Shelf-life of Ready-To-Serve, Ascorbic Acid-added and Pineapple and Lime-flavoured Sugarcane Juice Beverage

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Abstract

Sugarcane juice is a nutritious liquid that can be extracted by crushing mature sugarcane. Since sugarcane juice gets spoilt quickly after extraction, increasing its shelf-life is required to produce its ready-to-serve beverage. The aim of this study was to find out the possibility of enhancing the shelf-life of the pineapple and lime-flavoured sugarcane juice by adding ascorbic acid. The sugarcane variety SL 96 128 was used for extracting juice after its cleaning,peeling and blanching at 100^{o}C. Pineapple juice at 12% v/v and the lime juice at 3% v/v were added to the sugarcane juice as the flavours. After pasteurising the flavoured juice mixture at 70^{o}C for 10minutes, 100ppm of potassium sorbate, carboxy methyl cellulose 5 g/l) and 100, 150 and 200 ppm of ascorbic acid were added. After hot filling into bottles and sterilising them, the drink was stored at room temperature and under refrigeration at 4^{o}C. To determine the shelf-life, the physico-chemical, microbiological, and sensory characters of the flavoured sugarcane juice drink were measured and the proximate composition of the selected best sample was evaluated. The results revealed that the pH, Brix value, colour and polarity of the samples stored in room temperature decreased for a period of one month and of those under refrigeration for two months. The titratable acidity and microbial counts increased with time. The refrigerated samples

showed the minimum rate of change of all the parameters than those at room temperature, while addition of 200 ppm ascorbic acid showed the minimum rate of change of all parameters under both storage conditions. Addition of 200 ppm ascorbic acid extended the shelf-life of the product up to two months without affecting its sensory attributes. The proximate analysis revealed that the drink consisted of 78.8% moisture, 1.2% ash, 0.19% crude fat, 2.3% crude protein and 17.51% total carbohydrates and gives 80.95 kcal energy per100 ml.

Keywords: Ascorbic acid, Pineapple juice, Polyphenol oxidase, Sri Lanka, Sugarcane juice

INTRODUCTION

Sugarcane is an important agro-industrial crop, belonging to the grass family Poaceae which is used for sugar production in Sri Lanka. Sugarcane juice is commonly used as a delicious drink in both urban and rural areas of some countries, but it is still not commercially available in Sri Lanka. It is an excellent substitute for carbonated drinks such as cola. One hundred mililitres of sugarcane juice of 100 ml provides 40 Kcal of energy,10 mg of iron, and also it contains 75%-85% water, 3% reducing sugars, 10-21% non-reducing sugar (Swaminathan, 1995). Sugarcane juice is mainly processed for sugar and jaggery, and a small quantity is used as a soft drink in the raw form due to its desirable taste, flavour, nutritional and therapeutic values. The fresh sugarcane juice mainly contains nearly 78% water, 18% sugars and in small amounts polysaccharides, proteins, calcium, phosphorous, iron and vitamins. Even though there are many advantages of sugarcane juice, it is important to ensure its hygienic extraction. Also it is important to consume the sugarcane juice soon after its extraction due to its fast oxidisation. In general, fresh sugarcane juice cannot be stored for more than six hours, since it tends to get spoilt

quickly due to presence of simple sugars, abundant quantity of sucrose and little amount of glucose and fructose (Krishnakumar and Devadas, 2006).

The increasing demand for synthetic drinks and the rising trend in their prices have drawn the attention of the scientists for producing suitable natural substitutes like ready-to-serve sugarcane juice. The processing sugarcane juice for making such beverages as an independent industry does not exist in Sri Lanka due to lack of proper processing technology to prolong the shelf-life, problems in distribution in addition to seasonality of crushing and rapidity of fermentation of the juice. In this study, processing of sugarcane juice is attempted to retain its organoleptic characteristics and to improve its shelf-life and market potential by incorporating the permitted food additives.

