

Optimization of Operating Parameters for Continuous Manufacture of *Burfi* in SSHE

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Abstract: Burfi is among one of the traditional Indian dairy products, which is very popular all over India. It has been proved very successful for continuous manufacture of Khoa and Basundi in three stage scraped surface heat exchanger. Burfi was manufactured by adding sugar directly into preheated milk by varying scraper speed all three stages. The performance was evaluated in terms of quality of Burfi manufactured. The quality of Burfi was evaluated in terms of sensory evaluation by the panel of judges. Effect of scraper speed on the quality of Burfi was checked in different 27 scraper speed combinations. Scraper rpm of first, second and third stage 150, 150 and 15 respectively found the best.

Keywords: Burfi, SSHE, Sensory evaluation, scraper speed

I. INTRODUCTION

Traditional Indian dairy products are highly valued in the society as a source of nutrition and are an inseparable part of wedding ceremonies, feasts, festivals and religious occasions. Many traditional dairy products particularly khoa based sweets, Chhanna based sweets, and Paneer have enormous market presence and tremendous consumer base in India and overseas as well. The other popular indigenous milk products such as rabri, shrikhand, basundi, palada payasam etc. are region specific. Burfi is the most popular Khoa based traditional confection all over India. It has variation in flavour, colour, body and texture. Sugar is added in different proportions and other ingredients incorporated according to the demand of consumers. Burfi is prepared by heating a mixture of milk solids (khoa) and sugar to a homogenous consistency followed by cooling and cutting into small cubes. Even today, regardless of volume of production, Burfi is manufactured primarily in jacketed kettles by 'halwais', which inherently suffers from several disadvantages such as batch to batch variation in product quality, poor hygiene and sanitary conditions. The demand for uniform quality of Burfi in the dairy industry attracts the application of continuous processing methods. 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 present investigation was proposed with objectives to evaluate sensory quality of Burfi at different combination of scraper speed of three stage scraped surface heat exchanger.

II. METHODS AND MATERIALS

Experimental set-up: The experimental set up shown in Figure 1 was three stage scraped surface heat exchanger developed by Dodeja et al. [1]. The system includes: Thin Film Scraped Surface Heat Exchangers, Variable speed drives, Balance Tank, Feed Pump, valves for steam supply and Instrumentation.

Selection of raw material

Milk: Fresh buffalo milk and Skimmed milk was procured from Experimental Dairy NDRI, Karnal. Standardization was done to 6% Fat and 9% SNF. Acidity was increased up to 0.17% LA

Sugar: Commercial grade white crystalline sugar purchased from local market has been used in this present investigation.

Caustic Solution: Caustic solution of 0.75% strength was prepared by using sodium hydroxide flakes LR grade for CIP of TFSSHE.

Water: Potable water available at Dairy Engineering Division was used for washing and cleaning.

Burfi manufacturing method

First the buffalo milk was taken, filtered and standardized to a fat 6.0% and SNF 9.0%. This standardized milk is to be preheated to 90 °C for few seconds. This milk was mixed with white crystalline sugar in the balance tank. Then the steam valves of the steam header which are located at the rear side of three stages TFSSHE, were opened manually. The feed pump was then started and flow was varied between 155-205 kg/h with the help of electromagnetic flow meter by controlling the rpm of feed pump from the control panel. The rotor blade assembly of first, second and third TFSSHE was switched on and the speed of all three TFSSHE's were kept fix by control panel. We fix the Steam pressure in first, second and third stage 4 kg/cm², 2 kg/cm² and 1.5 to 2 kg/cm² respectively. Milk is first concentrated in first stage TFSSHE and then enters into the second stage where it is further concentrated. In third stage, we adjust the

steam pressure between 1.5 kg/cm² to 2.0 kg/cm² according observing the body of product coming to third stage, from second stage. The mass flow rate is approximately so adjusted to get the concentration required in the Burfi. From third stage, homogenous mixture of final product was collected in well-greased plates and spreading into uniform thick layer.

