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Formulation and quality assessment of cheeses enriched with sapota pulp

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ABSTRACT: Sapota, also known as chickoo, is one of the leading fruit crops cultivated in India. It is widely appreciated for its sweet flavour, which resembles a blend of brown sugar and beetroot, making it a popular choice across all age groups, particularly in Asia. Nutritionally, sapota is rich in bioactive compounds such as sugars, proteins, ascorbic acid, phenolics, carotenoids, and the glycoside sapotinine, along with essential minerals including iron, copper, zinc, calcium, and potassium. Cheese, a nutritious and adaptable dairy product derived from coagulated and concentrated milk, is available in numerous textures, flavours, forms, and varieties. Beyond its nutritional value, cheese serves as an effective medium for delivering probiotics, offering advantages over fermented milks and yogurts. This is primarily due to its ability to buffer the acidic environment of the stomach and maintain a relatively higher pH, thereby supporting the survival of probiotics in the gastrointestinal tract. The present study aimed to formulate cheese integrated with sapota pulp and to evaluate its quality. Cheeses were prepared by incorporating various concentrations of sapota pulp along with other ingredients, and the most acceptable formulation was selected based on sensory evaluation. Plain cheese served as the control sample. Sensory analysis revealed that the cheese containing 10% sapota pulp achieved the highest overall acceptability score of 8.91. Subsequently, both the control and the 10% sapota pulp cheese were analysed for their physico-chemical characteristics. The sapota-enriched cheese showed the following composition: moisture content of 53%, energy value of 292 kcal, carbohydrates at 17.67 g per 100 g, protein at 21.98 g per 100 g, fat content of 13.98 g per 100 g, pH of 5.0, and titratable acidity of 0.52. In comparison, the control cheese exhibited 48% moisture, 283 kcal energy, 12.35 g of carbohydrates per 100 g, 20.19 g per 100 g of protein, 15.67 g per 100 g of fat, a pH of 6.56, and a titratable acidity of 0.78.

Key words: Cheese, *Lactobacillus acidophillus*, physico-chemical, sensory evaluation, sapota

Fruit and vegetables are rich sources of many different bioactive phytocompounds, including phenolic components, anthocyanins, carotenoids, vitamin E and vitamin C which exhibit good antioxidant properties and therefore regarded as an unquestionable component that should be present in everyone's diet (Liu, 2003). Sapota comes under family *Sapotaceae* and it is one of the significant fruit crops which is grown and developed in India. Sapota is rich in fibre, vitamins, calcium, phosphorous, iron and polyphenolic compounds. It prevents constipation, cavities in tooth, viral infections and shows anti-bacterial properties and helps in prevention from cough and cold, helps in losing weight and act as a detoxifying agent (Banger *et al.,* 2022). Sapota is regarded as a natural energy booster as it contains fructose and sucrose. India's sapota production is higher in the world; hence its market value in India is less. Sapota is a delicious fruit and every part of the sapota plant has several medicinal and cosmetic properties. Medicinal properties of sapota are due to chemical constituents such as polyphenols, ascorbic acid, glycoside sapotinine*etc*. It is an excellent nutrient useful in the management of many diseases like inflammation, pain, diarrhoea *etc*. It can also be used in cosmetics (Relekar *et al.,* 2011). Recent investigations have been established its importance in cancer treatment as well as antimicrobial activity by developing silver nanoparticles. Therefore, due to its nutritional significance sapota was part of many food formulations as probiotics, wine and many other food and dairy products (Yadav *et al.,* 2021). Sapota constitutes maximum post-harvest losses. Value added products such as juice, vinegar, jam and wine increase the economic value of the sapota. These value-added products highly accepted in all over the world by consumers in every group and also have high medicinal uses such as controlling diabetes.

Shelf life of the value-added products is higher than fresh sapota fruits (Baskar *et al.,* 2020). Cheese is the generic name for a group of fermented milk-based food products produced throughout the world in a great diversity of flavours, textures and forms (Fox *et al.,* 2000). An essential part of the cheese-making process is the conversion of a liquid, milk, into a solid material, the curd, that contains casein and fat of the milk, but has expelled the main part of the water and usually, the whey proteins. This is achieved by the addition of rennet to coagulate the casein gel. The cheese curd thus forms the basis of the cheese, which is later modified by processes such as pressing, salting and ripening (Lomholt and Qvist, 1999). Aim of this study to develop and standardise sapota pulp incorporated cheese and to evaluate its physiochemical qualities.

