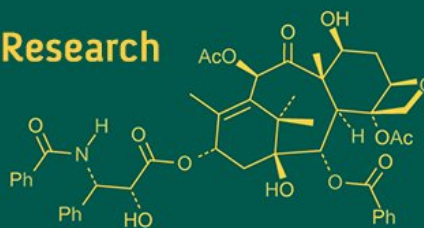


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Nutritional composition, antioxidant properties, and microbiological quality of fig (*ficus carica*)-incorporated camel and buffalo milk based khoa burfi under refrigerated storage conditions

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Abstract

The present study investigated the proximate composition, antioxidant activity, and microbiological quality of fig (*Ficus carica*) incorporated camel and buffalo milk (50:50) based khoa burfi during refrigerated storage ($4 \pm 1^\circ\text{C}$) up to 15 days. Four treatment combinations were prepared: T0 (control, 0% fig paste), T1 (10% fig paste), T2 (20% fig paste), and T3 (30% fig paste). Proximate analysis revealed a highly significant ($p < 0.01$) increase in crude protein with fig incorporation, from 16.10% in control to 23.15% in T3, while moisture and ether extract decreased significantly with increasing fig levels. Refrigerated storage stability was assessed through pH, titratable acidity (% lactic acid), thiobarbituric acid reactive substances (TBARS), ABTS, and DPPH radical-scavenging activity at 3-day intervals. The pH decreased significantly ($p < 0.01$) from 6.94 (day 0) to 5.76 (day 15), while titratable acidity increased progressively during storage. TBARS values increased from 0.143 to 1.071 mg MDA/kg over the 15-day storage period. ABTS and DPPH radical-scavenging activities were significantly higher ($p < 0.01$) in fig-incorporated burfi compared to control, with T3 exhibiting the highest antioxidant capacity; however, both activities declined with increasing storage duration. Microbiological analysis showed standard plate count (SPC) remained below BIS permissible limits (30,000 cfu/g) throughout the 15-day storage period, yeast and mould were undetected until day 6, and coliform counts were nil throughout. The production cost ranged from ₹290/kg (control) to ₹518/kg (T3). The results suggest that fig-incorporated camel and buffalo milk khoa burfi with 10% fig paste offers superior nutritional and functional attributes while maintaining acceptable microbial quality up to 12-15 days under refrigeration.

Keywords: Camel milk, Buffalo milk, Fig (Anjeer), Khoa burfi, Antioxidant activity, Storage stability

1. Introduction

India is the world's largest milk producer, achieving approximately 248 million tonnes annually with a per capita milk availability of 485 g/day. Despite this abundance, value-added utilization of diverse milk types remains limited. Khoa, a heat-desiccated indigenous dairy product, forms the base for a wide array of traditional Indian sweets, including burfi, peda, and gulabjamun. Burfi is among the most popular khoa-based confections consumed across India and increasingly sought after in global markets with Indian diaspora (Kumar, 2013) [27]. Camel milk has attracted considerable scientific interest due to its unique bioactive composition, including antimicrobial peptides, insulin-like proteins, and immunoglobulins. It is characterized by low fat (1.5-3%), high vitamin C, and anti-diabetic and anti-cancer properties (Agarwal *et al.*, 2003; Magjeed, 2005) [3, 30]. Buffalo milk, conversely, is nutritionally superior in fat, protein, and calcium, making it ideal for traditional Indian dairy products (D'Ambrosio *et al.*, 2008) [14]. The blend of camel and buffalo milk (50:50) thus presents an opportunity to produce khoa burfi that combines the functional advantages of both milk species. Fig (*Ficus carica*) is a nutritionally dense fruit rich in dietary fibre, polyphenols, flavonoids, anthocyanins, calcium, potassium, and iron (Caliskan and Polat, 2011; Veberic *et al.*, 2008) [11, 52]. Incorporation of fig paste into dairy confections not only enriches their

Inflammatory, and antimicrobial properties attributed to the phytochemicals present in the fruit (Mawa *et al.*, 2013; Oliveira *et al.*, 2022) [31, 35]. Fig has been reported to possess significant free radical-scavenging activity, making it a promising functional ingredient for extending the shelf life of dairy products. While prior studies from this research program have established the sensory quality and textural profile of fig-incorporated camel and buffalo milk khoa burfi there exists a critical gap in the literature regarding its proximate composition, antioxidant properties, storage stability indices, and microbiological quality during refrigerated storage. Understanding these parameters is essential for product commercialization, shelf-life determination, and regulatory compliance under BIS standards. The present investigation was therefore undertaken to evaluate: (i) proximate composition (moisture, ether extract, crude protein, total ash, carbohydrate) of fig-incorporated burfi; (ii) storage stability as measured by pH, titratable acidity, TBARS, ABTS, and DPPH radical-scavenging activity over 15 days of refrigerated storage (4 ± 1 °C); (iii) microbiological quality (standard plate count, yeast and mould count, coliform count) during storage; and (iv) the cost of production of the developed product.

2. Materials and Methods

2.1 Collection of Raw Materials

Fresh camel milk was collected from the camel dairy maintained at ICAR-NRC on Camel, Bikaner, and fresh buffalo milk was sourced from the Buffalo Unit, Department of Livestock Products Technology, CVAS, RAJUVAS, Bikaner. Fig fruits were procured from the local Bikaner market, cleaned, soaked in water for 12 hours, and homogenized into paste using a mixer-grinder. Powdered sugar was purchased from the local market. All milk samples were collected in sterile bottles under chilled conditions and transported immediately for processing.

2.2 Preparation of khoa burfi

Burfi was prepared following the method described by Reddy (1985), with a standardized blend of 50% camel milk and 50% buffalo milk (6% fat, 9% SNF). Milk was pre-heated to 35-40 °C, filtered, and subjected to continuous stirring-cum-scraping in an iron karahi over moderate heat until a pasty consistency was achieved. Temperature was lowered to 88-89 °C, after which sugar (30% w/w of khoa) and fig paste at specified levels were added with continuous stirring until a solid mass was obtained. The product was spread in greased stainless-steel trays, cooled, cut into rectangular blocks (approximately 30 g each), and stored at 4 ± 1 °C in 65-micron polyethylene pouches.

The treatment combinations prepared were: T0 - 100 parts khoa + 0% fig paste (control); T1 - 90 parts khoa + 10% fig paste; T2 - 80 parts khoa + 20% fig paste; T3 - 70 parts khoa + 30% fig paste.

2.3 Proximate analysis

Proximate analysis of the prepared burfi samples was performed in quadruplicate using standard procedures (AOAC, 2000) [1]. Moisture content was determined gravimetrically at 100 °C (IS: 1479, Part-II, 1961). Fat content was estimated by Gerber's method (IS: 1224, Part-II,

1977). Crude protein was estimated by the micro-Kjeldahl method (IS: 1981) using nitrogen-to-protein conversion factor 6.38. Total ash was determined by incineration at 550 °C for 3.5 h in a muffle furnace (IS: 1981). Carbohydrate content was calculated by difference: Carbohydrate (%) = Total Solids - (Fat + Protein + Ash).