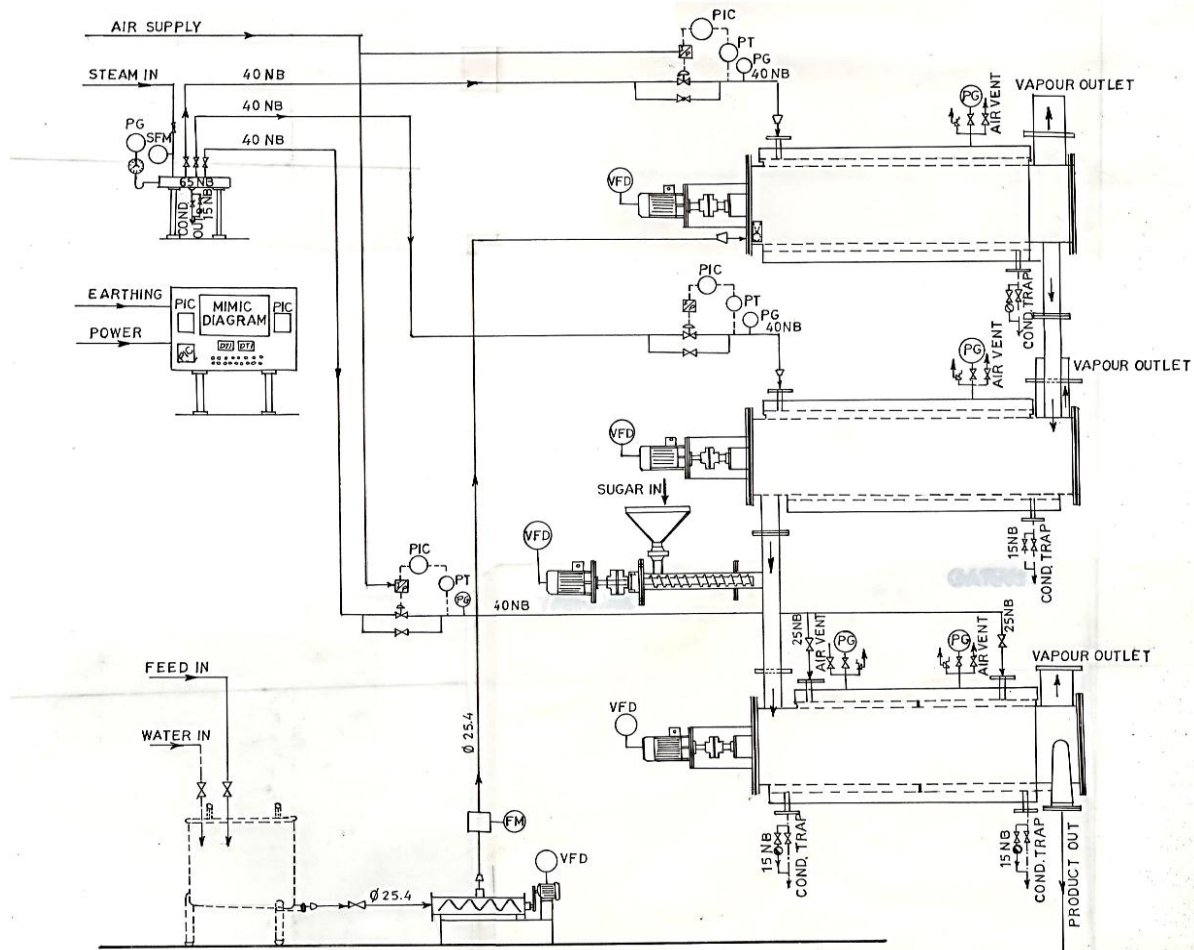


Fig. 1 Experimental Set up

Then cooling was done at room temperature and it was covered with Aluminium foil. When Burfi got properly cooled, it cut into pieces and analysis was done.

Analysis of Burfi: Sensory Evaluation: The Burfi made from fresh standardized buffalo milk have typical sensory attributes, which depends on the process variables under study, viz., steam pressure, rotor rpm, type of sugar dosing method and mass flow rate. The Burfi samples were subjected for sensory evaluation by a panel of 5-7 judges selected from Dairy Technology and Dairy Engineering Division. A 25 point descriptive scale was used (Appendix 1) for panel of judges.

III. RESULTS AND DISCUSSION

Preliminary Studies: Initially trials were conducted using standardized milk (6% Fat, 9% SNF) with different acidity levels (0.16, 0.17, 0.18, 0.19% LA) by using TFSSHE and it was found that size and type of grains formed in final product were most suitable to ideal quality of Burfi in case of using milk with 0.18 % LA. Acidity of milk was adjusted to predetermined value by using either natural souring by keeping it room temperature for some time (if acidity was to be slightly raised) or by addition of small quantities of 10% (w/v) citric acid solution in case acidity was to be raised quite a bit and measuring acidity after addition of citric acid solution. In no case milk was neutralized as milk received never exceeds initial acidity of 0.16 % LA.

