**Development and Quality Evaluation of Guava Beverages Enriched with Natural Colour**

**Abstract**

A study on the biochemical changes in guava beverages during storage was conducted in the Laboratory of the Department of Horticulture, Faculty of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India, during the academic year 2024-25. Pink or red guava is commonly used in the processing industry due to its attractive pulp colour, which contributes significantly to the appeal of food products. In the present investigation, different quantities of pomegranate seeds were used to impart colour to beverages made from white-fleshed guava, specifically Ready-to-Serve (RTS) drinks and squash. The results indicated that the use of 80 grams of pomegranate seeds per litre was optimal for achieving desirable colour in both RTS and squash formulations. Furthermore, it was observed that both guava RTS and squash retained the characteristic pomegranate colour for up to eight months.

**Keywords:** RTS, squash, storage, guava, pomegranate

**Introduction**

Guava (*Psidium guajava* L.) belongs to the family Myrtaceae and is commonly referred to as the "poor man's apple" or the "apple of the tropics" due to its remarkable adaptability, high yield potential, and rich nutritional profile. The genus Psidium includes approximately 150 species of small trees and shrubs; however, only a few species produce edible fruits, while the majority are wild types bearing inferior-quality fruits (**Singh *et al*, 2023**). Guava is cultivated commercially across several Indian states, including Uttar Pradesh, Bihar, Punjab, Andhra Pradesh, Karnataka, Gujarat, Maharashtra, West Bengal and Madhya Pradesh.

Guava is relatively low in protein and energy content but is an excellent source of pectin and ascorbic acid, containing approximately 83% moisture. It ranks third in vitamin C concentration after aonla and Barbados cherry. In addition to being rich in vitamin C, guava also contains significant amounts of other vitamins such as niacin, pantothenic acid, thiamine, riboflavin, and vitamin A. It is also a good source of essential minerals, including phosphorus, calcium, and iron. Due to its bioactive compounds, guava is often utilized in the formulation of various anti-aging skincare products. The edible portion of guava comprises the pericarp and thalamus, and the fruit is most commonly consumed fresh as a sweet and refreshing dessert. It is also widely processed into a variety of value-added products such as jam, jelly, ready-to-serve (RTS) beverages, squash, and toffees. Red-fleshed guava varieties are particularly popular in the beverage industry for their appealing colour, although they generally have lower vitamin C content compared to white-fleshed cultivars (**Kumar *et al*., 2024 and Singh and Singh, 2018**). However, post-harvest losses are a significant concern, with approximately 20–25% of guava fruit typically lost due to spoilage before consumption. Processing guava into a range of products-such as jam, jelly, cheese, canned guava, RTS beverages, nectar, squash, ice cream, toffees, fruit leather, and candies-offers an effective solution to reduce waste and enhance the fruit’s commercial value.

White-fleshed guava beverages are really tasty, but they are not very appealing. On the other hand, guava drinks with pink or red flesh have a pleasing flavor in addition to being visually appealing. Natural beverages have more antioxidant and nutritional value than manufactured ones. Astringency, bitterness, and other characteristics limit the usage of some fruits with high nutritional content. Blending two or more fruit and vegetable juices in the proper amounts is the best way to make RTS beverages. Many studies have shown that fruit combination enhances shelf life, vitamin characteristics, flavor, aroma, and taste (**Singh, 2018**). The production of functional beverages improves their sensory and nutritional attributes. Among the essential elements of RTS drinks that have a big influence on their shelf life are processing and preservation methods. New processing methods including as high hydrostatic pressure, high intensity pulse electric field, and ultrasound have been developed as alternatives to pasteurization, with promising results.

