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Physicochemical and Sensory Evaluation of Mixed Juices from Banana, Pineapple and Passion Fruits during Storage

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Abstract

Juices from fresh fruits offer various health benefits, including strengthening the immune system and preventing diseases. Mixed fruit juices tend to have good nutritional contents and organoleptic properties like colour, flavour, taste, and overall appeal of different fruits. This work investigated the physicochemical and sensory attributes of fruit juice of low viscosity banana juice blended with pineapple and passion juices. The prepared juices were pasteurised at 92 °C for 15 s, bottled in air-tight glass bottles, and subsequently stored in two different conditions: an ambient temperature of approximately 28 ± 2 °C and a fridge at 4 ºC for one month. Ascorbic acid content, total soluble solids, acidity, pH, and sensory evaluation were measured during the storage period. The results revealed that ascorbic acid and pH decrease significantly ($p < 0.05$) as the acidity increases. The changes ranged between 16 and 37% for ascorbic acid, 0.8 and 1.8% for pH, and from 12 to 27% for acidity were observed. The total soluble solids were found to increase until ten days of storage. The control samples showed no changes in all the physicochemical properties analysed during storage. The juice sample that consisted of 80% banana juice and 20% passion juice emerged as the utmost imperative sample as it scored the highest hedonic scale on all sensory attributes. The results imply that low viscosity banana juice can be used as a major component for the preparation of commercial mixed juices.

Keywords: Banana Juice; Chemical Analysis; Sensory Evaluation; Mixed Juice.

Introduction

Fruits are excellent sources of carbohydrates, vitamins, minerals, antioxidants, and fibres (Orrego et al. 2014, Slavin and Lloyd 2012). It is suggested that antioxidants obtained from fresh fruits scavenge free radicals (Pillay and Fungo 2016, Rasheed and Azeez 2019). Hence, consumption of fruits has health benefits such as reducing the risk of heart diseases and several types of cancer (Dhandevi and Jeewon 2015, Slavin and Lloyd 2012). Tanzania produces varieties of fruits such as bananas, mangoes, oranges, pineapples, passion, watermelons, avocados, and many more (NBS 2017). However, fruit consumption in most African countries, including Tanzania is below the recommended levels (Amao 2018, James and Zikankuba 2017, Okop et al. 2019, WHO 2003). Low consumption of fruits may be due to lack of awareness on fruit benefits and lack of postharvest management to make them available throughout a year (James and Zikankuba 2017, WHO 2003). Fruits are perishable products as they contain high moisture and are rich in nutrients.

Once harvested, fresh fruits undergo several biochemical processes, such as ripening and respiration (El-Ramady et al. 2015, James and Zikankuba 2017, Singh et al. 2014). These phenomena change the physicochemical properties, quality, and nutritional value of the fruits, and eventually cause fruit senescence. Moreover, a large number of fruits are available during peak seasons. James and Zikankuba (2017) reported that postharvest losses of fruits are higher than 30% in sub-Saharan Africa mostly due to lack of postharvest management technologies. Thus, proper postharvest handling, preservation, and processing strategies are indispensable to circumvent fruit losses during the peak seasons and to make fruits accessible and available during the off-season periods (Toivonen et al. 2014).

Fruits can be processed to produce various products like fruit juice, wine, vinegar, jam, concentrate, pulp, and dehydrated products. For instance, the juices are mostly extracted from fruits by mashing and pressing the pulp of a given fruit. However, a low viscosity banana juice is extracted from banana by a mechanical or enzymatic method (Byarugaba-Bazirake 2008, Kibazohi et al. 2017, Kyamuhangire et al. 2002, Majaliwa et al. 2019). Kibazohi et al. (2017) developed a mechanical method to extract low viscosity juice from ripe bananas. The method involves mashing of ripe bananas with high tannin content to allow the combination of tannin and protein to form an insoluble pulp, and enhance the separation of low viscosity banana juice from the pulp (Kibazohi et al. 2017). This technique was later optimised by Majaliwa et al. (2019) purposely to increase banana juice production for commercial purposes. However, the potential commercialisation of low viscosity banana juice requires a comprehensive understanding of juice formulation with other fruit juices and an assessment of consumer's acceptability. In the case of pineapple and passion juices, pineapple juice is mainly processed from ripe pineapple fruit by peeling, excising the core, mashing, and pressing to separate juice (Begum et al. 2018, Biswas et al. 2016). Passion juice can be extracted by cutting the passion fruit, scooping the cortex part and seeds, mashing, and pressing to separate juice from the pulp. The refreshing aroma, colour, and sweet-and-sour tartness taste of passion fruit make it appealing when eating (Kulkarni and Vijayanand 2010, Wong et al. 2014).