In case of milk with 0.16 % LA, there were no grains and product was very pasty in texture and loose body. In case of milk with 0.17 % LA, there were very small amount of grains and product was less pasty in texture as compared to previous level of acidity (0.16 % LA) and with weak body. As acidity was increased to 0.18 % LA, there was good amount of small grains which was most suitable to ideal quality of Burfi. In case of 0.19 % LA there was higher

amount of large and comparative hard grain formation which was suitable for Kalakand. Hence milk with 0.18 % LA was chosen for further optimization studies.

Effect of Scraper Speed on Sensory Attributes: The investigation was carried out to optimize the process parameters of three scraped surface heat exchanger for continuous manufacturing of Burfi in terms of sensory and textural profile analysis of the product. The Table 1 indicates trial codes with scraper speed, milk flow rate and steam pressure.

Effect of Scraper Speed on Flavor: Flavor is an important criterion for deciding the quality of any food product, which in turn, determines its overall acceptability. Table 2 indicates the effect of scraper speed on flavour. It is evident that as scraper speed increases flavour scores decreases. It can be observed from graphs that flavour scores are higher for lower scraper speed of previous stage. This may be due to the fact that at the higher scraper speed, the residence time of the product in the SSHE is reduced which leads to less release of flavouring compounds [2]. The flavour scores varied from 7.66 to 8.5.

Effect of Scraper Speed on Body and Texture: Body and texture is look and feel of how firm, lose or otherwise is the internal structure build-up of the product. It is very important to have a good body and texture of the product as it would affect its overall acceptability. Body and texture of the product must match to ideal body and texture of the Burfi. Table 2 indicates the effect of scraper speed on body and texture. It is evident that as scraper speed increases body and texture scores decreases in third stage. It is because of at lower scraper speed, texture development is good and vice versa. At higher scraper speed of third stage, the product come out side very fast just because of conveying type of scrapers which results into moist and loose product due to less heat transfer. At lower scraper speed of third stage, product come out side slowly and get higher residence time for texture development and good heat transfer occurs and results into good and hard body. It can be observed from graph that body and texture scores are highest when scraper rpm of second stage is kept at 150 and decreases on either side of 150 rpm. Also body and texture scores are lowest at lowest or highest values of rpm. Lower scraper rpm of second stage gives loose body and at higher scraper rpm of second stage gives slight sandiness in final product [2]. The body and texture scores varied from 5.8 to 8.5.

Effect of Scraper Speed on Colour and Appearance: Colour and appearance is a very important attribute of any food product as it is the first thing to be observed without any touch or feel from distance. Hence every food product is required to have a good colour and appearance in order to be further tested organoleptically as one would not feel like eating or even tasting a bad colouring or bad appearing product. Table 2 indicates the effect of scraper speed on colour and appearance. It is evident that as third stage scraper speed increases color and appearance scores decreases. As first stage scraper speed increases colour and appearance scores also increases. It can be observed from graphs that colour and appearance scores are higher when scraper speed of second stage is kept 150 to 175 rpm and lower than first stage scraper speed [2]. The colour and appearance scores varied from 3.33 to 4.5.

Effect of Scraper Speed on Overall Acceptability: Table 2 indicates the effect of scraper speed on overall acceptability. It is evident that as scraper speed of third stage increases overall acceptability scores decreases. It can be observed from graphs that overall acceptability scores are highest when scraper speed is kept at 150 rpm in first and second stage and decreases on either side of 150 rpm. Also overall acceptability scores are lowest at lowest or highest [2]. The overall acceptability scores varied from 17.5 to 21.12.

Table I Trial Codes with Scraper Speed and Steam Pressure

Trial Code	Milk flow rate (kg/h)	Scraper speed (rpm)			Steam Pressure (kg/cm ²)		
		1 st Stage	2 nd Stage	3 rd Stage	1 st Stage	2 nd Stage	3 rd Stage
T 1	205	200	200	25	4	2	1.6
T 2	205	200	200	20	4	2	1.6
T 3	205	200	200	15	4	2	1.5
T 4	200	200	175	25	4	2	1.7
T 5	200	200	175	20	4	2	1.6
T 6	200	200	175	15	4	2	1.6
T 7	195	200	150	25	4	2	1.9
T 8	195	200	150	20	4	2	1.8
T 9	195	200	150	15	4	2	1.6
T 10	200	175	175	25	4	2	1.8
T 11	200	175	175	20	4	2	1.7
T 12	200	175	175	15	4	2	1.6
T 13	190	175	150	25	4	2	1.8
T 14	190	175	150	20	4	2	1.7
T 15	190	175	150	15	4	2	1.7
T 16	175	175	125	25	4	2	2
T 17	175	175	125	20	4	2	2
T 18	175	175	125	15	4	2	1.9
T 19	185	150	175	25	4	2	1.6