Pomegranate (*Punica granatum*) is an ancient fruit-bearing shrub or small tree belonging to the family Punicaceae, and it is native to Iran and the Indian subcontinent. It is widely recognized for its diverse applications in food, medicine, and cosmetics. The fresh arils are commonly consumed raw, while the juice is a popular beverage known for its numerous health benefits. Pomegranate extracts and powders are frequently incorporated into dietary supplements due to their high antioxidant content, particularly punicalagins and anthocyanins. In the culinary field, pomegranate is used in salads, desserts, sauces, and various traditional dishes. Medicinally, it has long been valued for its anti-inflammatory, antimicrobial, and cardioprotective properties. It is believed to aid in lowering blood pressure, enhancing digestion, and strengthening the immune system. Furthermore, pomegranate peel and seed oil are widely utilized in the cosmetic industry for their skin-rejuvenating and anti-aging effects (**Singh *et al*. 2017; Singh, 2014 and Mehta *et al*. 2018**).

Pomegranates are high in calcium, and iron, whereas guavas are high in ascorbic acid. Therefore, adding pomegranate color into guava beverages could improve their nutritious content in addition to their visual attractiveness. In addition to its nutritional qualities, pomegranate color has antimicrobial qualities, and numerous studies have shown that it also helps extend the shelf life of food items. Therefore, pomegranate additions to guava drinks may also extend their shelf life.

**Materials and Methods**

The experiment comprising of five treatments, i.e., (i) 10% guava pulp + acidity 0.25% + pomegranate seed nil + sodium benzoate 100ppm, (ii) 10% guava pulp + acidity 0.25% + pomegranate seed 40g + sodium benzoate 100ppm, (iii) 10% guava pulp + acidity 0.25% + pomegranate seed 80g + sodium benzoate 100ppm (iv) 10% guava pulp + acidity 0.25% + pomegranate seed 120g + sodium benzoate 100ppm, (v) 10% guava pulp + acidity 0.25% + pomegranate seed 160g + sodium benzoate 100ppm) for ready to serve beverage and five treatments, i.e., (i) 25% guava pulp + acidity 1.1% + pomegranate seed nil + sodium benzoate 600ppm, (ii) 25% guava pulp + acidity 1.1% + pomegranate seed 40g + sodium benzoate 600ppm, (iii) 25% guava pulp + acidity 1.1% + pomegranate seed 80g + sodium benzoate 600ppm, (iv) 25% guava pulp + acidity 1.1% + pomegranate seed 120g + sodium benzoate 600ppm, (v) 25% guava pulp + acidity 1.1% + pomegranate seed 160g + sodium benzoate 600ppm for squash was conducted in Laboratory of the Department of Horticulture, Faculty of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India during the year 2024-25.

 Guava fruits were thoroughly washed under a gentle stream of tap water, cut into small pieces, and ground in a blender using water in a 1:1 ratio. The resulting mixture was strained through muslin cloth to obtain the guava pulp. Sodium benzoate was then added as a preservative at a concentration of 600 mg per litre of pulp and mixed thoroughly. The prepared pulp was filled into glass bottles, sealed hermetically with crown corks, pasteurized, and labeled for further use. The natural colour from pomegranate seeds was extracted by boiling the seeds in 100 ml of water for 10 minutes and allowing the mixture to stand overnight. The next day, the solubilized colour was filtered through muslin cloth and incorporated into guava beverages at different concentrations. For Ready-to-Serve (RTS) beverages, pomegranate extract was added at 0, 40, 80, 120, and 160 g per litre. The same concentrations were also used for guava squash. The syrup was prepared by heating a mixture of sugar, water, pomegranate extract, and citric acid, followed by filtration through muslin cloth. The guava pulp was then blended with the prepared syrup and filled into 200 ml bottles, leaving a 2 cm headspace. These bottles were hermetically sealed with crown corks. The entire procedure was replicated three times for consistency. The sealed RTS bottles were pasteurized in boiling water for 20 minutes and cooled at room temperature. Both RTS and squash samples were stored under ambient room temperature conditions for further storage studies. A panel of 10 semi-trained members conducted a sensory evaluation using a nine-point Hedonic scale, where a score of nine indicated “Like Extremely” and one indicated “Dislike Extremely” (Amerine *et al*., 1965). The biochemical parameters, including acidity, ascorbic acid, reducing sugars, non-reducing sugars, and total sugars in guava pulp and pomegranate-coloured RTS and squash, were estimated using titrimetric methods as described by Ranganna (1986). Total Soluble Solids (TSS) were measured using a hand refractometer. Statistical analysis was carried out using the Complete Randomized Design (CRD).

