J Food Sci Technol (January–February 2010) 47(1):114–118
ORIGINAL ARTICLE

Effect of processing variables on quality of milk *burfi* prepared with and without sugar

Chetana R. · **Ravi R.** · **Yella Reddy S.**

Revised: 14 August 2008 / Accepted: 19 June 2009
© Association of Food Scientists and Technologists (India), Mysore

Abstract Milk *burfi* is an Indian traditional confectionery prepared using concentrated milk and sugar. The texture and quality of *burfi* vary depending on processing conditions and storage period. The effect of processing variable namely total soluble solids (TSS) at the end of cooking and duration of storage on the texture and sensory quality of *burfi* prepared with and without sugar was studied by applying response surface methodology. Sorbitol with and without added aspartame was used as sugar alternative. Simultaneous optimization by desirability approach was carried out on the independent variables to get the optimum levels within the experimental conditions. It was found that the optimum conditions for *burfi* prepared with sugar were: TSS of 78°B and 2–3 days of storage. *Burfi* prepared at optimum conditions had a breaking strength of 13.3 N with a sensory overall acceptability score of 9.5 on a 10-point scale. Similarly, for *burfi* prepared with sorbitol to obtain a product close to its sugar counterpart required a TSS of 77.5°B and storage for 5–6 days to obtain a breaking strength of 12.9 N and a sensory overall acceptability score of 9.1.

Keywords Milk *burfi* · Sugar · Sorbitol · Sweetener

Introduction

Milk *burfi* is one of the most popular milk based sweets in India. *Burfi* is prepared by heating a mixture of concentrated milk solids (*Khoa*) and sugar to a near homogenous consistency followed by cooling and cutting into small cuboids. Beating and whipping operations prior to cooling are sometimes practiced to obtain a product with smooth texture and closely knit body. Several varieties of *burfi* are available in the market such as plain or *mawa/khoa burfi*, fruit and nut, cashew *burfi*, chocolate, saffron and *rava burfi*. *Burfi* sold commercially varies widely in colour, body, texture, sweetness and flavour characteristics (Sarkar et al. 2002). Variations in ingredients, their proportions and processing conditions affect the quality of *burfi, and* lack of knowledge in these aspects is a serious limitation for the process standardization and quality control. Although the Bureau of Indian Standards has laid down a standard for chemical and microbiological quality of milk *Burfi* (ISI 1970), there is a need for generating data on optimising processing and quality of milk *burfi*.

Public awareness of health risks involved with consumption of sugar and sugar rich products has created a demand for low sugar or sugar-free products. The discovery of a large number of new sweeteners over the past few decades has led to the development of various sugar-free or low sugar products, particularly for diabetics and people using special diets or prone to obesity (Ozdemir and Sadikoglu 1998). *Burfi* with sucralose, its analyses and storage stability are recently reported and found that *burfi* sweetened with low-calorie sweeteners ranked lower in various textural attributes compared to sucrose sweetened *burfi* even on storage (Arora et al. 2007, 2009). However, in confectionery products and traditional sweets, sugar does more than providing sweetness; it provides bulk, lowers water activity and modifies texture. High intensity sweeteners can not perform other physical functions of sugar except sweetness. Therefore, in the preparation of sugar-free sweets, the use of polyols or other polymeric bulking agents are necessary to obtain required texture and body. Polyols alone or combined with other sweeteners can be used to produce specialty sweets/confections for diabetics. These sugar replacers are physically, chemically and microbiologically stable (Bunting 1994). In order to replace sugar without affecting the desirable characteristics of a product, the formulation and processing parameters need to be optimized.

Chetana R.[1] · Ravi R.[2] · Yella Reddy S.[1]
[1]Department of Lipid Science and Traditional Foods;
[2]Department of Sensory Science, Central Food Technological Research Institute, (Council of Scientific and Industrial Research),
Mysore - 500 020, India

Reddy Y. S. (✉)
E-mail: sy_reddy@yahoo.com

Several workers have used response surface methodology (RSM) for optimization studies of cake formulations (Macdonald and Bly 1966, Kissel and Marshall 1967) *Tandoori roti* (Saxena and Rao 1986) and *puri* and south Indian *parotta* (Dasappa and Venkateshwara Rao 2001). In the present study RSM was applied to optimize process parameters to get good quality sugar-free burfi similar to sugar counterpart.