T 20	185	150	175	20	4	2	1.6
T 21	185	150	175	15	4	2	1.6
T 22	170	150	150	25	4	2	2
T 23	170	150	150	20	4	2	1.9
T 24	170	150	150	15	4	2	1.9
T 25	155	150	125	25	4	2	2
T 26	155	150	125	20	4	2	2
T 27	155	150	125	15	4	2	1.9

Table III Effect of Scraper Speed on Sensory Score of the Burfi

Trial Code	Sensory Evaluation Score			
	Flavor (10)	Body & Texture (10)	Color & Appearance (5)	Overall acceptability(25)
T 1	7.6	6.8	3.6	18.1
T 2	7.8	7.1	3.8	18.8
T 3	8.0	7.7	4.1	19.9
T 4	7.8	7.1	4.1	19.1
T 5	8	7.5	4.1	19.6
T 6	8.0	8	4.3	20.4
T 7	7.9	7.3	3.3	18.5
T 8	8	7.8	3.8	19.7
T 9	8.1	8.2	4.1	20.5
T 10	8	7.1	3.8	19
T 11	8.1	7.6	4.3	20.1
T 12	8.1	7.8	4.5	20.5
T 13	8	7.2	3.6	18.8
T 14	8.1	7.6	3.8	19.6
T 15	8.1	8	4.1	20.3
T 16	8	7	3.6	18.6
T 17	8.1	7.3	3.5	19.0
T 18	8.2	7.3	3.6	19.2
T 19	8.1	7.3	3.7	19.2
T 20	8.1	7.5	3.8	19.5
T 21	8.2	7.8	3.8	20
T 22	8.1	7.3	3.8	19.3
T 23	8.1	8.3	4.1	20.6
T 24	8.3	8.6	4.2	21.1
T 25	8.1	5.8	3.5	17.5
T 26	8.2	6.2	3.6	18.1
T 27	8.5	6.3	3.8	18.6

* Each value is average of three replications.

IV. CONCLUSION

The present study had been undertaken to optimize the process parameters of three stage scraped surface heat exchanger using milk having 6% Fat, 9% SNF and 0.18% LA for continuous manufacture of Burfi. The investigation was carried out to optimize the various process parameters like Milk Flow rate, Scraper speed and third stage steam pressure to get the best quality of Burfi and quality was determined using Sensory evaluation. In sensory characteristic scores, flavor increases with decrease in scraper speed, body and texture score is good in medium speed i.e. 150, colour and appearance score is increases with increase in speed. We found very good overall acceptability in trial no T24 using scraper RPM 150, 150 and 15 in first, second and third stage respectively.

REFERENCES

- [1]. Anon, "Managing growth is the challenge". In: Dairy India 2007, 6th Edn. Dairy India Yearbook, New Delhi: 15-42, 2007.
- [2]. A. K. Dodeja and A. Deep, "Mechanized manufacture of danedar khoa using three stage SSHE". Indian journal of dairy science, 65(4), 2012.

APENDIX-1

BURFI SCORE CARD

Please give the score and mark the defects in the space allotted for the sample.

Perfect score	Criticism	Score
Flavor (10)	Judge's score	
	Burnt	
	Stale	
	Salty	
	Oxidized	
	Rancid	
	Sour	
	Flat/Lacking	
	Metallic	
	Any other	
Body & Texture (10)	Judge's score	
	Weak/Loose	
	Grainy	
	Sandy/Gritty	
	Hard	
	Brittle	
	Sticky/Pasty	
	Chewy	
Any other		
Color & Appearance (5)	Judge's score	
	Uneven/ Mottled	
	Moist/Wet	
	Dry	
	Moldy	
	Oily	
Any other		
Total score (25)		

SCORE GUIDE FOR BURFI

Intensity of Defects	Score to be assigned	
	Flavor & Texture	Color & Appearance
Slight	> 7-9	>3-4
Moderate	>5-7	>2-3
Pronounced	3-5	1-2
Unacceptable	<3	0

Date:

Comments:

Signature