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* **Corresponding author.**
waseemullah6180@gmail.com

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Preparation and Fortification of Guava Squash with Physicochemical and Sensory Profiling

Waseem Ullah^{1*}, Hasnain Khan²

¹ Department of Agriculture, Faculty of Sciences, The University of Swabi, Anbar-Swabi, KPK, Pakistan.

² Pakistan Council of Scientific and Industrial Research (PCSIR), Peshawar, Pakistan.

Abstract

Background: Internship studies were carried out at PCSIR laboratories Complex Peshawar. Study's core objective was to determine physicochemical, sensory attributes and overall acceptance of fortified guava squash once prepared and being fortified with mint, nut powder (almond and cashew), carrot puree and guava leaves along with calcium and potassium. **Materials & Methods:** Five treatments were prepared (To= Non-fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends) and preserved at temperature around (25-30°C). Physicochemical parameters which include percent acidity, pH, TSS, reducing sugar, non-reducing sugar content and organoleptic characteristics including appearance, texture, flavor and overall acceptability were determined at regular interval for 30 day storage duration. **Results:** T1 (1.90) had highest mean value for percent acidity and T3 (1.43) had lowest value for percent acidity. Maximum mean pH value was detected in T3 (4.04) while minimum was observed in To (3.87). TSS had highest mean value for T3 (49.03) and lowest was recorded in To (48.13). Highest mean value for reducing sugar was discovered in T3 (27.37) and lowest was observed in To (26.37). Highest mean value for non-reducing sugar was detected in T3 (26.97) while lowest was seen in To (25.63). In the same manner data for other parameters was measured. **Conclusion:** Based on several criteria and analysis, at the end sample that was found most acceptable and stable physicochemically and organoleptically was T1 (Guava squash fortified with mint). Other samples also showed remarkable results but treatment T1 was found to be most acceptable to the end consumer.

Keywords: Fortified guava squash; Ambient temperature; Carrot puree; TSS; Physicochemically; Organoleptically; Percent acidity

1 Introduction

Guava (*Psidium guajava*) is a fruit native to many tropical and subtropical parts of the planet. *Psidium guajava* is an evergreen shrub with size ranging between 3 to 10 m and belongs to the (Myrtaceae) family. Guava is sometime referred as “poor man’s fruit” or “apple of the tropics”. According to Morton (1987) guava is believed to be originated from areas including parts of central America and southern Mexico meanwhile Spaniards and Portuguese are held accountable for distributing guava fruit to other continents of the world. According to guava global production statistics 2022, Pakistan ranked 4th in guava production while top 3 positions were taken by India, Indonesia and China respectively. Other countries involved in

guava production are Thailand, Brazil, Bangladesh and Nigeria. In Pakistan one can witness guava growth in almost each and every province while areas where major productions occur are Kasur and Lahore in Punjab, Kohat and Bannu in KPK, Larkana and Hyderabad in Sindh respectively. Being a vital source of Vitamin C, guavas can be consumed in multiple ways such as raw fruit, in juice form, in squash form, in form of smoothies, salad, candies or even in baked goods and its leaves can be used to produce tea as they include essential oil, tannins, flavonoids, phenol chemicals, carotenoids, and vitamin C. Variety of guavas commonly available in Pakistan are Gola (Round Shaped) and Surahi (Pear Shaped) namely Hyderabad Safeeda, Strawberry Pink Gola, China Surahi and China Gola etc.

According to studies by Ismail *et al.*, (2010)⁽¹⁴⁾ *Psidium guajava* is a climate sensitive fruit, because of its high rate of respiration, it is vulnerable to post-harvest losses. According to studies, post-harvest losses of guava crops range between 20% and 40% in underdeveloped nations. There are various factors that contribute to post harvest losses in guava for instance damage due to poor handling, chilling injury due to storage at severe low temperature, disease attacks, and certain insects' infestation which include fruit borers and Carib fly or guava fruit fly. In order to overcome post-harvest losses in guava, it is transformed into various forms which include guava squash, guava nectar, guava leather, guava jelly, jam, juice and certain other forms leading to both extended shelf life and greater outcomes in terms of income.