**Results**

**Standardization of Pomegranate Seed for Colour and Quality of RTS**

Organoleptic evaluation was conducted to assess the quality of pomegranate-enriched guava RTS beverages prepared with varying concentrations of pomegranate seed extract. Sensory attributes such as appearance, flavour, and overall acceptability were evaluated. The sensory data revealed that guava RTS supplemented with 80 g of pomegranate seed extract per litre received the highest overall acceptability score of 8.7 on the nine-point Hedonic scale, indicating a rating of "Liked Very Much." This formulation was preferred over other concentrations in terms of sensory quality. In addition to enhancing the sensory appeal, the incorporation of pomegranate seed extract also contributed to extending the shelf life of guava RTS.

**Standardization of pomegranate Seed for Colour and Quality of Squash**

Guava squash enriched with varying concentrations of pomegranate seed extract was evaluated for its quality attributes. The data indicated that the addition of 80 g of pomegranate seed extract per litre resulted in the best colour and taste, receiving the highest sensory score of 8.6 on the nine-point Hedonic scale and rated as "Liked Very Much," compared to other treatments (Table 2). Key sensory parameters-including colour, flavour, appearance, and overall acceptability-were recorded for both guava RTS and squash throughout the experiment. The organoleptic evaluation revealed that overall acceptability was highest when pomegranate seed extract was added at a concentration of 80 g/litre in both RTS and squash formulations, with both products being rated as "Liked Very Much." Currently, limited research has been conducted on the application of pomegranate seed extract in non-dairy beverages. This study highlights its potential as a natural colourant and flavour enhancer in fruit-based beverages.

**Table: 1** Organoleptic quality of guava RTS, enriched with pomegranate colour obtained from different amount of seed

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Amount of pomegranate****seed (g/litre)** | **Organoleptic quality** |
| **Score** | **Rating** |
| **T1** | Nil | 7.7 | LM |
| **T2** | 40 | 7.9 | LM |
| **T3** | 80 | 8.7 | LVM |
| **T4** | 120 | 7.6 | LM |
| **T5** | 160 | 6.8 | LM |

**Table: 2** Organoleptic quality of guava squash, enriched with pomegranate colour obtained from different amount of seed

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Amount of pomegranate seed(g/litre)** | **Organoleptic quality** |
| **Score** | **Rating** |
| **T1** | Nil | 7.6 | LM |
| **T2** | 40 | 7.9 | LM |
| **T3** | 80 | 8.6 | LVM |
| **T4** | 120 | 7.7 | LM |
| **T5** | 160 | 7.3 | LM |

 Note: LM- Liked Much; LVM- Liked Very Much

**Table 3.** Changes in pomegranate seed enriched guava RTS during storage

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Storage (Month)** | **Total Soluble Solids (%)** | **Acidity (%)** | **Ascorbic acid** | **Reducing sugars (%)** | **Non-reducing sugar (%)** | **Total sugars (%)** | **Non-enzymatic browning** |
| 0 | 13.00 | 0.25 | 17.50 | 7.39 | 3.94 | 11.33 | 0.14 |
| 1 | 13.00 | 0.25 | 17.13 | 7.39 | 3.94 | 11.33 | 0.14 |
| 2 | 13.00 | 0.25 | 16.70 | 7.39 | 3.94 | 11.33 | 0.14 |
| 3 | 13.00 | 0.25 | 16.25 | 7.39 | 3.94 | 11.33 | 0.14 |
| 4 | 13.20 | 0.26 | 16.10 | 7.67 | 3.81 | 11.42 | 0.14 |
| 5 | 13.40 | 0.26 | 15.35 | 7.67 | 3.81 | 11.42 | 0.14 |
| 6 | 13.40 | 0.27 | 14.80 | 7.67 | 3.81 | 11.42 | 0.14 |
| 7 | 13.50 | 0.28 | 14.46 | 7.94 | 3.62 | 11.62 | 0.14 |
| 8 | 13.50 | 0.28 | 14.11 | 7.94 | 3.62 | 11.62 | 0.14 |
| 9 | 13.70 | 0.29 | 13.37 | 8.18 | 3.5 | 11.66 | 0.15 |
| 10 | 13.70 | 0.30 | 13.00 | 8.18 | 3.5 | 11.66 | 0.16 |
| SEm± | 0.03 | 0.01 | 0.01 | 0.041 | 0.042 | 0.03 | 0.008 |
| CD (5%) | 0.01 | 0.02 | 0.03 | 0.128 | 0.126 | 0.095 | NA |

