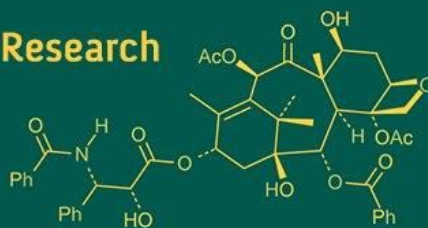


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Dhruvit D Dashlaniya
Dairy Technology
Department, SMC Collage of
Dairy Science, Kamdhenu
University, Anand, Gujarat,
India

Suneeta V Pinto
Dairy Technology
Department, SMC Collage of
Dairy Science, Kamdhenu
University, Anand, Gujarat,
India

Amit M Barot
Dairy Technology
Department, SMC Collage of
Dairy Science, Kamdhenu
University, Anand, Gujarat,
India

Application of response surface methodology for optimizing pumpkin seed and balancing sugar and palm jaggery in Burfi formulation

Dhruvit D Dashlaniya, Suneeta V Pinto and Amit M Barot

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Abstract

Burfi is an indigenous milk product made from khoa that is excellent in nutrition. Burfi contains various additives that boost its sensory appeal and customer acceptability. This study was conducted to optimize the level of pumpkin seed, sugar and replacement of sugar with jaggery using RSM for manufacture of pumpkin seed incorporated burfi using Response Surface Methodology (RSM) consisting of 20 experiments. The colour and appearance scores of pumpkin seed incorporated burfi ranged from 6.90-9.0 on 9-point hedonic scale. A significant ($p < 0.05$) negative effect on colour and appearance score was observed for increase in the level of pumpkin seeds at linear terms. The flavour score of pumpkin seed incorporated burfi ranged from 6.50-8.67 on 9-point hedonic scale. A significant ($p < 0.05$) negative effect on flavour score of pumpkin seed incorporated burfi was observed for increased pumpkin seeds and sugar level at linear level. The body and texture scores of pumpkin seed incorporated burfi ranged from 7.0-8.42 on 9-point hedonic scale. A significant ($p < 0.05$) negative effect on body and texture score of pumpkin seed incorporated burfi was observed for increase in the level of pumpkin seeds and sugar at linear level. The overall acceptability scores of pumpkin seed incorporated burfi ranged from 6.40-8.67 on 9-point hedonic scale. A significant ($p < 0.05$) negative effect on overall acceptability score of pumpkin seed incorporated burfi was observed for increase in the level of pumpkin seeds and sugar at linear level. The optimized formulation consisted of 3.09% pumpkin seed (w/w of milk), 6.89% sugar (w/w of milk) and 72.5% replacement of sugar with palm jaggery.

Keywords: Burfi, Pumpkin seeds, Jaggery, 9-point hedonic scale, Pumpkin seed incorporated burfi (PSIB)

Introduction

Burfi is one of the most popular traditional milk-based sweets of India, primarily prepared using khoa—a heat-desiccated form of milk. It holds a significant place in Indian cuisine, both as a daily delicacy and as a special treat during festivals, marriages, and other celebrations. The preparation involves heating a mixture of khoa and sugar to a near-homogeneous consistency, followed by cooling and cutting into small cubes or rectangular shapes (Ramakrishna *et al.*, 2010) [12]. The final product is characterized by a moderately sweet taste, a smooth texture with fine grains, a soft and slightly greasy body, and a pleasant, mildly caramelized flavour. The colour of Burfi typically ranges from off-white and creamy to light brown, depending on the ingredients and the extent of caramelization. Due to the remarkable adaptability of khoa—in terms of flavour, texture, and compatibility with various ingredients—a wide range of Burfi varieties are available across different regions of India viz. mawa burfi, coconut burfi, chocolate burfi, cashew burfi, mango burfi etc.

The addition of fruit seeds or seed powders in burfi is gaining popularity for its unique flavor and nutritional benefits. This innovation enhances the product's value by adding essential nutrients and supports consumer demand for healthier, functional dairy products (Sharma *et al.*, 2023) [13]. Pumpkin seeds (*Cucurbita pepo*), often discarded as waste, are a rich source of essential nutrients and bioactive compounds such as amino acids, phytosterols, unsaturated fatty acids, tocopherols, and minerals (Adsul and Madkaikar, 2021 [1]; Joachim and James, 2020). These seeds offer various health benefits including antioxidant, anti-inflammatory, antimicrobial, and anti-diabetic effects.

Corresponding Author:
Dhruvit D Dashlaniya
Dairy Technology
Department, SMC Collage of
Dairy Science, Kamdhenu
University, Anand, Gujarat,
India

Their nutty flavor, green color, and high nutritional value make them suitable for use in a variety of food products. Despite their potential, pumpkin seeds remain underutilized. Recent studies support their use in functional foods, such as bakery products, to improve nutritional quality and promote health (Patel, 2013) ^[11].

