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Studies on development of ready-to-serve (RTS) beverage from guava (*Psidium gujava* L.), wood apple (*Feronia limonia* L.) and ginger *(Zingiber officinale* Rosc.) blend

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Abstract
The present investigation was carried out at Post Graduate Laboratory, Department of Fruit Science and Department of Post-Harvest Technology, College of Horticulture & Forestry, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya-224229, U.P. India during 2022-2023. Guava (*Psidium gujava* L.), wood apple (*Feronia limonia* L.), and ginger (*Zingiber officinale* Rosc.) which have nutritional, medicinal and therapeutic values were blended in different ratios *viz*., 100:0:0 (T_1), 0:100:0 (T_2), 0:0:100 (T_3), 33.33:33.33:33.33 (T_4), 40:30:30 (T_5), 50:25:25 (T_6), 60:20:20 (T_7), 70:15:15 (T_8), 80:10:10 (T_9), and 90:5:5 (T_{10}) to get the best blend combination for the preparation of RTS. The blend comparising 60% guava pulp, 20% wood apple, and 20% ginger juice was found to be best over other treatments for the preparation of palatable quality of RTS. The 10% of best blend with 13% Total soluble solids, 0.30% acidity and incorporated with 70 ppm SO_2 was used to prepare RTS for storage study. During the storage TSS, acidity, reducing sugars, total sugars and browning increased whereas, ascorbic acid (vitamin-C), non-reducing sugar, pH and organoleptic quality decreased with the advancement of storage period whereas microbial growth initially increased then decreased during the period. The RTS was organoleptically acceptable upto 4 months of storage in case of both ambient and low temperatures.

Keywords: RTS, guava, wood apple, ginger, blend beverage, ambient and low temperatures storage, organoleptic quality

Introduction

Beverages play an important role in human consumption, in addition to their basic function of satisfying thirst. The beverages can be classified into two groups: unfermented (Non-alcoholic) and fermented (alcoholic). Non-alcoholic beverages include Nectar, RTS, Cordial, Squash, Crush, Syrup, and Natural sweetened juices that do not contain alcohol, whereas alcoholic beverages are made after fermentation of sugar rich raw materials. Fruit juices are commonly used for the preparation of different types of beverages. The extraction of juice from fruits will differ depend on the structure and composition of fruits (Shah and Nath, 2006) [33]. Fruit juices include important vitamins and polyphenolic chemicals that are linked to the consumption of bioactive components (AOAC, 2012). One of the new product advance strategies in the beverage industries to attract consumers is the combination of natural compounds found in different fruits, vegetables, medicinal and aromatic plants such as flavonoids, phyto-chemicals, antioxidants, and vitamins together in a way that is safe for human consumption (Bhuiyan *et al.*, 2012) [6]. Fruit beverages, which have a distinct flavor and disease-preventing qualities and are typically referred to as functional beverages, are currently in demand as an alternative to traditional drinks (Kausar *et al*., 2012; Sharma and Tandon, 2015) [18, 32]. There are various functional beverages with distinct health advantages, such as improving immunity, boosting energy, and improving heart health.

Guava (*Psidium guajava* L.), a member of the extensive Myrtaceae, or Myrtle family, is thought to have originated in southern Mexico and Central America (Somogyi *et al*. 1996) [28].

It began to be grown in India in the early 17th century and eventually gained importance as a crop for trade. It has a unique musky flavor that becomes considerably less with processing (Ayub *et al*., 2005) [1]. The guava fruit harvest is incredibly profitable and productive. Fruit farmers appreciate it because of its high returns per unit area and wide range of adaptation (Hassan *et al*., 2012) [12]. It is widely grown throughout the tropics and subtropics. Guavas are climacteric fruits that ripen quickly and have a short shelf life of two to three days at room temperature (Bassetto *et al*., 2005) [4]. Depending on the kind, the fruits differ in size, shape, and flavor. Some cultivars may be astringent, but the better ones are sweet (Yan *et al*., 2006) [36]. The guava is a fruit that is sometimes marketed as a "super fruit" because to its high vitamin A and C content, as well as its seeds, which are rich in dietary fiber, riboflavin, omega-3 and omega-6 polyunsaturated fatty acids, proteins, and mineral salts. Guava's high ascorbic acid content makes it an effective tool in the fight against oxidation and free radicals, the primary causes of degenerative illnesses. Guavas can be eaten raw or processed into a variety of products, including juice, nectar, pulp, jam, jelly, fruit bars, slices in syrup, and dehydrated goods. They can also be added as a flavoring to other fruit juices or pulps (Leite *et al*. 2006) [19]. Guavas have excellent flavor and nutritional value, making them a fantastic option for beverage production.

