

ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(11): 154-160
www.agriculturaljournals.com
Received: 08-09-2026
Accepted: 24-10-2026
Published: 04-11-2026

The names and affiliations of all authors are provided below, following the references.

Chemical and microbial quality of mousse enriched with Alphonso mango (*Mangifera indica* L.) pulp

Sayali R Zagade[1], VB Kadav[2], SS Ramod[3], AJ Mayekar[4], NN Prasade[5], SV Deshmukh[6], Bhakti Pawar[7], Rushikesh Palwe[8]

DOI: https://www.doi.org/10.33545/2664844X.2026.v8.i11c.89938

Abstract

The present investigation was carried out at the Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) to evaluate the chemical and microbial quality of mousse enriched with Alphonso mango (*Mangifera indica* L.) pulp. Mousse was prepared from chhana using three levels of sugar (0, 14 and 18 %) and three levels of mango pulp (20, 30 and 40 %), giving nine treatment combinations (S_{1M1} to S_{3M3}), and the experiment was analysed in a Randomized Block Design with five replications. Total solids, fat, protein, total sugar, ash, titratable acidity and pH differed significantly among the treatments ($P < 0.01$). Total solids ranged from 37.76 to 58.93 %, fat from 12.36 to 19.25 %, protein from 8.04 to 12.24 %, total sugar from 4.95 to 25.48 %, ash from 1.06 to 1.57 %, titratable acidity from 0.24 to 0.34 % and pH from 5.13 to 5.35. A higher level of mango pulp lowered total solids, fat, protein, ash and pH and raised total sugar and titratable acidity. The most acceptable treatment, S_{3M1} (chhana + 18 % sugar + 20 % mango pulp; overall acceptability score 8.82), was stored at 5 ± 1°C for 12 days and examined at 3-day intervals. The standard plate count increased from 0.31×10^5 to 3.32×10^5 cfu/g, coliforms were not detected at any stage, and yeast and mould were not detected up to the 6th day but reached 0.79×10^1 and 1.16×10^1 cfu/g on the 9th and 12th day, respectively. Overall acceptability declined from 8.20 to 5.20 during storage. The mango mousse remained microbiologically safe and acceptable for 9 days under refrigeration.

Keywords: Mango mousse, Chhana, Alphonso mango pulp, Chemical composition, Microbial quality, Refrigerated storage

1. Introduction

Milk is a nutrient-dense food that supplies high-quality protein, calcium and several vitamins, and its processing into value-added products is the main way of dealing with its perishable nature. India is the largest milk producer in the world, with production of 247.87 million tonnes in 2024–25 (Annual Report, 2025–26) [1]. A major group of Indian dairy products is made by heat and acid coagulation of milk, in which the coagulum is separated from the whey by straining (Jha *et al.*, 2010) [2].

Chhana is the acid-coagulated curd of cow or buffalo milk and is regarded as the Indian counterpart of soft cottage cheese. As per FSSR (2011) [3], it should contain less than 70 % moisture and not less than 50 % fat on dry-matter basis. About 6 % of the milk produced in India is converted into chhana (Ammu *et al.*, 2020) [4], where it serves as the base of sweets such as Rasogolla, Sandesh and Rasomalai (Minz *et al.*, 2016) [5]. Chhana contains most of the milk protein together with fat-soluble vitamins and essential fatty acids, and it is low in lactose (Yadav *et al.*, 2019) [6].

Mango (*Mangifera indica* L.) is the national fruit of India and Alphonso is one of the most valued cultivars of the Konkan region because of its colour, aroma and flavour (Dhumal *et al.*, 2022) [7]. The pulp is a source of vitamin C, carotenoids, phenolic compounds and dietary fibre (Jadhav, 2024) [8]. However, mango is seasonal and highly perishable, and processing the pulp into a dairy dessert offers a way to use surplus fruit.