Refined sugar is widely used in burfi, but its excessive intake is linked to health issues like obesity, diabetes, and heart disease. Growing health awareness has increased demand for healthier alternatives, with jaggery emerging as a popular choice due to its better nutritional profile. Jaggery (Gur) is a traditional, unrefined sweetener produced by boiling juice extracted from sugarcane or palm sources such as palmyra, date, and coconut (FSSAI, 2018). Unlike refined sugar, it retains essential minerals like calcium, magnesium, potassium, and iron, which contribute to muscle relaxation, blood pressure control, and anaemia prevention (Chandrakanth *et al.*, 2019 ^[12]; Jaffe, 2012) ^[9]. Among its types, palm jaggery is highly valued for its medicinal properties and unique earthy or chocolate-like taste. It contains 65-85% sucrose and is used in Ayurvedic medicine for its potential role in reducing lung cancer risk (Vengaiiah *et al.*, 2013) ^[15]. With its rich taste and nutritional value, jaggery is widely used in traditional sweets as a healthier alternative to refined sugar.

With increasing consumer awareness about the health impacts of diet, there is a rising demand for dairy products that are both nutritious and enjoyable. Traditional sweets like burfi offer a promising platform for innovation through the incorporation of natural, health-promoting ingredients. Integrating pumpkin seeds and jaggery into burfi not only enriches its nutritional value-boosting protein, minerals, fiber, and antioxidants-but also reduces reliance on refined sugar. These ingredients can enhance flavour, texture, and colour, contributing to a more appealing and functional dairy sweet.

Replacing cane sugar with jaggery in dairy ingredients is expected to enhance its depth and imparts a distinct, caramel-like flavour. The rich, unique taste of jaggery can impart a pleasing golden-brown colour which may improve its natural and appealing appearance. Despite the popularity of conventional burfi, limited research has explored the combined use of pumpkin seed and jaggery in its preparation. This study was therefore undertaken to determine suitable levels of pumpkin seed, sugar and the replacement rate of sugar with jaggery in developing a nutritious, cost-effective and consumer-acceptable burfi.

Materials and Methods

Fresh, raw mixed (cow and buffalo) whole milk received at Anubhav Dairy; Anand was used as the base material for manufacture of burfi. Pumpkin seeds of "True elements" brand, HW wellness solutions Pvt. Ltd. Maharashtra were used. Cane sugar of "Madhur" Shree Renuka sugars Ltd; Mumbai brand of commercial grade (M grade) was used. Tata salt, Tata chemicals Ltd., Gujarat was used. Palm jaggery of Urban platter palm jaggery, Istore direct trading Pvt. Ltd., Mumbai was used.

Compositional analysis: The determine the moisture content of burfi, a gravimetric method based on the (FSSAI 01.039:2022). Fat extraction of burfi was determined by Rose-Gottlieb method described in section (FSSAI 01.073:2022). Protein content in burfi was estimated by

Kjeldahl method (FSSAI 01.062:2022). Total carbohydrate was derived by difference. Ash content in burfi was determined as per the method described by (FSSAI 01.077:2022).

Preparation of pumpkin seed incorporated Burfi: Burfi was prepared from milk standardized to a level having 6.0% milk fat and 9.0% MSNF. Dry salt roasted (85-90 °C/15 min) pumpkin seeds were incorporated @ ~3.0% w/w of milk. Half of the dry salt roasted pumpkin seeds in the form of a paste were added after fore warming of milk (85°C/10 min). The remaining half (coarsely cut pumpkin seeds) were added after pat formation. Tentatively, sugar was added @ 3% w/w of milk and palm jaggery was added @ 3% w/w of milk. The contents were heated in an open pan with continuous stirring. After the desired consistency was obtained, the contents were thoroughly mixed and worked on a low flame for 2-4 min. Thereafter, the contents were spread in a clean greased tray, moulded and allowed to set at room temperature for 10-12 h. Burfi was cut into square pieces (40×30 mm size, 25 mm thickness) and packed in composite polyethylene terephthalate (PET)/ low density polyethylene (LDPE) film (50 µ thickness) pouches and placed in PET box.

Optimization of level of pumpkin seed, sugar and replacement of sugar with jaggery: The coded values for the three factors viz. pumpkin seed (A), sugar (B) and replacement of sugar with palm jaggery (C) in burfi were determined to be 2.5-4.5%, 6.5-7.5% and 60-85%, respectively. A total of 20 experiments were conducted in randomized order, including 8 factorial points, 6 axial points, and 6 central points. The sensory properties of these treatment samples were evaluated.