Guavas are low in calories but rich in vitamin C, which is vital for healthy skin and a stronger immune system. As per reports by United States Department of Agriculture (USDA) 100mg of guava will provide an individual with 68 calories. It is said that guava has 228.3 mg of ascorbic acid per 100 mg. Besides, vitamin C guavas are served to be high in vitamin A, potassium, folate, carbohydrates and protein. Guavas are excellent source of dietary fiber which ensures healthy digestive system by preventing constipation. Having a low Glycemic Index (GI) of about 20 to 25, makes guava a good choice for diabetic patients. Guava is also helpful in maintaining healthy vision and preventing eyesight related problems. A publication by Trade Development Authority of Pakistan (TDAP) prevails that Guavas also serve as rich source of manganese, which can help the body in absorbing other vital nutrients from the food that we consume. Due to antioxidant properties guava also serves as a barrier against cancer like diseases. A study by Doubova *et al.* (2007)⁽¹⁾ states that *Psidium guajavae* folium extract can be used to treat dysmenorrhea. Compared to conventional treatments a dose of 6mg/day of *Psidium guajavae* folium extract can significantly relieve the menstrual pain in women.

Guava has a long history for being used as medicine by Latin Americans, Mexicans, Africans and Asians due to its pharmacologic activities. According to Kafle *et al.* (2018)⁽²⁾ findings there are numerous potential health benefits we can get from guava leaves apart from the fruit for example it helps in blood pressure regulation, solving diarrhea problem, helps in weight loss, treat cough and cold, constipation, dysentery and scurvy. In China, people take guava leaves on empty stomach to help fight against diabetes. Guavas being an active source of ascorbic acid and iron help prevent mucous development and keep the respiratory tract free from unfriendly pathogens. Guavas, being excellent in carotene content, can act as shield against lung and oral cancer. It is found that guavas contain Tannins and flavonoids which give it property of faster wound healing and help give relief from pain. Naseer, S., *et al.* (2018)⁽³⁾ added that guava possess antimicrobial properties Methanolic extracts from the leaves

and bark of guava plant have high antimicrobial activity. The substance extracted can be of great help in inhibiting the growth of various bacteria for instance *Staphylococcus aureus*, *Bacillus* species and *Salmonella* bacteria.

In year 2022-23 area under cultivation was about 67.6 lakh and overall fruit production from this area was approximately 69.2 lakh tons according to reports by the Ministry of National Food Security & Research, Islamabad. In this Guava production from an area of around 58,500 hectares is about 560,000 tons per year. Sindh ranks 2nd major producer of guavas in state producing around 71,000 tons per year. In case of mass production in country, post-harvest losses of guava might be an alarming situation. To limit post-harvest losses of guavas, it is crucial to place the fruit in a cool environment with temperature around 10 °C (50 °F) and relative humidity varied from 90% to 95% in order to prevent moisture loss and retain fruit quality. This can keep the guavas in safe and sound condition for the next 15 days. For off season storage guavas are transformed into other products namely Guava squash, Guava nectar, blended RTS beverages and many more products depending on consumer preferences. According to Rani *et al.*, (2018)⁽⁴⁾ a beverage which is prepared from the combination of sugar, fruit pulp and water in particular ratio is known as squash. Fruit squash can be consumed after mixing it with water in appropriate proportions.

According to World Health Organization (WHO), food fortification is the process of intentionally increasing the concentration of vital micronutrients in a food item, such as vitamins and minerals, with objective to enhance its nutritional content and provide a public health benefit with minimum risk to health. In particular, food enrichment refers to restoring nutrients that are lost during food processing, whereas fortification involves introducing elements that are not found naturally. Since 1920, government and food manufacturers have employed various methods to help population avoid vitamin deficiencies. According to Dwyer *et al.*, (2015)⁽⁵⁾, fortification process can be used to balance food overall nutritional profile, to restore nutrients lost during processing, to avoid widespread nutrient consumption deficits and related deficiencies and to attract customers looking for supplementing their diet. Food fortification is a public health strategy for improving a population's nutritional intake. Going forward, we must work hard to establish responsible and efficient fortification regulations and practices, including conscientious fortified product marketing.