Materials and methods

Sorbitol syrup (68% solids), GRAS chemical (FDA 1993), was obtained from Maize Products, Ahmedabad, Gujarat, India. Aspartame used in the study was obtained from Ajinomoto Company Inc., Tokyo, Japan. Sucrose (cane sugar), *khoa* (semisolid concentrated milk) and hydrogenated vegetable fat were procured from the local market. *Khoa* used in this study contained moisture 22%, protein 25% and fat 32% as determined by AOAC (2005) methods.

Preparation of burfi: *Burfi* was prepared by following the traditional method of preparation (Sachdeva and Rajorhia 1982, Sarkar et al. 2002). A mixture of *khoa* (100 g), sugar (30 g) and fat (5 g) were heated till the mass reached total soluble solids (TSS) of 75, 78 or 80°B as measured with a hand refractometer (Erma, Japan). The hot mass was then transferred to a plate, cooled, spread evenly and cut into pieces of size 50 × 40 mm having average thickness of 10 mm. Sugar-free *burfi* was also prepared in the same manner, replacing sugar with sorbitol. However, aspartame was added at 200 ppm as permitted by PFA (2004) after cooking to obtain a sweetness level comparable to that of sugar.

Experimental design: The important independent processing variables selected were: TSS at end point (X_1) and storage days (X_2). The response variables were: the texture of *burfi* as measured by instrumental breaking force (snap), expressed in Newton (N) and the overall acceptability sensory score. These two response functions were selected as the total quality indicators. A central composite rotatable design developed by Box and Wilson (1951) was adopted to optimize the processing conditions. For 2 variables, 13-design points were selected with a central point replicated 5 times.

Texture measurement of burfi: The breaking strength of *burfi* was measured using a Universal Testing Machine (Llyods Instruments, Model LR 5K, UK). The sample dimension was 50 × 40 × 10 mm (length x breadth x thickness) with a span length of 30 mm, the 3-point break test was performed using a load cell of 50 N and replicated 6 times with a crosshead speed of 50 mm/min. The force required to break the *burfi* into 2 pieces was recorded as the breaking strength.

Sensory analyses: Sensory evaluation was carried out with a panel of 12 trained judges, using a 10-point linear rating scale (Amerine et al. 1965). The judges were asked to mark the perceived overall quality based on colour, snap, hardness, sweetness, lingering sweetness and off taste.

Statistical analysis: Experimental data were analyzed by the response surface regression procedure using statistical software Statistica'99 (Stat Soft Inc, USA). The following quadratic polynomial equation was used to fit the second order response surface (Montgomery 1997).

$$Y = b_0 + b_1X_1 + b_2X_2 + b_{11}X_1^2 + b_{22}X_2^2 + b_{12} X_1 X_2$$

Three dimensional response surfaces with independent variables against response variables were created from quadratic equation. Simultaneous optimization of independent variable with desired response values were done by desirability approach described by Derringer and Suich (1980), where the value of each desirability ranged from 0 (minimum) to 1 (maximum) as desirability of the associated response increased the one sided transformation suggested. The higher the desirability values the more desirable the system and thus, maximization of the response functions were achieved.

