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Valorization of guava leaves through development of functional gummies: Sensory, nutritional and storage evaluation

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Abstract

Guava (*Psidium guajava* L.) leaves are an underutilized source of bioactive compounds with potential for incorporation into value-added functional foods. The present study aimed to develop and standardize guava leaf gummies incorporating mint leaf extract and to assess their sensory quality, nutritional and bioactive characteristics, and storage stability. The formulation was prepared with different proportions of guava leaf extract and mint leaf extract. The sensory evaluation was carried out using a 9-point hedonic scale. The formulation T_3 with 40 per cent guava leaf extract, 10 per cent mint leaf extract and 50 per cent other ingredients received the highest score for appearance, colour, flavor, texture, taste and overall acceptability with the highest total sensory score of 46.86. This selected formulation was then kept for a period of two months of storage. The product was reasonably acceptable. Moisture content increased from 15.68 to 16.26% but total sugar decreased from 57.64 to 56.87 g. The total phenolic content was reduced from 55.80 to 55.17 µg GAE/mg, total flavonoid content from 35.78 to 35.22 µg QE/mg and total antioxidant activity from 32.57 to 31.95 mg AAE/g, showing a relatively good retention of bioactive constituents. The mineral contents also showed different levels of reduction during storage. Microbial counts increased with storage to reach 1.28×10^5 cfu/g for bacteria, 2.3×10^3 cfu/g for yeast and 0.33×10^3 cfu/g for fungi at two months. However, the study has revealed the potential of using guava leaf extract in a sensory acceptable gummy formulation, with T_3 having positive sensory characteristics and satisfactory nutritional, bioactive and storage stability.

Keywords: Guava leaves, gummies, functional food, storage stability

Introduction

Guava (*Psidium guajava* L.) leaves are an important underutilized plant resource containing several nutritionally and biologically active constituents, including phenolic compounds, flavonoids, tannins, terpenoids and minerals. These constituents have been associated with antioxidant, antimicrobial and other biological activities, making guava leaves a promising ingredient for functional food development (Naseer *et al.*, 2018) [6]. Recent studies have further highlighted the potential of guava leaves for incorporation into functional foods and other food systems because of their nutritional and phytochemical composition (Sahal *et al.*, 2025; Khandagale *et al.*, 2026) [4, 12].

The presence of phenolic and flavonoid compounds makes guava leaves particularly suitable for value addition. Quercetin, kaempferol, catechin, rutin, gallic acid, caffeic acid and other phenolic constituents have been reported in guava leaves and are associated with their antioxidant potential (Naseer *et al.*, 2018) [6]. The incorporation of guava leaf extract into food products may therefore provide an approach for improving the utilization of this underexploited plant material while developing products with potential functional properties.

Gummies are convenient and attractive food products in which functional ingredients can be incorporated into an acceptable food matrix. Recent studies have demonstrated the feasibility of incorporating natural antioxidant rich extracts into gummy formulations and evaluating their physicochemical, sensory and storage properties (Roudbari *et al.*, 2024) [2].

Therefore, the present study was undertaken to standardize guava leaf gummies using different proportions of guava leaf extract and mint leaf extract and to evaluate their sensory acceptability, physicochemical and nutritional characteristics, bioactive constituents and microbial quality during storage. The study aimed to identify the most acceptable formulation and assess its stability during storage.

Methodology

1. Standardization of guava leaf gummies

Guava leaf gummies were prepared following a modified standard procedure suggested by Roudbari *et al.* (2024) [7]. Different combinations of guava leaf extract (GLE) and mint leaf extract (MLE) were incorporated into the gummy formulation, while 50% other ingredients (OI) were maintained constant. The other ingredients consisted of sugar (15%), corn syrup (20%), gelatin (15% of 250 bloom), citric acid, potassium sorbate (600 ppm) and water. Five formulations were prepared by varying the proportions of guava leaf and mint leaf extracts. The treatments are given below:

T_1- 50% GLE + 50% OI
T_2- 45% GLE + 5% MLE + 50% OI
T_3- 40% GLE + 10% MLE + 50% OI
T_4- 35% GLE + 15% MLE + 50% OI

T_5- 30% GLE + 20% MLE + 50% OI

These formulations were subjected to sensory evaluation, and the treatment with the highest sensory acceptability was selected for further quality and storage evaluation.