It is therefore recognized that evaluating the use of banana juice, as the main ingredient in a mixed fruit juice of passion or pineapple juice, is important for both the fruit processing industry and consumer's acceptability. This also suits well for investigation and contribution to our understanding of the mixed juice process and quality. This is because different fruits have different functional properties. Hence, blending juices from different fruits may offer nutritional values and sensory attributes such as colour, flavour, taste, and palatability. However, previous studies have partially reported the development of mixed juices from several fruits such as mango, orange, and pineapple (Begum et al. 2018). Other studies blended pineapple, orange, papaya, and banana (Hossain et al. 2016), pears and pineapple (Reddy et al. 2017). This enlightens that investigation of mixed juice, using low viscosity banana juice as the primary ingredient and other fruit juices like passion or pineapple, is poorly explored. Also, studying the physicochemical properties of mixed juices is a crucial aspect in determining juice quality and commercialisation. The physicochemical properties of interest include vitamin C (ascorbic acid), acidity, pH, and total soluble solids. These are essential properties because ascorbic acid is a common indicator employed to evaluate the possible negative effects of nutritional value during food processing. Acidity is mostly used to assess the shelf-life of the product and unfold some chemical changes during storage (Begum et al. 2018, Hossain et al. 2016). This paper explores the physicochemical properties of mixed fruit juices from banana, passion, and pineapple fruits, as well as their sensory acceptance during one month of storage.

Materials and Methods

Materials

Banana (*Musa acuminata*), pineapple (*Ananas comosus*), and passion (*Passiflora edulis*) fruits were purchased from Urafiki-Mabibo local market in Dar es Salaam, Tanzania. About 20 kg of banana bunches and 10 kg of pineapple and passion fruits each were brought to the Food laboratory at the Department of Chemical and Mining Engineering, University of Dar es Salaam for experiments. Ascorbic acid, starch and phenolphthalein indicators, citric acid, sodium hydroxide, and iodine solution were purchased from Sigma-Aldrich (Steinheim, Germany) and used as standards and reagents for physicochemical analysis.

Juice extraction

Before juice extraction, banana fruits were allowed to ripen to stage 5 at an ambient temperature of 28 ± 2 °C following a colour index code suggested by USDA (2001). The ripe banana fingers were washed and manually peeled with a stainless knife. Subsequently, the peeled banana fingers were mashed with a mechanical blender (Blixer 4 V.V., Robot Couple, France) until the texture changed to a semi-solid state (Kibazohi et al. 2017, Majaliwa et al. 2019). The pulp was wrapped in a cheese-cloth and then pressed with a fruit pulp presser (50 PI, Voran Maschinen GmbH, Austria) to separate the juice from the pulp. The passion fruits were washed, sliced into two halves with a stainless knife, and the cortex parts together with seeds were scooped out with a spoon. In the case of pineapples, the fruits were washed, peeled, and sliced using a stainless knife. Both scooped and sliced samples were separately mashed using a mechanical blender (Blixer 4 V.V, Robot Couple, France). The obtained pulps were filtered through a cheese-cloth in a fruit pulp presser (50 PI, Voran Maschinen GmbH, Austria) to separate the juice. After filtration, the juice samples were stored in a horizontal freezer (Electrolux, ECM30132W) set at –20 °C for further analysis.

Formulation of mixed fruit juice

The mixed fruit juice was prepared in different ratios of low viscosity banana, pineapple, and passion juices as shown in Table 1. The first sample S_1 consisted of 80% of banana juice and 20% of pineapple juice. The second sample S_2 consisted of 70% of banana juice and 30% of pineapples juice. The third sample S_3 was made from 80% banana juice and 20% passion juice. The fourth sample S_4 consisted of 70% of banana juice and 30% passion juice. Low viscosity banana juice 100%, pineapple juice 100%, and passion juice 100% were also prepared and considered as control samples S_5, S_6, and S_7, respectively. The prepared mixed juice samples were diluted with distilled water to 13.8 °Brix. Then, citric acid (0.3%) was added to S_1, S_2, S_5, and S_6 formulations to adjust pH to about 3.9. Subsequently, these samples were pasteurised at 92 °C for 15 s using a coil pasteuriser (PA 90, Voran Maschinen GmbH, Austria) and immediately bottled in 330 mL amber glass bottles and crown capped.