MATERIALS AND METHODS

Collection and processing of raw materials

The experiment was conducted during 2023 at the Department of Community Science, College of Agriculture, Vellanikka, Kerala Agriculture University. Starter culture for the preparation of cheese was obtained from Verghese Kurian Institute of Dairy and Food Technology, Department of Dairy Microbiology, Thrissur, Kerala, India. Fresh cow's milk required for the study was procured from College of Dairy Science and Technology, Kerala Veterinary and Animal Sciences University, Mannuthy. The sapota was collected from the Department of Fruit Science, College of Agriculture, Kerala Agriculture University. Sapota were processed into pulp without adding any preservatives according to the modified procedure suggested by Herath *et al*. (2020). Sapota were washed, blanched, peeled and cut into pieces, and the prepared pulp was heated up to 80! for 20 min until it reaches to 14-19°Brix value of total sugar content. Other ingredients used for the preparation of cheese were rennet, food grade calcium chloride and sodium chloride.

Standardisation of sapota pulp incorporated cheeses

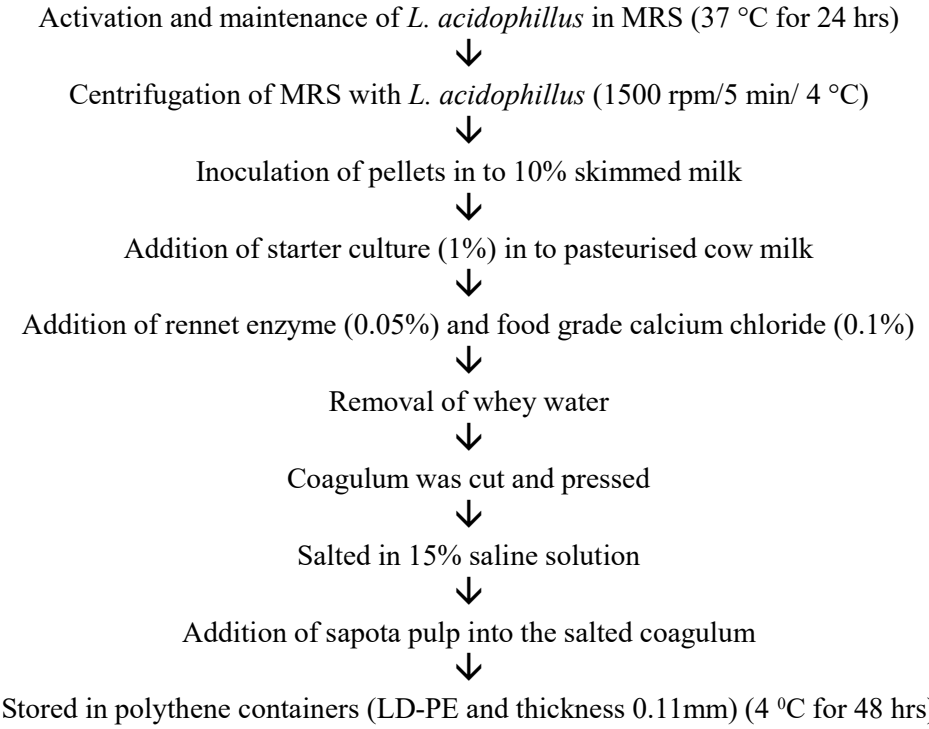

Fig.1: Flow diagram for the preparation of sapota pulp incorporated cheeses

Cheese was prepared as per the standard procedure of Mehaia (2002) with necessary modifications. *L. acidophillus* was activated in maintenance broth (MRS) at 30 ^{0}C for 24 hrs. After activation they were centrifuged (1500 rpm/5 min/ 4 ^{0}C) in order to obtain pellet. Pellet was inoculated in 10% skim milk powder (37 ^{0}C, 24 hrs). Milk was pasteurised (72 ^{0}C for 5 min) and cooled down to 37 ^{0}C. At this temperature, starter culture (1%) activated in skim milk powder was added. For the coagulation of the milk and the elimination of the whey, 30 min after the starter culture addition, rennet enzyme (0.05%) and food grade calcium chloride (0.1%) were added. The milk was coagulated for 90 min. Coagulum was cut and pressed overnight cheese was salted in 15% saline solution. Salted coagulum was homogenised with sapota pulp and prepared cheese was kept in plastic containers at 4 ^{0}C for 48 hrs. Sapota pulp incorporated cheeses were prepared by the addition of pulp at various concentrations ranging from 10 - 40 percent in different treatments ($T_2 - T_8$), respectively (Table 1) (Plate 2). Plain cheese without the addition of pulp served as control (T_1). The experiment was conducted in a completely randomised design (CRD) and was replicated thrice.