2. Organoleptic evaluation

The sensory quality of the five treatments were evaluated using a 9-point hedonic scale. The sensory attributes assessed includes appearance, colour, flavour, texture, taste and overall acceptability. The mean sensory scores were statistically ranked using Kendall's coefficient of concordance (W) and identified the most preferred formulation.

Fig 1: Flowchart for the preparation of leaves extract

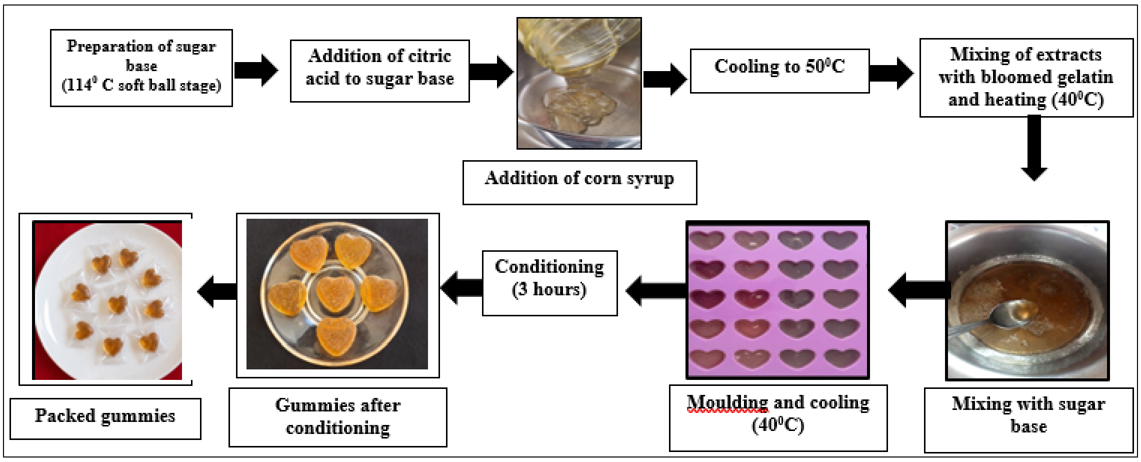

Fig 2: Flowchart for the preparation of guava leaves gummies

3. Storage study

The selected formulation was subjected to storage evaluation for two months, with observations recorded initially and at monthly intervals. Sensory attributes including appearance, colour, flavour, taste, texture and overall acceptability were also evaluated during storage. The physicochemical, nutritional and bioactive characteristics evaluated during storage included moisture, total sugar, reducing sugar, non-reducing sugar, total phenolic content (TPC), total flavonoid content (TFC), total antioxidant activity, calcium, phosphorus, sodium, potassium, iron and zinc. The results were statistically compared using the critical difference (CD) values.

4. Microbial quality

Microbial quality of the selected guava leaf gummies was assessed during the storage period by enumerating bacteria, yeast and fungi. Microbial counts were expressed as colony-forming units per gram (cfu/g).

Results

1. Organoleptic evaluation of guava leaves gummies

The best treatment of guava leaves gummies was selected organoleptically using 9-point hedonic scale as mentioned in table 1. The results of the organoleptic quality assessment using Kendall's coefficient of concordance to statistically rank the mean scores obtained for the guava leaves gummies are shown below. From this treatment (T_3) with 40% guava leaves extract (GLE) + 10% mint leaves extract (MLE) + 50% other ingredients (OI) was selected as the best combination.