MATERIALS AND METHODS

The matured sugarcane of the variety SL 96 128 was collected randomly from a field of the Sugarcane Research Institute (SRI), Uda Walawe, Sri Lanka, in the year 2016. They were properly cleaned and then the peel was removed. Sugarcane stalks were cut into small pieces, and blanched in hot water at 100^{o}C temperature for five minutes. Sugarcane was crushed and the juice was extracted. The fully-matured, freshly-harvested pineapple and limes were procured from the local market of Uda Walawe were brought to the Processing Technology Division of Sugarcane Research Institute for obtaining juice.

Juice Preparation: Pineapples were washed, peeled, and cut into small pieces. Then the pineapple pieces were blended, and the juice was filtered. Lime pieces were squeezed by hand, and the extract was filtered through the muslin cloth to remove the extraneous matter and seeds. Several trials were conducted to determine the proportions of pineapple, lemon juice and other

ingredients to develop organoleptically sound product. The sugarcane juice was flavoured by adding pineapple juice (12% v/v), and then salt (5 g/l) was added. Potassium sorbate (100 ppm) was added as a preservative, and carboxy methyl cellulose (5 g/l) was also added as a stabilser. The brix value of sugarcane juice was adjusted to 15^{o} with distilled water, and pH was adjusted to 4.6 by adding lime solution. After mixing all the ingredients, the sugarcane juice was homogenised and filtered through a muslin cloth. It was then pasteurised at 70^{o}C temperature for ten minutes, and ascorbic acid was added in three different concentrations separately (100 ppm, 150 ppm and 200 ppm). Hot filling was done into pre-sterilised glass bottles (190 ml), and they were sealed properly. The bottles were kept in an autoclave at 100^{o}C temperature for 20 minutes, and then, rapid cooling was done. The bottles were then stored at room temperature and at 4^{o}C under refrigeration. The shelf-life of the prepared sugarcane juice was tested for the treatments given in Table 1.

Table 1: The treatments of ascorbic acid concentrations and temperature used for testing shelf-life of sugarcane juice beverage

	Storage Temperature	
Ascorbic acid concentration	T_1-Room temperature (30^{o}C)	T_2-Refrigeration temperature (4^{o}C)
C_0 - 0 ppm	C_0T_1	C_0T_2
C_1 - 100 ppm	C_1T_1	C_1T_2
C_2 - 150 ppm	C_2T_1	C_2T_2
C_3 - 200 ppm	C_3T_1	C_3T_2

In order to determine the shelf life, physico-chemical, microbiological, and sensory characters of the developed sugarcane juice was examined and the proximate composition of the selected best sample was evaluated.

Physico-chemical Analysis

Total acidity (as % citric acid) was determined by titrimetric method (Ranganna, 1986). The Total soluble solid content was determined directly with a refractometer. The pH values were measured weekly up to three months of storage by a pH metre. . Sucrose percentage of sugarcane juice was taken at 15-day intervals up to three months of storage by using Polari metre. Colour of the prepared sugarcane juice was measured at 570 nm wavelength in the visible region at 15-day intervals up to three months of storage by using spectrophotometer.

Microbial Analysis

For microbial analysis, the content of bacteria, yeast and moulds were determined and expressed as colony forming units per milliliter (CFU/ml) according to the SLS (729) standard method.

Sensory Evaluation

The acceptance of the juice was tested using a five-point Hedonic scale and a panel of 30 semi-trained persons in a two-factor factorial Complete Randomised Design (CRD). The statistical analysis was carried out by Kruskal Wallis non-parametric test using “STATISTIX 10” software for Windows. Mean separation was done by using Dunn’s all-pair-wise comparisons test.

Proximate Analysis

The moisture, crude protein, crude fat and ash contents in the developed sugarcane juice were determined by the standard methods of AOAC, 1999.

RESULTS AND DISCUSSION

Physico-chemical Analysis

pH: During the preparation of the sugarcane juice, its pH was adjusted initially to 4.6 by adding lemon juice, and that pH was maintained throughout the processing. As shown in Figure 1 A and B, the pH values of sugarcane juice stored under room (A) and refrigerated (B) temperature conditions decreased with time, In the control (without addition of ascorbic acid), the pH showed a rapid decrease with time. However, there was no significant effect of the concentrations of the added ascorbic acid (100, 200 and 300 ppm) on the change in pH during the storage both at room and refrigerated temperatures. Furthermore, addition of 200 ppm (C_3) ascorbic acid showed a high stability of pH than C_2 (150 ppm) and C_1 (100 ppm). Moreover, the rate of reduction in pH value was found to be lower in the refrigerated samples than those stored at room temperature.