2.4 Storage stability analysis

Stored burfi samples (T0-T3) were analyzed at 0, 3, 6, 9, 12, and 15 days under refrigeration (4 ± 1 °C) for the following parameters

- **pH:** Measured using a digital pH meter (AOAC, 1995) [2] on a 10 g/50 mL suspension in distilled water, calibrated with standard pH 4.0 and 7.0 buffers.
- **Titratable acidity (% lactic acid):** determined by titrating a 10 mL homogenate (10 g burfi + 90 mL water) against 0.1 N NaOH using phenolphthalein indicator to a faint pink end-point.
- **TBARS (Thiobarbituric Acid Reactive Substances):** Lipid oxidation was measured by the extraction method of Witte *et al.* (1970) [55]. Absorbance was recorded at 532 nm and expressed as mg MDA/kg using the formula: TBARS = $A_{532} \times 5.2$.
- **ABTS Radical-scavenging activity:** Determined spectrophotometrically according to Salami *et al.* (2009) [42]. ABTS⁺ cation radical was generated by reacting ABTS stock solution with 2.45 mM potassium persulphate and allowing 16 h in dark at room temperature. Absorbance of reaction mixture was read at 734 nm after 20 min. ABTS activity (% inhibition) = $[(0.70 - A_{734})/0.70] \times 100$.
- **DPPH Radical-scavenging activity:** estimated by the method of Brand-Williams *et al.* (1995) [9]. Briefly, 2 mL DPPH (100 µM) was mixed with 0.5 mL Tris-HCl buffer (0.1 M, pH 7.4) and 50 µL sample, incubated in dark for 20 min at room temperature, and absorbance read at 517 nm. DPPH activity (% inhibition) = $100 - [(A_{517}/A_{517_0}) \times 100]$.

2.5 Microbiological analysis

Microbiological examination was performed according to BIS standards [8]. Standard plate count (SPC) was determined using plate count agar (IS: 5402, 1969), incubated at 37 °C for 48 h. Yeast and mould count (YMC) was determined using potato dextrose agar (pH 3.5 with tartaric acid) (IS: 5403, 1969), incubated at 25 °C for 5 days. Coliform count was determined using violet red bile agar, incubated at 37 °C for 24 h. All results are expressed as log cfu/g.

2.6 Cost evaluation

The cost of production of the developed burfi was calculated based on prevailing market prices of raw materials, processing, packaging, and incidental expenses at the time of the experiment.

2.7 Statistical analysis

All experiments were conducted in triplicate, and samples were analyzed in duplicate. Data were subjected to two-way analysis of variance (ANOVA) as described by Snedecor and Cochran (1994) [47]. Significant differences between means were evaluated using Duncan's New Multiple Range Test (DNMRT) as modified by Kramer (1957). Statistical significance was set at $p < 0.01$ and $p < 0.05$.

3. Results and discussion

3.1 Proximate composition of fig-incorporated khoa burfi

The proximate composition of camel and buffalo milk based khoa burfi incorporated with varying levels of fig paste is

presented in Table 1. A highly significant difference ($p < 0.01$) was observed among treatment groups for all proximate parameters.

Table 1: Proximate Composition (mean $\pm$ SE) of Fig (Anjeer)-Incorporated Camel and Buffalo Milk Khoa Burfi

Constituent (%)	T0 (Control)	T1 (10% Fig)	T2 (20% Fig)	T3 (30% Fig)
Moisture**	32.94 ^d $\pm$ 0.168	28.05 ^c $\pm$ 0.041	25.40 ^b $\pm$ 0.835	22.10 ^a $\pm$ 0.027
Ether Extract**	26.14 ^d $\pm$ 0.064	19.95 ^c $\pm$ 0.028	17.27 ^b $\pm$ 0.037	15.32 ^a $\pm$ 0.022
Crude Protein**	16.10 ^a $\pm$ 0.194	18.32 ^b $\pm$ 0.027	21.54 ^c $\pm$ 0.319	23.15 ^d $\pm$ 0.348
Total Ash**	4.86 ^a $\pm$ 0.081	4.66 ^b $\pm$ 0.014	4.40 ^c $\pm$ 0.052	4.03 ^d $\pm$ 0.127

T0 - camel and buffalo milk khoa without any fig paste incorporation, T1 - camel and buffalo milk khoa with fig paste (10 per cent), T2 - camel and buffalo milk khoa with fig paste (20 per cent), T3 - camel and buffalo milk khoa with fig paste (30 per cent) 4.03d $\pm$ 0.127 Note- Means bearing different superscripts differ significantly

** - significant at 1% ($p < 0.01$)

3.1.1 Moisture content

The moisture content of the burfi samples decreased significantly ($p < 0.01$) with increasing levels of fig paste incorporation, ranging from 32.94 $\pm$ 0.168% in T0 to 22.10 $\pm$ 0.027% in T3. The decrease in moisture with increasing fig content is attributable to the lower moisture content of dried fig paste (~30-35%) compared to the khoa base, and its hygroscopic sugars drawing free water into bound water fractions during heat processing. These values are in close agreement with those reported by Wadewale (2010) [53] for mandarin orange burfi (17.93-20.88%), Navale *et al.* (2014) [33] for wood apple burfi (16.96-20.30%), and Singh (2020) [45] for watermelon seed-incorporated camel and buffalo milk khoa burfi. Mete and Sadawarte (2017) [32] also reported a significant decrease in moisture content with increasing levels of khajoor in burfi.

3.1.2 Ether extract (fat) content

Ether extract (fat) content decreased significantly ($p < 0.01$) from 26.14 $\pm$ 0.064% in control to 15.32 $\pm$ 0.022% in T3. This declining trend results from the dilution effect: as fig paste (which is essentially fat-free) replaces a proportion of the fat-rich khoa fraction, the total fat percentage decreases proportionally. Lahankar (2017) [29] reported fat content of 20.50-22.20% in green pea burfi, and Dua *et al.* (2018) [18] recorded 27.96% fat in ghee residue burfi, while lower fat values in fruit-incorporated burfi are consistent with the present findings. The reduction in fat content with fig addition may also confer potential health benefits, as high dietary fat intake is associated with non-communicable disease risk (WHO, 2023) [54].

3.1.3 Crude Protein content

Crude protein content increased significantly ($p < 0.01$) from 16.10 $\pm$ 0.194% (T0) to 23.15 $\pm$ 0.348% (T3). This progressive increase reflects the protein contribution of fig,

which contains approximately 4.9 g protein per 100 g dry weight (Slatnar *et al.*, 2011) [46]. Dried figs are a recognized source of essential amino acids (Ercisli *et al.*, 2012) [20], and their incorporation substantially enriched the protein content of the burfi matrix. The values obtained are comparable to those reported for ghee residue burfi (23.68% protein; Dua *et al.*, 2018) [18] and higher than values reported for khoa from traditional formulations. This protein enrichment is a significant value-addition, especially for populations requiring high-protein supplementation.