A study by Mohammadi *et al.*, (2016)⁽⁶⁾ shows that if flavor, stability, and consumer acceptance are adequately managed, mineral fortified water could serve as a useful functional beverage option that can address basic micronutrient deficiencies. Squash, a concentrated fruit drink, can be strengthened by adding essential vitamins and minerals to address micronutrient deficiencies, particularly in populations with low dietary diversity. Squash is an excellent vehicle for

fortification because to its widespread consumption, particularly among youngsters, and its ease of including water soluble components like vitamin C, B-complex vitamins, and iron.

2 Objectives

1. To prepare fortified guava squash.
2. To assess the physical, chemical and sensory properties of fortified guava squash.
3. To introduce a profitable and stable new guava product into the market.
4. To understand the practical use of knowledge thought in syllabus.
5. To develop skills in a professional and technical environment.

3 Materials and Methods

3.1 Attaining Ingredients

Internship location was Food Technology Centre at Pakistan Council of Scientific and Industrial Research (PCSIR) Lab, Peshawar. Firm and ripe white Kohat variety guavas were purchased from a store in front of the research center at University Town Peshawar along with other raw materials including sugar and plastic bottles for packaging of the final product. The raw materials were brought into lab for further processing.

3.2 Cleansing and Pulping

In order to make sure the guavas were free from germs and surface contaminants, they were cleansed thoroughly with tap water. The seeds were then eliminated using clean stainless steel knives and the remaining section was sliced into four halves. In order to overcome the oxidative browning, guavas were treated with 0.1% citric acid solution which was prepared recently. Pulp was then extracted with the help of pulper machine. Extracted pulp used later to prepare squash.

3.3 Squash Formulation

Squash can be produced from combining raw materials in different amounts. Guava squash was produced using the following formulation:

Pulp	Sugar	Water
1	3	2

Table 1: Raw ingredients concentration used in guava squash preparation

S. No	Ingredients	Concentration
1	Pulp (kg)	1
2	Water (L)	2
3	Sugar (kg)	3
4	KMS (g)	0.5
5	Sodium Benzoate (g)	1
6	CMC (g)	1
7	Xanthan Gum (g)	2
8	Citric Acid (g)	10

3.4 Guava Squash Preparation

First for making squash all the raw ingredients i.e. guava pulp, sugar and water were weighted according to the given ratio. Then sugar was dissolved in boiling water, while citric acid was introduced to inhibit crystallization and balance pH. Xanthan gum and carboxy methyl cellulose (CMC) were incorporated acting as stabilizer, enhancing viscosity and ensuring a homogenous texture. As guava pulp is already rich in natural aroma and flavor, it eliminated the need for synthetic enhancers, preserving the squash natural image. After cooling the syrup, the pulp was blended into the mixture, followed by homogenization to mechanically disrupt CMC aggregates and achieve a uniform dispersion. Potassium metabisulphite (KMS), pre-dissolved in the reserved water, was added as an antimicrobial safeguard to extend product shelf life. The final product was filled hot into clean bottles under aseptic conditions and stored at ambient temperature. This process prioritized quality control, sensory appeal, and microbiological safety, yielding a shelf-stable guava squash.

3.5 Guava Squash Fortification

Functional elements were added to guava squash to improve its nutritional value and health promoting qualities. Guava pulp was blended with herbs mint to enhance its antioxidant content. As shown in guava bars, protein and β -carotene fortification was carried out using carrot puree and nut powders (such as cashew and almond), which may have comparable uses in squash. Minerals like potassium and calcium are important fortified components that were added either directly or through ingredient blends.