Table 1: Organoleptic evaluation of guava leaves gummies

Parameters	T_1	T_2	T_3	T_4	T_5	W
Appearance	6.88 (2.86)	6.51 (2.18)	7.35 (3.79)	7.04 (3.50)	6.8 (2.68)	0.186**
Colour	7.04 (2.57)	6.91 (2.25)	7.57 (4.29)	7.24 (2.89)	7.2 (3.00)	0.261**
Flavour	7.35 (2.57)	7.13 (2.21)	7.86 (4.39)	7.44 (3.21)	7.35 (2.61)	0.355**
Texture	7.4 (3.43)	7.02 (1.14)	7.91 (4.04)	7.55 (3.32)	7.35 (3.07)	0.515**
Taste	7.28 (2.57)	7.33 (2.57)	7.86 (4.17)	7.44 (2.60)	7.44 (3.00)	0.223**
Overall acceptability	7.73 (2.54)	7.68 (2.54)	8.31 (4.11)	8.06 (3.64)	7.48 (2.18)	0.326**
Total score	43.68	42.58	46.86	44.77	43.62	

T_1 - 50% GLE + 50% OI; T_2 - 45% GLE + 5% MLE + 50% OI; T_3 - 40% GLE + 10% MLE + 50% OI; T_4 - 35% GLE + 15% MLE + 50% OI; T_5 - 30% GLE + 20% MLE + 50% OI (GLE- Guava leaves extract. MLE- Mint leaves extract. OI- Other ingredients); (W-Kendall's coefficient of concordance, **Significant at 1% level; Values in parentheses indicate mean rank scores.

Plate 1: Selected treatment of guava leaves gummies (T_3)

The sensory evaluation revealed significant differences among the formulations for all the evaluated sensory attributes, as indicated by the significant W values. For appearance, T_3 received the highest score (7.35), followed by T_4 (7.04), while T_2 recorded the lowest score (6.51). Similarly, colour was most preferred for T_3 (7.57), whereas T_2 had the lowest score (6.91). In terms of flavour, T_3 obtained the highest score (7.86), followed by T_4 (7.44), while T_2 recorded the lowest score (7.13). Texture also showed the highest acceptability for T_3 (7.91), followed by T_4 (7.55), with T_2 receiving the lowest score (7.02). For taste, T_3 again achieved the highest score (7.86), whereas T_1 recorded the lowest score (7.28). The overall acceptability followed a similar trend, with T_3 obtaining the highest score (8.31), followed by T_4 (8.06), T_1 (7.73), T_2 (7.68) and T_5 (7.48). Based on the total sensory score, T_3 recorded the highest value (46.86), followed by T_4 (44.77), T_1 (43.68), T_5 (43.62) and T_2 (42.58). Thus, T_3 emerged as the most preferred formulation, receiving the highest scores for appearance, colour, flavour, texture, taste and overall acceptability. The consistently superior sensory performance of T_3 indicates that its formulation provided the most desirable combination of visual, flavour, textural and taste characteristics. In contrast, T_2 showed the lowest total sensory score, suggesting comparatively lower consumer preference. Overall, T_3 can be considered the best formulation based on sensory evaluation, making it the most suitable treatment for further product development and storage evaluation.

Table 2: Mean organoleptic evaluation of guava leaves gummies on storage (Selected treatment T_3 - 40% GLE + 10% MLE + 50% OI)

Parameters	Initial	1 MAS	2 MAS
Appearance	8.68	8.12	7.88
Colour	8.87	8.05	7.78
Flavour	8.51	7.65	7.48
Taste	8.32	8.24	8.07
Texture	8.08	7.15	7.44
Overall acceptability	8.94	7.46	7.32
Total score	51.4	46.67	45.97

MAS- Month After Storage; (GLE- Guava leaves extract. MLE- Mint leaves extract. OI- Other ingredients)