Wood apple (*Feronia limonia* L.), is a underutilized and indigenous fruit which belongs to Rutaceae family. It is commonly found throughout the plain areas of India, including Maharashtra, West Bengal, Chhattisgarh, Uttar Pradesh, Madhya Pradesh, and the Western Himalayas. It is also known by many vernacular names in different parts of the country, such as elephant apple, monkey apple, kotha, and kainth. It is one of the hardiest trees; that can withstand salinity, and drought, and grows best in deep, well-drained soils. The wood apples are used to make "Sarbat," a handmade and widely recognized beverage. Its strong flavor makes it uncommon to use it by itself for making jelly (Hayes, 1960) [11]. The pulp from wood apples is high in beta-carotene, which is a precursor to vitamin A. It also has a small quantity of ascorbic acid and a considerable amount of vitamin B, including riboflavin and thiamine (Kumar and Deen, 2017) [16]. Fruits have great medicinal value and are used as a liver and heart tonic in India, while unripe fruits are utilized in traditional remedies as an astringent to treat diarrhoea and dysentery. Fruits have great nutritional value and are widely recognized for their therapeutic qualities. The nutritional and chemical characteristics of fresh wood apple fruit pulp shows that they contain 9.45-21.70 percent TSS, 1.98-3.80 percent titratable acidity, 4.77-5.71 percent TSS/acid ratio, 0.30-6.03 percent reducing sugars, 5.65-13.80 percent non-reducing sugar, 7.95-19.83 percent total sugars, 3.86-6.82 mg/100g ascorbic acid, 21.50-80.10 mg/100g total phenol, and 1.22-1.30 percent pectin (Kumar and Deen, 2017). A plentiful supply of wood apples, which can be processed into various processed items, are found in the majority of the tribal regions of central India. Ginger (*Zingiber officinale* Rosc.), is a pungent and ancient medicinal plant native to Southeast Asia. It is a member of the Zingiberaceae family. India is the biggest producer and consumer of ginger. Major ginger-producing states in India are Madhya Pradesh, Karnataka, Assam, Maharashtra, West Bengal, Orissa, Gujarat, Sikkim, Kerala, Meghalaya and Manipur. Madhya Pradesh is the state that produces the most ginger in India. Ginger has long been recognized for its therapeutic benefits as an immune-stimulating agent, hepatic-protective agent, aphrodisiac, antiemetic, anticancer, anti-platelet, anti-microbial, anti-parasitic, anti-oxidant, anti-inflammatory, and an aid in digestion (Malhotra and Singh, 2003) [21]. Ginger is mostly utilized in the baking, meat processing, and soft drink manufacturing industries in nations like the United States, Canada, and the United Kingdom, although it is hardly ever used in cooking. The primary components of fresh ginger are protein (2.3%), fat (0.9%), carbohydrates (12.3%), minerals (1.2%), fiber (2.4%), and moisture (80.9%). Ginger contains 1.80% TSS, 0.08% acidity, and 1.90 mg/100 g of vitamin C (Deen and Kumar, 2014) [8]. Ginger contains minerals, including calcium, iron, and phosphorus. Fresh ginger is commonly used to make pickles and candies, while fresh ginger juice is used to prepare drinks. Dry ginger is used to make ginger powder, oleoresin, essence, soft drinks, non-alcoholic beverages, and ginger oil.

Blends of various fruits and plant extracts with nutritional, pharmacological, and therapeutic qualities can be used to make palatable blend beverages. The making of beverages with guava, wood apple and ginger blends would offer the best way to utilize these perishable raw materials with the least amount of post-harvest loss while also giving consumers access to tasty drinks with medical benefits. Consumers changing lifestyles, more health consciousness, and increased purchasing power are driving up demand for natural beverages that are high in nutrients and have both therapeutic and medical benefits. Fruit, herbal, and spice blend drinks are a great way to satisfy customer demand in both domestic and international markets. The present investigation, therefore, conducted to develop palatable RTS from best blend combination of guava, wood apple and ginger.

Material and Method

Raw material

The raw ingredients (Guava, Wood Apple, and Ginger) were obtained from different sources**.** Guava (var. L-49), purchased from Horticultural Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Wood apple collected from Jorium village of Milkipur Tehshil, Ayodhya, Uttar Pradesh and Ginger (Local variety) purchased from the local market of the university.

Extraction of guava pulp, wood apple pulp and ginger juice

The methods utilized to extract the guava pulp, wood apple pulp, and ginger juice have been shown in Fig.-1, Fig.-2, and Fig.-3, respectively.