Mousse is a soft, smooth and aerated dessert. Published work on mousse has dealt mostly with chocolate mousse, including probiotic and synbiotic types and whey-substituted types (Aragon-Alegro *et al.*, 2007; Cardarelli *et al.*, 2008; Bouizar *et al.*, 2021) [9, 10, 11], whereas a chhana-based mousse with mango pulp has received little attention. The physico-chemical composition decides the nutritive value, body and keeping quality of such a product, while its microbial quality decides its safety and shelf life. Mango pulp has high moisture and sugar contents and chhana is itself highly perishable, so both are expected to support microbial growth during storage. The present study was therefore undertaken to determine the physico-chemical composition of mousse prepared with different levels of sugar and Alphonso mango pulp, and to assess the microbial quality of the most acceptable treatment during refrigerated storage.

Corresponding Author:
Sayali R Zagade
M.Sc. Student, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India

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2. Materials and methods

The study entitled "Process development of mousse enriched with mango (*Mangifera indica* L.) pulp Cv. Alphonso" was conducted at the Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) during the academic years 2024–2025 and 2025–2026.

2.1 Raw materials

Fresh cow milk was obtained from the Instructional Dairy Farm of the College of Agriculture, Dapoli. Good-quality cane sugar and citric acid were purchased from the local market at Dapoli, and mango pulp was procured from the PHM unit of the University. Plate Count Agar, Violet Red Bile Agar and Potato Dextrose Agar were purchased from HiMedia Laboratories, Mumbai, and analytical grade reagents were used for chemical analysis.

2.2 Preparation of mango mousse

Mango mousse was prepared using the method standardized with slight modifications. Fresh cow milk was received and pre-heated to 35–40°C, followed by filtration and clarification. The filtered milk was then pasteurized at 90°C for 5 minutes and cooled to 70–72°C. The milk was coagulated by the slow addition of 2 per cent citric acid solution until complete coagulation and clear whey separation was achieved. The coagulated milk was then hung in a muslin cloth to drain the whey, and the resulting chhana was collected. The chhana was thoroughly ground to obtain a smooth and uniform consistency. Sugar was then added according to the respective treatments (0, 14 and 18 %) and the mixture was further ground. Subsequently, Alphonso mango pulp was incorporated at the respective treatment levels (20, 30 and 40 %) basis of chhana and mixed thoroughly by grinding to obtain a homogeneous mousse. The prepared mango mousse was then transferred into suitable containers and cooled and stored at 5°C until further analysis.

2.3 Treatments and experimental design

Three levels of sugar (S_1, S_2, S_3) and three levels of mango pulp (M_1, M_2, M_3) were combined to give nine treatments (Table 1). The experiment was laid out in a Randomized Block Design (RBD) with five replications.

2.4 Chemical analysis

Cow milk, chhana, mango pulp and the mousse were analysed in each replication. Total solids of mousse were determined by IS: 1479 (Part I) 1960 and fat by the Gerber method (IS: 1224, Part I, 1977) [12]. Protein was estimated as per cent nitrogen by the Micro-Kjeldahl method (IS: 1479, Part II, 1961) [13], with a nitrogen factor of 6.38 for milk and chhana and 6.25 for mango pulp. Total sugar, titratable acidity (as per cent lactic acid) and pH were determined as per IS: 1479 (Part II) 1961, and ash according to A.O.A.C. (1975). In mango pulp, fat was estimated by Soxhlet extraction and total sugar and ash by the methods of Ranganna (1975) [14]. Lactose of milk and chhana was determined as per IS: 1479 (Part II) 1961.

2.5 Sensory evaluation

Colour and appearance, body and texture, flavour and overall acceptability were scored by 8 to 10 semi-trained judges on a 9-point hedonic scale as per IS: 6273 (Part II) 1971. A score of 5.5 and above was taken as acceptable. On the basis of these scores the most acceptable treatment was selected for the storage study.