The sensory evaluation during the storage period showed a gradual decline in the sensory quality of the product, although the gummies remained reasonably acceptable for 2 months of storage. The total sensory score decreased from 51.40 initially to 46.67 at the first month and further to 45.97 at the second month, indicating a progressive reduction in overall sensory quality with storage. The appearance score declined from 8.68 initially to 8.12 at 1 MAS and 7.88 at 2 MAS, suggesting a gradual deterioration in visual appeal. Similarly, colour decreased from 8.87 to 8.05 and 7.78, while flavour declined from 8.51 to 7.65 and 7.48 over the storage period. Texture showed a reduction from 8.08 initially to 7.15 at 1 MAS, followed by a slight improvement to 7.44 at 2 MAS, indicating some variation during storage. Taste remained comparatively stable, decreasing only slightly from 8.32 initially to 8.24 at 1 MAS and 8.07 at 2 MAS. Overall acceptability showed the highest initial score (8.94) and declined to 7.46 and 7.32 at 1 and 2 MAS, respectively. The decline in sensory scores may be associated with gradual changes in colour, flavour, texture and other quality characteristics during storage. Thus, the relatively high scores recorded even after two months indicate that the product retained good sensory acceptability during the storage period, although a gradual deterioration in overall quality was evident.

2. Quality evaluation of guava leaves gummies

The nutritional parameters such as moisture, total sugar, reducing sugar, non-reducing sugar, total flavanoids content (TFC), total phenol content (TPC), calcium, phosphorus, sodium, potassium, iron, zinc and total antioxidant activity were evaluated at monthly intervals for a period of two months of storage and is given in table 3.

Table 3: Physicochemical composition of guava leaves gummies during storage

Parameters	Initial	1st MAS	2nd MAS	CD
Moisture (%)	$15.68^{c} \pm 0.06$	$15.89^{b} \pm 0.06$	$16.26^{a} \pm 0.05$	0.09^{NS}
Total sugar (g)	$57.64^{a} \pm 0.01$	$57.32^{b} \pm 0.01$	$56.87^{c} \pm 0.01$	0.02*
Reducing sugar (g)	$17.10^{a} \pm 0.00$	$17.05^{b} \pm 0.01$	$16.74^{c} \pm 0.01$	0.01**
Non-reducing sugar (g)	$40.54^{a} \pm 0.01$	$40.28^{b} \pm 0.01$	$40.14^{c} \pm 0.00$	0.01**
Total phenol content (µg GAE/mg)	$55.80^{a} \pm 0.00$	$55.33^{b} \pm 0.02$	$55.17^{c} \pm 0.02$	0.02*
Total flavanoid content (µg QE/mg)	$35.78^{a} \pm 0.03$	$35.37^{b} \pm 0.01$	35.22 ± 0.01^{c}	0.03*
Total antioxidant activity (mg AAE/g)	$32.57^{a} \pm 0.14$	$32.15^{b} \pm 0.04$	$31.95^{c} \pm 0.02$	0.14^{NS}
Calcium (mg)	$30.6^{a} \pm 0.49$	$30.35^{b} \pm 0.10$	$30.25^{b} \pm 0.05$	0.14^{NS}
Phosphorus (mg)	$9.45^{a} \pm 0.19$	$8.23^{b} \pm 0.02$	$6.54^{c} \pm 0.04$	0.04*
Sodium (mg)	$0.02^{a} \pm 0.43$	$0.01^{b} \pm 0.01$	$0.01^{b} \pm 0.01$	0.01**
Potassium (mg)	$50.78^{a} \pm 0.80$	$50.30^{b} \pm 0.02$	$49.63^{c} \pm 0.05$	0.05*
Iron (mg)	$0.23^{a} \pm 0.42$	$0.17^{b} \pm 0.01$	$0.06^{c} \pm 0.01$	0.01**
Zinc (mg)	$0.02^{a} \pm 0.04$	$0.01^{b} \pm 0.01$	$0.01^{b} \pm 0.01$	0.01**

Treatment (T_3)- 40% guava leaves extract (GLE) + 10% mint leaves extract (MLE) + 50% other ingredients (OI); DMRT column-wise comparison and Row wise indicates - CD Value (** significant difference at 1% level; * significant difference at 5% level and NS-Non-Significant); NS non-significant