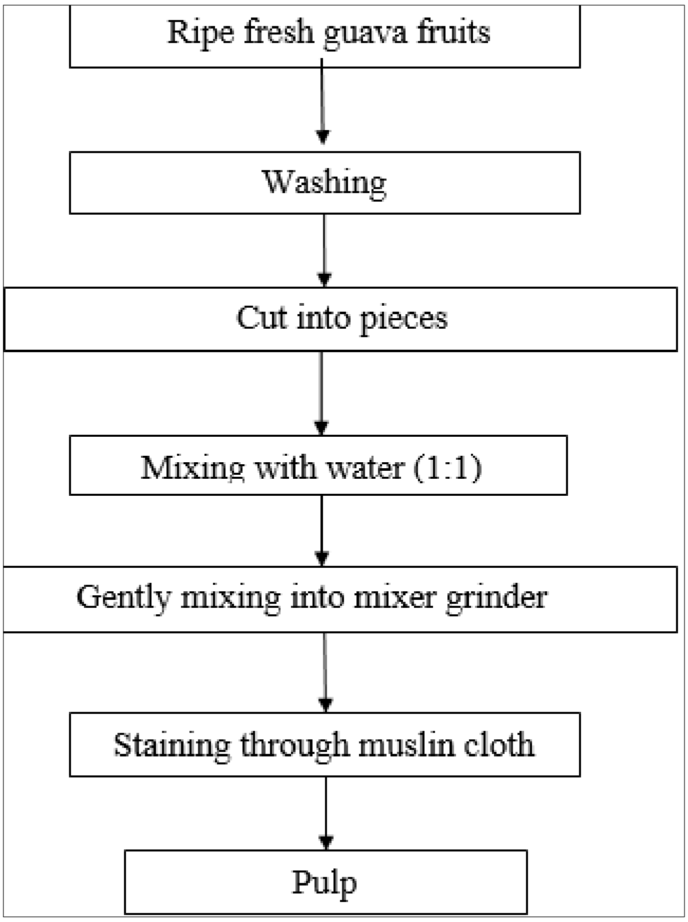

Fig 1: Flow chart for pulp extraction from Guava fruits

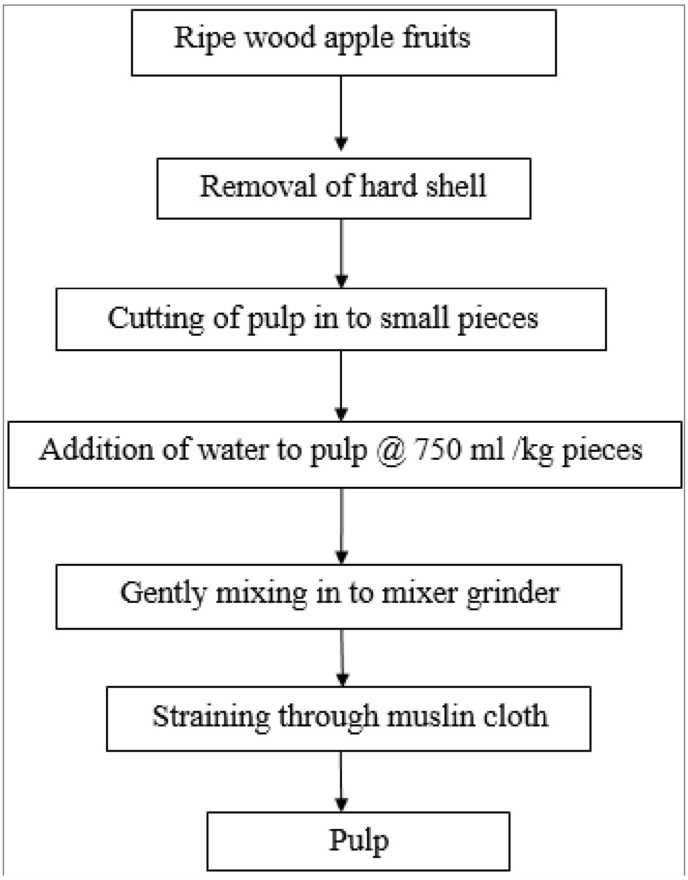

Fig 2: Flow chart showing pulp extraction from wood apple fruits

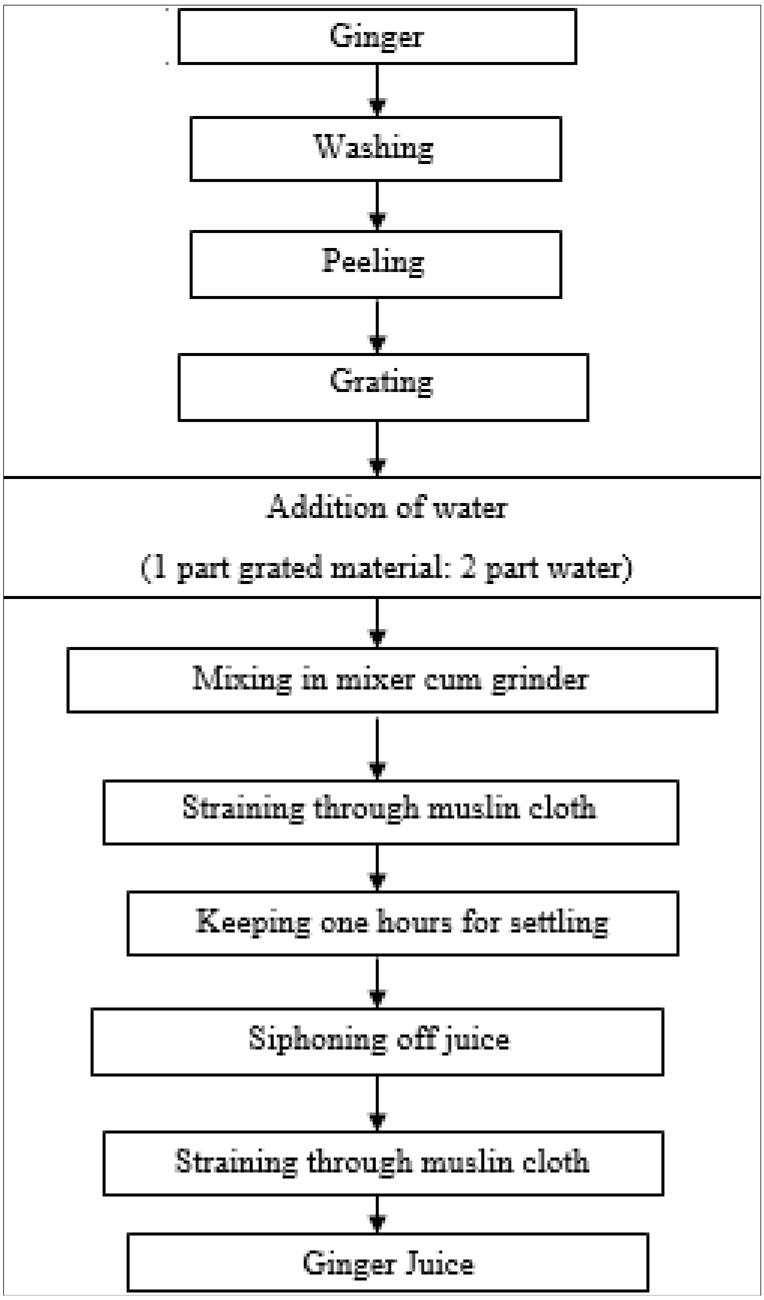

Fig 3: Flow chart showing juice extraction from ginger

Standardization of blends for RTS

The various combinations (treatments) of guava pulp, wood apple pulp, and ginger juice were used to determine the best combination for palatable RTS beverages through organoleptic evaluation:

T_1 10% blend made up of 100% guava pulp + 0% wood apple + 0% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_2 10% blend made up with 0% guava pulp + 100% wood apple + 0% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_3 10% blend made up with 0% guava pulp + 0% wood apple + 100% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_4 10% blend made up with 33.33% guava pulp + 33.33% wood apple + 33.33% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_5 10% blend made up with 40% guava pulp + 30% wood apple + 30% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_6 10% blend made up with 50% guava pulp + 25% wood apple + 25% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_7 10% blend made up with 60% guava pulp + 20% wood apple + 20 ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_8 10% blend made up with 70% guava pulp + 15% wood apple + 15% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_9 10% blend made up with 80% guava pulp + 10% wood apple +10% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

T_{10} 10% blend made up with 90% guava pulp + 5% wood apple + 5% ginger juice with 13% TSS, 0.3% acidity, and 70 ppm SO_2.

Preparation of RTS

One liter RTS from each blend combination, with 10% blend, 13% TSS, 0.30% acidity, and 70 ppm SO_2, were developed, and a panel of nine semi-trained judges assessed these beverages organoleptically to determine the ideal combination of guava pulp, wood apple pulp and ginger juice. Then, Ten liters of RTS were made using the best blend combination and filled into 200 ml glass bottles, leaving 2-centimetre headspace, crown corked, and pasteurized before being put for storage investigation at room temperature (16.17 to 27.96 °C) and low temperature (4-6 °C). Fig. 4 displays the flow chart used in the RTS preparation process.

