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RESEARCH PAPER

Process optimization for mechanized production of Doda Burfi using scraped surface heat exchanger

■ R. DEVARAJU*, MOHANJEE LAL, G. MAHESH KUMAR[1] AND R.K. KHOLI[2]

Department of Dairy Engineering, Dairy Science College, GULBARGA (KARNATAKA) INDIA (Email : draj.raju20@gmail.com, mohanjeelal@gmail.com)

[1]Department of Dairy Engineering, Dairy Science College, BENGALURU (KARNATAKA) INDIA (Email : dairyengineer@gmail.com)

[2]National Dairy Research Institute, KARNAL (HARYANA) INDIA

*Author for Correspondence

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SUMMARY :

Doda Burfi is region specific traditional Indian dairy product popular in northern states specially Punjab and Haryana. The product has pleasant characteristic nutty flavor. This product is highly nutritious. But even today it is manufactured by traditional method, which inherently suffers from various limitations, *viz*,, non-uniform quality, batch to batch variations etc. Scraped surface heat exchanger (SSHE) seems to be most suitable heat exchanger for handling high viscosity and heat sensitive products, which tend to foam and foul heat transfer surface. Therefore, it was planned to study on mechanized production of Doda Burfi using SSHE. Doda Burfi was manufactured by adding precooked germinated wheat flour, colour, skim milk powder, citric acid solution, sugar (50% of total sugar initially added into milk at 70^0C and remaining 50% sugar at 40% total solids). The investigation was carried out to optimize the various process parameter like scrapper speed (100, 125 and 175 RPM), steam pressure (1, 1.5, 2 and 2.5 kg/cm^2) The performance was evaluated on the basis of sensory evaluation (9 point hedonic scale). The best quality of Doda Burfi was found at scraper speed of 100 RPM, 2 kg/cm^2 steam pressure, decrease in overall acceptability score was found by further increase in scraper speed and steam pressure. Scrapper speed and steam pressure have shown significant effect ($P<0.05$) on sensory scores.

KEY WORDS : Doda Burfi, Germinated wheat flour, Skimmed milk powder, Sugar, SSHE

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Milk has been described as nature's nearly "perfect food" in that it provides vital nutrients like proteins, essential fatty acids, vitamins, minerals, lactose in balanced proportions. Traditional Indian dairy products contain a significant proportion of milk nutrients and, therefore, are highly nutritious. Burfi is the most popular Khoa based traditional confection all over India. The generic nomenclature "Burfi" covers a wide range of product variations that include plain, danedar, dudh, chocolate etc. has variation in flavor, color, body and texture. 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. These products are very delicious and good for health. The addition of cereals like wheat and rice, fruits, fruit pulps and vegetables in milk results into value addition in terms of nutrition. It is a common practice in Indian continent to consume milk along

with cereals and fruits. These products are highly nutritious and contain minor constituents that are deficient in milk are supplemented by cereal and vice versa. Such type of product is also very useful for infants and growing children's because of its flavor and its nutritional value, which provides essential nourishment for the body growth and maintenance in infants (Rajoria, 2000). The several type of foods or milk products are developed based on cereals foods such as malt milk food, infant foods etc. which are very nutritious, healthy and popular food (Aneja *et al.*, 2002).

In this manner sprouted wheat based milk product called Doda Burfi, a softer fudge like variation–resembling Burfi called 'Doda' is region specific traditional Indian dairy product quite popular in northern state specially Punjab and Haryana. The product has pleasant characteristic nutty flavor. This product is highly nutritious. Even today, Doda Burfi is manufactured primarily in 'karahi' and jacketed kettles by 'halwais', which inherently suffers from several disadvantages such as low heat transfer rates, high fouling behavior, heat losses, batch to batch variation in product quality, poor hygiene and sanitary conditions. The demand for efficient and labor saving processing of Doda Burfi attracts the application of mechanization 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. Studies on the applicability of scraped surface heat exchanger for the mechanization of Doda Burfi are also important field of investigation. In SSHE, the heat transfer wall is continuously scraped thus minimizes heat induced changes by minimizing the residence time distribution. In light of above facts, It is proposed to optimize various process parameters for manufacture of Doda Burfi. The quality of Doda Burfi so produced will be evaluated in terms of sensory evaluation using 9 point hedonic scale. Statistical analysis of sensory evaluation was done using two way ANOVA without interaction.