Table 1: Fruit juices formulation using banana, pineapple and passion fruit juices

Ingredients	Sample						
Formulation	S_1	S_2	S_3	S_4	S_5	S_6	S_7
Banana juice (%)	80	70	80	70	100	-	-
Pineapple juice (%)	20	30	-	-	-	100	-
Passion juice (%)	-	-	20	30	-	-	100
Citric acid	√	√	-	-	√	√	-

Storage experiment

The pasteurised samples were stored at two different temperatures for one month. The first portion, having 24 bottles with six bottles from each blended sample (S_1, S_2, S_3, and S_4), was kept in a fridge set at 4 ºC for the sensory evaluation test. The second part with 20 bottles consisted of five bottles from each mixed juice sample (S_1, S_2, S_3, and S_4) were placed at an ambient temperature of approximately 28 ± 2

°C for physicochemical analysis. The control samples: S_5, S_6, and S_7 were stored at 4 °C for physicochemical analysis.

Quality measurements

The first measurements for the physicochemical analysis were carried out immediately after juice extraction for ascorbic acid content, total soluble solids, titratable acidity, and pH. These parameters were also measured in each mixed fruit juice before pasteurisation. The next analyses were undertaken on the pasteurised juices on day zero and after every 10 days during the 30 days of storage at an ambient temperature. For each time point, one bottle was taken from each sample for the physicochemical analysis. The control samples were analysed at day zero and the end of the storage period, i.e., 30 days for ascorbic acid, acidity, pH, and total soluble solids. For sensory evaluation, the testing was performed at day zero and 30 days of storage at 4 °C.

Ascorbic acid content

The ascorbic acid content in mixed fruit juice samples was determined by titration method (Vicent et al. 2018) using an iodine solution of 0.1 M. For each sample, 25 mL of blended juice was poured into a 250 mL volumetric flask. Subsequently, 10 drops of a prepared soluble starch solution of 1% were added. The mixed solution was titrated with 0.1 M of iodine solution until a blue colour was observed to persist for 15 s. Before ascorbic acid determination in fruit juice samples, the titration method was optimised using standard solutions of ascorbic acid, which were titrated with 0.1 M iodine solution. The ascorbic acid determination was performed in three replicates per juice sample, and then the ascorbic acid content was quantified in mg ascorbic acid per 100 g of mixed fruit juice as shown in Equation (1).

$$[\text{Ascorbic acid}] = \frac{V_{\text{I}} \times F_{\text{AA}}}{m_{\text{juice}}} \times 100 \qquad (1)$$

Where: V_{I} is the volume of iodine solution consumed (L), F_{AA} is a conversion factor of the ascorbic acid consumed with iodine solution (mg of ascorbic acid per litre), which was obtained by taking the molarity of iodine times the molecular mass of ascorbic acid, and m_{juice} is the mass of the juice sample (g).

Titratable acidity

In each fruit juice sample, titratable acidity was analysed using 0.1 N NaOH solution as described by Bello et al. (2014). To this end, 5 mL of the mixed juice sample was diluted to 50 mL using distilled water and then poured into a 250 mL volumetric flask. Three drops of phenolphthalein indicator were added and the sample was titrated with 0.1 N NaOH solution until an endpoint of pink colour was observed. Titratable acidity was quantified as shown in Equation (2).

$$\%\ \text{acid} = \frac{\text{N}_{\text{NaOH}} \times V_{\text{NaOH}} \times F_{\text{acid}}}{V_{\text{juice}}} \times 100 \qquad (2)$$

Where: N_{NaOH} is the normality of NaOH used (g L^{-1}), V_{NaOH} is the volume of NaOH solution consumed (L), F_{acid} is an equivalent factor of the acid in the fruit juice sample = 0.067 equivalent weight of malic acid, and V_{juice} is the volume of the juice sample (L). The titratable acidity was expressed in percentage by assuming the density of juice is equal to that of water (g L^{-1}).

Total soluble solids and pH

Total soluble solids (TSS) in the mixed fruit juice samples was measured as °Brix using a digital pocket refractometer (ATAGO, Japan) with TSS ranging between 0 and 88 °Brix and a precision of 0.1 °Brix. The refractometer was tested for distilled water before each TSS measurement. The pH of the juice sample was examined by using a pH meter (HI98129, Hanna Instruments Inc, Limena, Italy) with 0.01 precision.