3.1.4 Total ash content

Total ash content decreased significantly from 4.86 $\pm$ 0.081% (T0) to 4.03 $\pm$ 0.127% (T3), likely due to the diluting effect of adding fig paste which has a relatively lower mineral concentration than the concentrated milk solids in khoa. These values fall within the range reported by Nikam (2012) for ash gourd burfi, Navale *et al.* (2014) [33] for wood apple burfi (2.56-2.98%), and Sharma and Gupta (1982) for market burfi. Importantly, the ash content of the product remained within acceptable limits throughout, indicating adequate mineral retention.

3.1.5 Carbohydrate content

Carbohydrate content estimated by difference increased from 20.06% in control to 35.40% in T3. The natural sugars in fig (glucose, fructose, sucrose; approximately 47-63 g/100 g dry weight) contributed significantly to the total carbohydrate content (Pereira *et al.*, 2017) [37]. This carbohydrate enrichment, combined with dietary fibre from fig, makes the product a good source of quick energy and beneficial prebiotic compounds.

3.2 Storage stability parameters

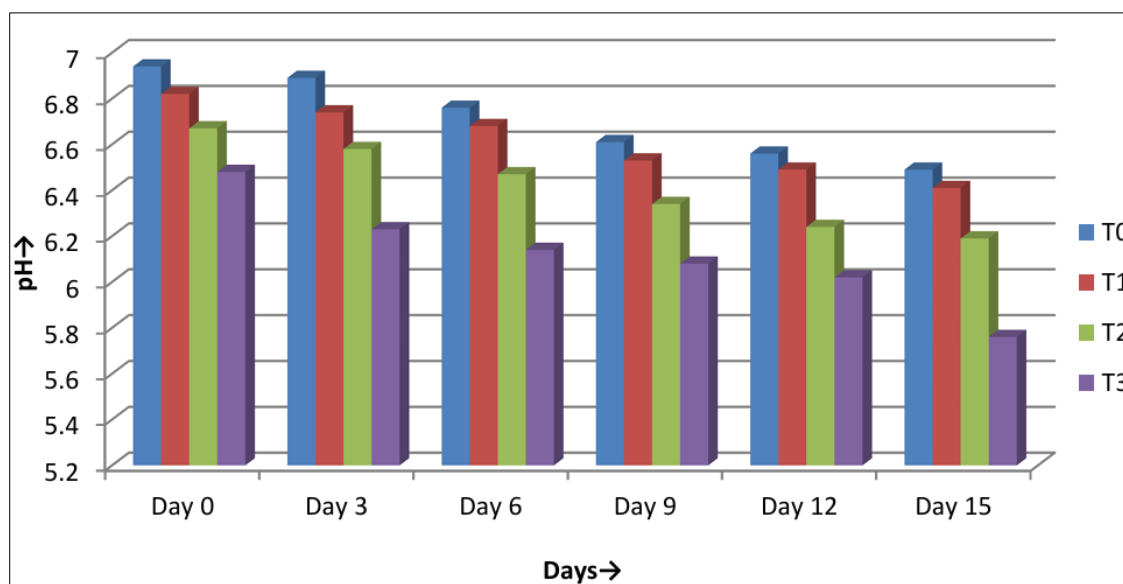
3.2.1 PH Determination

The pH values of camel and buffalo milk khoa burfi incorporated with fig paste during 15 days of refrigerated storage (4 $\pm$ 1 °C) are presented in Table 2. The overall pH of control (T0) was 6.70 $\pm$ 0.064, declining progressively to values of 6.62 $\pm$ 0.044 (T1), 6.41 $\pm$ 0.059 (T2), and 6.14 $\pm$ 0.069 (T3). A highly significant difference ($p < 0.01$) was observed between storage periods and between treatment groups.

Table 2: pH (Mean $\pm$ SE) of Fig-Incorporated Camel and Buffalo Milk Khoa Burfi during Refrigerated Storage

Day	T0	T1	T2	T3	Overall
Day 0	6.94 $\pm$ 0.058	6.82 $\pm$ 0.052	6.67 $\pm$ 0.084	6.48 $\pm$ 0.089	6.72 ^a $\pm$ 0.086
Day 3	6.89 $\pm$ 0.049	6.74 $\pm$ 0.064	6.58 $\pm$ 0.062	6.23 $\pm$ 0.086	6.61 ^b $\pm$ 0.073
Day 6	6.76 $\pm$ 0.072	6.68 $\pm$ 0.075	6.47 $\pm$ 0.072	6.14 $\pm$ 0.065	6.51 ^c $\pm$ 0.071
Day 9	6.61 $\pm$ 0.087	6.53 $\pm$ 0.061	6.34 $\pm$ 0.082	6.08 $\pm$ 0.082	6.32 ^d $\pm$ 0.072
Day 12	6.56 $\pm$ 0.104	6.49 $\pm$ 0.077	6.24 $\pm$ 0.071	6.02 $\pm$ 0.090	6.26 ^e $\pm$ 0.074
Day 15	6.49 $\pm$ 0.076	6.41 $\pm$ 0.082	6.19 $\pm$ 0.064	5.76 $\pm$ 0.105	6.21 ^f $\pm$ 0.068
Overall	6.70 ^A $\pm$ 0.064	6.62 ^B $\pm$ 0.044	6.41 ^C $\pm$ 0.059	6.14 ^D $\pm$ 0.069	

Note: Means bearing different superscript letters in a column (lowercase) and in a row (uppercase) differ significantly ($p < 0.01$)

**Fig 1:** pH of camel and buffalo milk based khoa burfi blended with fig paste during refrigerated storage

The pH of all treatments decreased continuously from day 0 to day 15 of storage. The initial pH of T3 (6.48 ± 0.089) was lower than the control (6.94 ± 0.058) at day 0, attributable to the inherently acidic nature of fig (pH $\sim$ 4.6-5.8) containing organic acids such as citric, malic, and oxalic acids (Solomon *et al.*, 2006) [48]. The progressive decline in pH during storage is attributed to microbial activity producing lactic acid and other organic acids through glycolysis of residual lactose and fig sugars (Daifas *et al.*, 1999) [15]. The Maillard reaction and associated organic acid production during khoa manufacture may also contribute to the gradual pH decrease (Goyal and Srinivasan, 1989) [22]. Similar pH decrease trends during refrigerated storage have been

reported by Chaudhary *et al.* (2019) [12] in aloe vera burfi, Shrivastava *et al.* (2018) [44] in rava burfi, and Singh (2020) [45] in watermelon seed-incorporated khoa burfi.

3.2.2 Titratable acidity (% lactic acid)

Titrateable acidity values of the burfi samples during refrigerated storage are presented in Table 3. Initial titrateable acidity (day 0) was significantly higher in fig-incorporated treatments (T3: $1.19 \pm 0.042\%$) compared to control (T0: $0.68 \pm 0.023\%$), reflecting the inherent acidity of fig paste. A highly significant ($p < 0.01$) increase in titrateable acidity was observed with both increasing storage duration and increasing fig incorporation level.