A series of acceptability trials of the sapota pulp incorporated cheese were carried out using simple triangle test at the laboratory level in the College of Agriculture, Vellanikkara by a selected a panel of twenty judges between the age group of 18-35 years as suggested (Jellineck, 1985). The judges were asked to indicate their opinion on a nine-point hedonic scale (9 for like extremely to 1 for dislike extremely). The experts analysed each treatment for their appearance, colour, texture, taste, flavour and overall acceptability of the product. Most accepted treatment was selected for further investigation.

Table 1: Treatments for the standardisation of sapota pulp incorporated cheeses

S. No	Treatments	Composition of cheese
1	T_1	100% Milk
2	T_2	90% Milk +10% SP
3	T_3	85% Milk +15% SP
4	T_4	80% Milk + 20% SP
5	T_5	75% Milk + 25% SP
6	T_6	70% Milk + 30% SP
7	T_7	65% Milk + 35% SP
8	T_8	60% Milk + 40% SP

SP-Sapota Pulp

Physico-chemical qualities assessment

The physico-chemical qualities like moisture, energy, carbohydrates, protein, fat, titratable acidity (Ercan, 2009) of the selected sapota pulp incorporated cheeses were estimated using the standard procedures. pH of the samples was analysed using a pH meter (Infradigi).

Shelf-life evaluation

Selected sapota pulp incorporated cheese and the control were stored at 4 ^{0}C for 48 hrs in polythene containers (LDPE and thickness 0.11mm) and organoleptic qualities of stored cheeses were evaluated at the interval of 10 days of storage for 30 days. These were evaluated for various sensory characteristics using 9-point hedonic scale by a panel of 20 judges.

Statistical analysis

The observations recorded during organoleptic evaluation, were tabulated and data was analysed by using Completely Randomized Design (CRD). The scores obtained for the organoleptic evaluation were evaluated by Kendall's Coefficient of Concordance (W). Physio- chemical qualities were analysed by using independent t-test.

RESULTS AND DISCUSSION

The results of the organoleptic evaluation and results of physico-chemical analysis of the selected best treatment in sapota pulp incorporated cheese are given in this section.

Organoleptic Evaluation

Sensory evaluation is used to quantify, analyse and evaluate how a product's attributes are experienced by consumers. The human senses of sight, hearing, taste, smell and touch are employed to quantify these sensory properties, which are a mixture of traits that

together create a sensory experience (appearance, texture, taste, colour and flavour). The sapota pulp incorporated cheese developed under different treatments were evaluated for higher acceptability through sensory analysis. Sapota contributes to the desirable appearance, flavour and sensory properties of desserts and confectioneries. In the study, the suitability of sapota pulp in cheese was assessed.
The mean score obtained for the organoleptic qualities of each treatment were statistically analysed using Kendall's coefficient of concordance and the mean scores were determined (Table 2). In the study based on sensory evaluation, treatment T_2 (10% sapota pulp) was selected as the best combination securing highest scores in all the organoleptic parameters such as appearance, colour, flavour, taste, texture and over acceptability.

The average sensory scores presented in Table 2 revealed that the incorporation of sapota pulp (SP) in the cheese significantly enhanced the overall sensory scores. The highest total score of 8.91 was noticed in T_2 followed by 8.76 (T_3), 8.20 (T_4), 7.50 (T_5), 7.09 (T_6), 6.69 (T_7) and 6.37 (T_8) respectively. Kendall's value showed that there was significant agreement between the judges at 1% level.

In the present study, maximum sensory score for colour (8.97), appearance (8.93) and taste (8.93) were obtained to the cheese containing 10 percent SP (T_2). The cheese prepared using 40 percent SP (T_8) scored the lowest score for both appearance and colour. It was found that as the level of SP increased the score of appearance declined. This may be because of the water content in the sapota pulp, which makes it less appealing to the judges. Malaka *et al*. (2017) investigated the development of dangke fresh cheese through the incorporation of passion fruit juice at concentrations of 7.5% and 10%. Their study revealed that the addition of 7.5% passion fruit juice resulted in significant alterations in the colour of the cheese, enhancing its visual appeal and increasing its acceptability among evaluators.

