



Studies on Sensory and Physico-chemical Analysis of Basundi Blended with Safflower Petals

G.R. Dhawale¹, S.G. Narwade¹, G.K. Londhe¹, S.G. Khandagale¹, N.K. Anarthe¹

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ABSTRACT

Background: This study aims to optimise the levels of safflower petals in traditional Indian basundi and assess sensory and physico-chemical properties. Basundi is a traditional, concentrated and sweetened whole milk product having sweetish caramel and pleasant aroma, light to medium brown colour, thick body and creamy consistency with or without soft-textured flakes that are uniformly suspended throughout the product. Basundi was prepared using buffalo milk standardized to 6% fat; safflower petals in flakes form were added at varying levels (0.2%, 0.4%, 0.6%, 0.8%).

Methods: Sensory evaluation (9-point hedonic scale) and physico-chemical tests (pH, acidity, moisture, total solids, fat, protein, ash, carbohydrate, fibre, colour index) were performed. Flakes form and addition at 50% volume reduction stage maximised sensory acceptability.

Result: The sensory score for (0.4% safflower) matched or exceeded the control in colour, flavour, body, texture and mouthfeel. Physico-chemical analysis showed increased total solids from (42.33 to 53.53), protein (8.10 to 8.32), ash (1.41 to 1.72) and carbohydrate (21.07 to 23.57) with increasing petal level; moisture decreased from (57.67 to 47.47), pH (6.48 to 5.80) and titratable acidity rose from (0.39 to 0.54). Basundi enriched with 0.4% safflower petals offers improved sensory and nutritional characteristics without adverse effects and can serve as a cost-effective alternative to saffron.

Key words: Basundi, Colour index, Physico-chemical analysis, Safflower petals, Sensory evaluation.

INTRODUCTION

India has a long-standing tradition of dairy production and consumption, deeply rooted in its cultural and economic life. Milk and milk-based sweets hold a special place in Indian cuisine, offering nourishment and indulgence alike. Among these, basundi is a much-loved delicacy, particularly in Maharashtra, Gujarat and Karnataka. It is prepared by slowly simmering milk until it thickens, yielding a sweetened product with a creamy texture, mild caramel flavor and rich aroma (Pagote, 2003). The Indian milk production system was getting a pull according to the demand of the segmented milk products market (Dadge *et al.*, 2015).

In recent years, growing interest in functional dairy products has led to the increased use of natural, plant-based ingredients, including edible flowers. These flowers are valued for their high content of bioactive compounds-flavonoids, phenolics, antioxidants and essential oils-that contribute to both health benefits and sensory appeal. Several researchers have successfully incorporated flowers, such as roses, hibiscus, calendula, chamomile and blue pea, into products like yoghurt, ice cream and shrikhand, thereby enhancing their antioxidant capacity, shelf life and sensory attributes (Sakshi and Kanvar, 2023).

Among various edible flowers, safflower (*Carthamus tinctorius* L.) stands out for its vibrant color and traditional medicinal significance. The petals are rich in pigments and bioactives, including carthamin and carthamidin, known for their antioxidant, anti-inflammatory and color-enhancing properties (Arslaner *et al.*, 2020). Traditionally, saffron (*Crocus sativus*) provides the distinctive golden hue and

¹Department of Animal Husbandry and Dairy Science, Vasantao Naik Marathawada Krishi Vidhyapeeth, Parbhani-431 402, Maharashtra, India.

Corresponding Author: S.G. Narwade, Department of Animal Husbandry and Dairy Science, Vasantao Naik Marathawada Krishi Vidhyapeeth, Parbhani-431 402, Maharashtra, India.
Email: narwades@rediffmail.com

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aroma in basundi, but its high price limits broader usage. Safflower petals could therefore serve as an economical and natural alternative.

Although safflower has been explored in other dairy products such as yoghurt, ice cream and shrikhand, its potential in basundi remains largely unstudied. The present work aims to assess the effect of dried safflower petals at varying concentrations on the sensory and physico-chemical properties of basundi, thereby addressing this gap and contributing to the innovation of functional traditional dairy desserts. In spite of remarkable increase in milk production, the milk and milk products are out of reach of vulnerable group, due to the high cost of milk and milk products. These situations demanded to development of the low cost substitute for milk and milk products (Pariskar *et al.*, 2026).

MATERIALS AND METHODS

The study “Studies on sensory and physico-chemical analysis of basundi blended with safflower petals” was conducted at the Department of Animal Husbandry and Dairy Science, College of Agriculture, Vasant Rao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani.

Dried safflower petals (variety *Purna*) in flake form were procured from the AICRP on Safflower, VNMKV, Parbhani. Fresh, whole buffalo milk was obtained from the department's buffalo unit. Commercial-grade sugar and food-grade plastic containers were purchased from the local market. The required laboratory equipment, including an iron *karahi*, stainless steel *khunti*, gas burner, precision balance, muffle furnace, pH meter and hot air oven, was available at the Department of Animal Husbandry and Dairy Science.