Sensory evaluation: A panel of 10 judges familiar with the typical characteristics of dairy-based sweets were selected. Panelists were chosen based on their regular consumption of such products and consistent sensory perception across evaluation sessions. The evaluation was carried out using a 9-point hedonic scale scorecard as recommended by Stone and Sidel (2004) ^[14].

Statistical analysis: Response Surface Methodology (RSM) was used for Optimization of level of pumpkin seed, sugar and replacement of sugar with jaggery. To achieve this, an advanced statistical software program, Design Expert 13, was utilized.

Results

Influence of varying the level of pumpkin seed, sugar and replacement of sugar with jaggery on the sensory properties

The sensory score of burfi made by different combinations of pumpkin seed, sugar and replacement sugar with jaggery as determined by response surface methodology along with designs as per their run order is shown in Table 1

The quadratic model for sensory parameters namely were colour & appearance, body & texture, flavour and overall acceptability were obtained through successive regression analysis. The model F values as per Table 2 for colour & appearance, body & texture, flavour and overall acceptability were 5.37, 8.29, 8.10 and 6.54 respectively. The calculated F values are more than the table F values at

5% level of significance which indicate the significance of the model terms. Furthermore, the coefficient of determination (R^2) shown in Table 2 reflects the proportion of variability in data explained or accounted by the model for colour & appearance, body & texture, flavour and overall acceptability of experimental burfi were 0.8286, 0.8818, 0.8793 and 0.8547 respectively. A larger R^2 values advocate a better fit of the selected quadratic model. The adequate precision measures the signal to noise ratio, the value of which should be greater than 4.0. The adequate precision value for colour & appearance, body & texture, flavour and overall acceptability were 8.1512, 8.8805, 7.1420 and 7.9523 respectively, which were greater than 4, hence, it is considered to be assisting the suitability of the model to navigate the design.

Colour & appearance: The colour and appearance scores of burfi samples prepared with varying levels of pumpkin seed, sugar, and jaggery (as a sugar replacer) ranged from 6.90-9.00 (Table 1). The lowest was recorded for 5.18% pumpkin seed, 7.00% sugar and 72.50% sugar replacement by jaggery (Run 5), while the highest score was observed for the formulation with 3.50% pumpkin seed, 7.00% sugar and 72.50% sugar replacement by jaggery (Run 15). Only level of pumpkin seed significantly affected the colour and appearance score ($p < 0.05$), while other factors did not ($p \geq 0.1$) at linear terms. Interaction level effects ($A \times B$, $A \times C$, $B \times C$) were non-significant ($p \geq 0.1$). Quadratic level effects of pumpkin seed and sugar replacement with jaggery were significantly negative at $p < 0.05$ and $p < 0.1$ respectively, indicating a decline in colour and appearance at higher levels. Sugar had a non-significant effect at quadratic level.

The final regression equation (coded factors) is

Colour and appearance score	=	$8.33 - 0.4219*A + 0.0505*B - 0.0191*C - 0.0712*A*B + 0.0787*A*C - 0.0212*B*C - 0.3789*A^2 - 0.0749*B^2 - 0.1615*C^2$
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As shown in the response surface plots (Figure 1), Increasing any two factors with keeping other one constant, colour score has been found slightly increased initially and declined at higher levels. Although no prior studies specifically addressed the combined effect of pumpkin seed, sugar, and jaggery, similar trends were noted by Sharma (2023) [13] in date seed powder burfi and by Yadav *et al.* (2018) [16] in peanut powder burfi, where higher additive levels reduced colour and appearance scores.

Flavour: Flavour is a key factor determining the sensory acceptability of burfi. The flavour scores varied between 6.50-8.67 (Table 2). The lowest score was recorded for the formulation with 3.50% pumpkin seed, 7.84% sugar, and 72.50% sugar replacement with jaggery (Run 10), whereas the highest score was obtained for the formulation with 3.50% pumpkin seed, 7.00% sugar, and 72.50% sugar replacement with jaggery (Run 15). Among the linear terms, pumpkin seed and sugar had significant ($p < 0.05$) negative effects on flavour score, while sugar replacement with jaggery showed a non-significant effect ($p \geq 0.1$). The negative coefficients suggest that increasing levels of pumpkin seed and sugar reduce the flavour acceptability, possibly due to excessive seed taste or over-sweetness. Interaction effects ($A \times B$, $B \times C$, $A \times C$) were non-

significant ($p \geq 0.1$). Significant quadratic effects ($p < 0.05$) for pumpkin seed and sugar, and a non-significant effect for sugar replacement with jaggery, were also observed, with all having negative coefficients. This implies that flavour scores decreased at higher levels of these components.

