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Development of Mechanized Process for *Malai Lachha* Based Sweet

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ABSTRACT

The study was conducted to come across various aspects of preparation to develop mechanized process for Malai Lachha with desirable quality using Scraped Surface Heat Exchanges (SSHE) and Flat Plate Heat Exchanger (FPHE). The preconditioning of the milk at three different levels of concentrations i.e. 30%, 35% and 40% TMS obtained in SSHE at steam pressure of 2 Kg/cm^2 and in FPHE at steam pressure 0.3, 0.5, 0.7 and 0.9 Kg/cm^2. Number of layers at FPHE 2, 3 and 4, cooling rates 1008, 1260 and 1515 W have been adopted in the present study work. Product obtained was subjected to sensory evaluation using trained panel of judges. Based on the trials, the operating parameter for formation of desired quality of the product has been optimized.

Key words: *Mechanized Process, Malai Lachha, Quality.*

INTRODUCTION

The market for indigenous products has vast potential. A great scope exists for further expansion of the market for indigenous milk products, provided quality and safety are ensured and the shelf life is extended to facilitate distribution over larger areas. The small-scale operations are associated with inefficient use of energy, poor hygiene and sanitation and non-uniform product quality[4].

Malai Lachha production in India is characterized by an unorganized nature of business mainly by cottage industry. In response to the changing style of industry, mechanization of *Malai Lachha* based sweets is a necessity for improving their production methods and as *Malai Lachha* has not received much attention, it deserve priority in the area of research. *Malai Lachha* is a heat desiccated clotted cream shredded thin firm layers, pale yellow to light caramel colour and delicious tastes. *Malai Lachha* is used as a finishing material on top of the sweets to make it more attractive by garnishining especially on the Bengali sweets. It also adds delicious taste and nutritive value of final products.

Most of the sweets manufacturers are producing *Malai Lachha* traditionally. This method is laborious, time consuming and unhygienic process.

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An attempt has been made to mechanize manufacturing process for *Malai Lachha* based sweet in Dairy Engineering Division, ICAR-NDRI, Karnal by using Scraped Surface Heat Exchanger and Flat Plate Heat Exchanger. This process was used for improving the hygienic quality, homogeneous product and avoiding grainy texture in the product, increasing shelf life, producing value added products and reducing man power and manufacturing time.

MATERIALS AND METHODS

The experimental set-up was developed for mechanized production of *Malai Lachha*. The basic requirements of the experimental set-up is to spread a regulated and deliberate quantity of concentrated milk on hot surface for layer formation and cool the *Malai Lachha* to produce quality product. The unit operations used for manufacture of *Malai Lachha* includes concentration, spreading, evaporation, cooling, cutting and scrapping. The experimental set-up is shown in Fig.1 majorly consists of following components:

Scraped Surface Heat Exchanger:

Scraped Surface Heat Exchanger is the heat exchanger for handling high viscous product[5]. The horizontal scrapped surface heat exchanger (SSHE) of 304 stainless steel, having 40 cm I.D., 0.3 cm wall thickness and 100 cm overall length, was used. Mild steel jacket of 45 cm I.D. with 0.3 cm wall thickness was provided. The heated length was 65 cm. For insulation the heat exchanger was provided with glass wool of 5 cm thickness. The end covers of heat exchanger were of 0.6 cm thickness and of 45 cm diameter. The rectangular outlet from heat exchanger of 15 x 7.5 cm^2 for the finished product had been provided with a rectangular slit to control the flow of finished product. The machine was provided with regulating steam control. The machine component has been assembled and fitted on an angle iron frame with an inclination of 20 mm. The rotor assembly of stainless steel (SS) shaft of 2.5 cm diameter with 100 cm length was used. The SS blades of length 53 cm with 2.2 cm width had been hinged. The thickness of blade was 0.16 cm.

Flat Plate Heat Exchanger: A flat plate heat exchanger (FPHE) made of 304 stainless steel, having top plate of 0.5 cm sheet thickness; other five bounding plates were made of Mild Steel of 0.8 cm thickness, was used. The dimension of flat plate heat exchanger was 60 cm X 38 cm X 5 cm. Three baffles were attached to inner side of top plate of FPHE at equal partitions that increases thermal efficiency of heat exchanger and avoids the bulging of heat exchanger. The FPHE has three ports, one for steam inlet and cooling water outlet, one for steam trap and cooling water inlet (Reddy, 2000) and one for spring-loaded safety valve, an air vent and compound pressure gauge.