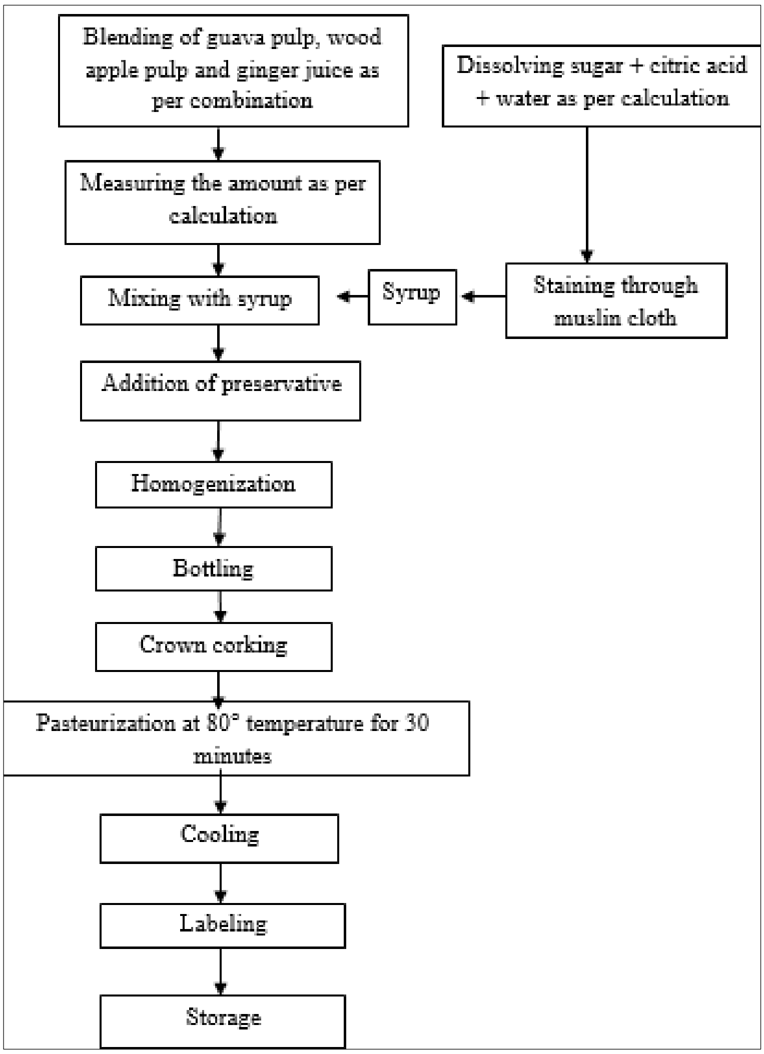

Fig 4: Flow chart for the preparation of RTS

Storage studies

The bottles containing prepared RTS were put for storage studies under ambient conditions and low temperature. During storage observations on changes in TSS, acidity, vitamin-C, reducing sugars, non-reducing sugar, total sugars, pH, browning, microbial growth and organoleptic quality were recorded at monthly intervals.

The TSS was determined using a hand refractometer (Erma Inc. Tokyo Japan, 0-32% and 28-62%). The values of TSS recorded at ambient and low temperatures were corrected to 20 °C with the help of a reference table and the mean value of the sample was expressed as per cent TSS content (Ranganna, 2010) [27]. The acidity was estimated by titrating a known quantity of sample against standard N/10 NaOH solution using 2-3 drops of phenolphthalein indicator and expressed as per cent anhydrous citric acid. Ascorbic acid (vitamin-C) content was determined by preparing sample in 3% HPO_3 (Metaphosphoric Acid) solution then titrating against 2, 6-dichlorophenol indophenol dye solution till the appearance of light pink colour (Ranganna, 2010) [27]. The reducing, non-reducing and total sugars were estimated using Fehling's solution A and B and methyl blue as an indicator in boiling stage. For the measurement of pH, the INSIF digital pH meter model (IE-702) was used, which was standardized and calibrated with different buffers of pH 4.0 and pH 7.0. To determine the non-enzymatic browning sample was taken and mixed with 30 ml 60% alcohol thoroughly then centrifuged for 15 minutes at 1500 rpm, filtered through Whatman filter paper No. 1 to obtain a clear solution. Thereafter the absorbance of the sample was recorded on the "Igene Labserve" model UV vis Double Beam spectrophotometer at 440 nm wavelength using 60% aqueous alcohol as blank. The increase in O.D. of a sample at 440 nm was expressed as non-enzymatic browning (Ranganna, 2010) [27]. The standard plate count method was used to determine the microbiological contamination and growth using the NA (Nutrient Agar Medium) and MRBA (Merfins Rose Bengal Agar) medium. After incubating the plate at 38 °C for 48 hours, the counting was completed using sterile distilled water as the control. For the evaluation of the organoleptic quality of RTS, a semi-trained panel of 9 judges scored on 9.0 point Hedonic Rating Scale (Amerine *et al*., 1965) [3].

Statistical analysis
The studies were carried out in three replications, and the computer program SPSS (Statistical Package for Social Sciences) was used to perform the statistical analysis of the data using the completely randomized design (CRD) as outlined by Panse and Sukhatne (1985).