The storage stability study showed significant changes in the physicochemical, nutritional and bioactive constituents of the product over the two-month storage period, as indicated by the CD values. Moisture content increased significantly from 15.68% initially to 15.89% at 1 MAS and 16.26% at 2 MAS, indicating gradual moisture absorption during storage. In contrast, total sugar decreased from 57.64 to 57.32 and 56.87 g, accompanied by reductions in both reducing sugar (17.10 to 16.74 g) and non-reducing sugar (40.54 to 40.14 g), suggesting gradual utilization or degradation of sugars during storage. The bioactive compounds also showed a slight but significant decline. Total phenol content decreased from 55.80 to 55.17 µg GAE/mg, while total flavonoid content declined from 35.78 to 35.22 µg QE/mg. Similarly, total antioxidant activity decreased from 32.57 to 31.95 mg AAE/g, representing a relatively small reduction and indicating good retention of antioxidant potential during storage. Among the minerals, calcium showed only a slight decrease from 30.60 to 30.25 mg, with the values at 1 and 2 MAS being statistically comparable. Phosphorus exhibited a more pronounced decline from 9.45 to 6.54 mg, while potassium decreased moderately from 50.78 to 49.63 mg. Iron showed a marked reduction from 0.23 to 0.06 mg, whereas sodium and zinc showed relatively small changes during storage. Overall, the product exhibited gradual moisture gain and corresponding reductions in sugars, phenolic compounds, flavonoids, antioxidant activity and certain minerals, with the most notable changes observed in phosphorus and iron. However, the relatively smaller reduction in phenolic, flavonoid and antioxidant contents suggests that, the product retained a substantial proportion of its functional properties during the two-month storage period, indicating a satisfactory effect on nutritional and bioactive stability.

3. Microbial enumeration of guava leaves gummies

Table 4: Microbial enumeration of guava leaves gummies

Microbial Growth	Initial	1 MAS	2 MAS
Bacteria ($\times 10^5$ cfu/g)	ND	0.3	1.28
Yeast ($\times 10^3$ cfu/g)	ND	ND	2.3
Fungi ($\times 10^3$ cfu/g)	ND	ND	0.33

MAS- Month After Storage; (GLE- Guava leaves extract. MLE- Mint leaves extract. OI- Other ingredients)

The microbial quality of the gummies during the two-month storage period showed a gradual increase in microbial load with storage duration. Bacterial counts were not detected (ND) initially, but increased to 0.3×10^5 cfu/g at 1 MAS and further to 1.28×10^5 cfu/g at 2 MAS, indicating progressive bacterial multiplication during storage. Similarly, yeasts were not detected initially or at 1 MAS, but appeared at 2.3×10^3 cfu/g by the second month, suggesting that yeast growth became evident during prolonged storage. Fungi were not detected initially or at 1 MAS, while a low count of 0.33×10^3 cfu/g was observed at 2 MAS. Overall, the results indicate that the product remained microbiologically stable during the first month of storage, with no detectable yeast or fungal growth and only a low bacterial count. However, microbial proliferation became more evident by the second month, particularly for bacteria and yeast. This increase in microbial counts may be associated with gradual moisture uptake during storage, as reflected in the corresponding increase in moisture content. Therefore, the relatively low microbial levels suggest that, the product maintained reasonable microbiological quality during the two-month storage period, although further extension of storage may require for appropriate packaging and moisture-control measures.

Discussion

1. Standardization and sensory acceptability

The sensory evaluation demonstrated the proportion of guava leaf and mint leaf extracts had a considerable influence on the acceptability of the gummies. Significant differences were observed among the five formulations for all evaluated sensory attributes, as indicated by the significant Kendall's coefficient of concordance values. Among the treatments, T_3 (40% GLE + 10% MLE + 50% OI) obtained the highest scores for appearance (7.35), colour (7.57), flavour (7.86), texture (7.91), taste (7.86) and overall acceptability (8.31). It also recorded the highest total sensory score of 46.86, indicating superior overall sensory performance. The influence of formulation composition on the sensory characteristics of gummy products has been reported previously, with variations in gelling agents, sweeteners and functional ingredients affecting texture, colour and sensory acceptability (Tireki *et al*., 2021) [15].