2.6 Microbial examination and storage study

The most acceptable treatment (S_{3M1}) was held at refrigeration temperature (5 ± 1°C) and examined at 3-day intervals up to the 12th day (0, 3, 6, 9 and 12 days) for standard plate count (SPC), coliform count and yeast and mould count, along with sensory evaluation. For SPC, 1 ml of the 10^5 dilution was pour-plated in duplicate with Plate Count Agar and incubated at 37°C for 48 h. For coliforms, 1 ml of the sample was pour-plated with Violet Red Bile Agar, overlaid with a second layer of the same medium and incubated at 37°C for 24 h. For yeast and mould, the sample was plated in duplicate with Potato Dextrose Agar, the pH of which was adjusted to 3.5 with 5 ml of sterilized 10 % tartaric acid, and the plates were incubated at 25°C for 5 days. Colonies were counted with a colony counter and expressed as cfu/g. The microbial work was carried out using the laminar air flow facility of the Department of Plant Pathology, College of Agriculture, Dapoli.

Table 1. Treatment details (chhana as base in all treatments)

Sugar level	20 % pulp (M1)	30 % pulp (M2)	40 % pulp (M3)
0 % (S_1)	S_{1M1}	S_{1M2}	S_{1M3}
14 % (S_2)	S_{2M1}	S_{2M2}	S_{2M3}
18 % (S_3)	S_{3M1}	S_{3M2}	S_{3M3}

2.7 Statistical analysis

The data were analysed by analysis of variance for RBD, and treatment means were compared by the critical difference (CD) at 5 and 1 % levels of significance.

3. Results and discussion

3.1 Composition of ingredients

The average composition of the ingredients is presented in Table 2. The cow milk had 13.25 % total solids, 4.25 % fat and 3.35 % protein, which is close to the values reported for cow milk by Rahate (2018) [15], Bhosale (2022) [16], Guthale (2023) [17] and Unde (2024) [18]. The chhana contained 45.15 % total solids, 23.85 % fat and 15.23 % protein, comparable with the chhana used by Patil (2012) [19] (45.37 % total solids, 23.38 % fat) and Dhawade (2022) [20] (48.30 % total solids, 29.60 % fat, 14.30 % protein). The mango pulp had 29.21 % total solids, 15.15 % total sugar and 0.44 % titratable acidity, in agreement with Dubal (2009) [21], Kadam (2014) [22] and Lande (2021) [23]. As chhana supplies most of the fat and protein and the pulp supplies sugar and acid, their proportions in the formulation govern the composition of the mousse.

Table 2. Average chemical composition of ingredients (%)

Constituent	Cow milk	Chhana	Mango pulp
Total solids	13.25	45.15	29.21
Fat	4.25	23.85	0.82
Protein	3.35	15.23	0.86
Lactose	4.91	2.43	–

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Constituent	Cow milk	Chhana	Mango pulp
Total sugar	–	–	15.15
Ash	0.74	1.85	0.35
Titratable acidity	0.14	0.26	0.44

– : not determined.

3.2 Chemical composition of mango mousse

The mean values of total solids, fat, protein and total sugar are given in Table 3 and Figs. 1 and 2, and those of ash, titratable acidity and pH in Table 4. The treatment effect was significant at both 5 and 1 % levels for all parameters (Table 5). The replication effect was also significant, except for pH, where it was non-significant (F = 0.70), which indicates uniform preparation and analysis.