Result and Discussion
Chemical attributes of guava pulp, wood apple pulp and ginger juice
The data recorded on the chemical characteristics of guava pulp, wood apple pulp, and ginger juice is presented in Table-1. The Total Soluble Solids (TSS), Acidity, Vitamin-C, Reducing sugar, Non-reducing sugar, Total sugar and pH of guava pulp were recorded 12.87%, 0.95%, 2.21.00 mg/100g, 3.55%, 6.15%, 9.70% and 4.35 respectively. Similar to the current study Thakre *et al.* (2023) [34] found that guava pulp contains 0.25 to 0.89% acidity, 3.6 to 3.94 pH, and 41.32 to 57.00 mg/100g ascorbic acid. Wazed *et al.* (2021) [35] observed that guava juice contains 12% TSS, 28.87 mg/100g ascorbic acid, 0.51% acidity. Kumar *et al.* (2020) [17] also found that guava pulp cv. Lucknow-49 contains 12.80% TSS, 0.44% acidity, 220.00mg/100g ascorbic acid, 6.47% reducing sugars, 3.08% non- reducing sugar and 9.55% total sugars. Wood apple pulp contained TSS, acidity, vitamin-C, reducing sugars, non-reducing sugar, total sugars and pH were recorded 10.72%, 1.99%, 5.47 mg/100g, 1.43%, 5.75%, 7.18% and 3.70 respectively. Similarly Kumar and Deen (2017) [16] reported that wood apple fruits contains 9.45 to 21.70% TSS, 1.98 to 3.80% acidity, 3.86 to 6.82 mg/100g ascorbic acid, 0.30 to 6.03% reducing sugars, 5.65 to 13.80% non-reducing sugar, 5.95 to 19.83% total sugars. Ghosh *et al.* (2010) [9] revealed that wood apple pulp contains 11.56% TSS, 1.94% acidity, 7.00 mg/100g ascorbic acid and 3.72 pH. Ginger juice contains TSS, acidity, vitamin-C, reducing sugars, non-reducing sugar, total sugars and pH were recorded 2.21%, 0.26%, 1.94 mg/100g, 0.62%, 1.15%, 1.77% and pH 5.67 respectively. Whereas, Harendra and Deen (2022) [15] revealed that ginger juice contains 2.20% TSS, 0.26% acidity, 1.90 mg/100g vitamin-C, 0.63% reducing sugars, 1.12% non-reducing sugar and 1.75% total sugars. Shukla *et al.* (2018) [30] considered that fresh ginger juice contains 2.4% TSS, 0.6% acidity, 2 mg/100g vitamin-C and 3.9 pH. The slight variation in chemical attributes of raw materials might be because of varieties, cultural practices and location of raw materials production.

Table 1: Chemical attributes of guava pulp, wood apple pulp, and ginger juice

S. No.	Chemical attributes	Mean value		
		Guava pulp	Wood apple pulp	Ginger juice
1	Total soluble solids (%)	12.87	10.72	2.21
2	Acidity (%)	0.95	1.99	0.26
3	Vitamin-C (mg/100 g)	221.00	5.47	1.94
4	Reducing sugars (%)	3.55	1.43	0.62
5	Non-reducing sugar (%)	6.15	5.75	1.15
6	Total sugars (%)	9.70	7.18	1.77
7	Ph	4.35	3.70	5.67

Standardization of blends for RTS
A palatable quality blended RTS with 10% blends comparising 60% guava pulp, 20% wood apple and 20% ginger juice adjusted to 13% total soluble solids, 0.3% acidity and 70 ppm SO_2 (T_7) was found to be best for preparation of RTS (Table-2). Simlarly Pali *et al.* (2023) [25] noticed that 80% carrot juice, 15% orange and 5% ginger juice was found best for the preparation of RTS beverages. Nadella *et al.* (2022) [24] reported that blended RTS beverages developed from 40% guava pulp and 60% pineapple juice had the greatest TSS, ascorbic acid, and organoleptic score in terms of smell, taste, and general acceptance. Harendra and Deen (2021) [14] determined that the greatest blend for the production of RTS was 10%, containing 55% mango pulp, 25% kagzi lime juice, 10% *Aloe vera* gel, and 10% ginger juice.

Changes during storage of prepared RTS
Data recorded on biochemical changes of RTS during storage is tabulated in Table-3 and Table-4, which observes that TSS of RTS increased continuously under both ambient (16.17-27.96 °C) and refrigerated (4-6 °C) temperatures from 13.00% to 13.50% and from 13.00% to 13.38%, respectively. The changes in TSS content might be due to inversion or hydrolysis of polysaccharides into simple sugars. The conversion rate was higher at ambient temperature as compare to refrigerated temperature, which might be due to temperature effects. The present findings are in agreement with the considerations of prior research worker like Bharati *et al.* (2023) [5] on sweet orange, guava and ginger based blended RTS. Nadella *et al.* (2022) [24] on guava and pineapple blended RTS. Hegde *et al.* (2018) [13] on kokum, aonla and ginger based RTS. Acidity content in blended beverages of RTS increased continuously during storage under both ambient as well as refrigerated temperatures. It was increased from 0.30 to 0.73% and from 0.30% to 0.58%, respectively. An increase in the acidity content might be due to degradation of pectic substances and formation of organic acid (Conn and Stumf, 1976) [7]. The formation of citric acid is more under ambient storage as compare to refrigerated storage conditions which might be because of higher rate of pectic substances degradation under higher temperature storage. Similar results that an increase in acidity content during storage of products were reported by Pali *et al.* (2023) [25] in carrot, orange and ginger RTS blends beverage. Nadella *et al.* (2022) [24] in guava and pineapple blended RTS. Shukla *et al.* (2018) [30] in *Aloe vera*, aonla and ginger blended RTS. Vitamin-C content of RTS prepared from guava, wood apple and ginger blends gradually decreased up to the end of storage time and content was found to be significantly reduced from 22.48 mg/100ml to 22.09 mg/100ml and 22.48 mg/100ml to 22.25 mg/100ml at ambient as well as low temperatures, respectively. The depletion in ascorbic acid (vitamin- C) content might be due to oxidation of ascorbic acid into dehydro-ascorbic acid by oxygen (O_2) trapped into containers and intramolecular space of the product. The present results on changes in ascorbic acid (vitamin-C) content during storage of beverages are also supported by the findings of Pali *et al.* (2023) [25] on carrot, orange and ginger RTS blends beverages. Bharati *et al.* (2023) [5] on sweet orange, guava and ginger based blended RTS. Nadella *et al.* (2022) [24] on guava and pineapple blended RTS. Mehta *et al.* (2018) [22] on guava, lime and ginger blended RTS Beverages. The decreasing trend of ascorbic acid content shows that loss of ascorbic acid content was more under low temperature conditions that might be due to temperature influence on ascorbic acid oxidation. The