The FPHE was attached with feed cylinder and variable lip slot die. The feed cylinder was made of SS-304 of thickness 0.3 cm with 51.5 cm length and 15.4 cm diameter. The variable lip slot die had a fixed and adjustable lip on die module, 51 cm length. Adjustable lip provides uniform slot thickness. For calculating of cooling load, two digital thermometers were attached on experimental set-up for noting down the temperatures of cooling water inlet and outlet and digital thermometer was attached to the FPHE for noting down the product temperature.

Materials Used:

Cow and buffalo milk was used in present study obtained from the experimental dairy of NDRI. sugar, dry fruits (Cashew, Cardamom and Almond) were used to make delicious in between *Malai Lachha* layers.

Experimental Methodology:

The cow and buffalo milk (20 liters) was taken into a storage tank in the ratio of 3:1 (5.0 % Fat and 8.5 % SNF) and mixed thoroughly. The milk was fed into the thin film SSHE at a pressure of 1 – 2 Kg/cm^2 for 13 – 29 minutes with rotor speed of 125 rpm and required mass flow rate to get the final desired level of concentration of milk. Sugar is added into the concentrated milk @ 3% in two parts 1:2. The concentrated milk was fed into the feed cylinder and spreaded through the 1mm opening of variable lip slot die, on FPHE. To and fro motion to the feed cylinder was given

by the hand lever and at the same time feed was given to die by tilting of feed cylinder with the help of tilting lever for uniformly spreading over flat plate heat exchanger. A uniform concentrated milk layer was formed and heated for production of *Malai Lachha* over flat plate heat exchanger at low steam pressure of 0.3 – 0.9 kg/cm^2 for 43 – 65 minutes.

Grounded dry fruit mixture (about 25 gm) is spreading manually in between of each layers of *Malai Lachha*. The concentrated milk was fed into the feed cylinder and spreaded through the 1mm opening of variable lip slot die, on FPHE. To and fro motion to the feed cylinder was given by the hand lever and at the same time feed was given to die by tilting of feed cylinder with the help of tilting lever for uniformly spreading over flat plate heat exchanger. A uniform concentrated milk layer was formed and heated for production of *Malai Lachha* over flat plate heat exchanger at low steam pressure of 0.3 – 0.9 kg/cm^2 for 43 – 65 minutes.

Cool the *Malai Lachha* layers immediately after drying on flat plate heat exchanger with a cooling water flow rate of 4 – 6 kg/min for 8 – 20 minutes. The cooling rate of *Malai Lachha* based sweet was calculated by equation as shown under and specific heat of water is taken as 4.2 KJ/kg K.

$Q=m*C_p*(T_{out}-T_{in})/(T)$

Where, Q = Cooling rate in Watt (W), m = Mass of cooling water in kg

C_p = Specific heat of water in J/kg K, T_{out} = Temperature of water outlet in K

T = Time in Sec

The *Malai Lachha* based sweet was packed into Polythene bag (lockable) and put into aluminium trays for chemical analysis and sensory evaluation of the product.

Compositional Analysis:

The milk, as raw material, was tested for fat, SNF, titratable acidity and total solids (TS) by using standard methodologies. The fat content in milk was determined by the Gerber method IS:1224 [3]. Moisture content of *Malai Lachha* based sweet was determined by gravimetric method used for Khoa as suggested by Indian Standards[2]. Fat content of *Malai Lachha* was determined by Mojonnier fat extraction tube. The total nitrogen of *Malai Lachha* was determined by the standard method of AOAC[1]. The sucrose content of *Malai Lachha* was determined as per the Indian Standard (1981) using invert sugar as standard.

The colour of the reconstituted *Malai Lachha* was measured using a Colourflex (Hunterlab, Reston, Verginia, USA) along with the universal software (version 4.10).

Sensory Evaluation:

A trained panel of judges performed sensory evaluation of different samples of *Malai Lachha* based sweet at different variable parameters. They are using 100 point score card, which comprised of flavour (50), body and texture (30), colour and appearance (15) and Packaging (5) was applied for sensory evaluation of the product.