Table 3. Total solids, fat, protein and total sugar (%) of mango mousse

Treatment	Total solids	Fat	Protein	Total sugar
S_{1M1}	40.94^{g}	19.25^{a}	12.24^{a}	4.95^{i}
S_{1M2}	39.34^{h}	16.93^{b}	10.83^{b}	6.28^{h}
S_{1M3}	37.76^{i}	14.63^{g}	9.36^{f}	7.53^{g}
S_{2M1}	54.93^{d}	16.86^{c}	10.72^{c}	18.95^{f}
S_{2M2}	53.33^{e}	14.83^{e}	9.45^{e}	20.24^{e}
S_{2M3}	51.73^{f}	12.75^{h}	8.21^{h}	21.46^{d}
S_{3M1}	58.93^{a}	16.32^{d}	10.34^{d}	22.96^{c}
S_{3M2}	57.34^{b}	14.45^{f}	9.14^{g}	24.28^{b}
S_{3M3}	55.73^{c}	12.36^{i}	8.04^{i}	25.48^{a}

Means with different superscripts in a column differ significantly ($P < 0.05$).

3.2.1 Total solids

The total solids of the mousse ranged from 37.76 % (S_{1M3}) to 58.93 % (S_{3M1}). Within each sugar level the total solids fell as the pulp level rose from 20 to 40 %, whereas they were much higher in the sugar-containing treatments (S_2: 51.73–54.93 %; S_3: 55.73–58.93 %) than in the treatments without sugar (S_1: 37.76–40.94 %). The fall with pulp may be attributed to the higher moisture of mango pulp compared with chhana and sugar, which dilutes the solids of the mix, while added sugar contributes solids directly. A similar decrease in total solids with an increase in guava pulp was reported in shrikhand by Hinwar (2013) [24], from 53.50 % in the control to 50.15 % at the highest pulp level.

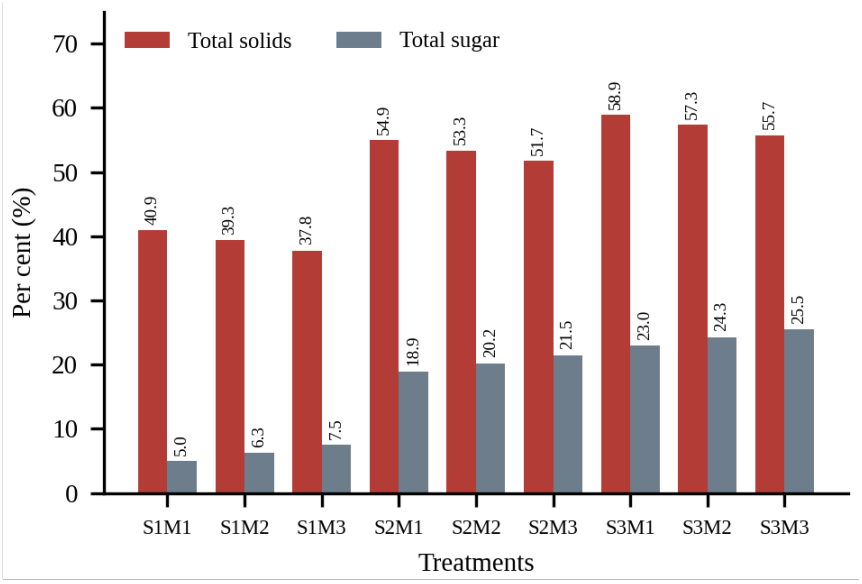


Figure 1. Total solids and total sugar (%) of mango mousse

3.2.2 Fat

The fat content varied from 12.36 % (S_{3M3}) to 19.25 % (S_{1M1}) and decreased with every increase in pulp and sugar level. Since mango pulp contains only 0.82 % fat and sugar contains none, a higher share of these two ingredients reduced the proportion of fat-bearing chhana in the mix, and the fat was thus diluted. Nagvekar (2016) [25] likewise observed that fat in pantua fell from 15.03 to 9.73 % when date pulp replaced half of the khoa-chhana mix.

3.2.3 Protein

Protein was highest in S_{1M1} (12.24 %) and lowest in S_{3M3} (8.04 %). As chhana is the principal source of protein, a larger proportion of pulp and sugar lowered the protein of the mousse, the pulp itself having only 0.86 % protein. The same trend was recorded by Nagvekar (2016) [25], where the protein of pantua decreased from 10.91 to 4.23 % with an increasing level of date pulp.