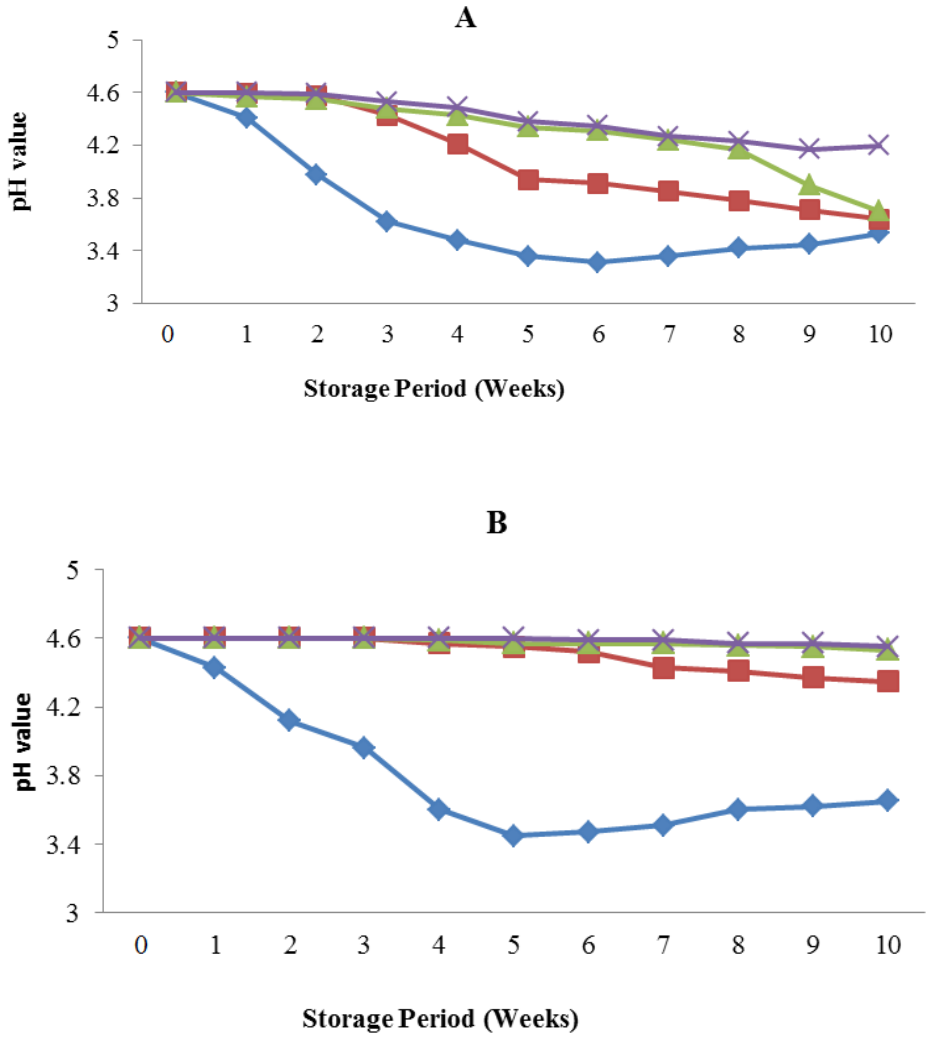


Figure 1: Changes in pH of sugarcane juice during storage at room temperature (A) and refrigerated temperature (B) conditions. Diamonds (◊) represent control, Square (□) represents C_1 (100 ppm), Triangle represent (Δ) C_2 (150 ppm), Cross (x) represent C_3 (200 ppm), ascorbic acid concentrations.