Sensory evaluation

Sensory acceptance of all the mixed juice samples was evaluated by 40 panellists of both genders (aged between 20 and 30 years) who were selected from the Department of Food

Science and Technology of the University of Dar es Salaam. The panellist team was briefed about the experiment before assessing the sensory acceptance of the mixed juice samples and were then requested to evaluate for colour, flavour, sweetness, and overall acceptability. The sensory analysis was based on a 9-point hedonic scale following the method of Curi et al. (2017). The hedonic scoring scale was arranged such that: 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. Organoleptic acceptance was carried out using the mixed juice samples stored at 4 °C.

The panellists were randomly served with about 30 mL of each juice mix in transparent plastic cups for evaluation. They were asked to drink water before testing the next sample. Sensory acceptance assessment was performed at day zero and after 30 days of storage period.

Data analysis

The resulting experimental datasets were imported into Matlab (R2017a, Mathworks Inc, Natick, MA, U.S.A), where the statistical analysis (factorial ANOVA with replication) was carried out to assess the significant effects of the storage time for each mixed juice sample. A two-sample Kolmogorov-Smirnov test ($p < 0.05$) was carried out for statistical comparison of the measured mean values expressed as mean and standard deviation ($\bar{x}$ ± S.D.).

Results and Discussion

Composition of banana, passion and pineapple juices

The prepared samples of low viscosity banana, passion, and pineapple juices were analysed for ascorbic acid, titratable acidity, pH, and total soluble solids. Table 2 shows the results of the physicochemical compositions measured in each fresh juice before mixing. The low viscosity banana juice had 6.33 ± 0.44 mg ascorbic acid per 100 g juice, 0.65 ± 0.20% titratable acidity, 4.60 ± 0.02 pH, and 23.6 ± 0.7 °Brix. Conversely, pineapple juice had 7.43 ± 0.29 mg ascorbic acid per 100 g juice, 0.63 ± 0. 07% titratable acidity, 4.37 ± 0.01 pH, and 14.5 ± 0.8 °Brix, while passion juice had 28.27 ± 0.73 mg ascorbic acid per 100 g juice, 3.24 ± 0.74% titratable acidity, 3.04 ± 0.01 pH and 16.2 ± 0.4 °Brix.

Table 2: Chemical compositions of fresh banana, pineapple and passion juices after extraction. The values were measured from three replicates and represented as mean and standard error ($\bar{x}$ ± S.D.).

Composition	Banana juice	Pineapple juice	Passion juice
Total soluble solid (°Brix)	23.6 ± 0.7	14.5 ± 0.8	16.2 ± 0.4
pH	4.60 ± 0.02	4.37 ± 0.01	3.04 ± 0.01
Titratable acidity (%)	0.65 ± 0.20	0.63 ± 0.07	3.24 ± 0.74
Ascorbic acid (mg per 100 g)	6.33 ± 0.44	7.43 ± 0.29	28.27 ± 0.73

Loss in ascorbic acid content

Figure 1 shows the concentrations of ascorbic acid measured in mixed fruit juices for unpasteurised samples and changes of ascorbic acid contents in pasteurised fruit juices during one month storage at an ambient temperature. In the unpasteurised samples, i.e., immediately after blending the fruit juices, ascorbic acid contents were measured and found to be 4.98 ± 0.42, 5.06 ± 0.46, 6.33 ± 0.25, and 8.52 ± 0.46 mg per 100 g of mixed fruit juice samples S_1, S_2, S_3, and S_4, respectively as shown in Figure 1a. This discrepancy in ascorbic acid content is obvious due to different fruit juices used, which were observed to have different ascorbic acid contents as presented in Table 2, and also resulted from the employed ratios during mixing. Pasteurisation at 92 °C for 15 s showed no significant change ($p > 0.05$) in ascorbic acid contents for each fruit juice formulation

(Figure 1a-b). The ascorbic acid contents of mixed fruit juices showed a significantly decreasing pattern ($p < 0.05$) with increasing storage time. The ascorbic acid decreased at a faster rate in the S_4 sample (36.8%) after 30 days of storage. This trend was also evident for S_1 and S_3 samples that had comparable ascorbic acid losses of approximately 21.1% and 22.2%, respectively. Moreover, the S_2 sample had a slow ascorbic acid loss of 15.9% during the one month of storage (Figure 1b). The loss in ascorbic acid may be due to the irreversible oxidation mechanism that occurs during storage, which may have rapidly converted L-ascorbic acid into dihydro-ascorbic acid (Tiwari et al. 2009).