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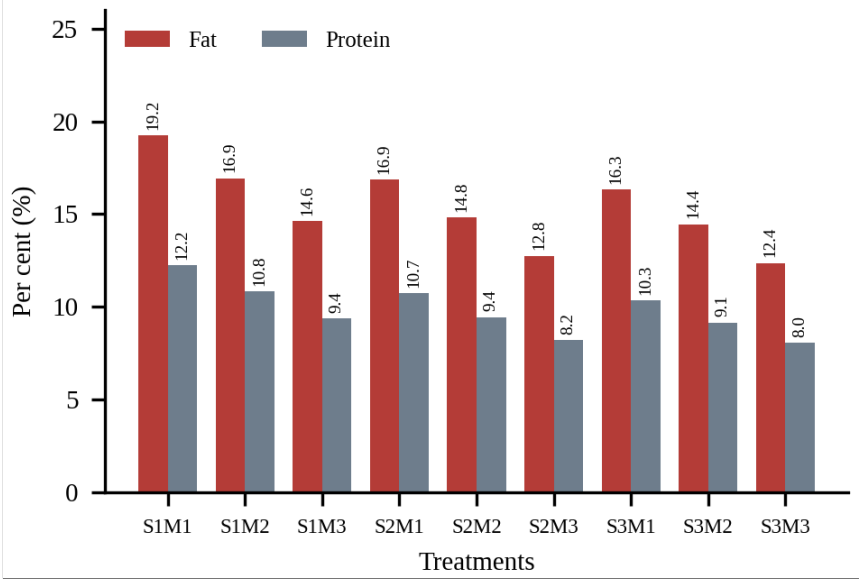


Figure 2. Fat and protein (%) of mango mousse

3.2.4 Total sugar

Total sugar increased significantly from 4.95 % (S_{1M1}) to 25.48 % (S_{3M3}). The treatments without added sugar contained 4.95–7.53 %, which came mainly from the natural sugars of the pulp and the lactose of chhana, and this rose to 18.95–21.46 % at 14 % sugar and 22.96–25.48 % at 18 % sugar. Within each sugar level a higher pulp level gave a higher total sugar content. Gond (2015) [26] also found that the total sugar of chhana whey beverage rose from 7.27 to 15.22 % as sweet orange juice was increased.

3.2.5 Ash

The ash content ranged from 1.06 % (S_{2M3}) to 1.57 % (S_{1M1}) and decreased as the level of pulp increased. Mango pulp had a much lower ash content (0.35 %) than chhana (1.85 %), so replacing part of the chhana base with pulp and sugar reduced the mineral content. Kadam *et al.* (2017) [27] observed a similar decline in the ash of chhana podo, from 1.45 to 1.10 %, when mango pulp was increased from 0 to 40 %.

Table 4. Ash (%), titratable acidity (% lactic acid) and pH of mango mousse

Treatment	Ash	Titratable acidity	pH
S_{1M1}	1.57^{a}	0.29^{c}	5.35^{a}
S_{1M2}	1.42^{b}	0.31^{d}	5.32^{ab}
S_{1M3}	1.25^{e}	0.34^{e}	5.21^{d}
S_{2M1}	1.36^{c}	0.25^{a}	5.31^{b}
S_{2M2}	1.24^{e}	0.27^{b}	5.27^{c}
S_{2M3}	1.06^{g}	0.28^{bc}	5.16^{e}
S_{3M1}	1.32^{d}	0.24^{a}	5.28^{c}
S_{3M2}	1.14^{f}	0.26^{ab}	5.22^{d}
S_{3M3}	1.07^{g}	0.27^{b}	5.13^{e}

Means with the same superscript in a column do not differ significantly ($P < 0.05$).