Preparation of basundi

Basundi was prepared following the traditional open-pan method described by De (1980), with slight modifications. The process flow is summarized below (Fig 1).

Treatment combinations

The following treatment combinations were considered for the preparation of basundi blended with safflower petals.

T₁ = 100 parts basundi + 0.015% saffron (control).

T₂ = 100 parts basundi + 0.2% safflower petals.

T₃ = 100 parts basundi + 0.4% safflower petals.

T₄ = 100 parts basundi + 0.6% safflower petals.

T₅ = 100 parts basundi + 0.8% safflower petals.

Sugar was added at 6 per cent based on the volume of milk.

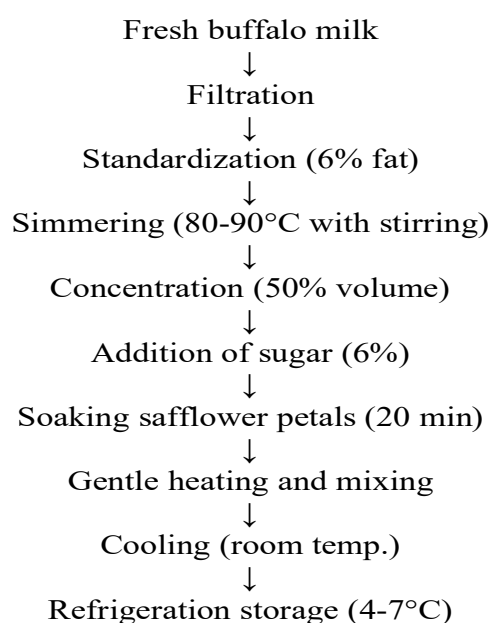


Fig 1: Flow chart for preparation of basundi blended with dried safflower petals.

Sensory evaluation of basundi

Sensory evaluation of basundi was carried out with 5 members of the panel from the technical staff of the Department of AHDS, VNMKV, Parbhani. Evaluation was done by using a 9-point hedonic scale for flavour, colour and appearance, mouthfeel, body and texture and overall acceptability by a semi-trained panel (Gupta, 1976).

Physico-chemical analysis of basundi

Determination of total solids

Determined by method as described in IS: SP (Part XI) 1981.

Moisture

The moisture content was determined by AOAC method (AOAC, 2005: method No.:925.10).

Fat

Determined by Gerber's method as in IS: 1224 (Part II) (1977).

Protein

Crude protein was estimated by Kjeldahl method (AOAC, 2010).

Carbohydrates

Total Carbohydrate and Starch was estimated by using standard methods as described in AOAC (2010).

Ash

The total ash content of the fresh and dried samples was determined as per AOAC, (2005) (AOAC, 2005: method No.:923.03).

Determination of colour index

Colour measurements (L*, a*, b* values) were determined using a ColorFlex EZ Colorimeter (HunterLab, USA).

Statistical analysis

The experimental data were subjected to analysis of variance (ANOVA) using a Completely Randomized Design (CRD) as described by Panse and Sukhatme (1985). Treatment means were compared using Critical Difference (CD) at p<0.05 level of significance. Statistical analysis was performed using OPSTAT software.

RESULTS AND DISCUSSION

Preliminary selection

Preliminary trials were conducted to standardize the processing technology for incorporating safflower petals in basundi, based on a review of literature and initial experimental results. The final formulation of basundi with safflower petals was optimised following the method described by De (1980). Four concentration levels of safflower petals 0.2%, 0.4%, 0.6% and 0.8% were selected based on sensory evaluation outcomes. Incorporating safflower petals at the stage when milk was reduced to 50% of its original volume resulted in better retention of

color and aroma compared to addition during the earlier boiling stage.

Sensory evaluation of safflower basundi

The sensory quality of basundi blended with safflower petals was evaluated using a 9-point hedonic scale for flavour, colour and appearance, body and texture, mouthfeel and overall acceptability, as shown in Table 1.

Flavour

The control sample T₁ obtained the highest flavour score, mainly due to its characteristic saffron aroma. Treatments T₂ and T₃ also received high scores and were well accepted for their mild floral notes, whereas T₄ and T₅ showed a gradual reduction in flavour scores, associated with a slight bitterness at higher safflower levels.

Colour and appearance

Treatment T₃ recorded the highest score for colour and appearance, exhibiting an attractive saffron-like hue. Treatments T₁ and T₂ were also visually appealing, while T₄ and T₅ showed darker shades that deviated from the typical appearance of basundi, resulting in slightly lower scores.