RESULTS AND DISCUSSION

Experiments were conducted with five variables as concentration of milk, steam pressure in SSHE, number of layers and cooling water flow rate at three levels each and steam pressure at FPHE at four levels. Three sets of concentration of milk (30, 35, and 40%), steam pressure in SSHE (1, 1.5, 2 Kg/cm^2), number of layers (2, 3 and 4) and cooling water flow rate (4, 5, 6 kg/min) and steam pressure at FPHE (0.3, 0.5, 0.7 and 0.9 Kg/cm^2) were used.

The condensed mix for *Malai Lachha* is prepared with varying two parameters - the degree of condensing (TMS of 30%, 35%, and 40%) for 3:1 cow & buffalo milk in SSHE. The process heating time for *Malai Lachha* varied from 13 to 29 minutes (Table-1). On the basis of trials, 1 and 1.5 Kg/cm^2 steam pressures at SSHE were rejected as processing time was very high (i.e. maximum time required 29 minute & 23 minute for 1 & 1.5 Kg/cm^2 respectively, as compare to 17 minute for 2 Kg/cm^2). The opening of lip slot die was kept constant at 1mm.

The process heating time for *Malai Lachha* is also dependent on the initial concentration of feed at FPHE and on number

of layers to be formed (Table 3). The 40% TMS concentration took the least time for making *Malai Lachha* but the spreading was uneven due to its consistency and gets lower sensory score, therefore 35% TMS concentrate is taken for further trials. Trials also revealed that steam pressure at FPHE 0.3, 0.5 Kg/cm^2 took more processing time whereas 0.9 Kg/cm^2 produce burnt flavour in the product. Therefore, *Malai Lachha* layer was formed at a steam pressure of FPHE 0.7 Kg/cm^2.

The cooling time significantly increased with increase in no. of layers and decreased with higher cooling rate (Table - 5). The cooling rate of 1515 W was favoured by both the sensory score and least time elapsed.

The colour value of *Malai Lachha* was varied for front side from 45.05 to 43.44 and for back side from 28.45 to 22.88 (Fig: 2 & 3). It is due to higher feed concentration of milk (% TMS) to FPHE and greater thickness of layers which leads to more process time and burning takes place. Therefore both front and back sides become dark in colour due to slight burning. As the bottom layer of product directly expose to FPHE, so the bottom layer was of dark colour.

The sensory score of product made of concentrated milk at 30% and 40% TMS with all three No. of layers (2, 3 and 4) and cooling rates (1008, 1260 and 1515 W) were found less than the concentrated milk at 35% TMS with 0.7kg/cm^2 steam pressure, 3 layers and 1515W cooling rate (Fig. 4-6). Hence a product made of combination of variable parameters, 2 Kg/cm^2 steam pressure at SSHE, concentration of milk at 35% TMS, 3 number of layers, 0.7 kg/cm^2 steam pressure at FPHE and 1515W cooling rate with 61 minutes of total processing time (heating time 51 minutes and cooling time 10 minutes) was found for the production of best quality *Malai Lachha*.

Finally the variable parameters were fixed at the steam pressure of SSHE (2 Kg/cm^2) and condensing up-to 35% TMS. At FPHE the steam pressure was kept at 0.7 Kg/cm^2 and cooling rate was fixed at 1515 Watt. The product obtained met the conditions for *Malai Lachha* based sweet with 21.748 % fat, 24.787 % condensed moisture content protein 15.21 %, Sucrose 11.91% and ash 3.346 %.

