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Value addition in Burfi through betel vine leaves (Piper betel) and Gulkand: A physico-chemical and economic study

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Abstract
The present study was undertaken to evaluate the effect of incorporating Betel vine leaves (Piper betel) and Gulkand in Burfi on its physico-chemical properties and cost of production. Five treatments were formulated by blending khoa with different proportions of Betel vine leaves (0, 8, 10, 12, and 14 parts) while keeping Gulkand constant at 5%. The prepared Burfi samples were analyzed for fat, protein, total solids, moisture, ash, solids-not-fat (SNF), and acidity. Results indicated that increasing levels of Betel vine leaves and Gulkand significantly influenced the nutritional composition. Fat, protein, total solids, and SNF decreased with higher incorporation, while moisture, ash, and acidity increased. The control sample (T_1) recorded the highest fat (14.25%) and protein (15.73%), while T_5 showed the highest ash (3.50%) and acidity (0.40%). Cost analysis revealed a progressive reduction from ₹366.47/kg in control (T_1) to ₹288.36/kg in T_5. Treatment T_4 (83:12 khoa to betel leaf with 5% Gulkand) was found to be most acceptable based on sensory quality, offering a balance of nutritional composition and economic feasibility. The study suggests that incorporating betel leaves and gulkand enhances functional value while reducing production cost, making it suitable for commercialization.

Keywords: Burfi, betel vine leaves, Gulkand, physico-chemical properties, cost of production

1. Introduction
Burfi is one of the most popular indigenous milk-based sweets in India, widely consumed due to its characteristic flavor, texture, and nutritional value. Traditionally prepared from khoa and sugar, attempts are being made to enhance its functionality and consumer appeal by incorporating fruits, vegetables, herbs, and medicinal plants.

Betel vine (Piper betel) leaves are widely recognized in Ayurveda for their antimicrobial, antioxidant, and digestive properties. They contain essential oils, bioactive compounds, and minerals that can impart functional benefits. Similarly, Gulkand, a traditional preparation of rose petals and sugar, is considered a natural coolant and therapeutic ingredient. Incorporating such ingredients into Burfi can not only improve its nutritional profile but also enhance sensory appeal and marketability.

Several studies have been reported on the incorporation of functional ingredients in Burfi, such as bottle gourd pulp (Bhosale *et al.*, 2018) [2], pumpkin pulp (Kolwate, 2019) [6], wood apple pulp (Patil, 2015) [9], and finger millet flour (Mohod *et al.*, 2020) [7]. However, limited work has been carried out on the utilization of betel vine leaves and Gulkand in dairy products. Therefore, the present investigation was undertaken to evaluate the effect of betel vine leaves and Gulkand incorporation on the physico-chemical properties and cost structure of Burfi.

2. Materials and Methods
2.1 Raw materials
Buffalo milk was procured from the local market of Nagpur for khoa preparation. Fresh betel vine leaves and Gulkand were purchased from local suppliers. Analytical-grade chemicals were used for compositional analysis.

2.2 Preparation of Burfi
Khoa was prepared from buffalo milk by the traditional method. Five treatments were formulated by blending khoa with different levels of betel vine leaves (0, 8, 10, 12, and 14 parts) while keeping Gulkand constant at 5% and sugar at 12%. The treatments were coded as T_1 (100:0), T_2 (87:8), T_3 (85:10), T_4 (83:12), and T_5 (81:14).

2.3 Analytical methods
The prepared Burfi samples were analyzed for fat, protein, total solids, moisture, ash, SNF, and acidity as per standard methods.

2.4 Cost analysis
The cost of production was calculated considering prevailing market prices of milk, betel vine leaves, Gulkand, sugar, fuel, electricity, and labor. The cost per kilogram of Burfi was computed for each treatment.

3. Results and Discussion
3.1 Fat content

Table 1: Fat content of Burfi prepared by different levels of betel vine leaves and Gulkand (percent).

Treatments	Replications					Mean
	R-1	R-2	R-3	R-4	R-5	
T_1	14.03	14.12	14.35	14.44	14.32	14.25
T_2	13.96	14.02	14.06	14.04	14.22	14.06
T_3	13.92	13.93	13.81	14.03	14.21	13.98
T_4	13.86	13.82	13.70	13.65	13.69	13.74
T_5	13.82	13.81	13.62	13.56	13.53	13.60
S.E ± 0.060 C.D.5% 0.174 ResultSig.						