Results and discussion

Moderately sweet taste, good breaking strength and a slightly greasy body with smooth texture and very fine grains characterize a highly acceptable *burfi*. Preliminary studies were conducted to find out the critical process parameters for RSM studies. Snap, a critical quality parameter of *burfi*, was found to increase (harden) during storage. Quality of *burfi* was influenced by TSS at the end of cooking during processing and also by storage period. Preliminary trials were conducted to fix the limits for TSS and storage days. This study indicated that *burfi* made with sugar by cooking to TSS of 75°B had a snap value of 4.4 N on the 1st day, while the same with TSS of 80°B and 10 days storage had 19.7 N (data not shown). For *burfi* with sorbitol, the values were 2.4 N and 16.1 N, respectively. An end point having of 80°B and a storage period of 2–3 days were found to be optimum for *burfi* with sugar to get desirable quality characteristics. In order to obtain a product without sugar (sorbitol) similar to that of sugar, it was necessary to have a TSS content of 77–78°B and to store the *burfi* for 5–6 days. The fresh product with sorbitol was soft unlike its sugar counterpart and was acceptable and to get texture similar to that of control, it required 5–6 days due to difference in crystallization between sugar and sorbitol and hence it was considered as optimum. Arora et al. (2007) reported higher hardness in sucrose sweetened *burfi* than those sweetened with low calorie sweeteners like sucralose, acesulfame K, aspartame and saccharin, mainly due to higher solids contributed by sucrose. However, in the present *burfi*, the differences were due to differences in crystallization.

Graining, a desirable attribute in *burfi* is mainly responsible for the breaking strength. This was observed in products prepared with sugar and also in sorbitol containing products, though delayed. This could be explained by the fact that graining might have occurred after preparation and during storage in *burfi* with sorbitol influencing the breaking strength, similar to *burfi* with sugar. However, the process was delayed in the former.

Effect of TSS and storage period on quality of sugar and sorbitol burfi: Instrumental texture and overall quality were markedly influenced by the TSS and storage period, as reflected in the response values (Table 1).

The ANOVA showed that the adequacy of the model (lack of fit) was not significant ($p<0.05$) for breaking strength and overall quality for *burfi* with sugar and for sorbitol *burfi*. The variation of the data was adequately explained by the coefficient of determination (R^2) values. The R^2 for *burfi* with sugar was 0.6349 and 0.7850 for texture and overall quality, respectively. For *burfi* with sorbitol the R^2 values were 0.894 and 0.9117 respectively. These results indicated that 2 fitted models adequately represented the data.

In *burfi* prepared with sugar, the TSS and storage period had significant influence on hardness as indicated by the breaking force (Fig. 1A). The overall sensory quality improved with increasing TSS and days of storage. The overall sensory quality increased with increasing days of storage, when prepared with TSS of low concentration, which is reversed when TSS were increased. The overall quality increased with increase of TSS from 75 to 80°B (Fig. 1B). When TSS ranged from 78–82°B, *burfi* was acceptable for 6–7 days, after which the hardness increased with surface dryness.

The surface plot of texture as a function of storage days and TSS showed a marginal increase in breaking strength of *burfi* with sorbitol, as TSS and days of storage increased. On storage, the breaking strength increased indicating probable graining which was rather slow compared to that of *burfi* with sugar (Fig. 1C). The highest breaking strength values (14 to 16 N) were associated with about 10 days of storage.

The overall acceptability of *burfi* prepared with sorbitol (Fig. 1D) generally increased with an increase in days of storage up to 10 days, but was optimum at 5 days. At lower TSS (75°B) and after 2 days of storage, the overall quality was low (6.1), which increased to 9.1 at 80°B and 5–6 days of storage. The TSS had a curvilinear effect on overall quality and a TSS of 78°B was best suited for *burfi* made with sorbitol.

Optimization of burfi processing: In order to find the optimum conditions for obtaining a desirable *burfi* having maximum overall quality and optimum texture, simultaneous desirability function approach was followed. The optimized values for *burfi* prepared with sugar were 80°B with 2–3 days of storage. This *burfi* had an optimum overall sensory score of 9.5 and a breaking strength of 13.3 N. For *burfi* prepared with sorbitol, the optimum values were 77.5°B, which is very close to experimental value of 78°B and 5–6 days of storage for obtaining a product having an overall acceptability of 9.1 and breaking strength of 12.9 N.

