4

Table 3: Average chemical composition of rawa

Sr. No.	Component	Per cent*
1.	Moisture	10.40
2.	Protein	12.50
3.	Fat	0.20
4.	Total Carbohydrate	72.83
5.	Ash	0.80

n=4

Table 4: U-values of open type SSHE during manufacturing of *RawaBurfi*

Batch size (kg)	Scraper speed (rpm)	Rate of evaporation (kg water/h)	U-value (W/m^2K)
10	30	1.70*	453.05*

n=4

Table 5: Heat losses and thermal efficiency of open type SSHE during manufacturing of *Rawa Burfi*

Heat input		Heat output		Energy losses (kJ/h)	Energy losses (%)	Thermal efficiency (%)
Feed (kJ/h)	LPG fuel (kJ/h)	Evaporated water (kJ/h)	Product (kJ/h)			
1360.20	24201.93	3847.63	4996.80	16717.70	61.00	31.00

Table 6: Sensory scores of *rawa burfi* prepared by traditional and mechanized method

Treatments	Sensory Scores			
	Flavour	Body &Texture	Colour &Appearance	Overall Acceptability
M (Mechanized)	8.35±0.21	8.26±0.20	8.32±0.18	8.38±0.19
T (Traditional)	8.31±0.18	8.24±0.22	8.30±0.17	8.36±0.22
SEm±	0.08	0.09	0.07	0.09
CD (P≤0.05)	NS	NS	NS	NS

Each observation is a mean ± SD of six replicate experiments (n=6); NS=Non significant at 5% level of significance

Table 7: Cost of manufacturing *Rawa Burfi*in open type SSHE

Cost of rawa burfi prepared in SSHE				
Sr. No.	**Material**	**Rate (Rs)**	**Quantity**	**Total cost (Rs)**
1.	Cost of SMP	265/kg	2.38 kg	630.70
2.	Cost of *rawa*	40/kg	2.38 kg	95.20
3.	Cost of sugar	42/kg	2.14 kg	89.96
4.	Cost of *ghee*	480/kg	1.66 kg	799.68
5.	Cost of cardamom	1000/kg	0.01 kg	10.00
Total material cost (A)				**1625.54**
Operating cost				
6.	Thermal energy (LPG fuel)	43.27/kg	0.22 kg	9.51
7.	Electrical energy	7.0/kWh	0251 kWh	1.75
8.	Labour cost	310/person/day	2 persons	44.28
9.	Interest on the cost of the machine	12 % of equipment cost (Cost of equipment: Rs 60,000)	----	1.42
10.	Depreciation	10 % of equipment cost (Cost of equipment: Rs 60,000)	----	1.19
11.	Repair and Maintenance	5 % of equipment cost (Cost of equipment: Rs 60,000)	----	0.59
12.	Cleaning chemicals	----	----	0.85
Total operating cost (B)				**58.17**
Total cost (A+B)				**1683.71**

Fig. 1:

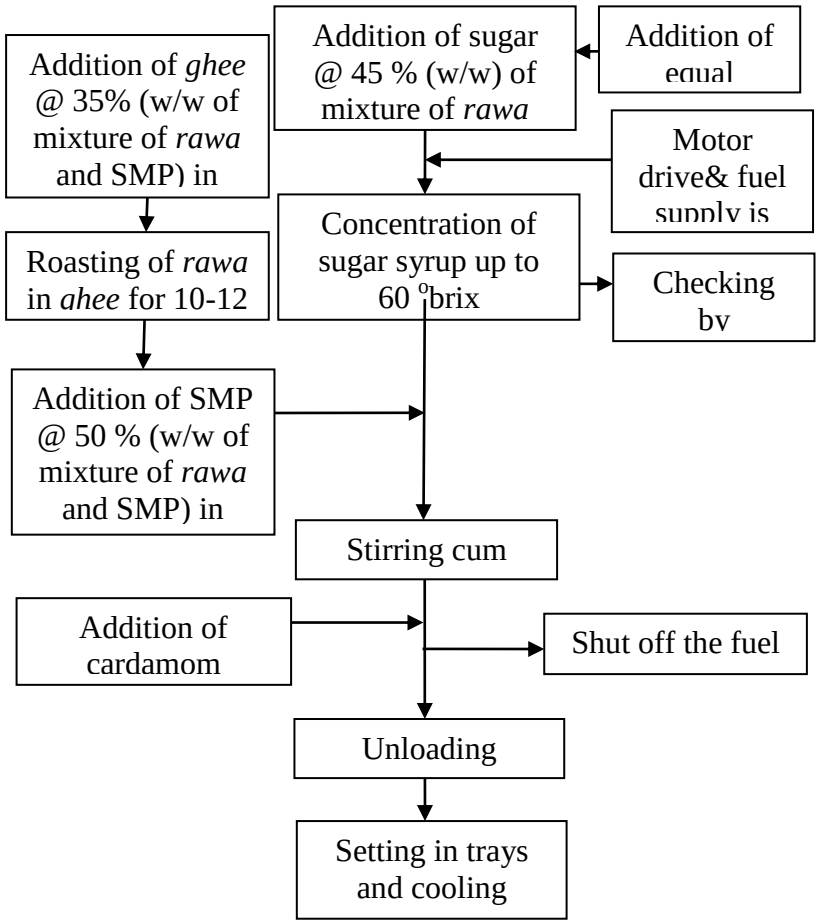

Fig. 2: Flow diagram for manufacture of *rawa burfi* in open type SSHE

CONCLUSIONS

The overall heat transfer coefficients (U-values) of open type SSHE obtained at 30 rpm of processing vat and 10 kg batch size was 453.05 W/m^{2}K. The LPG fuel consumption and thermal efficiency of open type SSHE during manufacture of rawa burfi was 0.22 kg fuel/batch and 31.00% respectively. The manufacture of rawa burfi in open type SSHE has consumed 251Wh electrical power. Sensory attributes as colour and appearance, flavour, body and texture and overall acceptability of rawa burfi manufactured using SMP in open type SSHE were at par ($P > 0.05$) with control product prepared by the traditional method. Cost estimated for manufacture of rawa burfi/kg in SSHE was Rs 168.37 in which the raw material cost was 96.54% and processing cost was 3.64%.

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