**Table 4.** Changes in pomegranate seed enriched guava squash during storage

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Storage (Month)** | **Total Soluble Solids (%)** | **Acidity (%)** | **Ascorbic acid** | **Reducing sugars (%)** | **Non-reducing sugar (%)** | **Total sugars (%)** | **Non-enzymatic browning** |
| 0 | 50.00 | 1.10 | 43.45 | 29.14 | 7.92 | 37.05 | 0.38 |
| 1 | 50. 00 | 1.10 | 43.02 | 29.14 | 7.92 | 37.05 | 0.38 |
| 2 | 50. 00 | 1.10 | 42.53 | 29.14 | 7.92 | 37.05 | 0.38 |
| 3 | 50. 00 | 1.10 | 41.91 | 29.14 | 7.92 | 37.05 | 0.38 |
| 4 | 50. 00 | 1.10 | 41.42 | 29.14 | 7.92 | 37.05 | 0.38 |
| 5 | 50.40 | 1.11 | 41.05 | 29.96 | 7.61 | 37.53 | 0.38 |
| 6 | 50.70 | 1.12 | 40.42 | 29.96 | 7.61 | 37.53 | 0.38 |
| 7 | 50.70 | 1.12 | 40.14 | 30.75 | 7.35 | 38.12 | 0.38 |
| 8 | 50.90 | 1.13 | 39.18 | 30.75 | 7.35 | 38.12 | 0.38 |
| 9 | 51.00 | 1.13 | 38.46 | 31.26 | 7.05 | 38.34 | 0.39 |
| 10 | 51.30 | 1.14 | 38.24 | 31.26 | 7.05 | 38.34 | 0.41 |
| SEm± | 14.21 | 0.02 | 0.07 | 0.002 | 0.014 | 0.002 | 0.008 |
| CD (5%) | N.A. | 0.01 | 0.22 | 0.006 | 0.041 | 0.006 | NA |

**Changes in** **Pomegranate Enriched Guava RTS During Storage**

No significant changes were observed in total soluble solids (TSS), reducing sugars, total sugars, and acidity of pomegranate-enriched guava RTS during the first three months of storage. However, all four parameters showed a significant increase from the fourth month onward until the end of the experiment. Ascorbic acid content in the RTS declined non-significantly during the first two months, followed by a significant reduction in subsequent months. The concentration of non-reducing sugars remained relatively stable up to six months of storage, after which a significant decline was recorded. No signs of non-enzymatic browning were observed in pomegranate-enriched guava RTS during the first eight months of storage; however, browning increased significantly thereafter. The organoleptic quality of pomegranate-enriched guava RTS remained unchanged for the first three months. A gradual, non-significant decline in sensory scores was observed from the fourth to the eighth month of storage.

**Changes in the Pomegranate Enriched Guava Squash During Storage**

The total soluble solids (TSS), acidity, reducing sugars, non-reducing sugars, and total sugars in pomegranate-enriched guava squash remained stable during the first four months of storage. However, from the fifth month onward, all parameters-except non-reducing sugars-showed a gradual increase until the end of the experiment. A significant increase in TSS was recorded after four months of storage. Non-reducing sugar content decreased non-significantly up to the eighth month. Ascorbic acid content declined non-significantly during the initial two months, followed by a significant reduction in the subsequent storage period. Non-enzymatic browning in the squash remained unchanged up to eight months but showed a non-significant increase thereafter. The organoleptic quality of pomegranate-enriched guava squash remained stable for the first four months. After this period, a slight, non-significant decline in sensory scores was observed. Despite the minor decrease, the squash remained organoleptically acceptable throughout the entire ten-month storage period, with an overall rating of "Liked Very Much."