Total Soluble Solids: The initial brix value of the prepared sugarcane juice was adjusted to 15^{o} by adding distilled water. The juice sample without ascorbic acid showed a significant reduction in the total soluble solid content under both refrigerated or room temperature conditions (Figure 2 A and B). There was no significant effect of the concentrations of the added ascorbic acid(100, 200 and 300 ppm) on the reduction in brix value during the storage both at room refrigerated temperatures. Moreover, under both conditions, the least reduction was observed in the sugarcane juice preserved by adding 200 ppm ascorbic acid. Furthermore, according to the results, the rate of reduction in brix value was lower in the refrigerated samples than those at room temperature. The brix value of the developed juice was found to be stable (Figure 2B).

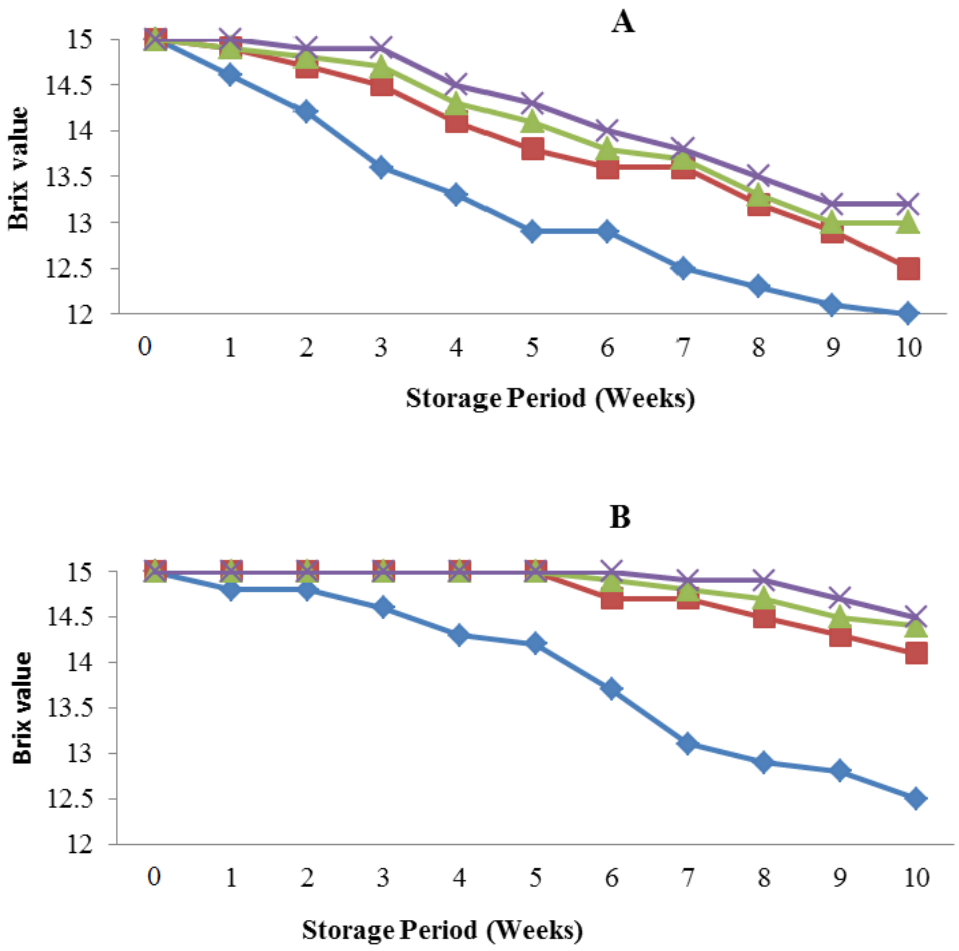
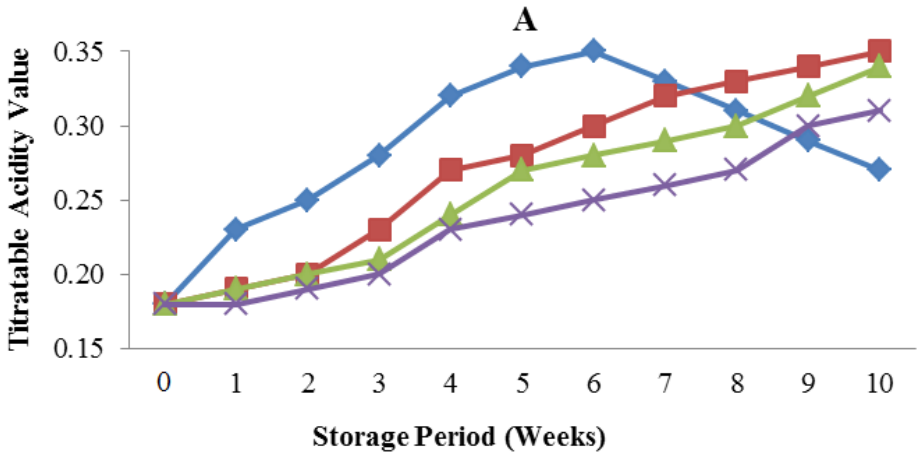