3.2.6 Titratable acidity and pH

Titratable acidity ranged from 0.24 % (S_{3M1}) to 0.34 % (S_{1M3}), and pH from 5.13 (S_{3M3}) to 5.35 (S_{1M1}). At each sugar level the acidity increased and the pH decreased with the pulp level. This may be attributed to the organic acids of Alphonso pulp, mainly citric and malic acids, as the pulp (0.44 %) was more acidic than chhana (0.26 %). The acidity was lower in treatments with sugar (S_2 and S_3) than in those without sugar (S_1), probably because the added sugar increased the weight of the mix and lowered the acid per unit weight. Patil *et al.* (2017) [28] reported that the acidity of sandesh rose from 0.27 to 0.36 % with 0 to 30 % mango pulp, and Meshram *et al.* (2019) [29] found that the pH of chhana whey beverage fell from 5.53 to 5.18 with increasing strawberry juice.

The treatment S_{3M1}, which was the most acceptable on sensory evaluation (overall acceptability 8.82), had 58.93 % total solids, 16.32 % fat, 10.34 % protein, 22.96 % total sugar, 1.32 % ash, 0.24 % titratable acidity and a pH of 5.28.

Table 5. Summary of analysis of variance for treatment effect (df = 8, error df = 32)

Parameter	F cal.	SEm	CD (5 %)	CD (1 %)	CV (%)
Total solids	746982.85	0.01	0.03	0.04	0.04
Fat	60135.31	0.01	0.03	0.03	0.13
Protein	20173.46	0.01	0.03	0.04	0.22
Total sugar	630485.33	0.01	0.03	0.04	0.14

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Parameter	F cal.	SEm	CD (5 %)	CD (1 %)	CV (%)
Ash	248.95	0.01	0.03	0.04	1.87
Titratable acidity	21.78	0.01	0.02	0.03	5.60
pH	57.70	0.01	0.03	0.04	0.41

F tab: 2.24 (5 %) and 3.13 (1 %); all F values are significant at both levels.

3.3 Microbial quality during refrigerated storage

The microbial quality of S_{3M1} during storage at 5 ± 1°C is shown in Table 6 and Fig. 3. The standard plate count rose steadily from 0.31 × 10^5 cfu/g on the day of preparation to 3.32 × 10^5 cfu/g on the 12th day, indicating gradual growth of the microflora during storage. Coliforms were not detected at any stage of the 12-day storage, which points to hygienic preparation and absence of post-process contamination. Yeast and mould were not detected up to the 6th day, and counts of 0.79 × 10^1 and 1.16 × 10^1 cfu/g appeared on the 9th and 12th day, respectively.

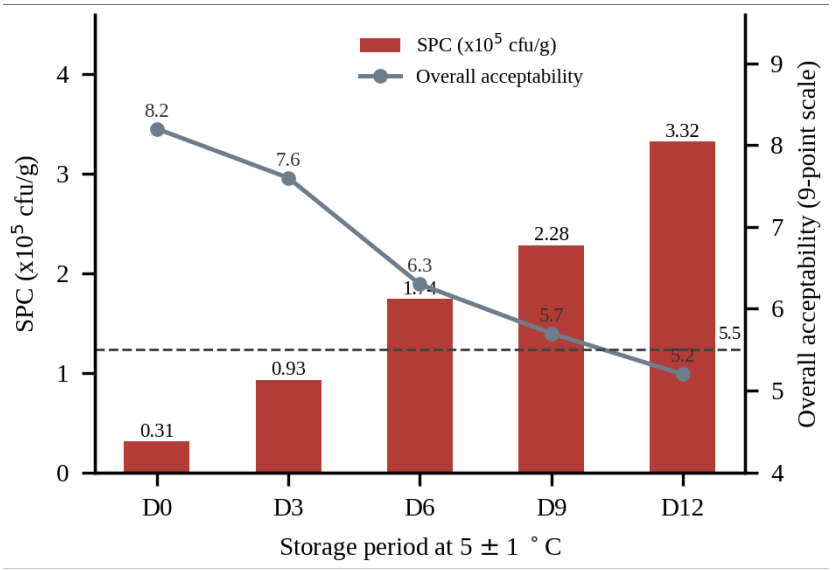


Figure 3. Standard plate count and overall acceptability of mango mousse (S3M1) during storage at 5 ± 1°C