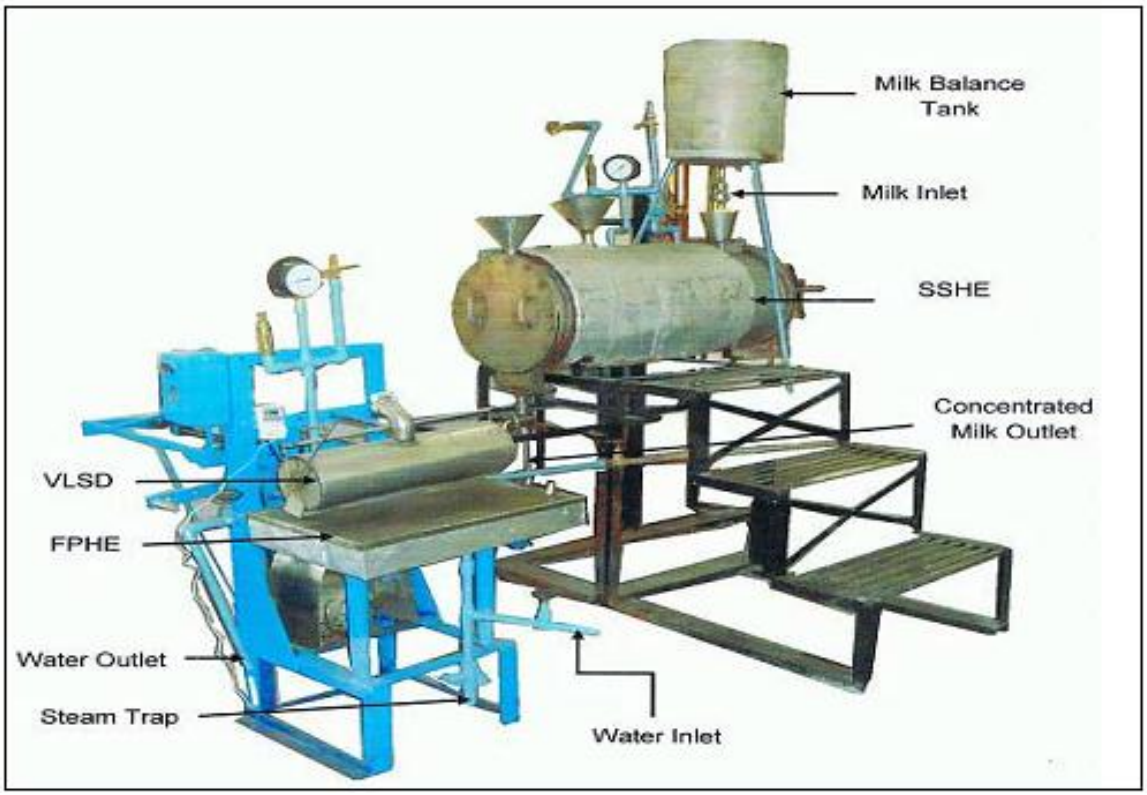

Fig. 1: Experimental set-up for preparation of *Malai Lachha*

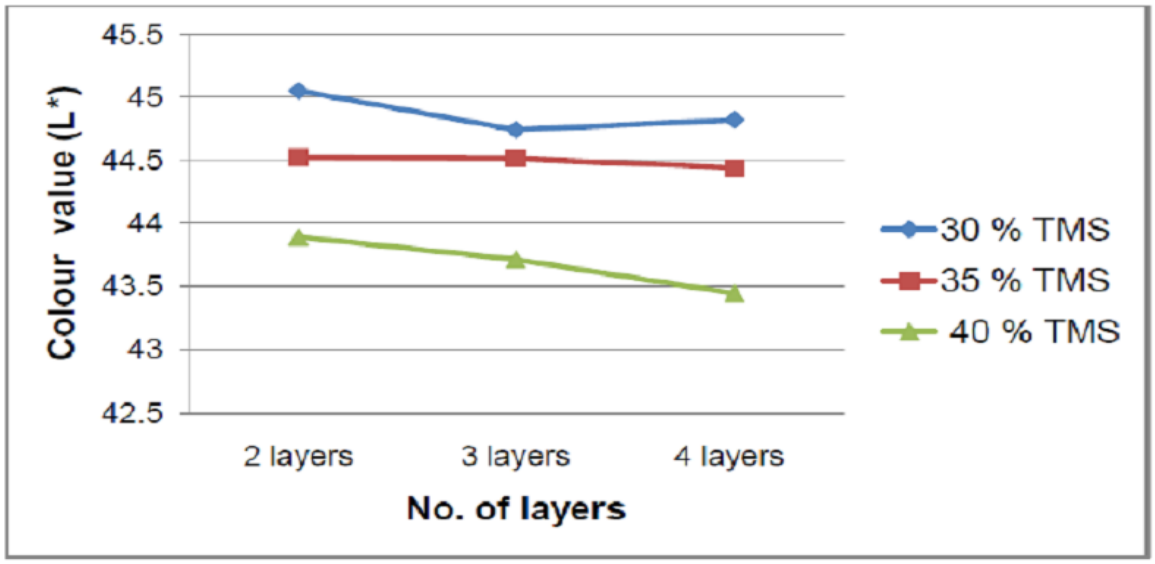

Fig. 2: Effect of No. of layers and feed concentration of milk to FPHE on color value (Top Layer)