Figure 2: Changes in brix of sugarcane juice during storage at room temperature (A) and refrigerated temperature (B) conditions. Diamonds (◊) represent control, Square (□) represents C_1 (100 ppm), Triangle represent (Δ) C_2 (150 ppm), Cross (x) represent C_3 (200 ppm), ascorbic acid concentrations

Titratable Acidity: The titratable acidity of the sugarcane juices with all the treatments increased with the storage time. The ascorbic concentration, at 200ppm (C3) showed the minimum change in titratable acidity during storage period under both conditions than those at 100 and 150ppm accorbic acid. The titratable acidity value of the control sample in room temperature showed a higher fluctuation than that of the other samples due to quick spoilage of the sugarcane juice. Titratable acidity values of all treatments except that of the control sample, slightly increased under refrigerated conditions. But the refrigerated samples showed lower titratable acidity values than those at room temperature (Figure 3 A and B).



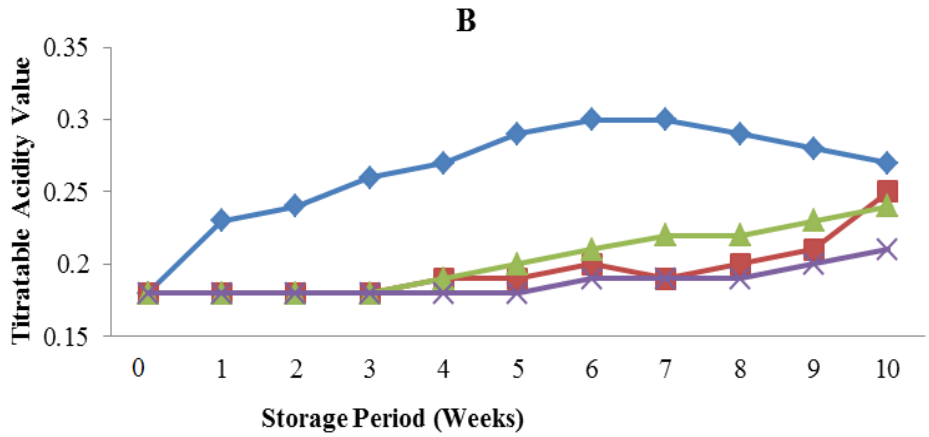


Figure 3: Changes in Titratable acidity of sugarcane juice during storage at room temperature (A) and refrigerated temperature (B) conditions. Diamond (◊) represents control, Square (□) represent C_1 (100 ppm), Triangle represent (Δ) C_2 (150 ppm), Cross (x) represent C_3 (200 ppm), ascorbic acid concentrations

Polarity: Figure 4 A shows that the polarity of the sugarcane juice added with ascorbic acid reduced slightly up to 15 days, and thereafter at a rapid rate. The results were limited up to 45 days in the control and C_1T_1 samples due to rapid increase the viscosity inside bottles. The results under refrigerated condition (Figure 4B) showed fluctuation in polarity of the sugarcane juice in the ascorbic acid-added samples. It may be due to decrease of the amount of non-reducing sugars (sucrose), while increasing the amount of reducing sugars during storage as a result of breakdown of non-reducing sugar into reducing sugars.