The final regression equation (coded factors) is

Flavour Score	=	$8.34 - 0.2035*A - 0.1954*B - 0.0306*C + 0.0187*A*B - 0.0812*A*C - 0.0187*B*C - 0.2902*A^2 - 0.4935*B^2 - 0.1576*C^2$
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As shown in the response surface plots (Figure 2), Increasing any two factors with keeping other one constant, flavour score has been found increased initially and declined at higher levels. Although no direct studies on pumpkin seed use in burfi were found, Sharma (2023) [13] observed that the addition of date seed powder reduced flavour due to slight bitterness. This aligns with the present findings where excess pumpkin seed reduced flavour scores.

Body and texture: Body and texture are critical sensory attributes that influence product optimization and consumer acceptability. The scores ranged from 7.00-8.42 (Table 2). The lowest score was noted in Run 11 (2.50% pumpkin seed, 7.50% sugar, 60% jaggery replacement), while the highest score was from Run 13 (3.50% pumpkin seed, 7.00% sugar, 72.50% jaggery replacement). Linear effects of pumpkin seed and sugar were significant ($p < 0.05$), with negative coefficients, indicating that higher levels of these ingredients adversely affected body and texture. Sugar replacement with jaggery had a non-significant linear effect ($p \geq 0.1$). Interaction effects were mixed: $A \times B$ showed a non-significant negative effect, $A \times C$ had a significant negative effect ($p < 0.1$), and $B \times C$ showed a significant positive effect ($p < 0.05$). Quadratic terms for pumpkin seed and sugar were significant ($p < 0.05$), while sugar replacement with jaggery was not ($p \geq 0.1$), all with negative coefficients, indicating that higher ingredient levels reduced body and texture scores.

The regression equation in coded terms is

Body and Texture score	=	$8.13 - 0.1541*A - 0.1491*B - 0.0307*C - 0.0487*A*B - 0.1487*A*C + 0.2062*B*C - 0.2490*A^2 - 0.2490*B^2 - 0.1341*C^2$
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As shown in the response surface plots (Figure 3), Increasing any two factors with keeping other one constant, body and texture score has been found increased initially and declined at higher levels. Although no prior studies reported the combined effect of pumpkin seed, sugar, and jaggery on burfi texture, Sharma (2023) [13] found similar trends where date seed powder improved texture up to a certain level, after which dryness led to a decline in texture scores.

Overall acceptability: Overall acceptability reflects the combined impact of all sensory attributes and is crucial for determining consumer preference. The scores ranged from 6.40-8.67 (Table 2). The lowest score was observed in Run 10 (3.50% pumpkin seed, 7.84% sugar, 72.50% sugar replacement with jaggery), and the highest in Run 15 (3.50% pumpkin seed, 7.00% sugar, 72.50% sugar

replacement with jaggery), suggesting that a balanced composition enhances acceptability. Pumpkin seed and sugar had significant negative effects ($p < 0.05$) at both linear and quadratic levels, indicating that high concentrations of these ingredients reduce product appeal. In contrast, sugar replacement with jaggery showed non-significant effects ($p \geq 0.1$). Among interaction effects, $A \times B$, $B \times C$ and $A \times C$ were non-significant ($p \geq 0.1$), with both positive and negative trends observed. Pumpkin seed and sugar levels showed significant ($p < 0.05$) quadratic effects on overall acceptability, while sugar replacement with jaggery with jaggery was non-significant ($p \geq 0.1$). Negative coefficients indicated that higher levels of each factor reduced acceptability.

The regression equation in coded terms is

Overall acceptability score	=	$8.26 - 0.2275*A - 0.2332*B + 0.0542*C + 0.0912*A*B - 0.0462*A*C + 0.0162*B*C - 0.2572*A^2 - 0.4517*B^2 - 0.0946*C^2$
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As shown in the response surface plots (Figure 4), Increasing any two factors with keeping other one constant, overall acceptability score has been found increased initially and declined at higher levels. Although no previous studies have specifically evaluated the combined effect of pumpkin seed, sugar, and jaggery on burfi's overall acceptability, similar trends have been observed in studies involving other functional ingredients.

Optimization of product formulation for Burfi Manufacture

Process optimization for the manufacture of burfi was carried out with the objective of determining the best possible combination(s) of different levels of factors viz. pumpkin seed (A), sugar (B) and replacement of sugar with palm jaggery (C) that would lead to the most acceptable product in terms of sensory scores. The goals or responses that were set for obtaining the best possible acceptability were kept maximum during optimization as these characteristics are having higher importance in the new product development in terms of sensory values combination are illustrated in Table 3.