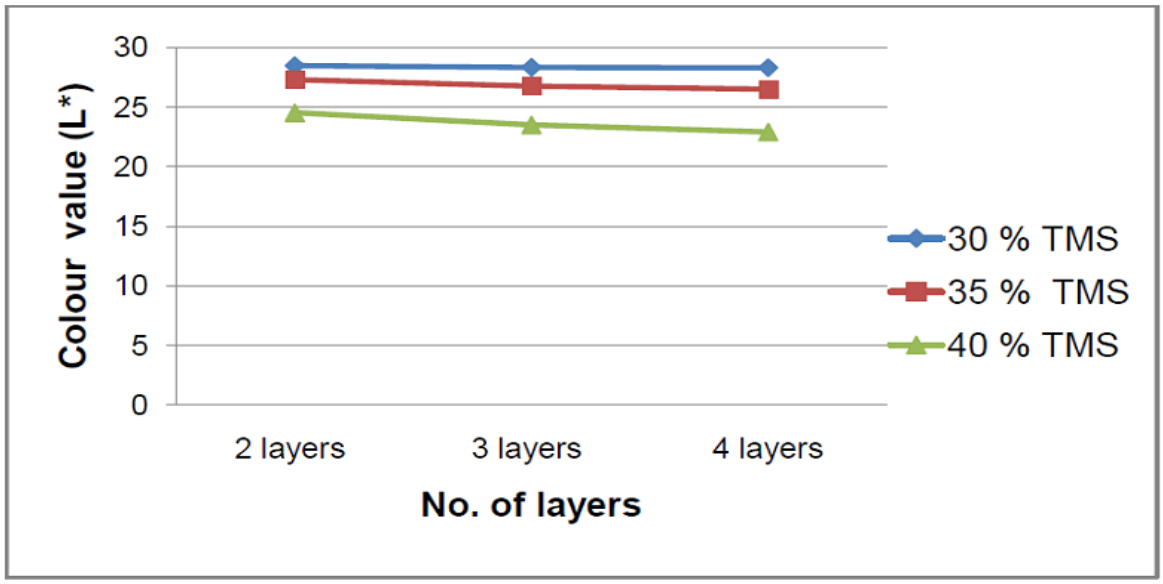

Fig. 3: Effect of No. of layers and feed concentration of milk to FPHE on color value (Bottom Layer)