Table 2: Research plan for proposed study

Treatment	Composition
To	Controlled Sample (unfortified)
T1	Squash + Mint
T2	Squash + Nut powder
T3	Squash + Carrot puree
T4	Squash + Guava leaves and Mineral blends

3.6 Physicochemical Analysis

During internship studies fortified guava squash was prepared in a safe working environment, then it was poured into bottles, labeled and samples were examined. Following parameters were measured from fortified guava squash samples: pH, (TSS), vitamin C content, total sugar, reducing sugar and non-reducing sugar concentration. Internship involved preparing fortified guava squash in order to fulfill the basic human dietary requirements, to preserve and use the guava fruit in a best profitable way in order to avoid food wastage across food chain as well as to analyze the physicochemical properties of the final product.

- **pH**

Association of Official Analytical Chemists (AOAC 2023)⁽⁷⁾ method of analysis was used to measure the pH of fortified guava squash. pH values of the fortified guava squash samples were evaluated with pH meter. To get more accurate results, buffer solutions bearing pH value of 4 and 9 were standardized using pH meters. After cleaning the pH meter electrodes with distilled water, paper towels were used to pat them dry. The probe of pH meter was then dipped into sterile beaker containing 10ml fortified guava squash sample to determine its pH.

- **Total Soluble Solids (oBrix)**

Digital refractometers and (AOAC 2023)⁽⁷⁾ approved procedure of analysis were used to determine Total Soluble Solids (TSS) content of sample at room temperature. After cleaning refractometer prism with distill water, it was dried with tissue paper. Subsequently small portion of fortified guava squash was placed on refractometer dry prism, and the value was noted from screen. For accurate findings, this technique was performed multiple times, and three consecutive readings were acquired.

- **Percent / Titratable Acidity**

Percent acidity of fortified guava squash was calculated through Association of Official Analytical Chemists (AOAC 2023)⁽⁷⁾ approved methodology of analysis.

- **NaOH standardized solution of 0.1 Normality Preparation**

6.3 g oxalic acid was weighed and dissolved in 1000 ml of purified water. Following that, NaOH pellets weighing 4.5 grams were dissolved in 1000 milliliters of distilled water. For standardization 0.1 N NaOH solution and 10 ml oxalic acid of 0.1 normality was taken in a conical flask. Around three drops of phenolphthalein were added to solution as indicator. In a clean burette NaOH solution of 0.1 normality was placed. Flask content was titrated against 0.1N NaOH solution until

appearance light pink tint. Formula (i) mentioned below was used to obtain NaOH solution of desired normality, after 3 successive readings were recorded.

$$N1 \times V1 = N2 \times V2$$

According to the given formula,

N1 = Normality of Oxalic Acid.

V1 = Volume Oxalic Acid.

N2 = Normality of NaOH.

V2 = Volume of NaOH.

- **Fortified guava squash sample Titration**

In volumetric flask 10ml of fortified guava squash sample was taken and diluted with 90ml distill water to make up upto 100ml volume. Next in a conical flask 10ml sample from the diluted solution was taken and around 3 drops of phenolphthalein were added as indicator to the sample. In a burette 0.1N standardized NaOH solution was taken. Sample was then titrated till light pink color was achieved. Three consecutive measurements were noted to obtain accurate result.

Using the formula below, % Acidity of the fortified guava squash was determined:

$$\% \text{ Acidity} = \frac{1}{10} \times \text{Equivalent weight of NaOH} \times \text{Normality of NaOH} \times \text{Titre}$$

- **Ascorbic Acid / Vitamin C Content**

Fortified guava squash vitamin C content (mg/100g) was measured by using AOAC (2023) official method of analysis.

Preparation of standardized Dye solution: For dye solution preparation 50mg of 2, 6-dichlorophenolindophenol (DCPIP) and 42gm of sodium bicarbonate was dissolved in warm distill water to make 250ml volume. 50ml of standard ascorbic acid was added to 250ml volumetric flask and volume was filled to the mark with 0.4% oxalic acid solution. 2ml sample of this prepared solution was placed in conical flask and titration against the dye solution was done until a light pink tint appeared.