These results concur with other studies that reported a decreasing pattern of ascorbic acid contents in some mixed fruit juices during storage (Begum et al. 2018, Hossain et al. 2016, Islam et al. 2014, Reddy et al. 2017). In this way, Hossain et al. (2016) reported a decreasing trend of about 42.9% of ascorbic acid in mixed juice of pineapple, orange, papaya, and banana fruits during four months of storage at 25 °C. Begum et al. (2018) described a gradual loss in ascorbic acid content in mixed fruit juices of mango, orange, and pineapple during one month of storage at an ambient temperature. Also, Islam et al. (2014) stated that losses in ascorbic acid ranged from 66% to over 79% in mixed fruit juices of oranges and pineapples during 35 days of storage. The differences between ascorbic acid losses reported in the current study and the aforementioned studies may be due to differences in storage plans and inherent material composition.

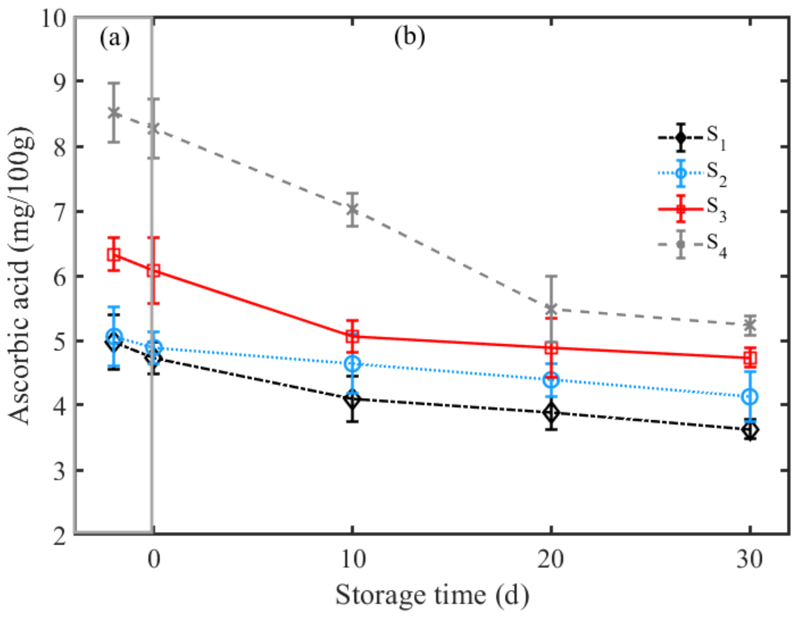

Figure 1: Concentrations of ascorbic acid (mg per 100 g) in different mixed fruit juice samples before pasteurisation (a). Changes of ascorbic acid in pasteurised mix juices (b) during a one-month storage period at an ambient temperature. The points are the means of the measured values from three replicates, with error bars denoting the standard error at each time-point.

Titratable acidity

Figure 2 presents acidity (%) in fruit juices before and after pasteurisation, and during storage at an ambient temperature for one month. The unpasteurised juices showed titratable acidity of 0.61 ± 0.07% (S_1), 0.57 ± 0.02% (S_2), 0.63 ± 0.02% (S_3), and 0.72 ± 0.02% (S_4) (Figure 2a). The pasteurised juice samples presented no changes in acidity at day zero (Figure 2b) compared to unpasteurised juices. A significant change ($p < 0.05$) was observed in the pasteurised juice during the storage period of 30 days. Sample S_4 had a high acidity percentage at day zero and throughout the storage period. This may be due to a high amount of passion juice used (Table 1), which was examined to be very acidic juice with 3.24 ± 0.74% acidity (Table 2). After 30 days of storage, the acidity (%) was observed to increase to 0.72 ± 0.07, 0.64 ± 0.06, 0.79 ± 0.05, and 0.90 ± 0.08 for S_1, S_2, S_3, and S_4 samples, respectively (Figure 2b). Changes of acidity throughout storage are similar to those reported by other researchers (Begum et al. 2018, Hossain et al. 2016, Islam et al. 2014). Begum et al. (2018) reported an acidity increase from 0.30 to 0.37% in mixed fruit juices during 30 days of storage at an ambient temperature. Hossain et al. (2016) stated an acidity increase from 0.30 to 0.56% in mixed fruit juice during four months of storage at 25 °C. Islam et al. (2014) worked on mixed fruit juice of orange and pineapple and described similar results in acidity increase during the storage period of 35 days.