The data were analyzed by design expert package 13. Considering the parameters and their limits, the RSM suggested the one most suited solution. Suggested solution from RSM analysis for burfi is presented in Table 4.

The predicted sensory scores of optimized burfi from RSM analysis are depicted in Table 5. The goals of all sensory parameters were kept maximum during optimization as these characteristics are having higher importance in the new product development in terms of sensory values.

The final product was manufactured employing this suggested formulation and the actual results were obtained from the PSIB manufacture. The predicted values of the criteria/ responses selected for optimization under study were compared with the actual values of the selected responses. The results obtained confirmed that the selected combination is the best one in terms of the sensory responses delineated at the beginning of the study. The results are also validated statistically by 't' test. The calculated 't-value' for all the parameters is reported in Table 5. The values for 't' test being less than the table values, it is inferred that there is no significant ($P > 0.05$) difference between the predicted and actual values of responses as shown in Table 5.

The suggested proportion from RSM of pumpkin seed (w/w of milk), blend of sugar (w/w of milk) and rate of replacement sugar with palm jaggery (w/w of sugar) was 3.09, 6.89 and 72.75% respectively and the desirability of the model was found to be 0.83.

Standardized method for manufacture of pumpkin seed incorporated burfi

Standardized method for manufacture of pumpkin seed incorporated burfi as shown in Figure 5.

Composition analysis: both the control burfi and PSIB samples were analysed for selected compositional attributes- namely moisture, fat, protein, carbohydrate and ash content. The control burfi contained 23.08% moisture, 21.12% fat, 14.14% protein, 39.31% carbohydrates and 2.35% ash. In comparison, the PSIB sample showed slightly higher values in moisture (23.77%), fat (22.15%) and protein (14.66%), while exhibiting a reduced carbohydrate content of 36.30% and increased ash content of 3.12%.

Figure format

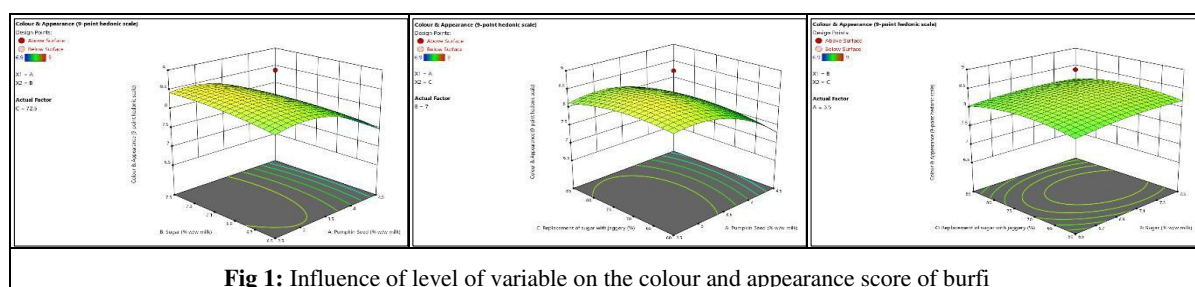


Fig 1: Influence of level of variable on the colour and appearance score of burfi