Dye factor was determined according to formula below:

$$\text{Dye Factor} = \frac{\text{milliliter of standard Ascorbic acid solution}}{\text{Titer or ml of dye used}}$$

Sample Titration: 10ml of fortified guava squash was obtained and diluted with 90ml 0.4% oxalic acid to make 100ml solution. Then in a conical flask, 10ml diluted sample was titrated against the standard dye solution until it turned

into light pink tint. At least three consecutive readings were obtained.

Ascorbic acid content was measured with formula listed below:

$$\text{Ascorbic acid (mg/100g)} = \frac{D.F \times T \times \text{Dilution volume} \times 100}{S \times D}$$

According to the given formula (IV)

D.F = Indicate dye factor

T = milliliter of dye used

Dilution volume = Total volume of the solution after dilution

S = milliliter of diluted sample used for titration

D = milliliter of sample used for dilution

- **Total Sugar (%)**

Total sugar content for fortified guava squash was determined with the help of AOAC official method of analysis (2023).

First Fehling A and Fehling B solutions were prepared according to the given procedure.

Fehling A solution Preparation: 70 grams of copper sulphate was dissolved in 100ml distill water. The solution was mixed well until copper sulphate was fully dissolved. Volume was increased to 250ml with distill water in order to prepare 500ml sample.

Fehling B solution Preparation: 173 grams of Potassium sodium tartrate also known as Rochelle salt was taken along with 50 grams of NaOH, which was then fully dissolved in distilled water. To prepare a 500ml sample, distilled water was used to increase the volume to 250ml.

Sample Titration: A precise 5ml sample of fortified guava squash was taken. By adding distilled water the original volume was raised to 100ml. Next 0.1N NaOH solution was used to neutralize the sample until it reached pH 7. After neutralizing, increase the volume up to 250 ml and take a 50 ml sample. Add 5 g citric acid and simmer for 10 minutes. After cooling, neutralized the sample with a pH meter by titrating it with a 20% NaOH solution until the pH reaches 7-8. Fill the burette with sample, then place a beaker containing 10ml Fehling A and Fehling B solution (5ml each) on the burner beneath the burette for titration. Right after that, begin titration and when the red brick color shows up, add several methyl blue drops as indicator. Continued titration until light pink tint appeared, after which reading was taken.

- **Reducing Sugar (%)**

Sample was collected from an already prepared 250ml solution, from which 50ml sample was used to determine total sugar. Burette was filled with the remaining sample, place 10ml of fehling A and fehling B solution (5ml each) in beaker, turned on the burner and began titration process. Few drops of methyl blue were added when red brick color appeared and the titration continued until light pink color got visible, at that point the readings were recorded.

- **Non-Reducing Sugar (%)**

To measure non-reducing sugar in fortified guava squash, AOAC (2023)⁽⁷⁾ official method of analysis was used. According to which reducing sugar that was determined earlier in fortified guava squash was subtracted from total sugar content as both reducing and non-reducing sugar combine to constitute total sugar content.

For non-reducing sugar calculation listed formula was used:

$$\text{Non-reducing Sugar} = \text{Total sugar} - \text{Reducing sugar}$$

3.7 Sensory Evaluation

Selected fortified guava squash samples were evaluated organoleptically for appearance, taste and texture as described by Elaine Larmond 1997. Its scoring was done on Hedonic scale as evaluated by the judges showing the overall acceptability of prepared fortified guava squash among the consumers.

Table 3: 9 Points Hedonic scale used for organoleptic evaluation

Scale	Verbal Descriptor
9	Like Extremely
8	Like Very Much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

3.8 Statistical Analysis

All essential readings were analyzed using mean values as described in S. M. Chaudhry's book Introduction to Statistical Theory II (2010).