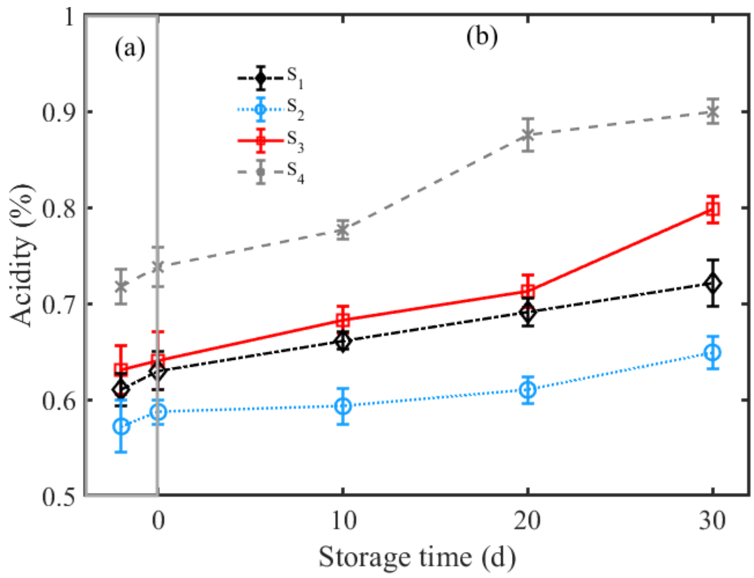

Figure 2: Titratable acidity (%) of different mixed fruit juice samples before pasteurisation (a). Changes of titratable acidity in pasteurised fruit juice samples during a one-month storage period at an ambient temperature (b). The points are the means of the measured values from three replicates, with error bars indicating the standard error at each time-point.

pH

Figure 3 displays pH in fruit juice samples before and after pasteurisation, and during storage at an ambient temperature for one month. For each mixed fruit juice, pH values ranging between 3.87 and 3.90 were quantified in unpasteurised mixed juices (Figure 3a). The pasteurised juices S_3 showed a considerable change in pH from 3.90 ± 0.02 to 3.84 ± 0.02 at day zero (Figure 3b). This implies that the pasteurisation process affected the juice sample S_3 and not juice samples S_1, S_2, and S_4 as depicted in Figure 3. On the other hand, the pH decreased to 3.86 ± 0.06, 3.87 ± 0.04, 3.84 ± 0.02, and 3.83 ± 0.03 in samples S_1, S_2, S_3, and S_4, respectively at the end of 30 days of storage (Figure 3b). In general, pH is inversely proportional to the acidity of the respective solution. As such, the results explicitly showed that the increase in titratable acidity (Figure 2b) decreases the pH of the respective sample during storage (Figure 3b). Both reductions in pH and increase in acidity can probably be explained by the degradation of carbohydrates in the respective juice during storage. These findings are aligned with the results reported by other researchers (Begum et al. 2018, Biswas et al. 2016, Hossain et al. 2016). Biswas et al. (2016) reported that the pH of fruit juices decreased from 3.9 to 3.6 as the acidity increased from 0.17% to 19% during 21 days of storage. Likewise, Hossain et al. (2016) stated a gradual decrease in pH during storage. However, it should be pointed out that these researchers worked on fruit juices blended from different fruits, rather than the ones presented in this current study.