In the current study, treatment T_2, with a score of 8.86, exhibited the highest organoleptic rating for flavour compared to all other cheese samples incorporated with sapota pulp. Lashkari*et al*. (2020) conducted a study to assess the effect of pomegranate juice on the manufacturing process and characterisation of feta type cheese during storage. They found that samples containing 15 and 20% pomegranate juice have the highest flavour score. El-Sayed (2020) conducted research to evaluate the optimal concentration of spinach powder in cheese and to assess its functional properties. The study found that incorporating nano-spinach powder at levels of 0.5% to 1% resulted in cheese with desirable composition and flavour. This research introduces a novel cheese product enriched with spinach powder, providing a nutritious source of essential nutrients for supporting normal physiological functions.

As per the findings of Fatma *et al.* (2015) fortification of ricotta cheese with 15% of dates, mango and guava pulp enhanced total sensory score of the resultant cheese. The highest flavour and total scores points (8.99) were gained by ricotta cheese, fortified with 15% dates pulp followed by ricotta cheese

Table 2: Mean score for organoleptic evaluation of sapota pulp incorporated cheeses

Parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Kendall's W value
Appearance	9.00 (7.17)	8.93 (6.87)	8.95 (6.97)	8.17 (4.90)	7.64 (3.70)	7.44 (3.27)	6.75 (1.93)	6.37 (1.20)	0.963**
Colour	9.00 (7.00)	8.97 (6.87)	8.91 (6.57)	8.75 (5.57)	7.77 (4.00)	6.62 (2.73)	6.26 (1.83)	6.20 (1.43)	0.940**
Flavour	8.93 (7.33)	8.86 (7.17)	8.57 (6.33)	7.82 (4.43)	7.15 (3.03)	6.97 (2.60)	7.20 (3.43)	6.64 (1.67)	0.832**
Taste	8.95 (7.27)	8.93 (7.20)	8.73 (6.50)	7.95 (4.90)	7.42 (3.97)	6.93 (2.97)	6.46 (1.87)	6.28 (1.33)	0.951**
Texture	9.00 (7.53)	8.88 (7.07)	8.57 (6.17)	7.80 (4.43)	7.60 (3.87)	7.33 (3.27)	6.91 (2.40)	6.15 (1.27)	0.874**
Overall acceptability	8.93 (6.80)	8.93 (6.77)	8.86 (6.60)	8.71 (5.83)	7.42 (3.57)	7.28 (3.17)	6.60 (1.53)	6.60 (1.73)	0.904**
Total mean rank score	8.96	8.91	8.76	8.20	7.50	7.09	6.69	6.37	

Figures in parenthesis indicate mean rank score (**Significant at 1% level)

(7.87) containing 15% mango pulp. The Ricotta cheese samples with dates and mango pulps had higher flavour scores than the other treatments due to the combination of fruit and dairy flavours. In the present study addition of fruit pulp also improved the texture and body of final product which could be associated with the fibre content in fruit.

In this present investigation cheese incorporated with 10 percent sapota pulp achieved an overall acceptability score of 8.93, comparable to the control sample. Consequently, among the various treatments, T_2 was identified as the most favourable due to its high acceptability among the evaluators. In contrast, cheese samples containing more than 10% sapota pulp exhibited darker coloration, reduced firmness and pronounced pungent flavours and taste. According to Sameen *et al*. (2010), cheese samples became significantly less firm over time, as measured by sensory evaluations. Both hand firmness and first bite firmness decreased with ripening, while the scores for chew down degree of breakdown and chew down smoothness increased. The fat content in milk had a significant impact on the sensory attributes of the cheese. Cheese made from milk with 1.5% fat had higher scores for hand firmness (6.73), first bite firmness (7.13), and chew down degree of breakdown (6.60), but lower scores for chew down smoothness. The smoothness of all cheese samples increased as ripening progressed, which was a highly desirable sensory attribute. This increase in smoothness may be due to changes in the average size of fat globules, the distance between fat globules, and variations in globule size.