Body and texture

Body and texture scores remained high and comparable for T₁, T₂ and T₃, indicating that safflower incorporation up to 0.4% maintained the desired smooth and creamy texture of basundi. A slight decline in scores for T₄ and T₅ was observed, which can be attributed to the increased fibre content from the petals, leading to a marginally coarse texture.

Mouthfeel

Mouthfeel scores were highest in T₁, followed closely by T₂ and T₃, suggesting that safflower petal levels up to 0.4% did not adversely affect the characteristic creamy mouth-coating sensation of basundi. Lower scores in T₄ and T₅ indicated a slightly coarse or dry sensation at higher petal concentrations.

Overall acceptability

Overall acceptability was highest for T₃ (0.4% safflower petals), followed by T₂ and T₃, showing that moderate safflower incorporation provided the best balance of flavour, colour, texture and mouthfeel. Higher inclusion levels (T₄ and T₅) reduced overall acceptability because of excessive colour intensity, increased fibre content and mild bitterness.

Physico-chemical evaluation of basundi blended with safflower petals

The physico-chemical properties such as pH, titratable acidity, fat, protein, ash, moisture, total solids and carbohydrates, as shown in Table 2.

pH

The pH of basundi decreased progressively from T₁ to T₅, indicating a gradual increase in acidity with higher levels of safflower petals. This trend suggests that organic acids and phenolic constituents from the petals influenced the acid-base balance of the product.

Titratable acidity

Titratable acidity increased from T₁ to T₅, showing an inverse relationship with pH. The rise in acidity can be attributed to

Table 1: Sensory evaluation of basundi.

Treatment	Sensory evaluation				
	Flavour	Colour and appearance	Body and texture	Mouthfeel	Overall acceptability
T ₁	8.49 ^a	8.37 ^b	8.37 ^{ab}	8.59 ^a	8.45 ^{ab}
T ₂	8.37 ^{ab}	8.32 ^{bc}	8.38 ^{ab}	8.58 ^{ab}	8.41 ^{ab}
T ₃	8.34 ^{ac}	8.67 ^a	8.40 ^a	8.44 ^b	8.46 ^a
T ₄	8.00 ^b	8.06 ^c	8.15 ^b	8.20 ^c	8.10 ^b
T ₅	7.65 ^c	7.69 ^d	7.68 ^c	7.97 ^d	7.75 ^c
S.E	0.07	0.05	0.03	0.03	0.06
C.D	0.20	0.14	0.09	0.09	0.18

Table 2: Mean physico-chemical composition of *basundi* blended with dried safflower petals.

Treatment	Physico-chemical properties							
	pH	Acidity (%)	Moisture (%)	Total solids (%)	Fat (%)	Protein (%)	Ash (%)	Carbohydrate (%)
T ₁	6.48 ^a	0.39 ^e	57.67 ^a	42.33 ^e	12.43 ^a	8.10 ^a	1.41 ^e	21.07 ^{de}
T ₂	6.32 ^b	0.43 ^d	55.87 ^b	44.13 ^d	12.28 ^b	8.15 ^d	1.46 ^d	21.27 ^d
T ₃	6.13 ^c	0.47 ^c	53.07 ^c	46.93 ^c	12.13 ^c	8.20 ^c	1.54 ^c	21.76 ^c
T ₄	5.94 ^d	0.50 ^b	49.77 ^d	50.23 ^b	11.99 ^d	8.26 ^b	1.66 ^b	23.16 ^b
T ₅	5.80 ^e	0.54 ^a	47.47 ^e	53.53 ^a	11.84 ^e	8.32 ^a	1.72 ^a	23.57 ^a
S.E	0.03	0.01	0.22	0.02	0.3	0.01	0.02	0.12
C.D	0.10	0.03	0.68	0.05	0.12	0.02	0.05	0.35

the natural acidic components of safflower petals, which contributed to a slightly higher lactic acid equivalent in the basundi matrix.

Moisture content

Moisture content of basundi decreased as the level of safflower petal incorporation increased. This reduction in moisture is associated with the presence of fibrous plant material, which tends to bind water and increase the proportion of total solids.

Total solids

Total solids content increased across treatments from T_1 to T_5 , corresponding to the decline in moisture. The added safflower petals supplied additional insoluble and soluble solids, including fibre and pigment, thereby enhancing the overall solids content and contributing to a richer body.

Fat content

Fat content showed a slight decline from T_1 to T_5 . This decrease is likely due to a dilution effect, where the proportion of fat is reduced relative to the increasing number of non-fat solids introduced by the petals. Deshpande *et al.* (2024) shows similar results while addition of modified psyllium husk in basundi.

Protein content

Protein content increased marginally with higher levels of safflower petals. This trend reflects the contribution of safflower proteins to the total protein fraction of basundi, adding to the milk proteins already present.

Ash content

Ash content, representing total mineral content, increased steadily from T_1 to T_5 . The rise in ash values indicates enhanced mineral contribution from safflower petals, which are naturally rich in various micronutrients.