reducing sugars content of RTS increased continuously up to the termination of storage period under both ambient and low temperatures and it was increased from 1.03 to 1.74% and from 1.03 to 1.46%, respectively. The increase in reducing sugars of products might be due to conversion of non-reducing sugar into reducing sugars. Similar considerations were also reported by the earlier workers like Pali *et al*. (2023) [25] in carrot, orange and ginger RTS blended beverage. Bharati *et al.* (2023) [5] in sweet orange, guava and ginger based blended RTS. Shagiwal and Deen (2022) [29] in strawberry, *Aloe vera* and ginger based RTS beverage. These findings support the results of present investigation. The non-reducing sugar content of RTS showed gradual decreasing trend stored under ambient temperature (From 12.23% to 11.86%) and refrigerated temperature (From 12.23% to 11.96%). Antithesis to reducing and total sugars, reduction in non-reducing sugar might be due to conversion of non-reducing sugar. The results are similar with the prior results of Pali *et al*. (2023) [25] in RTS beverage prepared from carrot, orange and ginger. Bharati *et al.* (2023) [5] in sweet orange, guava and ginger based blended RTS beverages. Zambare *et al.* (2009) [37] in wood apple based RTS beverage. These considerations support are in conformity to present findings on changes in non-reducing sugar content of products during storage. The total sugars content of RTS increased gradually from 13.26% to 13.60% and from 13.26% to 13.42% when stored under ambient as well as low temperatures, respectively. A rise in total sugars of product might be due to inversion of non-reducing sugar into reducing sugars. The present results on increase of total sugars content in RTS is also similar to findings of different fruits based beverages (Pali *et al*., 2023; Bharati *et al.*, 2023; Shagiwal and Deen, 2022; Zambare *et al.*, 2009) [25, 5, 29, 37] The pH of RTS decreased continuously up to the termination of storage period under ambient as well as refrigerated conditions from 4.48 to 4.16 and from 4.48 to 4.28, respectively. The cause of decrease in pH content was might be due to increasing in acidity of these products. Similar observations were recorded by Bharati *et al.* (2023) [5] in sweet orange, guava and ginger based blended RTS beverage. Shagiwal and Deen (2022) [29] in strawberry, *Aloe vera* and ginger based RTS beverage. Hegde *et al.* (2018) [13] in blended RTS drink from ginger and aonla. These reports support the observations recorded on pH of RTS beverage in present studies. The browning in RTS increased continuously up to the termination of storage under ambient as well as refrigerated temperatures. It was increased from 0.22 (O.D.) to 0.48 (O.D.) and 0.22 (O.D.) to 0.39 (O.D.), respectively. An increase in browning of RTS could be mainly due to the non- enzymatic reaction (Millard reaction) in which organic acid reacts with sugars and amino acids and leads to the formation of brown pigments. The browning of beverages stored at low temperature was found to be slow in comparison to ambient storage conditions because low temperature might slowed the Millard reaction. The present findings are also in agreement with the findings of previous research workers like Pali *et al.* (2023) [25] on RTS developed from blend of carrot, orange and ginger. Shagiwal and Deen (2022) [29] on RTS prepared from blend of strawberry, *Aloe vera* gel and ginger. Gautam (2015) [10] on blended beverages prepared from guava and *Aloe vera*. The number of microorganisms grew during the initial phase of storage then begun to decline. The lowest recorded microbial population was 0.238 x10^3 cfu/ml and 0.181 x10^3 cfu/ml in RTS at ambient and low temperature, respectively. The microbiological growth of RTS, was elevated up to two months of storage at ambient temperature and two months of storage at low temperature. After that, the growth of these microorganisms steadily decreased over the course of the storage time in all the products. The presence of some bacteria, the possibility of contamination during processing and trapped oxygen into container could be the cause of the rise in microbial development in the first and second months. The reduction in microbial growth during later stages of storage could perhaps be attributed to increasing sugar and acidity content, as these substances have preservation abilities that inhibit microbial development. The published work of Rammiya *et al.* (2019) [26] on developed from guava carbonated drink, Moussa *et al*. (2019) [20] on prepared guava whey blend beverage and Markam and Singh (2012) [23] on custard apple made RTS beverage are in support of present result on trend of microbial growth. The organoleptic quality of RTS reduced continuously with the storage period and it was acceptable up to four months of storage under ambient and refrigerated conditions. It was reduced from 8.18 to 7.28 and from 8.18 to 7.40 under ambient and refrigerated temperature, respectively. It might be due to temperature, because temperature plays an important role in biochemical changes that leads to development of off flavour as well as discolouration in the beverages. The reduction in organoleptic quality are also reported in previous studies performed by Pali *et al*. (2023) [25] in carrot, orange and ginger RTS blended beverage, Nadella *et al.* (2022) [24] in guava and pineapple blended RTS beverage and Sangma (2016) [31] in *Aloe vera*, ginger, sweet lime, and amla RTS drinks.