Semeniuc *et al*. (2023) conducted a study to develop a Gouda-type cheese from cow's milk, incorporating lavender flower powder at a concentration of 0.5 g/L into the matured milk. The cheese was ripened for 30 days under controlled conditions of 14°C and 85% relative humidity. The inclusion of lavender flower powder led to an increase in volatile compounds and lactic acid bacteria concentration during the ripening process, which in turn enhanced the cheese's nutritional and textural properties.

G. asiatica fruit extract at 0.7% significantly improved the microbial, lipid, and sensory quality of kalari cheese during storage, while also enhancing antioxidant enzyme levels and reducing oxidative stress in rats fed a cheese-based diet. This study highlights the potential of the extract to enhance both the storage quality and functional value of cheese (Sharma *et al.,* 2023). A study found that supplementing Queso Blanco cheese with powdered microcapsules containing tomato extracts significantly increased its lycopene content, enhanced its texture, and improved sensory properties, including tomato flavor and firmness, during 60 days of ripening. The supplementation also led to a steady increase in short-chain fatty acids and a slight rise in LAB counts over the ripening period (Jeong *et al.,* 2017). Tarakci and Yolasan (2024) carried out an investigation aimed at developing a novel cheese variety by incorporating dried black mulberry, blackberry, black grape, and raspberry into white cheese, with the objective of assessing its sensory characteristics. Their findings indicated that the inclusion of these fruits enhanced the sensory attributes of the white cheese in comparison to the control, which consisted of standard white cheese without any fruit addition.

A study found that adding white mulberry, chia, green barley, or spirulina to processed cheeses allowed for a 50% reduction in emulsifying salts and an 18% reduction in rennet cheese, enhancing nutritional value. Notably, green barley increased cheese hardness, making it suitable for sliced cheese, while the highest acceptable sensory levels were 0.5% for green barley, 1% for chia and spirulina, and 3% for white mulberry (Garbowska *et al.,* 2023).

Physico-chemical analysis of the cheese

The cheese which was selected as best in the organoleptic evaluation (T_2) was evaluated for nutritional value along with control (Table 3). The moisture content of the selected cheese was observed to be 53 percent and for control it was 48 percent. Kankhare *et al*. (2019) observed that the moisture content of mango herbal quarg cheese varied between 72.20 to 74.18%. The moisture content of mango herbal quarg cheese significantly increased with addition of mango pulp and spices.

To achieve an ideal pH, acidity is a crucial consideration. When the mixture is pasteurised, the presence of excessive amount of acid may cause the mixture to curdle. In the present study, the acidity of the control cheese was 0.78% with a pH 6.56 and developed sapota cheese was lower than the control, 0.52 percent acidity with a pH of 5.00 is optimum. The pH of dangke soft cheese decreased with increased ripening time, starting at 5.34 and dropping to 4.1 by the end of the 28-day storage period (Malaka *et al.,* 2017). A study demonstrates that incorporating blueberry-based ingredients, including concentrated syrup and lyophilized bagasse powder, into synbiotic Petit Suisse cheese enhances its fibre content, bioactive compounds, and antioxidant activity, with the best sensory results found in the formulation with 10% syrup and 2% bagasse. These additions also maintained stable acidity and probiotic viability during 21 days of cold storage, making it a promising approach for creating functional dairy snacks (Hurtado-Romero *et al.,* 2023).

Revealing the carbohydrate amount of foods is important for determining the nutritional value. The carbohydrate content of the selected cheese was observed to be 17.67 g/100gm and for control it was 12.35 g/100g. Addition of sapota pulp increased the carbohydrate content in the prepared cheese.

As per the findings of Sharma *et al*. (2011) as broccoli concentration increases (from 3% to 50%), the â-carotene and total phenolic content of the cheese also increases significantly. This suggests that higher broccoli content enriches the cheese with antioxidants, improving its nutritional value.

The air interface in cheese is stabilised in part by milk proteins, which is crucial for overall structure and stability. Protein content of control was 20.19 g/100g and the developed sapota cheese was 21.98 g/100g. The protein amount in cheese is changed by proteolysis which continues during ripening (Cebeci *et al.,* 2020). Mohamed *et al*. (2016) conducted a study to assess the physio chemical changes with respect to the addition of carrot paste in cheese. Increasing carrot paste levels (from 0% to 15%) results in a decrease in protein content and an increase in ash, â-carotene, and total phenolic content. The rise in â-carotene, particularly from 15.6 mg/kg at 5% paste to 29.23 mg/kg at 15% paste, suggests that carrot paste significantly boosts the antioxidant content of the cheese.