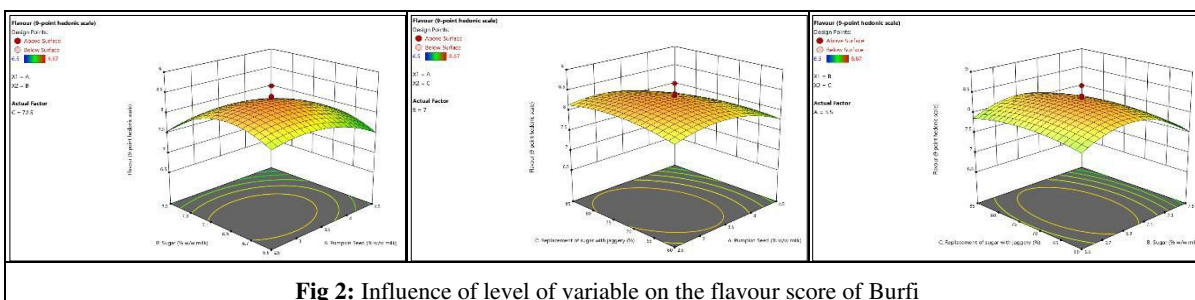


Fig 2: Influence of level of variable on the flavour score of Burfi

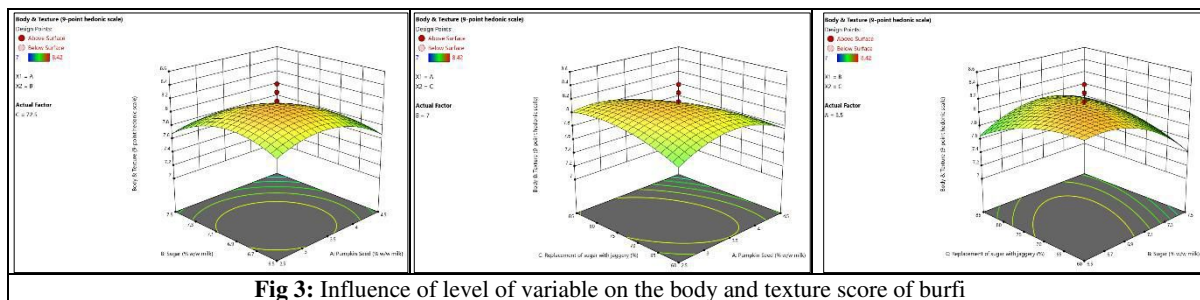


Fig 3: Influence of level of variable on the body and texture score of burfi

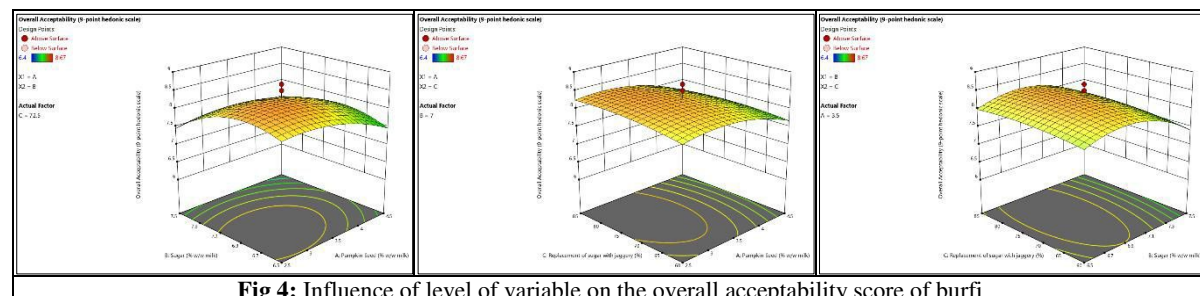


Fig 4: Influence of level of variable on the overall acceptability score of burfi

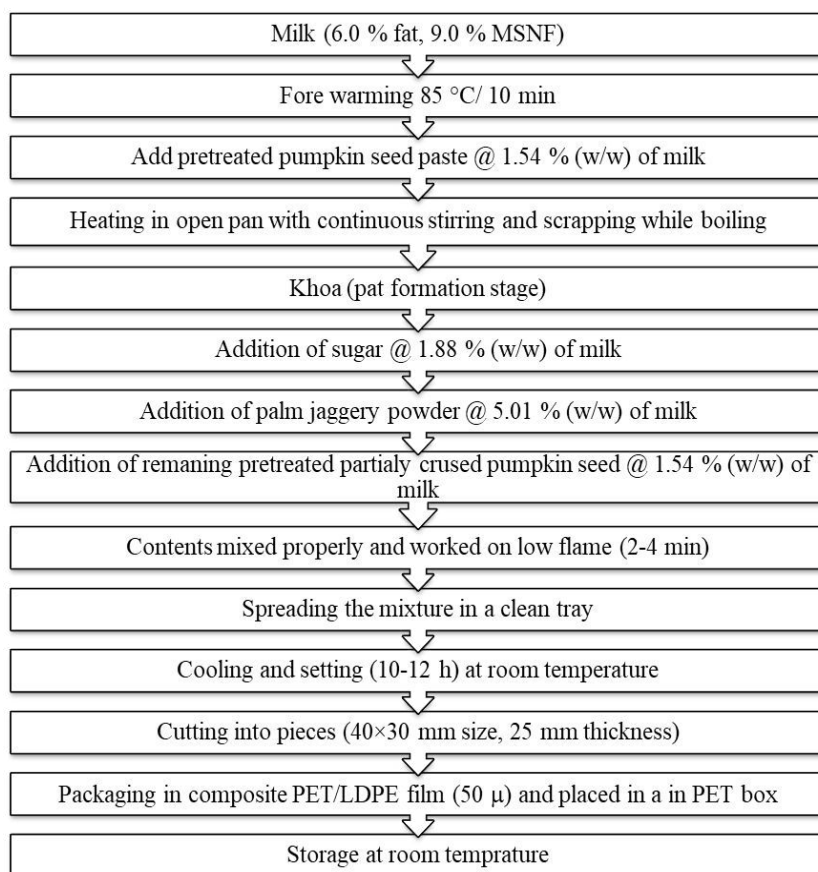


Fig 5: Standardized process for the manufacture of one kg developed burfi



Fig 6: Control burfi (left side) and pumpkin seed incorporated burfi (right side)