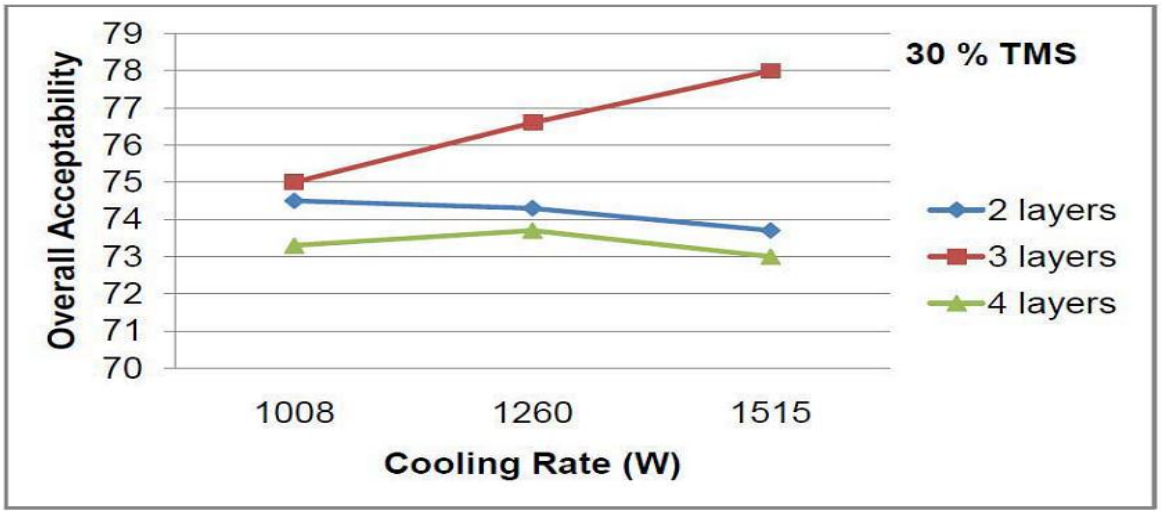

Fig. 4: Overall acceptability score as affected by cooling rate

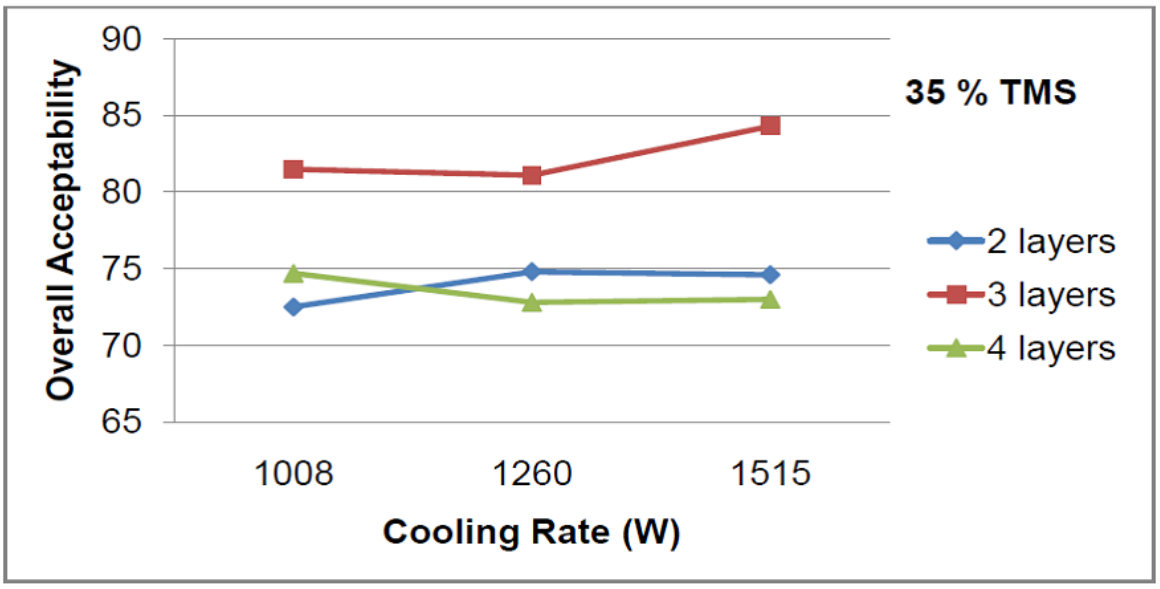

Fig. 5: Overall acceptability score as affected by cooling rate

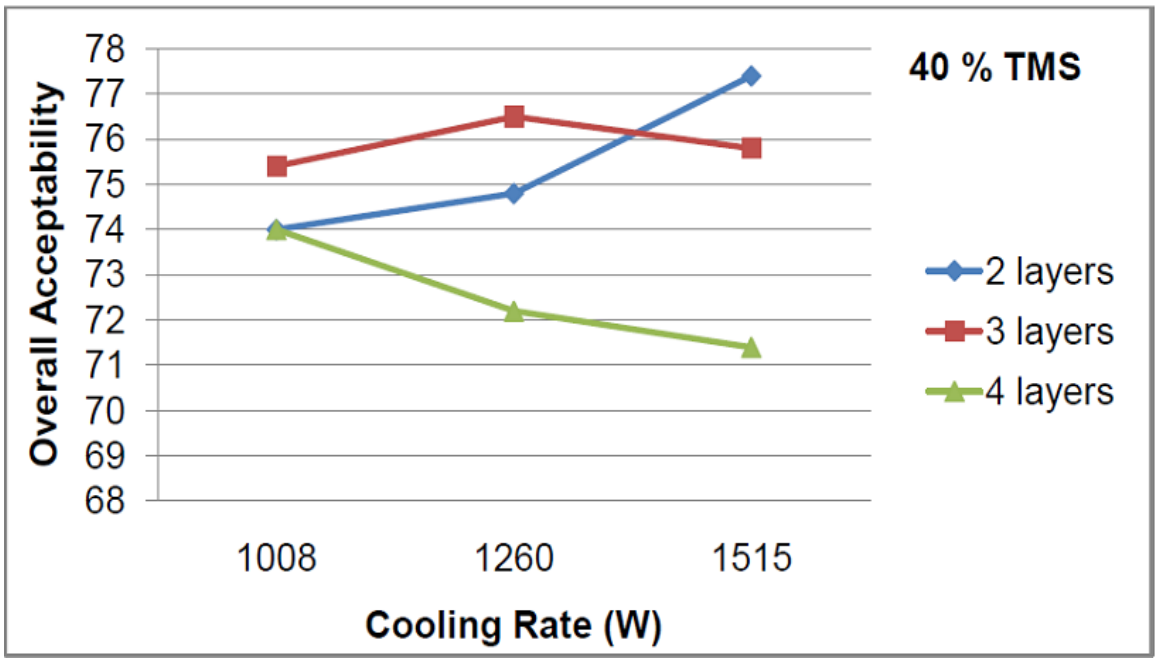

Fig. 6: Overall acceptability score as affected by cooling rate

Table 1: Variation in processing time as affected by steam pressure and initial TMS in SSHE

Steam pressure	Time in Minutes		
	30 % TS	35 % TS	40 % TS
1.0 Kg/ cm^2	24	27	29
1.5 Kg/cm^2	16	20	23
2.0 Kg/cm^2	13	15	17

Table 2: Statistical Analysis for Variation in processing time as affected by steam pressure and initial TMS in SSHE

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F- crit**
Concentration	206.8889	2	103.4444	169.2727	0.000136	6.944271
SSHE Steam pressure	42.88889	2	21.44444	35.09091	0.002908	6.944271
Error	2.44444	4	0.61111			
Total	252.2222	8				

Table 3: Process heating time as affected by the number of layers and feed concentration of milk to FPHE

No. of layers	Time in Minutes		
	30 % TS	35 % TS	40 % TS
4	65	55	50
3	55	51	48
2	50	48	43

Table 4: Statistical Analysis for Process heating time as affected by the number of layers and feed concentration of milk to FPHE

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Concentration	140.667	2	70.3333	10.55	0.02539	6.944271
SSHE Steam pressure	140.667	2	70.3333	10.55	0.02539	6.944271
Error	26.66667	4	6.666667			
Total	308	8				

Table 5: Variation in cooling time as affected by cooling rate and number of layers at FPHE Cooling rate 2 layer 3 layer 4 layer