4 Results and Discussion

Physicochemical analysis of fortified guava squash: This section explains the physicochemical properties and sensory

results of fortified guava squash.

4.1 Fortified guava squash pH with Storage interval

pH meter was used to obtain an exact pH value for fortified guava squash, three successive measurements R1, R15, and R30 at different storage interval were collected for each sample (To= Non fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends). Mean value for each treatment which represents the core accurate reading, was (To= 3.87), (T1= 3.92), (T2= 3.97), (T3= 4.04), and (T4= 3.94). Maximum of the samples' pH showed increase in the pH value as time passed by, meanwhile sample T1 deviated from the trend and showed decrease in the pH value. Maximum increase was observed in T3 (7.93%) followed by T2 (7.27%). Negligible increase in value was shown by T4 (0.51%) followed by To (2.62%). Decline in pH value was seen in T1 (2.02%). Similar pH values in guava squash samples were determined using standard methods as described by Rani *et al.*, (2018) (4).

Table 4: Fortified guava squash pH with Storage interval

Treatment	Storage Intervals			% Increase or % Decrease	Mean
	1	15	30		
To	3.82	3.87	3.92	2.62	3.87e
T1	3.96	3.91	3.88	-2.02	3.92d
T2	3.85	3.94	4.13	7.27	3.97b
T3	3.91	3.98	4.22	7.93	4.04a
T4	3.93	3.94	3.95	0.51	3.94c
Mean	3.894c	3.928b	4.020a	-	-

4.2 Fortified guava squash TSS (oBrix) with Storage interval

Digital refractometer was used to obtain exact TSS value for fortified guava squash, three successive measurements R1, R15, and R30 at different storage interval were collected for each sample (To= Non fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends). Mean value for each treatment which represents the core accurate reading, was (To= 48.13), (T1= 48.57), (T2= 48.77), (T3= 49.03), and (T4= 48.27). All the samples showed increase in TSS value with the passage of time. Maximum increase was observed in T3 (2.06%) followed by T2 (1.86%). Minimum increase in value was shown by T1 (1.66%) followed by To (1.25%). Negligible increase in Total Soluble Solids value was seen in T4 (0.62%). Similar TSS values

in guava squash samples were determined using standard methods which were described by Namdev *et al.*, (2024) (8).

Table 5: TSS (oBrix) of fortified guava squash with Storage interval

Treatment	Storage Intervals			% Increase or % Decrease	Mean
	1	15	30		
To	47.9	48	48.5	1.25	48.13e
T1	48.2	48.5	49	1.66	48.57c
T2	48.3	48.8	49.2	1.86	48.77b
T3	48.5	49.1	49.5	2.06	49.03a
T4	48.1	48.3	48.4	0.62	48.27d
Mean	48.200c	48.540b	48.920a	-	-

4.3 Fortified guava squash Percent / Titratable Acidity with Storage interval

To obtain an exact % acidity value for fortified guava squash, three successive measurements R1, R15, and R30 at different storage interval were collected for each sample where (To= Non fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends). Mean value for each treatment was measured, which represents core accurate reading, was (To= 1.77), (T1= 1.90), (T2= 1.70), (T3= 1.43), and (T4= 1.80). Maximum of the samples showed increase in % acidity value as time passed, meanwhile sample T3 deviated from the trend and showed decrease in the % acidity value. Highest increase was observed in T1 (23.53%) followed by T4 (17.65%). Minimum increase was shown by T2 (12.50%) followed by To (11.76%). Decrease in % acidity value was seen in T3 (6.67%). Similar pH values in guava squash samples were determined using standard methods described by Thasleem *et al.*, (2024) (9).