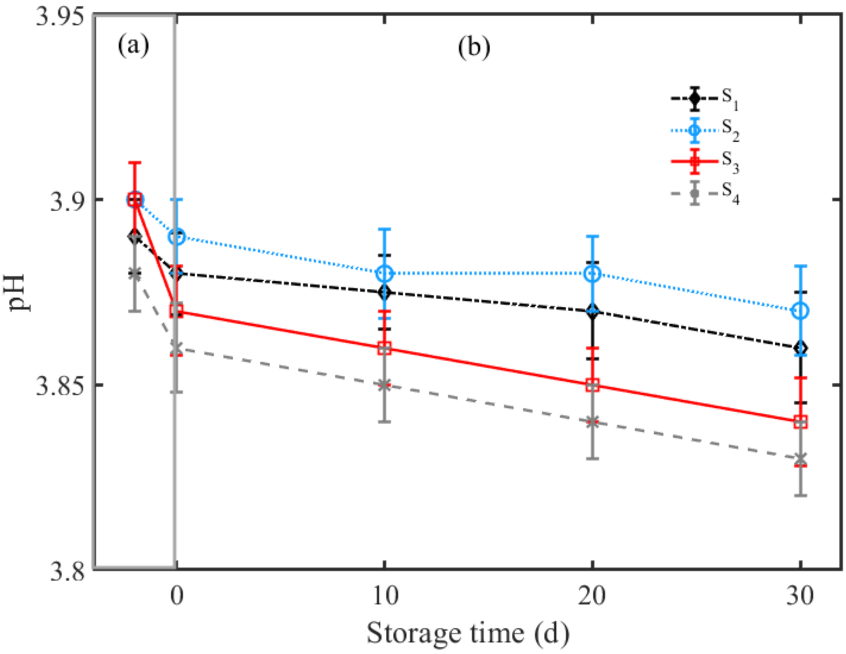

Figure 3: pH of different mixed fruit juice samples before pasteurisation (a). Change of pH in pasteurised fruit juices during a one-month storage period at an ambient temperature (b). The points are the means of the measured values from three replicates, with error bars representing the standard error at each time-point.

Total soluble solids (TSS)

Figure 4 shows the total soluble solids in unpasteurised samples and pasteurised juices. TSS values ranging from 13.7 to 13.9 °Brix were found in the unpasteurised juice samples. Significant changes ($p < 0.05$) in TSS were observed in samples S_1, S_2, and S_3 after pasteurisation. These changes were measured to be 13.4 ± 0.08, 13.6 ± 0.06, 13.6 ± 0.04, and 13.7 ± 0.18 °Brix in S_1, S_2, S_3, and S_4 samples, respectively. The data showed substantial increase in TSS values for all the samples during ten days of storage at an ambient temperature, which were quantified to be 13.6 ± 0.01, 13.8 ± 0.06, and 13.9 ± 0.06 °Brix in S_1, S_2, and S_3 samples, respectively (Figure 4b). However, no further changes were noticed in TSS for all the samples after ten days of storage. Begum et al. (2018) suggested that TSS may increase during storage due to the conversion of complex carbohydrates to simple sugar in the juice.

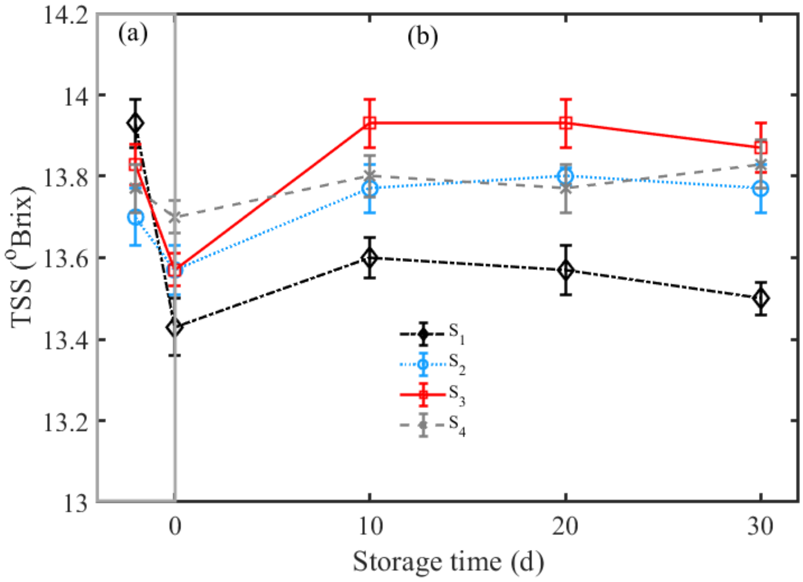

Figure 4: Total soluble solids (°Brix) in different mixed juice samples before pasteurisation (a). Changes of total soluble solid (°Brix) in pasteurised fruit juices during a one-month storage period at an ambient temperature (b). The points are the means of the measured values from three replicates, with error bars denoting the standard error at each time-point.

The control samples showed insignificant changes ($p > 0.05$) in physicochemical analyses of ascorbic acid, TSS, acidity, and pH during 30 days of storage at 4 °C.