EXPERIMENTAL METHODS

Horizontal scraped surface heat exchanger :

The scraped surface heat exchanger of 304 stainless steel was fabricated having 40 cm I.D., 0.3 cm wall thickness and 100 cm overall length. Mild steel jacket of 45 cm I.D. 0.3 cm wall thickness has been provided. The effective heating length is 65 cm. The heat exchanger has been provided with glass wool of 5 cm thickness. The end covers of heat exchanger are of 0.6 cm thickness and of 45 cm diameter. The rectangular outlet from heat exchanger of 15 cm by 7.5 cm for the finished product has been provided with a regulating slit to control the flow of product. The machine has been provided with regulating and safety valves for steam. The machine components have been assembled and fitted on an angle iron frame with an inclination of 20 mm. Rotor assembly is of S.S blades of length 53 cm with 2.2 cm width has been hinged. The thickeness of blade is 0.16 cm.

Incubator :

Incubator was used to maintain the constant required temperature for germination of wheat at 25 ± 1^0C. Water was placed in the incubator to maintain the humidity. Formaldehyde was placed in the small beaker to avoid growth of yeast and molds during germination.

Tray dryer :

Tray dryer was used for drying the sprouted wheat grains at $60^0C\pm5^0$C for 5-6 hours. A perforated aluminum tray was used to dry the sprouted wheat grains.

The buffalo milk used in manufacture of Doda Burfi was analyzed for their composition *i.e.* fat, total solids, SNF, and titrable acidity. It has been taken and filtered using muslin cloth, then standardized to 6 per cent milk fat and 9 per cent SNF. This standardized milk was pre-heated to 70^0C in SSHE. (0.04%) of citric acid (2 - 4 % solution) was added in order to obtain granular texture of the product. Sugar 1st stage *i.e.*, 50% of total weight of crystalline sugar along with skim milk powder and chocolate brown colour in the requisite quantity were weighed, mixed and blended. The complete liquid mass was taken in overhead tank. When it allowed to flow in the SSHE the single pulley speed drive of SSHE was switched on to make the scraper assembly to rotate at 100, 125, and 175 rpm, respectively. Then the steam valve of the steam header located above the SSHE was opened manually and adjusted to the required pressure at 1, 1.5, 2, and 2.5 kg/cm^2, respectively. Precooked germinated wheat flour was added into the system through the optional inlet cone one provided above the SSHE. Remaining 50% sugar was added after 40 per cent of total solid concentration. After final concentration the Doda Burfi so formed was collected in trays and then weighed. The product was cooled for 3 hours at room temperature and analysis was done. The time consumed for processing of Doda Burfi in SSHE was 45 – 50 min. for 10 litres quantity of buffalo milk. The experiment was repeated with different scraper speed and steam pressure. Doda Burfi manufactured was analysed for following parameters. The moisture content of the standard product has been determined by the standard procedure described in ISI:XI (1981). The Doda Burfi made has been subjected for sensory evaluation by a panel of judges.

EXPERIMENTAL FINDINGS AND ANALYSIS

Fig. 1 and Table 1 indicate the effect of scraper RPM and steam pressure on flavour of the product. It is evident that as scraper speed increased, flavour score decreased. Flavour score increased as steam pressure increased up to 2.00 kg/cm^2 and decreased above 2.00 kg/cm^2. It is also observed from Fig. 1

that flavour scores were higher for lower speed of scraper. 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 flavoring compounds at higher speeds.