Cooling Rate	Time in Minutes		
	2 layer	3 layer	4 layer
1008 W	13	17	20
1260 W	10	14	18
1515 W	8	12	15

Table 6: Statistical Table for Variation in cooling time as affected by cooling rate and number of layers at FPHE

ANOVA						
Source of Variation	***SS***	***Df***	***MS***	***F***	***P-value***	***F crit***
No of Layer	37.55556	2	18.77778	169	0.000137	6.944272
Cooling Rate	80.88889	2	40.44444	364	0.00	6.944272
Error	0.444444	4	0.111111			
Total	118.8889	8				

CONCLUSION

Chemical composition of *Malai Lachha* based sweet did not vary significantly with feed concentration of milk (%TS) and No. of layers. The process heating time significantly increased with increase of No. of layers and decrease of feed concentration of milk in FPHE. The cooling time significantly increased with increase in No. of layers and decreased with higher cooling rate. The sensory characteristics of final *Malai Lachha* based sweet was found to be best in case of 35% TMS concentrated milk (3:1 ratio of cow and buffalo milk), 0.7Kg/cm^2 steam pressure in FPHE, 3 layers and 1515W cooling rate with 61 minutes of process time (heating and cooling) among all the combinations, with the sensory score of flavour 42.5, body and texture 29.5, colour and appearance and overall acceptability 84.3. Intensity of colour darkness (L* value) significantly decreased with increase in concentration and No. of layers.

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