Table 3: Titratable Acidity (% Lactic Acid, Mean $\pm$ SE) of Fig-Incorporated Khoa Burfi during Refrigerated Storage

Day	T0	T1	T2	T3	Overall
Day 0	0.68 $\pm$ 0.023	0.71 $\pm$ 0.023	1.06 $\pm$ 0.065	1.19 $\pm$ 0.042	0.91 ^a $\pm$ 0.057
Day 3	0.69 $\pm$ 0.021	0.74 $\pm$ 0.027	1.11 $\pm$ 0.021	1.38 $\pm$ 0.111	0.98 ^b $\pm$ 0.061
Day 6	0.70 $\pm$ 0.028	0.77 $\pm$ 0.021	1.15 $\pm$ 0.024	1.47 $\pm$ 0.030	1.02 ^c $\pm$ 0.066
Day 9	0.71 $\pm$ 0.017	0.78 $\pm$ 0.031	1.19 $\pm$ 0.029	1.53 $\pm$ 0.027	1.05 ^d $\pm$ 0.069
Day 12	0.77 $\pm$ 0.012	0.81 $\pm$ 0.027	1.21 $\pm$ 0.033	1.56 $\pm$ 0.028	1.07 ^e $\pm$ 0.081
Day 15	0.91 $\pm$ 0.029	0.97 $\pm$ 0.023	1.24 $\pm$ 0.021	1.59 $\pm$ 0.034	1.09 ^f $\pm$ 0.092
Overall	0.70 ^A $\pm$ 0.022	0.79 ^B $\pm$ 0.022	1.16 ^C $\pm$ 0.039	1.45 ^D $\pm$ 0.047	

Note: Means bearing different superscript letters in a column (lowercase) and in a row (uppercase) differ significantly ($p < 0.01$)

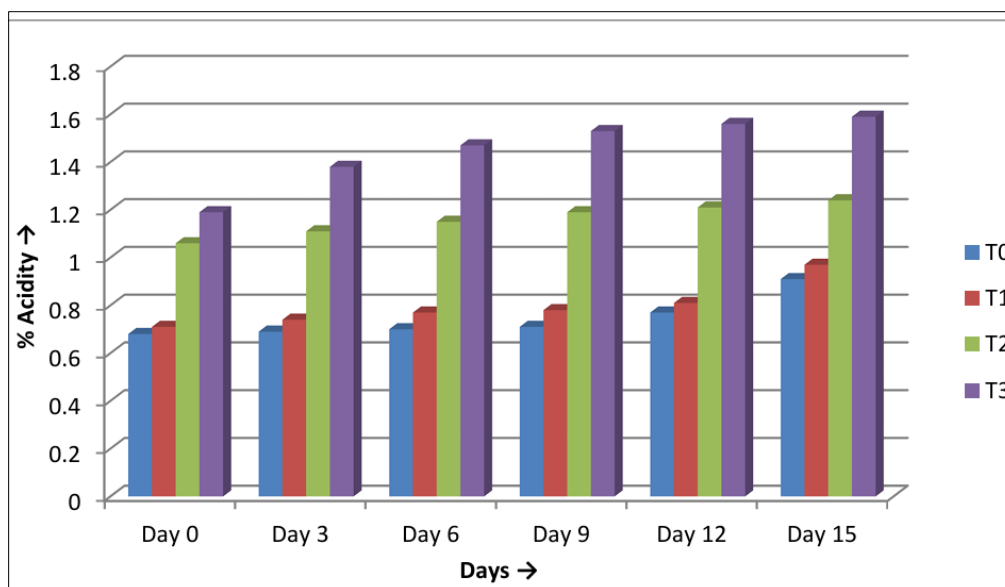


Fig 2: Titratable Acidity (TA) of camel and buffalo milk based khoa burfi blended with fig paste

The rise in titratable acidity during storage is consistent with microbial production of lactic acid, formic acid, acetic acid, and other short-chain organic acids from the fermentation of lactose and sugars (O'Brien, 1997) [34]. The higher acidity in fig-incorporated treatments (T2, T3) from day 0 is directly due to the organic acid content of fig, particularly citric and malic acids (Pereira *et al.*, 2017) [37]. These results are in conformity with findings of Banjare *et al.* (2015) [7] in traditional peda, Shrivastava *et al.* (2018) [44] for rava burfi, Kumar *et al.* (2016) [28] for pineapple burfi, and Pal *et al.* (2018) [36] for bottle gourd and carrot burfi. The observed

increase in acidity was well below levels that would cause sensory rejection, indicating adequate storage life under refrigeration.

3.2.3 Thiobarbituric acid reactive substances (tbars)

TBARS values, used as an index of lipid oxidation and rancidity development, are presented in Table 4. Initial TBARS values ranged from 0.143 ± 0.025 (T0) to 0.206 ± 0.021 (T3), increasing significantly ($p < 0.01$) to 1.016-1.071 mg MDA/kg by day 15 across all treatments.

Table 4: TBARS Values (mg MDA/kg, Mean $\pm$ SE) of Fig-Incorporated Khoa Burfi during Refrigerated Storage

Day	T0	T1	T2	T3	Overall
Day 0	$0.143^{aA} \pm 0.025$	$0.157^{aB} \pm 0.028$	$0.184^{aC} \pm 0.028$	$0.206^{aD} \pm 0.021$	$0.172^a \pm 0.024$
Day 3	$0.204^{bA} \pm 0.034$	$0.223^{bB} \pm 0.038$	$0.246^{bC} \pm 0.039$	$0.258^{bD} \pm 0.027$	$0.232^b \pm 0.025$
Day 6	$0.323^{cA} \pm 0.024$	$0.337^{cB} \pm 0.029$	$0.361^{cC} \pm 0.019$	$0.391^{cD} \pm 0.023$	$0.353^c \pm 0.036$
Day 9	$0.467^{dA} \pm 0.035$	$0.478^{dB} \pm 0.018$	$0.493^{dC} \pm 0.009$	$0.526^{dD} \pm 0.024$	$0.491^d \pm 0.017$
Day 12	$0.738^{eA} \pm 0.021$	$0.763^{eB} \pm 0.029$	$0.789^{eC} \pm 0.016$	$0.804^{eD} \pm 0.025$	$0.773^e \pm 0.011$
Day 15	$1.016^{fA} \pm 0.027$	$1.035^{fB} \pm 0.038$	$1.059^{fC} \pm 0.021$	$1.071^{fD} \pm 0.012$	$1.045^f \pm 0.020$
Overall	$0.480^A \pm 0.051$	$0.495^B \pm 0.052$	$0.522^C \pm 0.056$	$0.542^D \pm 0.060$	

Note: Means bearing different superscript letters in a column (lowercase) and in a row (uppercase) differ significantly ($p < 0.01$)