Table 2: Organoleptic quality of RTS prepared from different blends of guava pulp, wood apple pulp, and ginger juice

Treatments	Different combination of blends			Organoleptic quality	
	Guava pulp (%)	Wood apple pulp (%)	Ginger juice (%)	Score	Rating
T_1	100	Nil	Nil	8.00	Like very much
T_2	Nil	100	Nil	7.90	Like moderately
T_3	Nil	Nil	100	7.05	Like moderately
T_4	33.33	33.33	33.33	7.50	Like moderately
T_5	40	30	30	7.70	Like moderately
T_6	50	25	25	7.95	Like moderately
T_7	60	20	20	8.18	Like very much
T_8	70	15	15	8.00	Like very much
T_9	80	10	10	7.85	Like moderate
T_{10}	90	5	5	8.10	Like very much
SE.m±				0.02	
CD at 5%				0.06	

Table 3: Changes during storage in RTS under ambient temperature

Storage period (Month)	TSS (%)	Acidity (%)	Vitamin-C (Mg/100)	Reducing Sugars (%)	Non-Reducing Sugars (%)	Total Sugars (%)	pH	Browning (O.D.)	Microbial Growth(x 10³ cfu/ml)	Organoleptic quality	
										Score	Rating
0	13.00	0.30	22.48	1.03	12.23	13.26	4.48	0.22	0.275	8.18	LVM
1	13.14	0.35	22.43	1.21	12.14	13.35	4.44	0.25	0.293	7.95	LM
2	13.26	0.46	22.35	1.36	12.04	13.40	4.37	0.29	0.417	7.65	LM
3	13.39	0.61	22.24	1.55	11.95	13.50	4.27	0.38	0.282	7.35	LM
4	13.50	0.73	22.09	1.74	11.86	13.60	4.16	0.48	0.238	7.05	LM
SE.m±	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.05	
CD at 5%	0.06	0.06	0.06	0.07	0.04	0.05	0.06	0.04	0.02	0.16	

LVM: Like very much, LM: Like moderate

Table 4: Changes during storage in RTS under low temperature

Storage period (Month)	TSS (%)	Acidity (%)	Vitamin-C (Mg/100)	Reducing Sugars (%)	Non-Reducing Sugars (%)	Total Sugars (%)	pH	Browning (O.D.)	Microbial Growth (x 10³ cfu/ml)	Organoleptic quality	
										Score	Rating
0	13.00	0.30	22.48	1.03	12.23	13.26	4.48	0.22	0.275	8.18	LVM
1	13.07	0.32	22.46	1.12	12.18	13.30	4.46	0.23	0.283	8.05	LVM
2	13.18	0.37	22.41	1.23	12.11	13.34	4.41	0.26	0.345	7.88	LM
3	13.30	0.48	22.36	1.32	12.03	13.35	4.35	0.32	0.219	7.7	LM
4	13.38	0.58	22.25	1.46	11.96	13.42	4.28	0.39	0.181	7.4	LM
SE.m±	0.07	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.05	
CD at 5%	0.22	0.05	0.04	0.05	0.06	0.03	0.04	0.03	0.02	0.17	

LVM: Like very much, LM: Like moderate

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Conclusion
It may be concluded from above findings that 10 per cent of the blend comparising 60% guava pulp, 20% wood apple pulp and 20% ginger juice was found to be best on Hedonic Scale for the preparation of palatable quality RTS adjusted to 13 per cent TSS and 0.30 per cent acidity with 70 ppm SO_2. The TSS, acidity, reducing sugars, total sugars and browning was increased, whereas vitamin-C, non-reducing sugar, pH and organoleptic quality was decreased during storage whereas microbial growth initially increased, then decreased during the period under both ambient (16.17 - 27.96 °C) and low (4-6°C) temperatures. The RTS can be stored with acceptable quality up to 4 months under both ambient as well as low temperatures.

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