The fat content ranged from 14.25% in control (T_1) to 13.60% in T_5. A decreasing trend was observed with higher incorporation of betel vine leaves due to partial replacement of khoa, which is the primary source of fat. Similar decreasing trends were reported by Patil *et al.* (2015) [9] in date Burfi and Bhosale *et al.* (2018) [2] in bottle gourd Burfi.

3.2 Protein content
Protein content decreased from 15.73% (T_1) to 14.24% (T_5). The reduction is attributed to dilution of milk solids by non-proteinaceous components of betel vine leaves and Gulkand. T_4 recorded 14.55% protein, which was optimal for nutritional balance. Similar results were observed by Ramteke *et al.* (2018) [10] in potato flour Burfi.

Table 2: Protein content of Burfi prepared by different levels of betel vine leaves and Gulkand (percent)

Treatments	Replications					Mean
	R-1	R-2	R-3	R-4	R-5	
T_1	15.62	15.85	15.67	15.79	15.70	15.73
T_4	15.28	15.42	15.34	15.38	15.37	15.36
T_3	14.60	14.99	14.90	14.93	14.95	14.87
T_2	14.36	14.66	14.56	14.59	14.60	14.55
T_5	14.12	14.32	14.22	14.25	14.28	14.24
S.E ± 0.047 C.D. 5% 0.137 ResultSig.						

3.3 Total solids and moisture
Total solids showed a declining trend from 84.54% (T_1) to 83.32% (T_5), whereas moisture content increased from 15.47% (T_1) to 16.68% (T_5). This inverse relationship reflects the high moisture content of betel leaves. Kapare (2017) [5] and Mohod *et al.* (2020) [7] also reported such trends in finger millet Burfi.

Table 3: Total solids content of Burfi prepared by different levels of betel vine leaves and Gulkand(percent)

Treatments	Replications					Mean
	R-1	R-2	R-3	R-4	R-5	
T_1	84.60	84.50	84.70	84.58	84.33	84.54
T_2	84.35	84.32	84.11	84.55	84.11	84.29
T_3	84.20	84.18	84.10	84.45	84.08	84.20
T_4	83.80	83.44	83.40	83.70	83.60	83.59
T_5	83.65	83.40	83.34	83.18	83.02	83.32
S.E ± 0.080 C.D. 5% 0.234 ResultSig.						

Table 4: Moisture content of Burfi prepared by different levels of betel vine leaves and Gulkand (percent)

Treatments	Replications					Mean
	R-1	R-2	R-3	R-4	R-5	
T_1	15.40	15.50	15.30	15.42	15.77	15.47
T_2	15.65	15.68	15.89	15.45	15.89	15.71
T_3	15.80	15.82	15.90	15.55	15.92	15.79
T_4	16.20	16.56	16.60	16.30	16.40	16.41
T_5	16.35	16.60	16.66	16.82	16.98	16.68
S.E ± 0.0831 C.D. 5% 0.2427 ResultSig.						

3.4 Ash content
Ash content increased significantly with higher betel leaf incorporation, ranging from 2.49% (T_1) to 3.50% (T_5). This indicates enhanced mineral contribution from betel leaves. Comparable findings were reported by Bhosale *et al.* (2018) [2] in vegetable-based Burfi.

Table 5: Ash content of Burfi prepared by different levels of betel vine leaves and Gulkand (percent)

Treatments	Replications					Mean
	R-1	R-2	R-3	R-4	R-5	
T_1	2.36	2.50	2.58	2.60	2.42	2.49
T_2	2.62	2.74	2.87	2.93	2.74	2.78
T_3	2.76	2.84	2.92	3.10	2.87	2.89
T_4	3.16	3.20	3.21	3.34	3.16	3.21
T_5	3.40	3.54	3.46	3.67	3.44	3.50
S.E 0.048 CD 5% 0.141 ResultSig.						

3.5 Solids-not-fat (SNF)
SNF content decreased marginally from 70.29% (T_1) to 69.66% (T_5). The decline may be attributed to dilution of milk solids by leaf material. Dhande & Bhosale (2017) [3] observed similar patterns when incorporating non-dairy ingredients into Burfi.