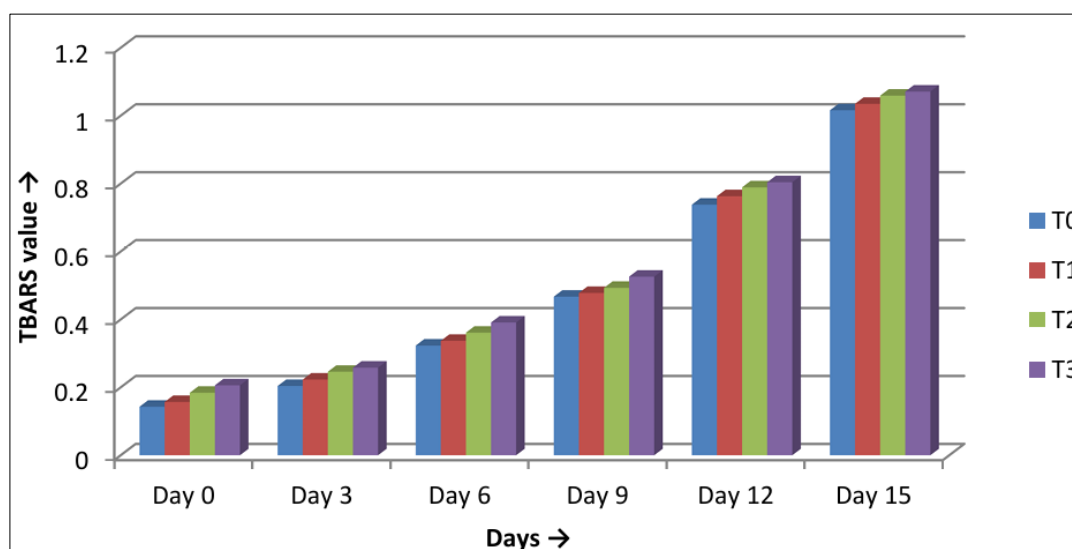


Fig 3: TBARS value of camel and buffalo milk based khoa burfi blended with fig paste

All TBARS values throughout the 15-day storage period remained below the permissible limit of 1.5 mg MDA/kg for fat-containing dairy products (Das *et al.*, 2015) [16], indicating no organoleptic rancidity. The progressive increase in TBARS with storage duration reflects gradual oxidation of unsaturated fatty acids (particularly from camel milk, which contains proportionally higher C18:2 and C18:3 polyunsaturated fatty acids (Konuspayeva *et al.*, 2009) [26]. The slightly higher TBARS in fig-incorporated treatments compared to control at equivalent storage periods suggests that fig paste, while containing antioxidant compounds, may also carry pro-oxidant phenolics at higher concentrations or introduce minor amounts of iron that catalyze lipid peroxidation (Slatnar *et al.*, 2011) [46]. Comparable TBARS increases during refrigerated storage of dairy products have

been documented by Bukhari *et al.* (2012) [10] in kaladhi, Devi (2018) [17] in camel-buffalo milk nuggets, Prajapat (2019) [38] in camel-goat milk paneer, and Singh (2020) [45] in watermelon seed khoa burfi.

3.2.4 ABTS Radical-scavenging activity

ABTS (% inhibition) values of all burfi samples during 15 days of refrigerated storage are presented in Table 5. The antioxidant activity assessed by the ABTS method was significantly ($p < 0.01$) higher in fig-incorporated samples than in control, with T3 recording the highest overall ABTS activity ($45.42 \pm 0.531\%$) compared to T0 ($23.14 \pm 0.474\%$). A highly significant ($p < 0.01$) decline in ABTS activity was observed with increasing storage duration across all treatment groups.

Table 5: ABTS Activity (% Inhibition, Mean $\pm$ SE) of Fig-Incorporated Khoa Burfi during Refrigerated Storage

Day	T0	T1	T2	T3	Overall
Day 0	32.36 ^{FA} $\pm$ 0.068	44.13 ^{FB} $\pm$ 0.070	49.58 ^{FC} $\pm$ 0.012	57.35 ^{FD} $\pm$ 0.091	45.85 ^F $\pm$ 0.367
Day 3	28.01 ^{EA} $\pm$ 0.057	38.48 ^{EB} $\pm$ 0.049	44.62 ^{EC} $\pm$ 0.094	53.32 ^{ED} $\pm$ 0.069	41.07 ^E $\pm$ 0.579
Day 6	25.07 ^{DA} $\pm$ 0.016	31.26 ^{DB} $\pm$ 0.086	38.13 ^{DC} $\pm$ 0.043	47.16 ^{DD} $\pm$ 0.027	37.92 ^D $\pm$ 0.529
Day 9	21.13 ^{CA} $\pm$ 0.013	28.64 ^{CB} $\pm$ 0.081	31.08 ^{CC} $\pm$ 0.052	41.44 ^{CD} $\pm$ 0.074	34.85 ^C $\pm$ 0.499
Day 12	18.49 ^{BA} $\pm$ 0.019	24.53 ^{BB} $\pm$ 0.045	26.97 ^{BC} $\pm$ 0.038	36.16 ^{BD} $\pm$ 0.091	31.28 ^B $\pm$ 0.261
Day 15	15.18 ^{AA} $\pm$ 0.064	20.24 ^{AB} $\pm$ 0.088	23.47 ^{AC} $\pm$ 0.062	31.30 ^{AD} $\pm$ 0.064	26.27 ^A $\pm$ 0.169
Overall	23.14 ^A $\pm$ 0.474	36.06 ^B $\pm$ 0.447	39.06 ^C $\pm$ 0.294	45.42 ^D $\pm$ 0.531	

Note: Means bearing different superscript letters in a column (lowercase) and in a row (uppercase) differ significantly ($p < 0.01$). Interaction between treatment and period: S** ($p < 0.01$)

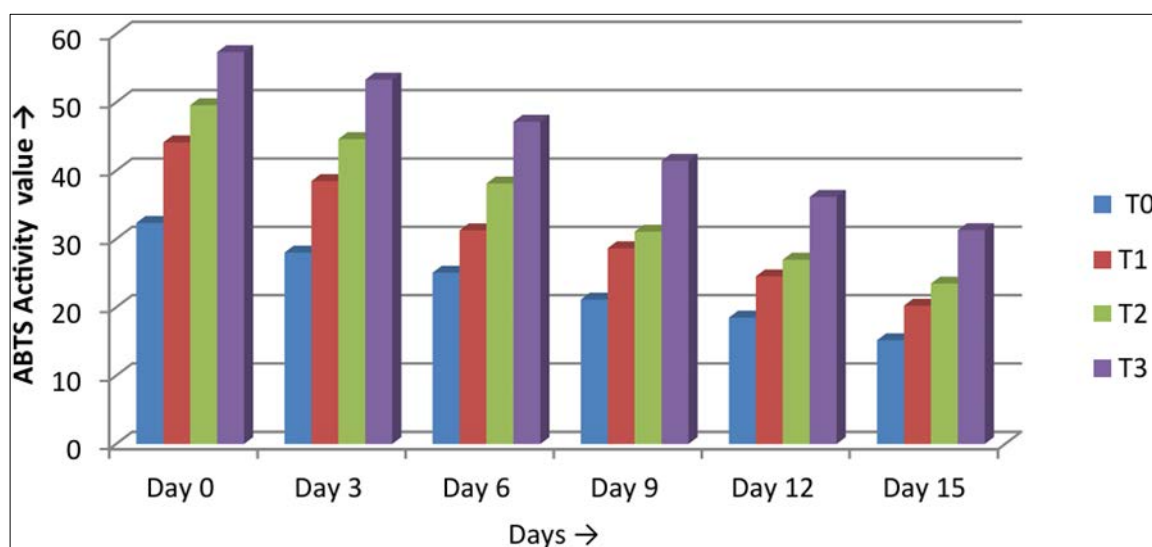


Fig 4: ABTS radical-scavenging activity (% inhibition) of fig-incorporated camel and buffalo milk khoa burfi during refrigerated storage