Tables

Table 1: Design matrix with the experimental data on sensory attributes of burfi for response analysis

Run	Variables (g/ 100 g of burfi)			Sensory attributes as response (9-point hedonic scale)			
	Pumpkin Seed % w/w milk	Sugar % w/w milk	Replacement of sugar with jaggery %	Colour and appearance	Flavour	Body and Texture	Overall acceptability
1	3.50	7.00	72.50	8.25	8.37	8.00	8.19
2	3.50	7.00	72.50	8.25	8.08	8.00	7.96
3	4.50	7.50	60.00	7.00	7.20	7.10	7.20
4	2.50	6.50	85.00	8.00	7.60	7.60	7.80
5	5.18	7.00	72.50	6.90	7.25	7.10	7.30
6	3.50	6.16	72.50	8.12	7.70	7.60	7.80
7	4.50	6.50	85.00	7.10	7.10	7.30	7.20
8	4.50	7.50	85.00	7.15	6.90	7.10	7.05
9	3.50	7.00	72.50	8.08	8.17	8.17	8.10
10	3.50	7.84	72.50	8.37	6.50	7.37	6.40
11	2.50	7.50	60.00	8.50	7.30	7.00	7.25
12	2.50	7.50	85.00	8.00	7.40	7.80	7.60
13	3.50	7.00	72.50	8.25	8.42	8.42	8.50
14	3.50	7.00	93.52	8.08	8.00	7.70	8.25
15	3.50	7.00	72.50	9.00	8.67	8.30	8.67
16	3.50	7.00	51.48	7.92	8.10	7.92	7.97
17	4.50	6.50	60.00	7.20	7.25	7.92	7.10
18	2.50	6.50	60.00	8.08	7.50	7.83	7.83
19	1.82	7.00	72.50	7.87	8.10	7.87	8.00
20	3.50	7.00	72.50	8.12	8.25	7.87	8.12

Table 2: Coefficient of the full second order polynomial model for coded sensory responses to different levels of ingredients of burfi

Parameters		Sensory score as response			
		Colour and appearance	Flavour	Body and Texture	Overall acceptability
Intercept		8.33	8.34	8.13	8.26
Linear Level	A	-0.4219 [#]	-0.2035 [#]	-0.1541 [#]	-0.2275 [#]
	B	0.0505 ^{ns}	-0.1954 [#]	-0.1491 [#]	-0.2332 [#]
	C	-0.0191 ^{ns}	-0.0306 ^{ns}	-0.0307 ^{ns}	0.0542 ^{ns}
Interactive Level	A*B	-0.0712 ^{ns}	0.0187 ^{ns}	-0.0487 ^{ns}	0.0912 ^{ns}
	A*C	0.0787 ^{ns}	-0.0812 ^{ns}	-0.1487	-0.0462 ^{ns}
	B*C	-0.0212 ^{ns}	-0.0187 ^{ns}	0.2062 [#]	0.0162 ^{ns}
Quadratic Level	A ²	-0.3789 [#]	-0.2902 [#]	-0.2490 [#]	-0.2572 [#]
	B ²	-0.0749 ^{ns}	-0.4935 [#]	-0.2490 [#]	-0.4517 [#]
	C ²	-0.1615	-0.1576	-0.1341 [#]	-0.0946 ^{ns}
R ²		0.8286	0.8818	0.8793	0.8547
Model F-value		5.37	8.29	8.10	6.54
APV		8.1512	8.8805	7.1420	7.9523
Suggested Model		Quadratic	Quadratic	Quadratic	Quadratic

#: $p < 0.05$; ns: non-significant, $p \geq 0.1$; APV= Adequate Precision Value; A = pumpkin seed; B = sugar; C = replacement of sugar with jaggery; R² = Coefficient of determination

Table 3: Criteria/responses chosen for process optimization of burfi manufacture

Sr. No	Parameter	Units	Goal	Lower Limit	Upper Limit	Level of Importance
1	A: Pumpkin Seed	%	In range	2.50	4.50	3
2	B: Sugar	%	In range	6.50	7.50	3
3	C: Replacement of sugar with palm jaggery	%	In range	60.00	85.00	3
4	Colour and appearance	1-9	Maximize	6.90	9.00	3
5	Flavour	1-9	Maximize	6.60	8.67	5
6	Body and Texture	1-9	Maximize	7.00	8.42	4
7	Overall acceptability	1-9	Maximize	6.40	8.67	5