Conclusion

Sugar-free *burfi* could be prepared using sorbitol along with aspartame and the product was comparable in quality with its sugar counterpart. RSM was used to study the effect of processing variables such as total soluble solids (°B) and days of storage on response functions such as texture and overall acceptability in order to optimize process parameters. The TSS content is an indicator of end point in the preparation of *burfi*. The optimum conditions for *burfi* with sugar were a breaking strength of 13.3 N and a sensory overall acceptability score of 9.5 and these could be achieved at TSS of 80°B and for storing up to 2–3 days. In

Table 1 Central composite rotatable design (CCRD) with response variables

Design points	Coded variables		Uncoded variables		*Burfi* with sugar		*Burfi* with sorbitol	
	X_1	X_2	°Brix	Days	Breaking strength, N	OQS	Breaking strength, N	OQS
1	–1	–1	75.7	2.3	8.2	6.0	4.9	6.1
2	–1	1	75.7	8.6	8.8	6.8	6.1	7.1
3	1	–1	79.2	2.3	13.6	9.0	11.6	8.3
4	1	1	79.2	8.6	16.3	8.1	14.3	8.0
5	–1.414	0	75.0	5.5	13.6	7.4	13.7	6.2
6	1.414	0	80.0	5.5	16.3	8.6	14.1	8.6
7	0	–1.414	77.5	1.0	11.7	8.2	6.5	8.8
8	0	1.414	77.5	10.0	18.3	6.9	14.3	8.9
9	0	0	77.5	5.5	14.6	7.8	12.8	9.0
10	0	0	77.5	5.5	14.8	8.3	12.9	8.9
11	0	0	77.5	5.5	15.1	7.6	13.1	9.1
12	0	0	77.5	5.5	14.9	7.9	12.8	9.2
13	0	0	77.5	5.5	14.8	8.1	12.9	9.4

