SENSORY CHARACTERIZATION AND PROXIMATE COMPOSITION OF ALMOND BURFI PREPARED WITH OPTIMIZED LEVELS OF ALMOND AND SUGAR BY RESPONSE SURFACE METHODOLOGY

V.H. Hajare[1], G.K. Londhe[2], R.L. Korake[3]

ABSTRACT

Burfi, a *khoa* based delicious milk sweet, amply available in Indian market, is also blended with fruits to impart aroma and improve nutritivity. However, preparation of almond *burfi* with optimization of levels of its principal components (almond and sugar) was not tried earlier. This paper describes the production protocol of almond *burfi*, prepared from 6% fat standardized buffalo milk *khoa*, containing different levels of almond (*Terminalia catappa*) kernel powder and sugar in the product, optimized for maximum scores of sensory characteristics, *viz*., flavor (FL), body & texture (B&T), colour & appearance (C&A), and overall acceptability (OA), evaluated on the basis of a 25 point hedonic scale. The sensory characteristics of thirteen formulations with three levels of almond (kernel) powder (10%, 15%, 20%) and sugar (20%, 25%, 30%) were evaluated as per central composite design (CCRD) using response surface methodology (RSM). The input variables were coded as -1, 0, and 1 for the analysis. The study revealed that the formulation of almond *burfi* containing 15% almond (kernel) powder and 32% sugar accrued the highest score in respect of FL (9.0), B&T (8.5), C&A (4.5), and OA (22.0). The level of ingredients significantly ($P \leq 0.01$) affected all the quality parameters (FL, B&T, C&A, and OA) as reflected from the 'F' values. The RMCs of almond reflected significant ($P \leq 0.01$) negative quadratic effect with respect to FL (A^2 = -0.623) and OA (A^2 = -0.751), while the RMCs of sugar had significant ($P \leq 0.01$) positive linear effect on B&T (0.577), C&A (0.276), and OA (0.955). The predicted sensory scores of the best formulation containing 15% almond powder and 32% sugar on *khoa* basis were rated, 8.68 for FL, 8.5 for B&T, 4 for C&A and 21.8 for OA. This did not vary significantly ($P \geq 0.05$) from the actual score for FL (8.84), B&T (8.7), C&A (4.22), and OA (22.39). Proximate analysis revealed that fat (20.5%) and protein (17.86%) contents of almond *burfi* were higher than the control *burfi* without almond. The response surface equations were derived to modulate changes in sensory characteristics, as per need. It is concluded that almond *burfi* developed by us was more nutritious than the common *khoa burfi*.

KEY WORDS

Almond *burfi*, Response Surface Methodology, Sensory quality

Author attribution: [1]MSc (Agri) Scholar, College of Agriculture, [2]Deputy Director (Animal Science), Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra, India–431402, [3]Assistant Professor, Department of Animal Science & Dairy Science, College of Agriculture (VNMKV), Golegaon, Maharashtra, India– 431705. [3]Corresponding author (E-mail: ravikorake@yahoo.co.in).
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INTRODUCTION

Traditional dairy products and sweets are an integral part of Indian heritage and have great social, religious, cultural, medicinal, and economic significance. They have been developed over a long period with the culinary skills of homemakers and *halwais* (sweet meat makers).

Burfi, prepared from partially dehydrated, heat desiccated whole milk (*khoa*) with an appropriate content of sugar, is an extremely popular sweet confectionery of Indian subcontinent (Arora et al., 2010; Chetna et al., 2010).

Hybrid *burfi*, prepared with fruit additives, such as, cashew nut (Rao et al., 1993), ber (Kathalkar, 1995), wood-apple (Sakate et al. 2004; Navale et al., 2014), papaya and sapota (Khedkar et al. 2007), fig (Matkar and Deshmukh, 2007; Kamle et al., 2015), mango (Kadam et al,. 2009), and pineapple (Kamble et al., 2010) are liked due to its delicacy and nutritivity. However, preparation of almond *burfi* using Indian almond (*Terminalia catappa*) as an adjunct was not tried earlier.

Almond is rich in energy and healthy mono-unsaturated fats. The kernel has good nutrient profile packed with anti-oxidants, dietary fiber, vitamins, and minerals. Almond (*Terminalia catappa*) kernel contains significant amounts of oleic and linoleic fatty acids that contribute to hypocholesterolemic effects that increases HDL cholesterol and decreases LDL cholesterol levels, reduces body weight due to satiating effect and glucose homoeostasis, prevents oxidative stress, and protects from degenerative diseases like cancer and cardiovascular ailments, and improves spatial memory (Esfahlan et al., 2010; Kamil and Chen, 2012; Mbah et al., 2013; Hull et al., 2015).