The superior acceptability of T_3 may be attributed to the optimum balance between guava leaf extract and mint leaf extract. The incorporation of 10% mint leaf extract may have helped moderate the characteristic flavour and taste of guava leaf extract without excessively altering the sensory identity of the product. In contrast, formulations containing higher proportions of mint leaf extract did not produce a corresponding improvement in sensory scores. T_2, containing 45% guava leaf extract and 5% mint leaf extract, recorded the lowest total score (42.58), suggesting that the lower level of mint extract may not have provided sufficient sensory modification. Therefore, the development of functional gummies requires optimization of the concentration of the incorporated bioactive ingredient because increasing the level of plant-derived ingredients can influence flavour, colour, texture and overall consumer acceptance (Roudbari *et al*., 2024) [7].

2. Changes in sensory characteristics during storage

The selected gummy formulation showed a gradual decline in sensory quality during storage. The total sensory score decreased from 51.40 initially to 46.67 at one month and 45.97 at two months. Appearance declined from 8.68 to 8.12 and 7.88, while colour decreased from 8.87 to 8.05 and 7.78 during the same period. Flavour also decreased from 8.51 initially to 7.65 and 7.48 at one and two months, respectively.

Overall acceptability exhibited a decline from 8.94 initially to 7.46 at one month and 7.32 at two months. Such reductions may be associated with progressive changes in colour, flavour and texture during storage. The relatively high sensory scores retained at two months, however, indicate that the gummies remained reasonably acceptable throughout the evaluated storage period. Similar storage associated changes in sensory and physical characteristics have been reported in gummy confections, where storage duration influenced colour, texture and sensory attributes (Tireki *et al*., 2021) [15].

Texture showed a decrease from 8.08 initially to 7.15 at one month, followed by a slight increase to 7.44 at two months. This variation may be related to changes in moisture distribution and the structural properties of the gelatin-based gummy matrix during storage. Taste showed comparatively greater stability, decreasing only slightly from 8.32 to 8.07 over the storage period. Changes in moisture, gelatin concentration and storage conditions have been shown to influence the textural properties of gummy confections during storage (Tireki *et al*., 2021) [15].

3. Moisture and sugars

Moisture content increased significantly from 15.68% initially to 15.89% at one month and 16.26% at two months. The gradual increase suggests moisture absorption during storage. Increased moisture availability can influence the textural characteristics of gummies and may also contribute to the subsequent development of microorganisms. Moisture migration is an important factor influencing the physical stability, texture and microbiological quality of gummy products during storage (Nguyen *et al*., 2025) [8]. A recent study evaluated low-sugar plant-based gummies stored for two months at 5 and 25^{0}C. Storage affected several physicochemical characteristics, including moisture, water activity, colour, hardness, gumminess, elasticity and cohesiveness. The study reported that changes became more evident after approximately 28 days (Dey and Sheth, 2023) [3].

The researchers developed gelatin-based gummies with different sucrose, glucose syrup, sugar replacers and prebiotics and evaluated them after two months of storage. They specifically explain that water activity in gummies is influenced by moisture content and sugar profile (Cebin *et al*., 2024) [2]. A corresponding decline was observed in total sugar, which decreased from 57.64 to 57.32 and 56.87 g, respectively. Reducing sugar decreased from 17.10 to 16.74 g, whereas non-reducing sugar declined from 40.54 to 40.14 g. The reduction in sugars during storage may be associated with their utilization or chemical changes occurring during storage. The increase in moisture coupled with the decrease in sugar concentration is particularly relevant to the storage stability of the product, as moisture migration and changes in soluble solids can influence both textural quality and microbial stability.

4. Stability of phenolic and flavonoid compounds

The bioactive constituents showed relatively small but significant reductions during storage. Total phenolic content decreased from 55.80 to 55.17 µg GAE/mg, while total flavonoid content declined from 35.78 to 35.22 µg QE/mg over the two-month storage period. Total antioxidant activity similarly decreased from 32.57 to 31.95 mg AAE/g. The observed decline in phenolic and flavonoid contents may be associated with storage-related oxidation and degradation of susceptible phytochemicals. Previous studies have demonstrated that processing and storage conditions can influence the stability of phenolic acids and flavonoids in plant-derived foods (Ali *et al*., 2018) [1]. Oxidative modification of flavonoids can also reduce their antioxidant capacity, depending on the structure and storage environment (Speisky *et al.*, 2022) [13].