OQS: Overall quality score with max. of 10

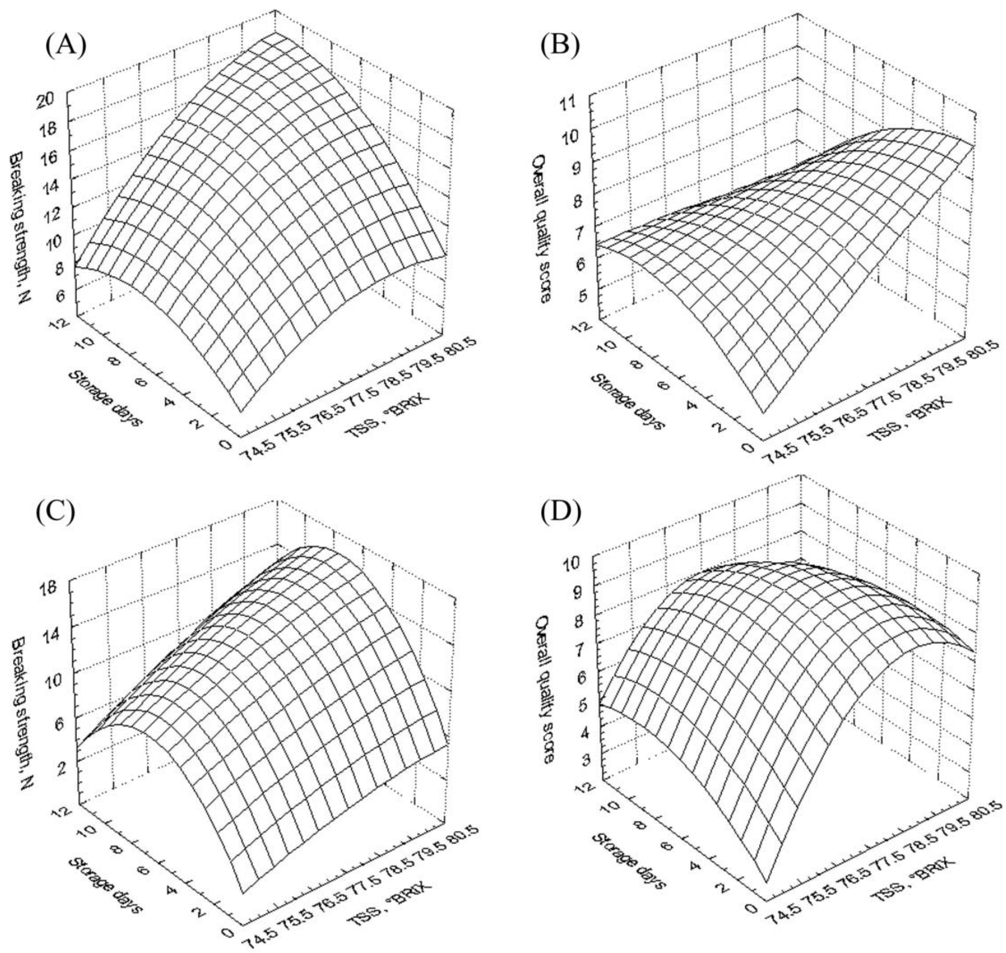

Fig. 1 Response surface graph showing the influence of TSS and storage days on breaking strength and overall quality of milk *burfi* made with sugar (A, B) and Sorbitol (C, D)

the case of *burfi* with sorbitol to obtain a product close to its sugar counterpart, TSS of 77.5°B and 5–6 days of storage were needed for obtaining a *burfi* with breaking strength of 12.9 N and an overall acceptability score of 9.1. Studies have shown that *burfi* prepared using sorbitol has the desirable quality and could be comparable with traditionally prepared product using sugar.

Acknowledgement Authors thank Lokesh BR, Head, LSTF Department and Prakash V, Director, CFTRI, Mysore for their keen interest in the work.

References

Amerine AM, Pangborn RM, Roessler BE (1965) Principles of sensory evaluation of food. Academic Press Inc, New York, p 356–358

AOAC (2005) Official methods of analysis. 18th edn, Association of Official Analytical Chemists, Maryland, USA

Arora S, Singh VP, Sharma V, Wadhwa BK, George V, Singh AK, Sharma GS (2009) Analysis of sucralose and its storage stability in burfi. J Food Sci Technol 46:114–117

Arora S, Singh VP, Yarrakula S, Gawande H, Narendra K, Sharma V, Wadhwa BK, Tomer SK, Sharma GS (2007) Textural and microstructural properties of *burfi* made with various sweeteners. J Text Stud 38:684–697

Box GEP, Wilson KG (1951) On the experimental attainment of optimum conditions. J Royal Statistics Soc 13:1–45

Bunting C (1994) Sugar-free ingredient-a review. Manuf Conf 74(10):55–58

Dasappa I, Venkateshwara Rao G. (2001) Optimization of the quality of South Indian *parotta* by modeling the ingredients and composition during response surface methodology. Int J Food Sci Technol 36:189–197

Derringer G, Suich R (1980) Simultaneous optimization of several response variables. J Qual Technol 12:214–219

FDA (1993) Office of the Federal Register, General Services Administration. Code of Federal Regulations, Title 21, Section 184.1835, Washington DC

ISI (1970) IS:5550. Specification for *burfi*, Bureau of Indian Standards, New Delhi

Kissel LT, Marshall BD (1967) Multifactor responses of cake quality to basic ingredients ratio. Cereal Chem 39:16–30

Macdonald TA, Bly DA (1966) Determination of optimum levels of several emulsifiers in cake mix shortenings. Cereal Chem 43:571–584

Montgomery DC (1997) Introduction to statistical quality control. 3rd edn, John Wiley and Sons, New York, p 512–572

Ozdemir M, Sadikoglu H (1998) Characterization of rheological properties of systems containing sugar substitutes and carageenan. Int J Food Sci Technol 33:439–444

PFA (2004) Prevention of Food Adulteration Act 1955. Amended 25 June 2004, Ministry of Health and Family Welfare, Govt of India, Nr 273, Part II, Section 3(1)

Sachdeva S, Rajorhia GS (1982) Technology and shelf life of *Burfi*. Indian J Dairy Sci 35:513–518

Sarkar K, Ray PR, Ghatak PK (2002) Effect of sodium and potassium metabisulphites on the shelf life of cow milk *burfi*. Indian J Dairy Sci 55:79–82

Saxena DC, Rao PH (1986) Optimization of ingredients and process conditions for the preparation of Indian *roti* using response surface methodology. Int J Food Sci Technol 31: 345–351