Almond *burfi* is prepared like the indigenous *burfi* where *khoa* and almond kernel (powder) are used in combination along with appropriate level of sugar. The development of almond *burfi* by us is an endeavour to popularize Indian milk sweets in western countries, with a sizable population of resident Indians, who still crave for Indian sweets.

Looking in to the health benefits, delicious taste, and market demand of almond *burfi*, this research project was undertaken to develop a production protocol of almond *burfi*, with optimized levels of almond (kernel) powder and sugar, estimated by CCRD and RMC.

MATERIALS AND METHODS

Milk: Good quality buffalo milk, obtained from Dairy Unit of Department of Animal Husbandry and Dairy Science, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, was standardized to 6% fat and filtered to remove dirt and other extraneous matter, before use.

Almond (kernel) powder: Good quality dried almond kernels were procured from the local market of Parbhani. Almond kernels were blanched in

boiling water for one minute by hanging in muslin cloth, wiped with tissue paper, and then the skin of the kernels were removed by pressing them with the thumbs of both hands. Kernels without skin were cut into small pieces with a knife, and finally converted into powder by using coffee grinder (pulsing 3 to 4 times up to 30 seconds / pulse).

***Khoa*:** *Khoa* was prepared by heating milk in an iron pan (*Karahi*) as per the method described by Sachdeva and Rajorhia (1982) with slight modification.

Preparation of almond *burfi*: The lab-scale method standardized in our laboratory was followed for the production of almond *burfi*. *Khoa* was placed in an iron *karahi* (60 cm diameter and 25 cm depth) and was heated on a cooking gas flame till the temperature of *khoa* reached to about 80°C. Sugar was added first to heated *khoa* in the *karahi*, followed by almond (kernel) powder with continuous stirring and scrapping, till the desired texture was obtained.

The contents of the *karahi* were then removed and transferred into a stainless steel tray, and spread for cooling and setting at room temperature (30°C). Finally, the mass was cut into small rectangular blocks of 3x3 cm size with a knife.

Sensory evaluation: The samples of almond *burfi* prepared from thirteen formulations containing different levels of almond (kernel) powder and sugar were evaluated by seven judges for flavour (10), body and texture (10), colour and appearance (5), and overall acceptability (25) using twenty five points score card. The panelists were acquainted with the quality attributes and the defects generally associated with almond *burfi*, before scoring.

Optimization of levels of almond powder and sugar: The levels of almond (kernel) powder and sugar in *khoa* (w / w) based on sensory attributes were evaluated and optimized by response surface methodology (RSM) by the method described by Myers and Montgomery (2002), using STATE EASE Design Expert software (Version 8.0.4.1). Central Composite Rotatable Design (CCRD), face centered with two factors and five centre points was used. A quadratic model was used to describe the response variables in the following manner:

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_1^2 + b_4x_2^2 + b_5x_1x_2$$

Where,

Y = response (dependent variable),

x_1 = level of almond (independent variable),

x_2 = level of sugar (independent variable),

b_0, b_1, b_2, b_3, b_4, and b_5 = response model coefficients.

In the present study, three levels of almond (kernel) powder (10%, 15%, and 20%) and three levels of sugar (20%, 25%, and 30%) were used for evaluation. In total, thirteen formulations were prepared using

Table-1. Experimental variables, their coded values and decoded (actual) values.

Order	Almond (%)	Sugar (%)		Order	Almond (%)	Sugar (%)
1	10	20		8	15	32
2	20	20		9	15	25
3	10	30		10	15	25
4	20	30		11	15	25
5	8	25		12	15	25
6	22	25		13	15	25
7	15	18				

different proportions of the ingredients as per CCRD design using RSM (Table-1). The coded levels of almond were -1 (10%), 0 (15%), and 1 (20%), and the coded levels of sugar were -1 (20%), 0 (25%), and 1 (30%).

Proximate composition: The proximate composition of the almond *burfi* prepared from optimized formulations were evaluated in terms of moisture (IS: 2785, 1964), fat (ISI, 1981), protein (Menefee and Overman, 1940), total sugar (ISI, 1981), and ash (AOAC, 1975).

RESULTS AND DISCUSSION

Sensory parameters: The sensory parameters chosen to evaluate the quality of almond *burfi*, were flavor, body & texture, colour & appearance, and overall acceptability. The sensory scores of thirteen categories of almond *burfee* with different proportions (actual values) of almond (kernel) powder (8-22%) and sugar (18-32%) depicted in Table-2, revealed that almond *burfi* with 15% almond (kernel) powder and 32% sugar obtained the highest scores in respect of flavor (9.0), body & texture (8.5), colour & appearance (4.5), and overall acceptability (22.0).

Response model coefficients and Response surfaces: The response model coefficients (RMC) of second order polynomial model for coded sensory responses at different levels of almond powder and sugar in almond *burfi* have been depicted in Table-3, and response surfaces in Figures 1a-1d.