Sensory analysis

Table 3 shows the mean scores for sensory evaluation in each sample stored at 4 °C for 30 days. The sensory analyses were carried out to evaluate colour, flavour, sweetness, and overall acceptability of the mixed juices during one month of storage. At day zero, the colour for S_3 and S_4 samples were equally ranked as "liked very much" with the mean score of 8.6 and 8.4, respectively. In comparison, S_1 and S_2 samples scored low mean values of 6.4 and 6.9, respectively. The results revealed that S_3 had the highest mean score of 8.6 and was the most acceptable sample in terms of juice colour preference followed by sample S_4. This trend was also seen for all the samples during 30 days of storage, although the mean scores for the colour decreased slightly. It was determined that the S_3 and S_4 samples scored mean values of 8.1 and 7.9, respectively for the colour attribute at 30 days. In contrast, the S_1 sample scored the lowest value of 5.4, followed by the S_2 sample that had 5.9 mean score. In terms of flavour preference, the S_3 sample scored the highest mean value of 7.7, while the S_2 and S_1 samples scored 7.2 and 7.1, respectively, and the S_4 sample obtained the lowest score of 6.9

at day zero (Table 3). After 30 days of storage, the S_3 sample scored the highest mean value of 7.8 and was ranked as "likely moderate" in terms of its flavour. The least mean value of 6.0 was found in the sample S_4, which indicates the least preference by the panellists in terms of flavour (Table 3). No significant difference ($p > 0.05$) in flavour was found in S_1, S_2, and S_3 samples throughout the storage time. At day zero, the S_1 sample scored the mean value of 7.8 in terms of the sweetness parameter and was preferred by the panellists. After 30 days of storage, the tested S_3 sample became the sweetest sample as it scored the mean value of 7.5. In addition, the S_1 and S_2 samples were observed to be significantly different ($p < 0.05$) from the S_3 sample (Table 3) in terms of sweetness attribute. The overall acceptance results indicated that the S_3 sample had the highest scores of 7.8 at day zero and 7.6 at 30 days. Therefore, these results suggested that the S_3 sample of 80% banana juice and 20% passion juice was the most appealing sample for all the sensory attributes, i.e., colour, flavour, sweetness, and overall acceptance during storage.

Table 3: Mean scores for sensory evaluation of mixed fruit juices at 0 d and 30 d of the storage period in a fridge set at 4 °C; values with different superscripts for each sensory parameter indicate that the means are significantly different at $p < 0.05$.

Storage time (d)	Sensory attributes							
	0				30			
Sample	Colour	Flavour	Sweetness	Overall acceptance	Colour	Flavour	Sweetness	Overall acceptance
S_1	6.4^a	7.1^a	7.5^a	7.2^{ab}	5.7^a	6.4^a	6.5^a	6.8^a
S_2	6.9^a	7.2^a	7.1^a	7.0^{ab}	5.9^a	6.5^a	6.6^a	6.7^a
S_3	8.6^b	7.7^a	7.4^a	7.8^a	8.1^b	7.8^b	7.5^b	7.6^b
S_4	8.4^b	6.9^a	6.8^a	6.9^b	7.9^b	6.0^a	6.8^{ab}	6.3^a

Conclusion

In this study, the physicochemical and organoleptic properties of mixed fruit juices that contain low viscosity banana juice as the main component with pineapple or passion fruit juice were investigated. The ascorbic acid content, acidity, total soluble solids, and pH changed during one month of storage. The results demonstrated a decreasing trend in ascorbic acid and pH as the acidity increases when stored at an ambient temperature. Total soluble solids increased during ten days of storage. The ratio of 80% low viscosity banana juice and 20% passion juice scored the highest hedonic scale on each sensory attribute considered throughout the storage time. Hence, banana juice can be the main ingredient of the mixed juices, especially when blended with passion fruit juice at the observed ratio.

The results of this study are very useful to stakeholders in the food sector. They provide insights on understanding the quality changes of mixed fruit juices during shelf-life storage for low viscosity banana juice blended with passion or pineapple juice. The data presented in this work, are indispensable for assessing quality and consumers' acceptability, which were previously missing, especially for low viscosity banana juice blended with passion or pineapple juice. Future work will focus on microbial analyses, which may provide insights into low viscosity banana juice blended with passion and pineapple juices during long shelf-life storage.

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Conflict of Interest: The authors declare that there is no conflict of interest regarding this work.

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