The overall acceptability score decreased from 8.2 on day 0 to 5.2 on day 12, and the fall in sensory quality ran parallel to the rise in microbial population. The score was 5.7 on the 9th day, still above the acceptability limit of 5.5, but dropped below it by the 12th day. The mousse therefore remained safe and acceptable up to 9 days under refrigeration, and signs of deterioration set in beyond this period.

Waikar (2024) [30] likewise recorded a rise in SPC of mango-flavoured channa shree during refrigerated storage, with yeast and mould counts of 1.02 and 1.28 × 10^1 cfu/g at 21 days and no coliforms in any sample, which is of the same order as the present findings. Dahanayaka (2004) [31] found no growth of aerobic bacteria, coliforms or yeast and mould in chocolate mousse kept at 4 and 8 °C for 21 days, and Aragon-Alegro *et al.* (2007) [9] detected yeasts and moulds in chocolate mousse only after 14 days at 4 ± 1 °C, with no coliforms or *Escherichia coli* during 28 days. The shorter keeping period of the present mousse can be related to its composition, as the moisture and sugars of mango pulp and the protein of fresh chhana provide a good medium for growth, the pH (5.28) is not low, and no heat treatment was given after the pulp and sugar were mixed in, so the shelf life depends on the hygienic quality of the ingredients and on the cold chain.

Table 6. Microbial quality and sensory score of mango mousse (S3M1) during storage at 5 ± 1°C

Day	SPC (10^5 cfu/g)	Coliform (10^1 cfu/g)	Yeast and mould (10^1 cfu/g)	Overall acceptability
0	0.31	ND	ND	8.20
3	0.93	ND	ND	7.60
6	1.74	ND	ND	6.30
9	2.28	ND	0.79	5.70
12	3.32	ND	1.16	5.20

ND: not detected. Overall acceptability on a 9-point hedonic scale.

4. Conclusion

Mousse enriched with Alphonso mango pulp could be prepared from chhana, and its chemical composition was significantly influenced by the levels of sugar and mango pulp. A higher pulp level reduced total solids, fat, protein, ash and pH, and increased total sugar and titratable acidity, while added sugar raised total solids and total sugar. The most acceptable treatment, S_{3M1} (chhana + 18 % sugar + 20 % mango pulp), contained 58.93 % total solids, 16.32 % fat, 10.34 % protein, 22.96 % total sugar, 1.32 % ash, 0.24 % titratable acidity and had a pH of 5.28. During storage at 5 ± 1 °C the standard plate count and yeast and mould count increased gradually, coliforms were not detected, and the product remained microbiologically safe and organoleptically acceptable for 9 days.

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Acknowledgements

The authors thank the Head, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, for providing the laboratory facilities, and support required for carrying out the present investigation.

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How to cite this article: Zagade SR, Kadav V, Ramod S, Mayekar A, Prasade N, Deshmukh S, et al. Chemical and microbial quality of mousse enriched with Alphonso mango (*Mangifera indica* L.) pulp. *International Journal of Agriculture and Food Science*. 2026;8(11):154-160. doi: https://www.doi.org/10.33545/2664844X.2026.v8.i11c.89938

Authors

Sayali R Zagade
M.Sc. Student, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India
VB Kadav
Assistant Professor, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India
SS Ramod
Associate Professor, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India
AJ Mayekar
Ex-Head, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India
NN Prasade
Head, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India
SV Deshmukh
Assistant Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India
Bhakti Pawar
M.Sc. Student, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India
Rushikesh Palwe
M.Sc. Student, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra, India

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