Table 6: SNF content of Burfi prepared by different levels of betel vine leaves and Gulkand (percent)

Treatments	Replications					Mean
	R-1	R-2	R-3	R-4	R-5	
T_1	70.57	70.38	70.35	70.14	70.01	70.29
T_2	70.39	70.3	70.05	70.51	69.89	70.23
T_3	70.28	70.25	70.29	70.42	69.87	70.22
T_4	69.94	69.62	69.7	70.05	69.91	69.84
T_5	69.83	69.63	69.72	69.62	69.49	69.66
S.E 0.090 CD 5% 0.263 ResultSig.						

3.6 Acidity

Table 7: Acidity content of Burfi prepared by different levels of betel vine leaves and Gulkand (percent)

Treatments	Replications					Mean
	R-1	R-2	R-3	R-4	R-5	
T_1	0.29	0.31	0.32	0.30	0.28	0.30
T_2	0.31	0.32	0.33	0.34	0.34	0.32
T_3	0.32	0.34	0.35	0.38	0.36	0.35
T_4	0.34	0.35	0.36	0.41	0.39	0.37
T_5	0.35	0.37	0.39	0.44	0.46	0.40
S.E ± 0.0126 C.D. 5% 0.0366 ResultSig.						

Acidity increased steadily from 0.30% (T_1) to 0.40% (T_5), suggesting higher acid development with more betel leaf addition. This could be due to the organic acids naturally present in betel leaves. Navale *et al.* (2014) [8] observed comparable trends in wood apple Burfi.

3.7 Cost structure

Table 8: Cost of production for 1 Kg Betel vine leaves and Gulkand Burfi prepared under various treatments

Sr. No.	Items	Treatments									
		T_1		T_2		T_3		T_4		T_5	
		Qyt	Value (Rs.)	Qyt	Value (Rs.)	Qyt	Value (Rs.)	Qyt	Value (Rs.)	Qyt	Value (Rs.)
1	Milk (lit.) @ Rs. 60/lit. (Khoa g)	4.5 (893)	270	4.2 (786)	252	3.8 (772)	228	3.5 (758)	210	3.0 (745)	180
2	Betel vine leaves @ Rs.70/kg	0	0	63	4.41	77	5.39	91	6.37	107	7.49
3	Gulkand @ 5% constant (gm) Rs.100/kg	0	0	44	4.4	44	4.4	44	4.4	44	4.4
4	Sugar @ 12% of mix (gm) @ Rs.40/kg	107	4.28	107	4.28	107	4.28	107	4.28	107	4.28
5	Fuel Charges LPG (gm) Rs. 951.5/14.2 Kg	500	33.5	500	33.5	500	33.5	500	33.5	500	33.5
6	Electricity charges @ Rs.6.10/unit	0.40	2.44	0.40	2.44	0.40	2.44	0.40	2.44	0.40	2.44
7	Labour charges @ Rs.225/8 hr	2	56.25	2	56.25	2	56.25	2	56.25	2	56.25
8	Weight of Burfi obtained (gm)	1000		1000		1000		1000		1000	
9	Cost of Burfi/Kg (Rs.)		366.47		357.28		334.26		317.24		288.36

Cost of production showed a decreasing trend with increasing substitution of khoa by betel leaves and Gulkand. The highest cost was recorded in control (T_1) at ₹366.47/kg, while the lowest was in T_5 at ₹288.36/kg. The selected treatment T_4 had a cost of ₹317.24/kg, which was significantly lower than the control and economically viable. Similar reductions in cost were reported in coconut Burfi (Talekar, 2015) [11] and besan Burfi (Jadhav, 2015) [4].

4. Conclusion

The incorporation of betel vine leaves and Gulkand significantly influenced the physico-chemical properties and cost of Burfi. Increasing levels of supplementation reduced fat, protein, total solids, and SNF, while increasing moisture, ash, and acidity. Cost of production decreased with higher incorporation due to partial replacement of khoa by relatively cheaper ingredients. Among the treatments, T_4 (83:12 khoa to betel leaf with 5% Gulkand) emerged as the most suitable formulation, offering an optimal balance of sensory attributes, nutritional composition, and cost efficiency. The study highlights the potential of betel vine leaves and Gulkand as functional ingredients for developing value-added dairy products.

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