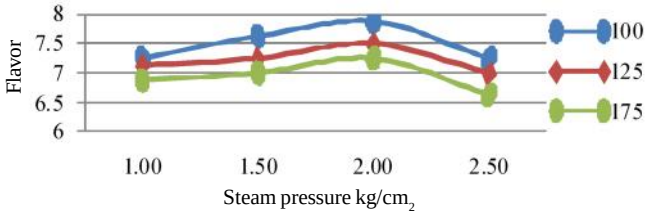

Fig. 1: Effect of steam pressure and scraper RPM on flavour

Table 1 : ANOVA for flavour

SOV	SS	df	MS	F	P-value	F crit
SP	0.5872	3	0.1957	34.6923	0.0003	4.7570
RPM	0.6328	2	0.3164	56.0769	0.0001	5.1432
Error	0.0338	6	0.0056			
Total	1.2539	11				

Fig. 2 and Table 2 indicate the effect of scraper RPM and steam pressure on body and texture. It is evident that as scraper speed increased body and texture scores decreased. Body and texture score increased as steam pressure increased up to 2.00 kg/cm^2 and further decreased with increase in steam pressure. It is because of at lower scraper speed, texture development is good and vice versa. Particle damage increases with increase in scraper RPM due to particle blade collisions.

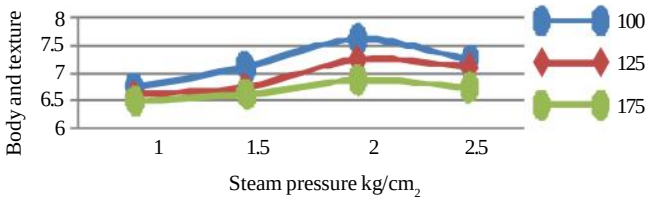

Fig. 2: Effect of steam pressure and scraper RPM on body and texture

Table 2 : ANOVA for body and texture

SOV	SS	df	MS	F	P-value	F crit
SP	0.6510	3	0.2170	15.625	0.0030	4.7570
RPM	0.5	2	0.25	18	0.0029	5.1432
Error	0.0833	6	0.0138			
Total	1.2343	11				

Fig. 3 and Table 3 indicate the effect of scraper RPM and steam pressure on color and appearance. It is evident that as scraper RPM increased colour and appearance scores decreased. As steam pressure increased colour and appearance scores also increased. Lower scraper speed and higher steam pressure gave pronounced brown colour which is more desirable. It is observed from Fig. 3 that colour and appearance scores were higher when scraper RPM was kept at 100 rpm and at 2 kg/cm^2 steam pressure.

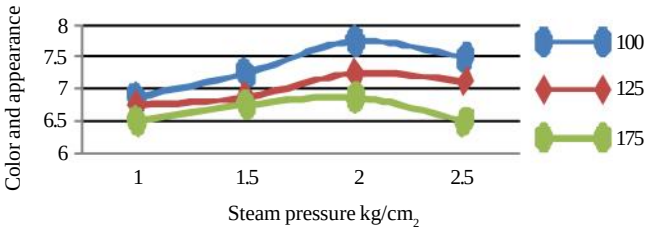

Fig. 3: Effect of steam pressure and scraper RPM on color and appearance

Table 3 : ANOVA for color and appearance

SOV	SS	df	MS	F	P-value	F crit
SP	0.5208	3	0.1736	6.5573	0.0253	4.7570
RPM	0.9453	2	0.4726	17.8524	0.0029	5.1432
Error	0.1588	6	0.0264			
Total	1.625	11				

Fig. 4 and Table 4 indicate the effect of scraper speed on overall acceptability. It is evident that as scraper RPM increased overall acceptability scores decreased. It is also observed from figure that overall acceptability score was highest when scraper speed was kept at 100 rpm and decreased at 125 and at 175 rpm, respectively. Overall acceptability scores were highest at 2 kg/cm^2 steam pressure and decreased at 2.5 kg/cm^2.