Carbohydrate content

Carbohydrate content of basundi increased from T_1 to T_5 with incremental addition of safflower petals. This increase can be linked to naturally occurring carbohydrates and dietary fibre in the petals, which add to the lactose and sucrose already present in the formulation.

Colour index

L* value (Lightness)

In the Table 3, the L* value decreased from T_1 to T_5 , indicating that basundi became progressively darker with increasing safflower levels. Higher pigment concentration and heat-induced colour development contributed to this reduction in lightness.

a* value (Red-green axis)

It is revealed from the Table 3, the a* value shifted towards the red axis as safflower incorporation increased. This change reflects the growing influence of red-orange pigments from the petals, resulting in warmer visual tones in the product.

b* value (Yellow-blue axis)

It can be observed from the Table 3, the b* value increased consistently from T_1 to T_5 , confirming an enhancement in yellowness with higher safflower levels. This strong yellow-orange hue is due to the presence of water-soluble yellow pigments in safflower, which effectively coloured the milk matrix.

The sensory evaluation established that 0.4% safflower petal incorporation (T_3) yielded the highest overall acceptability score, surpassing the saffron control (T_1), particularly in colour and appearance, while maintaining equivalent flavour, body, texture and mouthfeel characteristics. This optimal performance mirrors Jadhav (2019), who documented peak sensory acceptance at 1.0% safflower extract in shrikhand, where moderate levels balanced pigment intensity with minimal bitterness development. Higher concentrations (T_4 , T_5) exhibited declining scores due to phenolic bitterness from elevated flavonoid content, consistent with Demgunde *et al.* (2019) observations of flavour reduction in pumpkin pulp-enriched basundi beyond optimal levels (Jadhav, 2019; Demgunde *et al.*, 2019).

Physico-chemical transformations align with safflower petal composition. The pH decline from 6.48 (T_1) to 5.80 (T_5) and corresponding titratable acidity increase (0.39% to 0.54%) result from thermal release of organic acids (citric, malic) and phenolics during simmering, as similarly reported by Borate *et al.* (2022) for anjeer-blended basundi where pH dropped from 6.40 to 6.04 (Borate *et al.*, 2022). Moisture reduction (57.67% to 47.47%) and total solids elevation (42.33% to 52.53%) stem from petal fibre's water-binding capacity and insoluble solid contribution, enhancing body as observed by Bawale (2018) with custard apple pulp incorporation (Bawale, 2018). Fat content dilution (12.43% to 11.84%) reflects non-fat solid addition, while protein enrichment (8.10% to 8.32%) derives from safflower's 15-20% protein content, predominantly albumins and globulins (Wakde *et al.*, 2019). Ash increase (1.41% to 1.72%) indicates mineral supplementation (K, Mg, Ca) and carbohydrate rise (21.07% to 23.57%) originates from petal hemicellulose and natural sugars (Yadav, 2015).

Instrumental colour analysis confirms safflower's saffron-mimetic potential. Decreasing L* values reflect

Table 3: Colour index of basundi.

Treatment	Colour index		
	L* value	a* value	b* value
T_1	81.23 ^a	-2.77 ^a	26.61 ^d
T_2	79.36 ^b	-6.48 ^{de}	30.10 ^c
T_3	76.53 ^c	-5.69 ^d	34.88 ^b
T_4	74.40 ^d	-4.22 ^c	41.41 ^{ab}
T_5	71.36 ^e	-3.36 ^{ab}	42.84 ^a
S.E	0.50	0.29	0.51
C.D	1.50	0.87	1.53

Maillard-induced darkening from pigment-protein interactions, while escalating b^* values (26.61 to 42.40) validate carthamin and carthamidin deposition, producing characteristic yellow-orange hues as demonstrated by Machewad *et al.* (2012) in safflower-pigmented ice cream. The a^* shift toward red coordinates with flavonoid quinoid formation under alkaline milk conditions, paralleling Mukhekar *et al.* (2016) findings in mango pulp basundi (Machewad *et al.*, 2012; Mukhekar *et al.*, 2016).

CONCLUSION

Safflower is an economical and natural alternative. The use of safflower petals (*Carthamus tinctorius* L.), which contain pigments such as carthamidin and precarthamidin and offer antioxidant, anti-inflammatory and colour-enhancing properties. Addition of safflower petals into basundi did not only coloured the basundi but also improved the nutrition of basundi. From the sensory point of view, the optimal formulation (0.4% safflower) matched or exceeded control in colour, flavour, body, texture and mouthfeel. The chemical composition of basundi T3 contains moisture 53.07, fat 12.13, protein 8.20, ash 1.54, carbohydrate 21.76, total solids 46.93 per cent, Acidity 0.47 and pH 6.12.

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Conflict of interest

The authors declare that there is no conflict of interest.

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