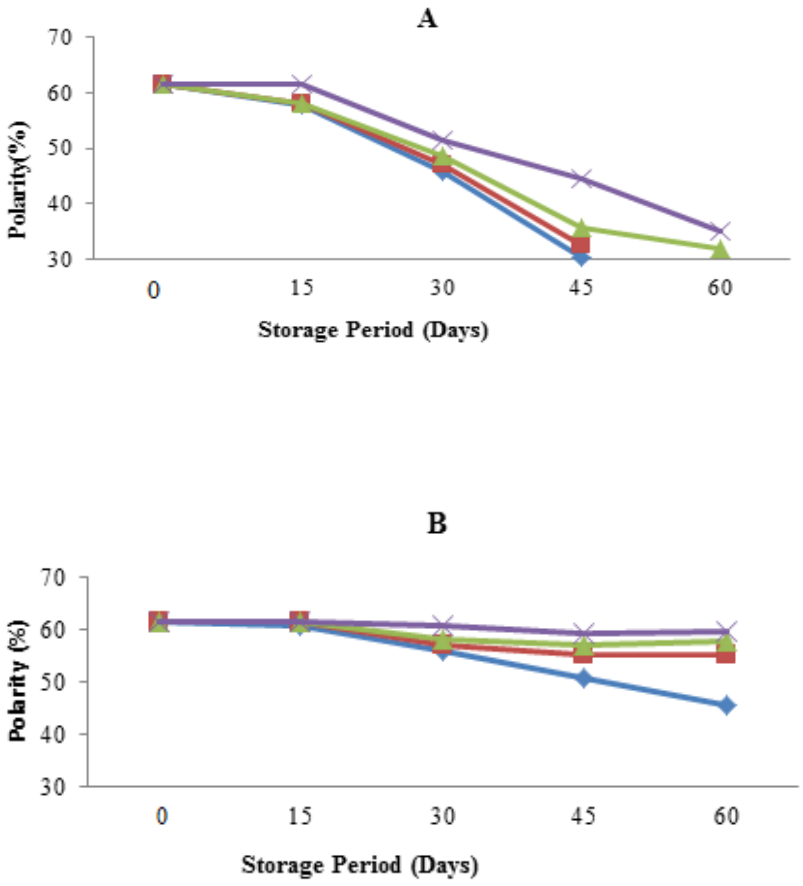


Figure 4: Changes in Polarity of sugarcane juice during storage at room temperature (A) and refrigerated temperature (B) conditions. Diamond (◊) represents control, Square (□) represent C_1 (100 ppm), Triangle represent (Δ) C_2 (150 ppm), Cross (x) represent C_3 (200 ppm), ascorbic acid concentrations

Colour: A rapid deterioration after 30 days of storage was observed in the sugarcane juice without addition of ascorbic acid (control sample) with an obvious browning and rapid increase in the viscosity (visual observation) which may be due to the fermentation at room temperature condition As shown in Figure.5 A, the colour of the sugarcane juices with all the treatments was found to be reduced slightly after 30 days under room temperature condition. The results

revealed that sugarcane juice treated with 200 ppm ascorbic acid (C_3) showed the highest absorbance level under both room temperature and refrigerated temperature conditions, due to the preservative effect of the ascorbic acid content. But, the minimum change in the colour was observed in the C_3T_2 where sugarcane juice with 200 ppm ascorbic acid and stored under refrigerated conditions (Figure 5B).