The superior antioxidant activity of fig-enriched burfi is attributable to the polyphenolic compounds, flavonoids, anthocyanins, and phenolic acids present in fig fruits, including rutin, chlorogenic acid, and quercetin derivatives (Veberic *et al.*, 2008; Oliveira *et al.*, 2022) [35, 52]. Additionally, camel milk is a known source of bioactive peptides and vitamin C that contribute to radical-scavenging activity (El-Hatmi *et al.*, 2007; Agrawal *et al.*, 2011) [4, 19]. The ABTS activity of T3 declined from 57.35% at day 0 to 31.30% by day 15, indicating gradual degradation of heat-labile antioxidant compounds during extended storage under refrigeration. This observation aligns with Devi (2018) [17] in flaxseed-incorporated camel-buffalo milk nuggets (53.20% Declining to 21.71%), Badola *et al.* (2018) [6] in herbal

Essential oil burfi, and Singh (2020) [45] in watermelon seed burfi. The superior antioxidant retention in fig-burfi compared to plain burfi throughout storage suggests that fig incorporation meaningfully extends the oxidative stability of the product.

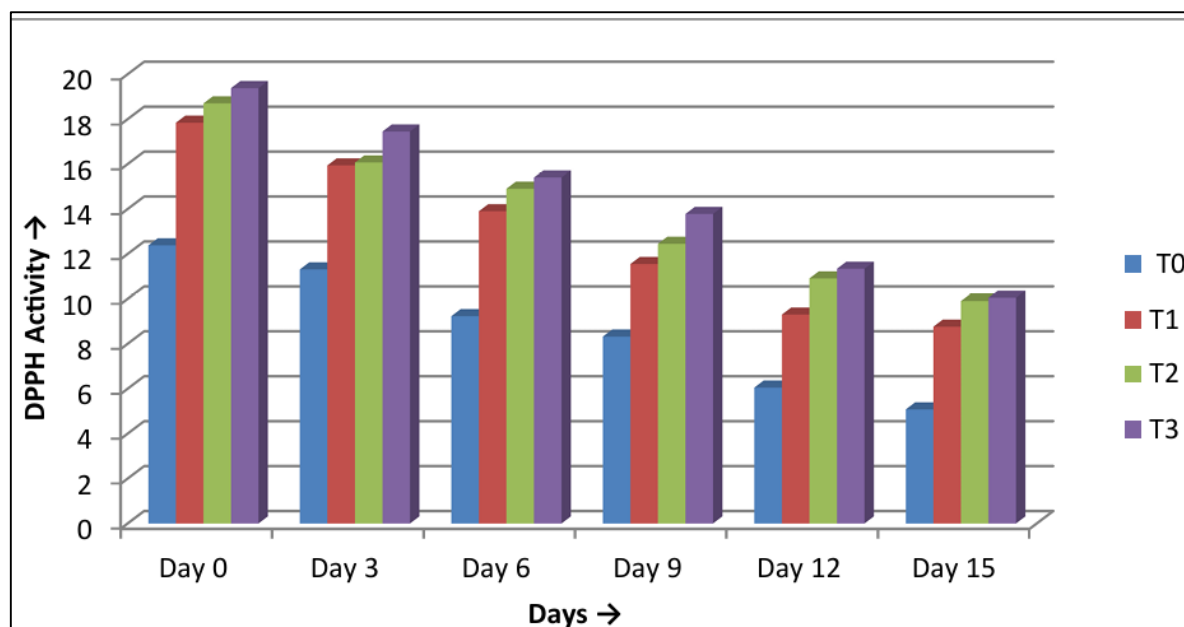
3.2.5 DPPH Radical-Scavenging Activity

DPPH radical-scavenging activity data (Table 6) corroborated the ABTS findings. Overall DPPH activity was significantly ($p < 0.01$) higher in T3 ($14.56 \pm 0.345\%$) compared to control ($8.72 \pm 0.317\%$), and a highly significant decrease ($p < 0.01$) was observed with advancing storage period as well as interaction between treatment and period.

Table 6: DPPH Activity (% Inhibition, Mean $\pm$ SE) of Fig-Incorporated Khoa Burfi during Refrigerated Storage

Day	T0	T1	T2	T3	Overall
Day 0	12.38 ^{fA} $\pm$ 0.013	17.84 ^{fB} $\pm$ 0.021	18.70 ^{fC} $\pm$ 0.042	19.38 ^{fD} $\pm$ 0.021	17.07 ^f $\pm$ 0.438
Day 3	11.31 ^{eA} $\pm$ 0.074	15.94 ^{eB} $\pm$ 0.041	16.07 ^{eC} $\pm$ 0.084	17.45 ^{eD} $\pm$ 0.058	15.18 ^e $\pm$ 0.434
Day 6	09.23 ^{dA} $\pm$ 0.025	13.90 ^{dB} $\pm$ 0.038	14.90 ^{dC} $\pm$ 0.037	15.40 ^{dD} $\pm$ 0.081	13.35 ^d $\pm$ 0.458
Day 9	08.32 ^{cA} $\pm$ 0.034	11.55 ^{cB} $\pm$ 0.041	12.45 ^{cC} $\pm$ 0.029	13.78 ^{cD} $\pm$ 0.069	11.52 ^c $\pm$ 0.453
Day 12	06.05 ^{bA} $\pm$ 0.051	09.30 ^{bB} $\pm$ 0.064	10.91 ^{bC} $\pm$ 0.041	11.34 ^{bD} $\pm$ 0.018	09.40 ^b $\pm$ 0.441
Day 15	05.08 ^{aA} $\pm$ 0.065	08.76 ^{aB} $\pm$ 0.028	09.90 ^{aC} $\pm$ 0.020	10.05 ^{aD} $\pm$ 0.049	08.44 ^a $\pm$ 0.433
Overall	08.72 ^A $\pm$ 0.317	12.88 ^B $\pm$ 0.337	13.82 ^C $\pm$ 0.328	14.56 ^D $\pm$ 0.345	

Note: Means bearing different superscript letters in a column (lowercase) and in a row (uppercase) differ significantly ($p < 0.01$).

**Fig 5:** DPPH radical-scavenging activity (% inhibition) of fig-incorporated camel and buffalo milk khoa burfi during refrigerated storage

The DPPH inhibition values of fig-burfi (T1-T3) were consistently superior to control across all storage days, confirming the functional antioxidant contribution of fig paste. The highest DPPH activity was observed at day 0 for T3 (19.38 $\pm$ 0.021%), declining to 10.05 $\pm$ 0.049% by day 15. The reduction in DPPH activity during storage may be attributed to oxidation and thermal degradation of phenolic compounds, reaction of antioxidants with free radicals generated during lipid peroxidation, and possible polymerization of polyphenols at refrigeration temperature (Quideau *et al.*, 2011) [39]. The correlation between higher ABTS and DPPH activities in fig-enriched burfi is expected, as both assays measure hydrogen-donating and electron-transfer capacities of phenolic antioxidants. These results

are consistent with Gorachiya (2017) [21] in pomegranate whey beverages, Tak (2017) [49] in fermented camel milk, Devi (2018) [17] in flaxseed milk nuggets, and Singh (2020) [45] in khoa burfi.