It was observed that the level of ingredients significantly ($P \leq 0.01$) influenced all the quality parameters (FL, B&T, C&A, and OA) as reflected from the 'F' values. The RMCs of almond were significant ($P \leq 0.01$) and non-linear with respect to flavor ($A^2 = -0.623$) and overall acceptability ($A^2 = -0.751$). The RMCs of sugar were significant ($P \leq 0.01$) and linear with respect to B&T (0.577), C&A (0.276), and OA (0.955), with FL as the exception.

The coefficient of determination (R^2) values were very high for all the characteristics, *viz*., FL (0.845), B&T (0.885), C&A (0.852), and OA (0.84) explaining the credibility of the model.

The adequate precision levels for FL (9.318), B&T (10.51), C&A (10.229), and OA (9.45), were higher than the table value of 4.0 required for developing a suitable model. The predicted residual error sum square (PRESS) values for FL (3.725), B&T (1.094), C&A (0.966), and OA (11.464) supported this contention as the best structures had lower values.

The following response surface equations were derived to predict changes in sensory qualities with different levels of ingredients in actual terms.

Flavour = 0.05 + 0.84 * Almond powder – 0.28 * Sugar + 0.003 * Almond powder * Sugar – 0.02 * Almond powder^2 + 0.007 * Sugar^2

Body and Texture = 1.484 + 0.021 * Almond + 0.395 * Sugar – 0.001 * Almond * Sugar - 0.0003 * Almond^2 – 0.005 * Sugar

Colour and Appearance = -2.279 + 0.361 * Almond + 0.215 * Sugar – (-0.008) * Almond * Sugar 0.004 * Almond^2 – (-0.0008) * Sugar^2

Overall acceptability = 4.255 + 1.224 * Almond + 323 * Sugar – 0.001 * Almond * Sugar – 0.030 * Almond^2 + 0.00095 * Sugar^2

Optimization of product formulation: Based on the results obtained from sensory evaluation of almond *burfi* with different levels of almond powder and sugar on *khoa* basis, suitable levels of almond powder and sugar were selected for verification of their sensory status. The goals for factors were chosen in the range from minimum to maximum, whereas sensory scores were targeted towards maximum values (Table-4).

The results revealed that the best formulation contained 15% almond powder and 32% sugar on *khoa* basis. The predicted sensory scores were rated 8.68 for FL, 8.5 for B&T, 4 for C&A, and 21.8 for OA.

The actual sensory scores for FL (8.84), B&T (8.7), C&A (4.22), and OA (22.39) were not different ($P \geq 0.05$) from the predicted scores (Table-5).

Proximate analysis: The proximate analysis of almond *burfi* prepared with 15% almond (kernel) powder and 32% sugar on *khoa* basis (Table-6) revealed that it contained higher amounts of fat (20.5%) and protein (17.86%), compared to control *burfi* (without almond).

Discussion: Preparation of almond *burfi* and optimization of its principal components, i.e. almond and sugar were not tried earlier. However, increase in flavor scores in *burfi* with increasing levels of fruit pulps of mango or orange (Thaware et al., 2009) and pineapple (Kamble et al., 2010) did not agree with our results, since we observed significant non-linear effect of the level of almond on flavor and overall acceptability in almond *burfi*, and thus needed optimization.

Table-2. Sensory scores of almond *burfi* with different combinations of almond (kernel) powder and sugar.

Combination	Almond (%)	Sugar (%)	Flavour	Body & Texture	Colour & Appearance	Overall acceptability
1	10	20	7.3	7.2	3.2	17.7
2	20	20	7.6	7.1	3.8	18.5
3	10	30	7.5	8.4	4.0	19.9
4	20	30	7.5	8.2	3.8	19.5
5	8	25	7.0	8.0	3.7	18.7
6	22	25	7.3	8.0	3.9	19.2
7	15	18	8.5	7.0	3.5	19.0
8	15	32	9.0	8.5	4.5	22.0
9	15	25	8.4	8.2	4.0	20.6
10	15	25	8.2	8.0	4.0	20.2
11	15	25	8.0	8.0	3.8	19.8
12	15	25	8.2	7.5	3.9	19.6
13	15	25	8.0	8.0	4.0	20.0

Table-3. Response model coefficients (RMC) of second order polynomial model for coded sensory responses at different levels of almond (kernel) powder and sugar in almond *burfi*.

Factor	RMC	Flavour	Body&Texture	Colour&App.	Acceptability
Intercept	b_0	8.16	7.94	3.94	20.04
Almond powder (A)	b_1	0.090	-0.0625	0.085	0.113
Sugar (B)	b_2	0.100	0.577*	0.276*	0.955*
A^2	b_3	-0.623*	-0.007	-0.12	-0.751*
B^2	b_4	0.176	-0.132	-0.02	-0.023
AB	b_5	-0.075	-0.025	-0.2*	-0.3
R^2	---	0.845	0.885	0.852	0.840
Adequate precision	---	9.318	10.51	10.229	9.450
PRESS	---	3.725	1.094	0.966	11.464
Model 'F' value	---	7.662*	10.805*	8.105*	7.961*

Note: (1) PRESS = Predicted Residual Error Sum of Squares. (2) *Significant at $P \leq 0.01$.