Table 4: Suggested solution from RSM analysis for burfi

Solution No.	Solutions			Desirability
	A: Pumpkin Seed (%)	B: Sugar (%)	C: Replacement of sugar with palm jaggery (%)	
1	3.09	6.89	72.75	0.83

Table 5: Comparison of predicted v/s actual values of responses used for process optimization of burfi manufacture

Response	P-Value	Predicted Value *	Actual Value @	Cal. t-Value #	Level of Significance
Colour and appearance (1-9)	0.7067	8.435	8.35	0.3900	NS
Flavour (1-9)	0.6559	8.385	8.30	0.4627	NS
Body and Texture (1-9)	0.3182	8.192	8.45	1.0644	NS
Overall acceptability (1-9)	0.8764	8.365	8.40	0.1606	NS

* Predicted values of Design Expert 13 package; @ Actual values are average of seven trials for optimized product; # t-values found non-significant at 5% level of significance NS = Non-Significant; Tabulated t-value = 2.447 (cal. t-value less than tabulated value)

Conclusion

The optimized formulation for pumpkin seed incorporated burfi (PSIB) was achieved by incorporating pumpkin seeds at 3.09% (w/w of milk), sugar at 1.88% (w/w of milk), and palm jaggery at 5.01% (w/w of milk). This combination resulted in a product with desirable sensory attributes in terms of colour, appearance, texture and overall acceptability. Replacing a portion of sugar with palm jaggery contributed to a more natural sweetness while also enhancing the nutritional profile through the improvement in protein, fat and mineral content compared to control.

References

1. Adsul S, Madkaikar V. Pumpkin (*Cucurbita pepo*) seed. In: Oilseeds: Health Attributes and Food Applications. Singapore: Springer; 2021, p. 473-506.
2. Chandrakanth V, Annaiah HNM, Shivalingaiah S, Chikkappaiah L. Cardamom (*Elettaria cardamomum* (L.) Maton) fortified jaggery: its physicochemical characterization and *in vitro* antioxidant capacity. Sugar Tech. 2019;21:388-397.
3. Dotto JM, Chacha JS. The potential of pumpkin seeds as a functional food ingredient: A review. Sci Afr. 2020;10:e00575.
4. Food Safety and Standards Authority of India. Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011 (Updated 2018) [Internet]. New Delhi: FSSAI; 2018 [cited 2025 Jul]. Available from: <https://www.fssai.gov.in>
5. Food Safety and Standards Authority of India. Manual of methods of analysis of foods: Dairy and dairy products (FSSAI 01.039:2022). New Delhi: FSSAI; 2022.
6. Food Safety and Standards Authority of India. Manual of methods of analysis of foods: Dairy and dairy products (FSSAI 01.062:2022). New Delhi: FSSAI; 2022.
7. Food Safety and Standards Authority of India. Manual of methods of analysis of foods: Dairy and dairy products (FSSAI 01.073:2022). New Delhi: FSSAI; 2022.
8. Food Safety and Standards Authority of India. Manual of methods of analysis of foods: Dairy and dairy products (FSSAI 01.077:2022). New Delhi: FSSAI; 2022.
9. Jaffe WR. Health effects of non-centrifugal sugar (NCS): a review. Sugar Tech. 2012;14:87-94.
10. Kamble PA, Kahate SD, Chavan, Thakare VM. Effect of pineapple pulp on sensory and chemical properties of burfi. Int J Agric Sci. 2010;2(7):329-331.
11. Patel S. Pumpkin (*Cucurbita* sp) seeds as nutraceutical: a review on status quo and scopes. Mediterr J Nutr Metab. 2013;6:183-189.
12. Ramakrishna C, Ravi RS, Reddy Y. Effect of processing variables on quality of milk burfi prepared with and without sugar. J Food Sci Technol Mysore. 2010;47(1):114-118.
13. Sharma A, Kartikeyan S, Asgar S, Khare A, Choudhary KK. Studies on incorporation of date seed (*Phoenix dactylifera* L.) powder for development of burfi. Pharma Innov J. 2023;12(3):5510-5512.
14. Stone H, Sidel JL. Sensory Evaluation Practices. 3rd Ed, New York: Elsevier Academic Press; 2004, p. 88.
15. Vengaiah PC, Ravindrababu D, Murthy GN, Prasad KR. Jaggery from Palmyrah palm (*Borassus flabellifer* L.) Present status and scope. Indian J Tradit Knowl. 2013;12:714-717.
16. Yadav P, Rai DC, Singh UP, Patel V. Optimization of technical process for manufacture of peanut powder enriched burfi. Int J Curr Microbiol App Sci. 2018;7(9):1344-1351.