3.3 Microbiological quality during refrigerated storage

3.3.1 Standard plate count

The standard plate count (SPC) data for all treatment groups during 15 days of refrigerated storage are presented in Table 7. SPC increased significantly ($p < 0.01$) with advancing storage period across all treatments. At day 0, SPC ranged from 3.272 $\pm$ 0.102 log cfu/g (T0) to 4.143 $\pm$ 0.093 log cfu/g (T3). By day 15, SPC had increased to 3.567 log cfu/g (T0) and 4.232 log cfu/g (T3).

Table 7: Standard Plate Count [log (cfu/g), Mean $\pm$ SE] of Fig-Incorporated Khoa Burfi during Refrigerated Storage

Day	T0	T1	T2	T3	Overall
Day 0	3.272 $\pm$ 0.102	3.657 $\pm$ 0.071	4.069 $\pm$ 0.106	4.143 $\pm$ 0.093	3.384 ^a $\pm$ 0.091
Day 3	3.408 $\pm$ 0.081	3.835 $\pm$ 0.079	4.097 $\pm$ 0.091	4.152 $\pm$ 0.099	3.639 ^{ab} $\pm$ 0.095
Day 6	3.416 $\pm$ 0.092	3.899 $\pm$ 0.089	4.123 $\pm$ 0.077	4.168 $\pm$ 0.082	3.951 ^{bc} $\pm$ 0.086
Day 9	3.441 $\pm$ 0.094	3.929 $\pm$ 0.094	4.158 $\pm$ 0.079	4.188 $\pm$ 0.086	4.111 ^{cd} $\pm$ 0.082
Day 12	3.498 $\pm$ 0.079	3.960 $\pm$ 0.087	4.191 $\pm$ 0.088	4.213 $\pm$ 0.073	4.133 ^{de} $\pm$ 0.084
Day 15	3.567 $\pm$ 0.103	4.018 $\pm$ 0.075	4.204 $\pm$ 0.096	4.232 $\pm$ 0.073	4.196 ^e $\pm$ 0.076
Overall	3.832 ^A $\pm$ 0.089	3.885 ^B $\pm$ 0.096	3.918 ^C $\pm$ 0.094	3.975 ^D $\pm$ 0.087	

Note: Means bearing different superscript letters in a column (lowercase) and in a row (uppercase) differ significantly ($p < 0.01$).

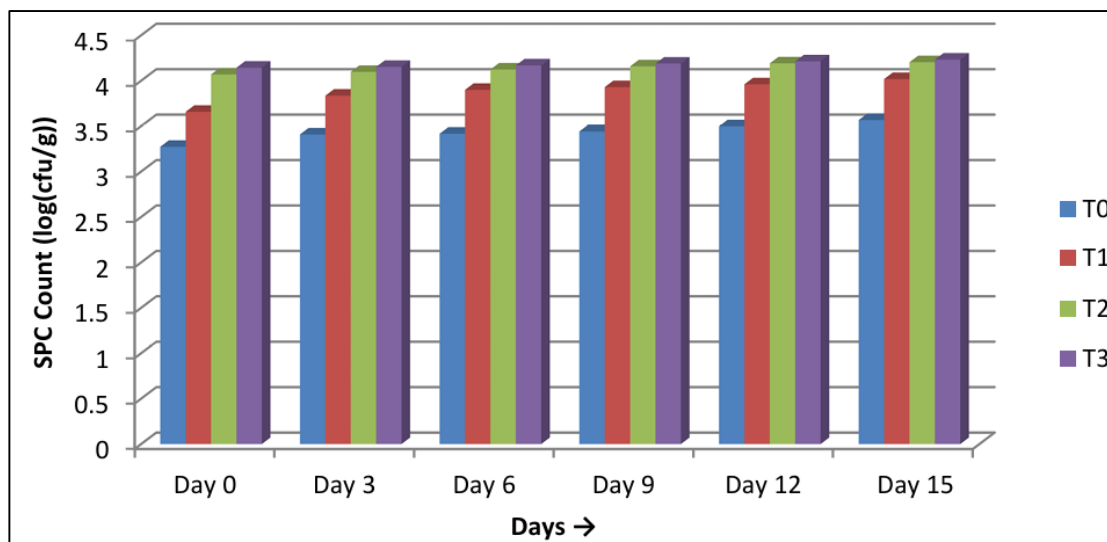


Fig 6: Standard plate count [log (cfu/g)] of fig-incorporated camel and buffalo milk khoa burfi during refrigerated storage

Critically, SPC values for control (T0) remained well below the BIS permissible limit of 30,000 cfu/g (log 4.477) throughout the 15-day storage period, indicating microbiologically acceptable product quality. The higher initial SPC in fig-incorporated treatments (T2, T3) at day 0 relative to control is attributed to the higher moisture content of fig paste facilitating microbial multiplication, as well as the natural microflora associated with the dried fruit. However, all SPC values across treatments remained within acceptable limits per IS 5550:2005. The gradual increase in SPC during refrigerated storage is consistent with the behavior of mesophilic bacteria at reduced temperatures (Prabha, 2006; Londhe, 2006) and is comparable to

observations of Chawla *et al.* (2015) [13] in doda burfi, Vasava *et al.* (2018) [51] in gluten-free gulabjamun, and Singh (2020) [45] in watermelon seed khoa burfi.

3.3.2 Yeast and mould count

Yeast and mould count (YMC) data during refrigerated storage are presented in Table 8. No yeast or mould growth was detected (NIL) in any treatment group up to day 6 of refrigerated storage, demonstrating good hygienic preparation conditions. From day 9 onwards, YMC began to increase significantly, reaching a maximum of 1.081 ± 0.068 in T3 by day 15.