**Discussion and Conclusion**

During storage at room temperature, the pomegranate-enriched guava beverages' total soluble solids, acidity, reducing sugars, and total sugars all marginally increased. Similar outcomes were noted by Rashid *et al*. (2018) in the RTS of bio-colored guava, by Jan and Masih, (2012) in the lime, aonla, mango, and pineapple spiced RTS beverage, and by Bal *et al*. (2014) in the guava nectar. The observed increase in total soluble solids (TSS) in pomegranate-enriched guava RTS and squash during storage may be attributed to the hydrolysis of polysaccharides and oligosaccharides into monosaccharides, particularly reducing sugars. The increase in acidity over time is likely due to the breakdown of pectic substances present in the fruit pulp. The increase in reducing and total sugars can be explained by the inversion of non-reducing sugars into reducing sugars, as well as the hydrolysis of complex carbohydrates into simpler sugar forms. The increase in non-enzymatic browning during storage is likely a result of complex Maillard-type reactions involving nitrogenous compounds and sugars, nitrogenous compounds and organic acids, sugars and organic acids, and interactions among organic acids themselves. Additionally, browning may occur due to reactions involving the carbinol group of cyclic sugars with basic proteins or amino acid complexes. Over the storage period, a decline was noted in ascorbic acid content, non-reducing sugars, and the organoleptic quality of pomegranate-enriched guava beverages, reflecting the natural degradation of nutritional and sensory attributes with time.

The loss of ascorbic acid, non-reducing sugar and organoleptic quality was also observed by Choudhary *et al*. (2008) in nectar of guava cv. Lucknow-49, Bal *et al*. (2014) in nectar of guava cv. Lalit, Jakhar *et al*. (2012) in guava-barbados cherry blend RTS, Selvi *et al*. (2013) in guava, lime and ginger blended RTS, Sarkar and Bulo (2017) in guava and pineapple blended RTS and Ravi et al. (2018) in RTS and squash of different varieties of guava. The loss of ascorbic acid, non-reducing sugars, and organoleptic quality during storage has also been reported in earlier studies. Choudhary *et al*. (2008) observed similar trends in guava nectar of cv. Lucknow-49, while Bal *et al*. (2014) reported such losses in guava nectar of cv. Lalit. Comparable findings were noted by Jakhar *et al*. (2012) in guava-Barbados cherry blended RTS, and by Selvi *et al*. (2013) in guava, lime, and ginger blended RTS.

The degradation of ascorbic acid in pomegranate-enriched guava RTS and squash may be attributed to the use of transparent bottles, as ascorbic acid is highly sensitive to both light and temperature. Additionally, the reduction in ascorbic acid content could be due to oxidative reactions involving trapped oxygen within the bottles, leading to the formation of dehydroascorbic acid. The gradual decline in non-reducing sugars observed during storage is likely a result of their conversion into reducing sugars. The organoleptic scores of pomegranate-enriched guava RTS and squash began to decline after three and four months of storage, respectively. However, pomegranate-enriched RTS remained acceptable for up to 10 months, and the squash maintained its acceptability throughout the entire experimental period (up to 10 months). The findings of the present study suggest that pomegranate not only enhanced the visual appeal of the guava beverages but also contributed to their extended shelf life. The delayed biochemical changes and prolonged storability of pomegranate-enriched guava RTS and squash may be attributed to the antimicrobial properties of pomegranate colour, as reported by Yolmeh *et al*. (2014) and Najafi *et al*. (2018). This is particularly noteworthy considering that typical fruit-based RTS and squash products generally remain acceptable only up to 4-6 months and 6-8 months, respectively.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT,

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