The gradual decline in phenolic and flavonoid contents may be attributed to progressive degradation or oxidation of these compounds during storage. Phenolic compounds are susceptible to oxidative changes, and such changes can contribute to the reduction in antioxidant activity. Nevertheless, the relatively small magnitude of decline indicates good retention of the bioactive components in the gummy formulation during the evaluated storage period. The retention of antioxidant activity suggests that the product continued to possess considerable functional potential after two months of storage.

5. Mineral composition

Guava leaves themselves are recognized as a source of nutritionally important minerals, including calcium, phosphorus, potassium, sodium, iron and zinc, although concentrations vary considerably with cultivar and growing conditions (Raj *et al*., 2023) [11]. The mineral constituents exhibited varying degrees of change during storage. Calcium decreased only slightly from 30.60 to 30.25 mg, and the values at one and two months were statistically comparable. Phosphorus showed a comparatively greater reduction from 9.45 to 6.54 mg, while potassium decreased from 50.78 to 49.63 mg. Iron showed the most pronounced reduction, declining from 0.23 to 0.06 mg. Sodium and zinc exhibited relatively smaller changes during storage. The observed variation in mineral concentrations may be related to changes in the product matrix and moisture content during storage. Since mineral elements are generally chemically more stable than phenolic compounds, apparent changes may also reflect changes in moisture distribution and concentration within the food matrix. Guava leaves are recognized as a source of several nutritionally important minerals, supporting their potential use as a functional food ingredient (Kumar *et al*., 2021) [5].

Studies on functional gummy products have demonstrated that incorporation of plant-derived ingredients can substantially influence the mineral and nutritional composition of the final product. Paternina *et al*. (2024) [10] reported increased ash and mineral-related nutritional content following incorporation of Spirulina biomass and açai pulp into gummy candies, while Lakatos *et al*. (2024) [2] demonstrated that fruit-derived ingredients significantly contributed to potassium and iron contents of gummy products.

The observed differences among minerals may be related to changes in the product matrix and storage-associated chemical changes. However, mineral concentrations are generally more stable than bioactive compounds, and the changes observed in the present study should be interpreted in relation to moisture changes and the overall composition of the gummy matrix.

6. Microbial quality during storage

Microbial enumeration showed a gradual increase in microbial load during storage. Bacteria were not detected initially but increased to 0.3×10^5 cfu/g at one month and 1.28×10^5 cfu/g at two months. Yeast remained undetected initially and at one month but increased to 2.3×10^3 cfu/g at two months. Fungi were also undetected during the first month and reached 0.33×10^3 cfu/g at two months. The progressive increase in microbial counts may be associated with changes in moisture availability during storage. Water availability is a major factor governing microbial growth and food stability, and increased moisture availability can favour microbial proliferation when other preservation hurdles are insufficient (Tapia, *et al*., 2020) [14]. This relationship has also been reported specifically for gummy products, where moisture exchange during storage has been associated with changes in microbiological quality and sensory deterioration (Nguyen *et al*., 2025) [8].

Overall, the guava leaf gummies demonstrated good sensory acceptability, satisfactory retention of phenolic, flavonoid and antioxidant constituents, and acceptable quality during two months of storage, although gradual moisture uptake, reduction in nutritional and bioactive constituents and increasing microbial counts were evident. The findings support T_3 (40% guava leaf extract + 10% mint leaf extract + 50% other ingredients) as the most suitable formulation for further development.

Conclusion

The study demonstrated the potential of guava (*Psidium guajava* L.) leaves for developing a value-added functional gummy. The optimized formulation, T_3 containing 40% guava leaf extract and 10% mint leaf extract, showed superior sensory acceptability and retained appreciable nutritional and bioactive properties during two months of storage. Although gradual moisture gain, nutrient and bioactive losses, and increased microbial counts were observed, the product remained reasonably acceptable, indicating its potential as a convenient guava leaf-based functional food.

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