Table 8: Yeast and Mould Count [log (cfu/g), Mean $\pm$ SE] of Fig-Incorporated Khoa Burfi during Refrigerated Storage

Day	T0	T1	T2	T3	Overall
Day 0	NIL	NIL	NIL	NIL	0 ^a
Day 3	NIL	NIL	NIL	NIL	0 ^a
Day 6	NIL	NIL	NIL	NIL	0 ^a
Day 9	0.452 ± 0.108	0.478 ± 0.096	0.513 ± 0.115	0.723 ± 0.107	$0.541^b \pm 0.051$
Day 12	0.672 ± 0.108	0.688 ± 0.107	0.762 ± 0.104	0.884 ± 0.104	$0.751^{bc} \pm 0.046$
Day 15	0.953 ± 0.100	0.973 ± 0.103	1.023 ± 0.098	1.081 ± 0.068	$1.072^c \pm 0.045$
Overall	$0.692^A \pm 0.066$	$0.713^{AB} \pm 0.151$	$0.766^{BC} \pm 0.072$	$0.896^C \pm 0.077$	

Note: Means bearing different superscript letters in a column (lowercase) and in a row (uppercase) differ significantly ($p < 0.01$)

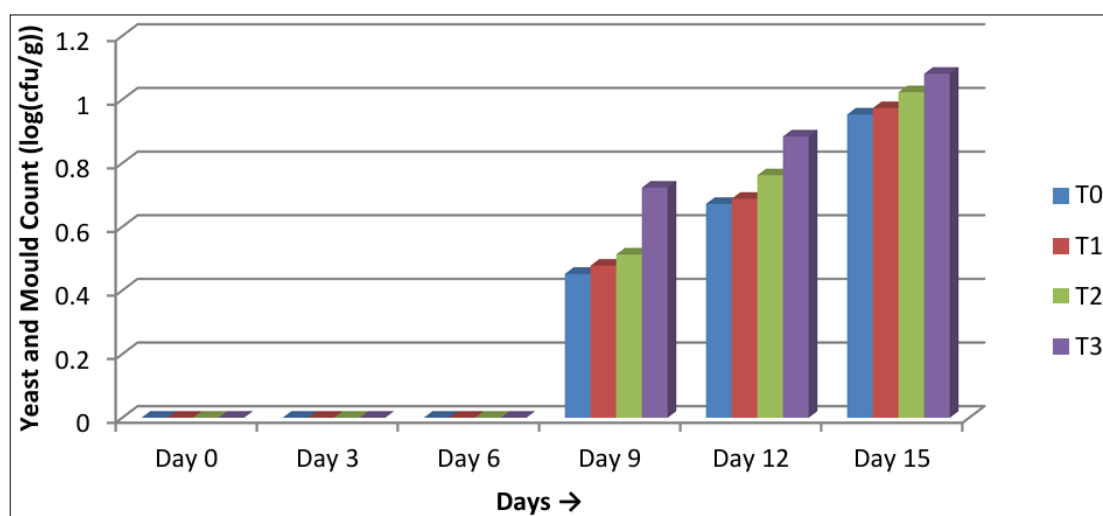


Fig 7: Yeast and mould count [log (cfu/g)] of fig-incorporated camel and buffalo milk khoa burfi during refrigerated storage

The BIS specification (IS 5550:2005) for burfi mandates yeast and mould count not exceeding 10 cfu/g (log 1.0). At day 15, the YMC of T3 (1.081 log cfu/g = approx. 12 cfu/g) marginally exceeded this limit, while T0, T1, and T2 remained within acceptable levels. The detection of yeast and mould only from day 9 onwards indicates that the product is microbiologically safe for at least 6 days of refrigerated storage without yeast or mould concerns. The subsequent growth from day 9 is attributable to the increasing moisture availability and decreasing pH providing a favorable environment for osmophilic yeasts and xerophilic moulds (Sachdeva and Rajorhia, 1982; Chawla *et al.*, 2015) [13, 41]. The slightly higher YMC in fig-incorporated treatments may be due to the higher sugar content of fig promoting yeast growth. Similar observations have been reported by Vaja (2012) [50] in gulabjamun, Chawla *et al.* (2015) [13] in doda burfi, and Aparna *et al.* (2018) [51] in rava burfi.

3.3.3 Coliform count

No coliform organisms were detected in any of the burfi treatment groups (T0-T3) throughout the entire 15-day refrigerated storage period. This finding confirms the

hygienic manufacturing conditions maintained during product preparation and demonstrates that the product met the BIS specification for burfi (IS 5550:2005), which requires absence of coliforms. The elimination of coliforms is consistent with the heat treatment applied during khoa preparation (continuous heating at >100 °C), which effectively destroys coliform organisms (Sarkar *et al.*, 2002) [43]. These results are in agreement with Gupta *et al.* (2010) in coconut burfi, Shrivastava *et al.* (2017) [44] in rava burfi, Vasava *et al.* (2018) [51] in gluten-free gulabjamun, and Singh (2020) [45] in watermelon seed khoa burfi. Coliform absence is an important indicator of product safety and good manufacturing practices.

3.4 Cost evaluation of the developed khoa burfi

The cost of production of the developed camel and buffalo milk khoa burfi with varying levels of fig paste incorporation is presented in Table 9. The cost increased progressively from ₹290/kg (T0, control) to ₹366/kg (T1, 10% fig), ₹442/kg (T2, 20% fig), and ₹518/kg (T3, 30% fig), primarily due to the relatively high market price of dry fig (Anjeer).

Table 9: Cost Evaluation (₹/kg) of Fig-Incorporated Camel and Buffalo Milk Khoa Burfi

Particulars	T0 (Control)	T1 (10% Fig)	T2 (20% Fig)	T3 (30% Fig)
Camel & Buffalo Milk Khoa + Sugar (₹)	240	216	192	168
Fig (Anjeer) (₹)	—	100	200	300
Processing (₹)	10	10	10	10
Packaging (₹)	20	20	20	20
Other (₹)	20	20	20	20
Total Cost (₹/Kg)	290	366	442	518

Note: T0 - control (0% fig); T1 - 10% fig; T2 - 20% fig; T3 - 30% fig. Costs calculated at prevailing market prices during the study period

Given the superior sensory acceptability of T1 and the present findings of acceptable proximate composition, antioxidant activity, and microbial quality, T1 (₹366/kg) represents the most commercially viable formulation. The modest premium of ₹76/kg over the control is justified by the nutritional and functional value addition conferred by fig incorporation particularly the protein enrichment, dietary fibre, and antioxidant properties. Similar cost-quality trade-off analyses have been conducted for fruit-fortified dairy products (Kamble *et al.*, 2010; Lahankar, 2017) [25, 29]. Considering that artisanal and premium Indian sweets command higher prices in urban and export markets, the T1 product at ₹366/kg remains competitively priced.

4. Conclusion

This study comprehensively established the proximate composition, antioxidant properties, storage stability, and microbiological safety of fig-incorporated camel and buffalo milk (50:50) khoa burfi over 15 days of refrigerated storage. The incorporation of fig paste significantly enhanced the crude protein content (up to 23.15% at 30% fig level) and carbohydrate content while reducing moisture and fat. Fig incorporation imparted significantly higher antioxidant activity (both ABTS and DPPH radical-scavenging) to the burfi, with the effect diminishing progressively during storage but remaining significantly superior to control throughout. Storage stability analyses confirmed progressive but controlled increases in titratable acidity and TBARS, and decreases in pH, consistent with cold-chain preservation. Microbiologically, the product demonstrated

acceptable quality with no coliforms detected at any storage day, yeast and mould below BIS limits up to day 12 (T0-T2), and SPC well within permissible limits throughout. On the basis of optimum sensory quality textural properties, proximate enrichment, antioxidant activity, and microbial safety, 10% fig paste incorporation (T1) at ₹366/kg is recommended as the optimal and commercially viable formulation for aerobically packaged camel and buffalo milk khoa burfi with a refrigerated shelf life of 12 days.

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Conflict of interest

All the authors declare no conflict of interest.

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