Table 6: % Acidity of fortified guava squash with Storage interval

Treatment	Storage Intervals			% Increase or % Decrease	Mean
	1	15	30		
To	1.7	1.7	1.9	11.76	1.77c
T1	1.7	1.9	2.1	23.53	1.90a
T2	1.6	1.7	1.8	12.5	1.70d
T3	1.5	1.4	1.4	-6.67	1.43e
T4	1.7	1.7	2	17.65	1.80b
Mean	1.640c	1.680b	1.840a	-	-

4.4 Fortified guava squash Ascorbic acid (mg/100g) content with Storage Interval

To obtain an exact ascorbic acid (vitamin c) value for fortified guava squash, three successive measurements R1, R15, and R30 at different storage interval were collected for each sample where (To= Non fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends). Mean value for each sample was measured, which represents the core accurate reading, was (To= 1.77), (T1= 1.90), (T2= 1.70), (T3= 1.43), and (T4= 1.80). All samples showed decline in ascorbic acid value as time passed, meanwhile sample T4 showed negligible decrease in the ascorbic acid value. Maximum decline in ascorbic acid value was seen in the treatment To (4.58%) followed by T2 (3.82%). Minimum decrease in value was shown by the treatment T1 (2.31%) followed by T3 (3.79%). Negligible decline in ascorbic acid content was seen in T4 (1.53%). Similar ascorbic acid values in guava squash samples were determined using standard methods as described by Rashid *et al.*, (2018)⁽¹⁰⁾.

Table 7: Fortified guava squash Ascorbic acid content with Storage interval

Treatment	Storage Intervals			% Increase or % Decrease	Mean
	1	15	30		
To	131	128	125	4.58	128.0e
T1	130	128	127	2.31	128.3d
T2	131	129	126	3.82	128.7c
T3	132	129	127	3.79	129.3b
T4	131	130	129	1.53	130.0a
Mean	131.00a	128.80b	126.80c	-	-

4.5 Fortified guava squash Total sugar (%) content with Storage interval

To obtain exact total sugar (%) value for fortified guava squash, three successive measurements R1, R15, and R30 at different storage interval were collected for each sample where (To= Non fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends). Mean value for each treatment was measured, which represents core accurate reading, was (To = 1.77), (T1 = 1.90), (T2 = 1.70), (T3 = 1.43) and (T4 = 1.80). All the samples showed decrease in total sugar (%) value as time passed, meanwhile sample T4 showed negligible increase in total sugar (%) content. Highest increase was seen in treatment To (4.58%) followed by T2 (3.82%). Minimum increase was determined in treatment T1 (2.31%) followed by T3 (3.79%). T4 (1.53%) showed negligible increase in total sugar (%) value. Similar

total sugar (%) values in guava squash samples were determined using standard methods as described by Pottapengera & Mishra, (2017)⁽¹¹⁾.

Table 8: Total sugar (%) content of fortified guava squash with Storage interval

Treatment	Storage Intervals			% Increase or % Decrease	Mean
	1	15	30		
To	50	52	54	8	52.00e
T1	51	53	56	9.8	53.33c
T2	51	54	56	9.8	53.67b
T3	52	54	57	9.62	54.33a
T4	51	52	56	9.8	53.00d
Mean	51.00c	53.20b	55.80a	-	-

4.6 Fortified guava squash Reducing sugar (%) content with Storage interval

To obtain exact reducing sugar (%) value for fortified guava squash, three successive measurements R1, R15, and R30 at different storage interval were collected for each sample where (To= Non fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends). Mean value for each treatment was measured, which represents core accurate reading, was (To= 26.37), (T1= 26.87), (T2= 27.03), (T3= 27.37) and (T4= 26.70). All treatments reducing sugar (%) value increased as time passed by, meanwhile lowest increase in reducing sugar (%) value was determined in treatment T3. Maximum increase was determined in treatment To (12.40%). Three samples T1 (12.16%), T2 (12.16%) and T4 (12.16%) exhibited similar rise in values. T3 (11.92%) showed lowest increase in reducing sugar (%) content. Similar reducing sugar (%) values in guava squash samples were determined using standard methods as described by Verma *et al.*, (2024)⁽¹²⁾.