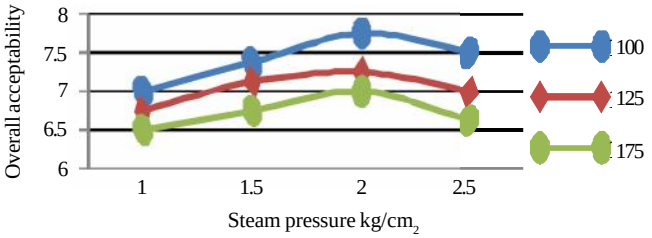

Fig. 4: Effect of steam pressure and scraper RPM on overall acceptability

Table 4 : ANOVA for overall acceptability

SOV	SS	df	MS	F	P-value	F crit
SP	0.5143	3	0.1714	19.75	0.0016	4.7570
RPM	0.9479	2	0.4739	54.6	0.0001	5.1432
Error	0.0520	6	0.0086			
Total	1.5143	11				

Fig. 5 and Table 5 indicate the effect of scraper RPM and steam pressure on moisture content. It is evident that moisture content decreased as scraper RPM and steam pressure increased. It was observed from figure that moisture content was higher for lower scraper RPM and at lower steam pressure. It is due to fast evaporation at higher scraper RPM and steam pressure. Also at higher scraper RPM and higher steam pressure there was a rupturing of gelatinized wheat grain, and product became softer.

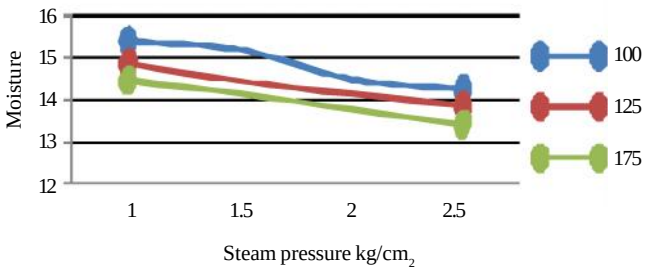

Fig. 4: Effect of steam pressure and scraper RPM on moisture

Table 5 : ANOVA for moisture

SOV	SS	df	MS	F	P-value	F crit
SP	2.0505	3	0.6835	74.2934	3.9E-05	4.7570
RPM	1.4922	2	0.7461	81.1014	4.54E-05	5.1432
Error	0.0552	6	0.0092			
Total	3.5979	11				

There was a significant effect of scraper RPM and steam pressure on flavour, body and texture, colour and appearance, and on overall acceptability of the product. It also showed a significant effect of scraper RPM and steam pressure on moisture content of the product (Table 6).

Table 6 : Effect of scrapper speed and steam pressure on sensory evaluation of Doda Burfi using 9 point hedonic scale

Scrapper RPM	Steam pressure kg/cm^2	Flavor	Colour and appearance	Body and texture	Overall acceptability	Moisture
100	1.0	7.25	6.75	6.75	7.00	15.40
100	1.5	7.50	7.25	7.00	7.25	15.19
100	2.0	7.75	7.75	7.50	7.75	14.49
100	2.5	7.25	7.50	7.25	7.50	14.26
125	1.0	7.00	6.75	6.50	6.75	14.87
125	1.5	7.25	7.00	6.75	7.00	14.45
125	2.0	7.50	7.25	7.25	7.25	14.15
125	2.5	7.00	7.00	7.00	7.00	13.87
175	1.0	6.75	6.50	6.50	6.50	14.46
175	1.5	7.00	6.75	6.75	6.75	14.15
175	2.0	7.25	6.75	7.00	7.00	13.77
175	2.5	6.50	6.50	6.75	6.50	13.42

Conclusion :

- Flavour, body and texture, colour and appearance and moisture score increased with decreasing scrapper rpm and increased with increasing steam pressure.
- Overall acceptability score of 7.75 was found at 100 scraper rpm and at 2 kg/cm² steam pressure.
- Best combination - 100 rpm at 2 kg/cm² and addition of GWF, color initially into milk, gave highest sensory score.

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