El-Sayed (2020) revealed that adding spinach powder (from 0.5% to 2%) results in a slight increase in protein content and a slight decrease in total solids, moisture, and fat content. The ash content increases slightly, indicating the addition of mineral content. This suggests that spinach powder has a modest impact on the nutritional profile of UF-soft cheese, with potential health benefits.

As per the findings of Jeong *et al*. (2017) the incorporation of tomato extracts (from 0.5% to 2%) in UF soft cheese results in a slight increase in protein content while slightly decreasing moisture and fat content. The total solids and ash content remain relatively stable. The presence of tomato extracts enhances the â-carotene content, indicating improved antioxidant potential in the cheese.

Arbutus unedo extracts, rich in quinic acid and cat-

Table 3:Physico-chemical analysis of sapota pulp incorporated cheese

Sl No.	Quality parameters	Control cheese (100% cheese)	Sapota cheese (90% cheese+10% SP)	t value
1.	Moisture (%)	48	53	3.06*
2.	Titratable acidity (%) (as lactic acid)	0.78	0.52	3.12*
3.	pH	6.56	5.00	3.14*
4.	Energy (kcal)	283	292	4.98**
5.	Carbohydrate (g/100g)	12.35	17.67	3.63*
6.	Protein (g/100g)	20.19	21.98	2.35*
7.	Fat (g/100g)	15.67	13.98	2.72*

(**Significant at 1% level; *Significant at 5% level, SP – Sapota Pulp)

echin, enhanced the protein content, firmness and DPPH scavenging activity of soft cheeses when fortified at 0.3 and 1 g/L. Notably, the 0.3 g/L dose increased cheese yield without altering colour or sensory properties, suggesting its potential as a functional food with added bioactive compounds (Masmoudi *et al.,* 2020).

Cheese is a high-fat and high-calorie food. Indeed, types of cheese are often classified according to the fat content and the dough of the cheese changes accordingly from soft to hard. The fat content of the selected cheese in the present study was observed to be 13.98 g/100gm and for the control it was 15.67g/100g. The fat content was significantly reduced by the incorporation of fruit pulp, attributable to the lower fat content of fruit pulp in comparison to milk. As per the findings of Cebeci *et al*. (2020) amount of fat in plain cheeses ranged between 14.3 and 32.0 g and the average fat of cheeses was 23.6 ± 4.3 g. Cankurt *et al*. (2024) conducted a study to evaluate the influence of carrot fibre on the properties of block-type melting cheese. The study's key findings suggest that if carrot fibre is to be utilized in cheese production, it is advisable to further reduce the fibre size. Additionally, it is recommended that the concentration of carrot fibre be maintained between 2.5% and 5.0%, without exceeding this range. Although the inclusion of carrot fibre increased cheese yields compared to the control, the study advises that the amount of added water should not surpass 10%. As per the findings of Ramadhany*et al*. (2023) adding tomato paste to cheddar cheese during production increases lycopene content while slightly reducing curd formation. The resulting cheese is extra-hard, low-fat, with increased firmness and hardness, but decreased chewiness and springiness, especially as tomato paste concentration increases.

Shelf-life evaluation

Shelf-life assessment of sapota pulp incorporated cheese and control were done by organoleptic evaluation. The storage period for this assessment was 30 days. Organoleptic qualities of selected sapota incorporated cheese along with control were statistically analysed using Ducan's Multiple Range Test and Independent sample student t test and the results are shown in Table 4.

Pettersen *et al*. (2005) observed an increase in acidulous flavour in cream cheese during storage and re-

Table 4: Mean score for organoleptic evaluation of developed sapota pulp incorporated cheese during storage

Parameters	Days of storage				
	1st Day	10th Day	20th Day	30th Day	CD (0.05)
Appearance					
T_1	9.00[a]	8.91[b]	8.65[c]	8.25[d]	0.03*
T_2	8.93[a]	8.62[b]	8.34[c]	7.75[d]	0.045*
Colour					
T_1	9.00[a]	9.00[a]	8.63[b]	8.00[c]	0.506*
T_2	8.97[a]	8.97[a]	8.56[b]	7.94[c]	0.038*
Flavour					
T_1	8.93[a]	8.93[a]	8.89[b]	8.24[c]	0.039*
T_2	8.86[a]	8.86[a]	8.71[a]	7.89[b]	0.155*
Taste					
T_1	8.95[a]	8.45[b]	8.03[c]	8.16[d]	0.006*
T_2	8.93[a]	8.32[b]	7.89[c]	7.67[c]	0.120*
Texture					
T_1	9.00[a]	8.71[b]	8.54[c]	8.02[d]	0.006*
T_2	8.88[a]	8.67[b]	8.34[c]	7.72[d]	0.062*
Overall acceptability					
T_1	8.93[a]	8.93[a]	8.12[b]	7.86[c]	0.005*
T_2	8.93[a]	8.90[b]	8.00[c]	7.98[d]	0.001*