Table 9: Reducing sugar (%) content of fortified guava squash with Storage interval

Treatment	Storage Intervals			% Increase or % Decrease	Mean
	1	15	30		
To	25	26	28.1	12.4	26.37e
T1	25.5	26.5	28.6	12.16	26.87c
T2	25.5	27	28.6	12.16	27.03b
T3	26	27	29.1	11.92	27.37a
T4	25.5	26	28.6	12.16	26.70d
Mean	25.50c	26.50b	28.60a	-	-

4.7 Fortified guava squash Non-reducing sugar (%) content with Storage interval

To obtain exact non-reducing sugar (%) value for fortified guava squash, three successive measurements R1, R15, and R30 at different storage interval were collected for each sample where (To= Non fortified guava squash, T1= Guava squash with mint, T2= Guava squash with nut powder, T3= Guava squash with carrot puree, T4= Guava squash with guava leaves and mineral blends). Non-reducing sugar (%) value was measured directly by subtracting the measured reducing sugar (%) value from total sugar (%) value at each storage interval. This method is well established and offers an accurate estimation of non-reducing sugars. Each treatment mean value was measured accordingly, which represents core accurate reading, was (To= 25.63), (T1= 26.47), (T2= 26.63), (T3= 26.97) and (T4= 26.30). Non-reducing sugar (%) value for all treatments increase as time passed, meanwhile sample To showed lowest increase in non-reducing sugar (%) value. Three treatments exhibited highest increase value T1 (7.45%), T2 (7.45%) and T4 (7.45%) followed by T3 (7.31%). In To (3.60%) lowest increase for non-reducing sugar (%) value was observed. Similar data for guava squash non-reducing sugar (%) content was determined using standard methods as mentioned by Priyanka *et al.*, (2015)⁽¹³⁾.

Table 10: Non-reducing sugar (%) of fortified guava squash with Storage interval

Treatment	Storage Intervals			% Increase or % Decrease	Mean
	1	15	30		
To	25	26	25.9	3.6	25.63e
T1	25.5	26.5	27.4	7.45	26.47c
T2	25.5	27	27.4	7.45	26.63b
T3	26	27	27.9	7.31	26.97a
T4	25.5	26	27.4	7.45	26.30d
Mean	25.50c	26.50b	27.20a	-	-

4.8 Sensory evaluation of Fortified guava squash

Sensory qualities of fortified guava squash were evaluated by judges using 9 point hedonic scale, according to the scale 1 represents "dislike extremely" while 9 represents "like extremely". Sensory evaluation focused on three essential organoleptic properties: appearance, flavor and texture. And at last final acceptability for every treatment was found. Based on these findings, treatment T1 seems to be very acceptable based on the score for overall acceptability followed by To. Treatment T2 was liked slightly while T3 got neutral remarks. T4 received lowest score in the group and was referred to as disliked slightly.

Table 11: Sensory evaluation of fortified guava squash for overall acceptability

Treatment	Parameters			Overall Acceptability
	Appearance	Taste	Texture	
To	8	7	7	7b
T1	9	8	7	8a
T2	6	7	6	6c
T3	5	6	5	5d
T4	5	4	5	4e

5 Conclusions and Recommendations

From this study it was concluded that potassium metabisulphite together with citric acid and sugar can have significant effects on final quality of fortified guava squash. During these 30 days storage period, minor modifications were identified in physiochemical properties, but these alterations did not influence the quality of fortified guava squash upto greater extent. Among all treatments, T1 (Guava squash fortified with mint) was found to be highly satisfactory both physicochemically and organoleptically.

Recommendations

1. More research should be carried out on value added guava squash and its diversification by keeping modern market trends in mind.
2. While heat contributed to significant loss of ascorbic acid content in samples more work should be carried out to minimize these losses.
3. Future studies should explore how packaging material influence the product quality.
4. Research should be done on blending guava with other fruits, such as papaya, which has been revealed to improve organoleptic and sensory attributes of squashes.

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