Table-4. Goals set for lower limit (L. Limit) and upper limit (U. Limit) for levels (%) of almond powder and sugar on *khoa* basis, and sensory scores targeted to predict the optimal combinations.

Feature	Factors		Responses			
	Almond%	Sugar%	Flavour	Body&Texture	Color&App.	Acceptability
Goal Set	Range	Range	Maximize	Maximize	Maximize	Maximize
L. Limit	10	20	7.0	7.0	3.2	17.7
U. Limit	20	30	9.0	8.5	4.5	22.0

Table-5. Verification of predicted sensory quality of optimized almond *burfi* prepared with optimum combination of almond (kernel) powder and sugar.

Parameter	Predicted score	Actual score#	Calculated 't'
Flavour	8.68	8.84	1.38
Body and texture	8.50	8.70	1.12
Colour and appearance	4.0	4.22	1.90
Overall acceptability	21.80	22.39	1.66

#Average of three replicates of the experiment, Table value of $t_{0.05}$ is 4.30.

Table-6. Proximate composition of almond *burfi* prepared with optimum combination of almond (kernel) powder and sugar.

Parameter	Moisture (%)	Fat (%)	Protein (%)	Sugar (%)	Ash (%)
Control *burfi*	19.23	19.11	15.21	43.39	3.03
Almond *burfi*	17.5	20.5	17.86	42.24	2.40

CONCLUSION

It is concluded from the optimization study using CCRD and RSM analysis that almond *burfi* containing 15% almond (kernel) powder and 32% sugar scored maximum with respect to flavor, body and texture, colour and appearance, and overall acceptability, and was nutritionally better with high protein content compared to the control *burfi* (without almond).

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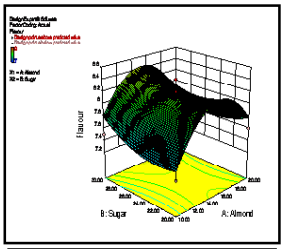

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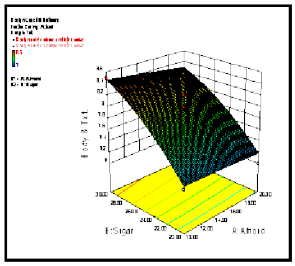

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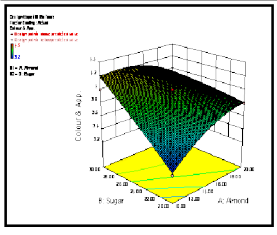

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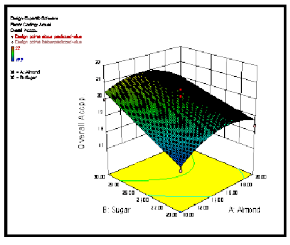

1d

Figures 1a-1d. Response surface relating to sensory scores as influenced by levels of almond powder and sugar.

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Keywords: Almond seed, proximate composition, mineral elements, and anti-nutrients and oil characteristic _. INTRODUCTION.Â 5ml of freshly prepared vanalin hydrochloric acid was added and the solution was allowed to stand for 20 minutes for colour development. The absorbance was measured at 550nm using spectronic 20 and the machine value was used in calculating the tannin content. Results and discussion.Â The iodine value of almond seed oil was found to be 1.27. Oils with iodine value less than 1.30 are non drying oil and are not suitable for paint making (Hilditch, and Seavell, 1950), therefore almond seed oil is not suitable for paint making. CONCLUSION. the optimized level of bottle gourd to be added in burfi making. The basic ingredients of bottle gourd burfi constitute as-bottle gourd shreds, khoa and sugar, wherein bottle gourd is source of dietary fiber and other vital components to the product. Five different levels of BGS were tested in burfi making, considering minimum lowest and maximum highest ranges of bottle gourd above and below which product structural integrity in not possible and nomenclature is not valid.Â Chemical composition: The chemical composition of finished product for different treatments is shown in Table 2. The moisture content of finished product increased as the proportion of BGS increased and is attributed to more proportion of water in the bottle gourd shreds. Summary An optimized formulation was developed for the preparation of parotta. This was modelled by response surface methodology (RSM) by using a Central Composite Rotatable Design (CCRD) with five independent variables (water, salt, sugar, egg and oil), each at five different levels. The dependent variable or response measured for each treatment was the overall sensory quality score.Â It was found that the optimum conditions for burfi prepared with sugar were: TSS of 78Â°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.