T_1: 100% Milk; T_2: 90% Milk+10% SP; DMRT- Colum wise comparison (1* significant at 5% level, SP-Sapota Pulp)

ported that cream cheese packed in PET/PE 70 mm (polyethylene terephthalate þ polyethylene) in the dark at 6°C led to increased acidulous flavour intensity from 5.59 to 6.50 (on a 10 mm scale) during 6 months of storage. These authors also reported that cream cheese stored in PET/PE 25 mm under the same conditions showed values from 3.83 to 5.17 after 6 months of storage. Acidulous and fermented flavours are closely related because both sensory attributes are associated with fermentation products. The sensory evaluation scores of present study revealed that acceptability was highest for cheese in the initial days and it was slightly decreased at the end of storage. Appearance of T_1 scored 9 in the initial day of storage and it was decreased in to 8.25 at the end of 30th day. Sapota pulp incorporated treatment had 8.93 in the initial and it was decreased into 7.75 at the end of storage. The same pattern is followed in the case of colour, flavour, taste and texture.

Texture plays a crucial role in regulating the release and perception of flavour. Initially, in sensory analysis, the texture of sapota cheese was rated as 8.88 which decreased to 7.72 by the conclusion of storage. This change in texture over the three-week period may be due to enzymatic activity affecting the protein structure, thereby altering sensory characteristics like colour, elasticity, and the overall texture of the cheese (Lucey *et al.,* 2003). As per the findings of Siyar *et al*. (2021) encapsulating saffron extract in liposomes made with soy lecithin was effective, and adding it to ricotta cheese improved its hardness and chewiness, creating a novel functional food. The overall acceptability of control and the selected treatment was same in the initial (1st day) of storage (8.93). It was decreased 7.86 in control and 7.98 in selected treatment at the end of storage (30th day). Other factors, such as environmental conditions, microorganisms or compound oxidation, can also influence milk flavour.

Messias *et al.* (2021) developed Petit Suisse cheese with blackberry and guabiroba pulps, achieving high sensory acceptability and distinct physicochemical properties. The formulations showed microbiological stability for over 28 days, with higher energy content than commercial products.

Morales-Cortes *et al*. (2023) developed a guava-flavoured functional symbiotic petit cheese with probiotics and prebiotics, showing good organoleptic properties and maintaining probiotic viability for 28 days, with 82% of consumers expressing purchase intent.

A study conducted by de Sousa *et al*. (2021) aimed to prepare guava-flavored petit-suisse kefir cheese with inulin and to evaluate the physicochemical, microbiological and sensory characteristics of the product in refrigerated storage. They found that addition of inulin significantly altered the physicochemical characteristics of guava-flavoured petit-suisse kefir cheese, except for moisture, water activity, ash, proteins, and carbohydrates. Sensory attributes, such as flavour, overall impression, and purchase intention, were also influenced by the concentration of inulin, except for appearance, aroma, and texture.

CONCLUSION

Value-added products derived from sapota significantly enhance its economic viability, finding widespread acceptance among consumers worldwide. Cheese stands out as a particularly promising avenue in this regard. Incorporating sapota pulp into cheese not only extends its shelf life beyond that of fresh sapota fruits but also ensures year-round availability, thereby bolstering farmers' economic prospects. In conclusion, the incorporation of sapota pulp into cheese significantly enhances its sensory qualities and nutritional profile. The study found that cheese with 10 percent sapota pulp achieved high overall acceptability, with notable improvements in moisture content and carbohydrate levels while maintaining a balanced nutritional composition. The sapota cheese demonstrated desirable physio-chemical properties, including a lower fat content and a favourable pH for probiotic survival, making it a promising alternative to traditional cheese. This innovative approach not only broadens the variety of cheese products available but also leverages the nutritional benefits of sapota, offering a novel and appealing option for consumers.

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