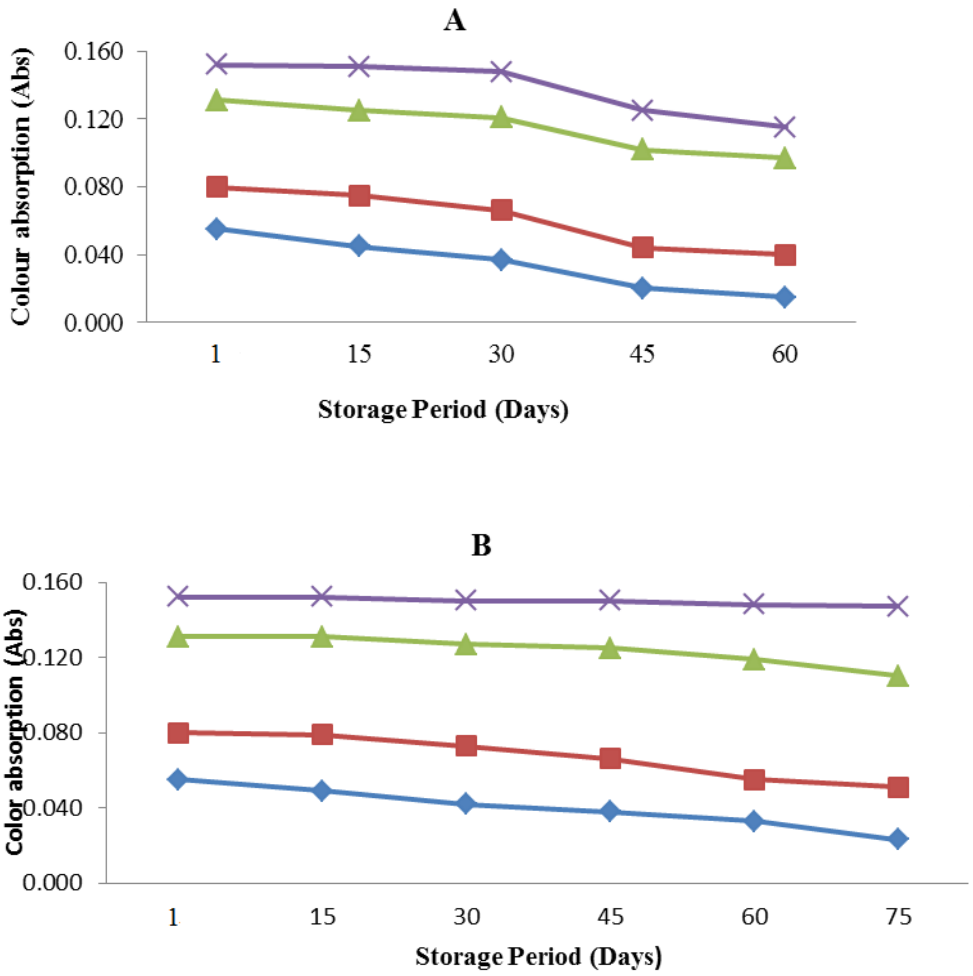
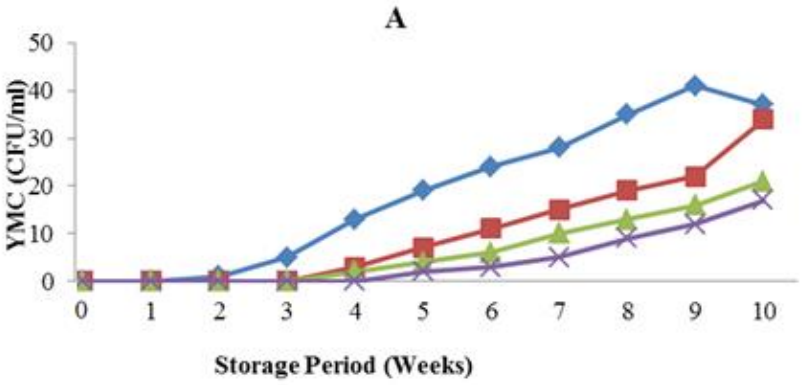


Figure 5: Changes in colour of sugarcane juice during storage at room temperature (A) and refrigerated temperature (B) conditions. Diamond (◊) represents control, Square (□) represent C_1 (100 ppm), Triangle represent (Δ) C_2 (150 ppm), Cross (x) represent C_3 (200 ppm), ascorbic acid concentrations

Microbial Analysis

As shown in Figure 6 A, the total plate count (TPC) of the sugarcane juice samples with 100 ppm and 150 ppm ascorbic acid and stored at room temperature increased from the 3rd week and those with 200 ppm ascorbic acid from the 4th week (C_3) of storage. On the other hand, storage of sugarcane juice at refrigerated temperature after treating with 200 ppm ascorbic acid extended the shelf-life up to 9th weeks (Figure 6 B). Even though, there an increase in the TPC in the samples with ascorbic acid 200ppm and stored under refrigeration, It was within the SLSI standard level of 50 CFU/ml for fruit juices (CODEX STAN 247, 2005).



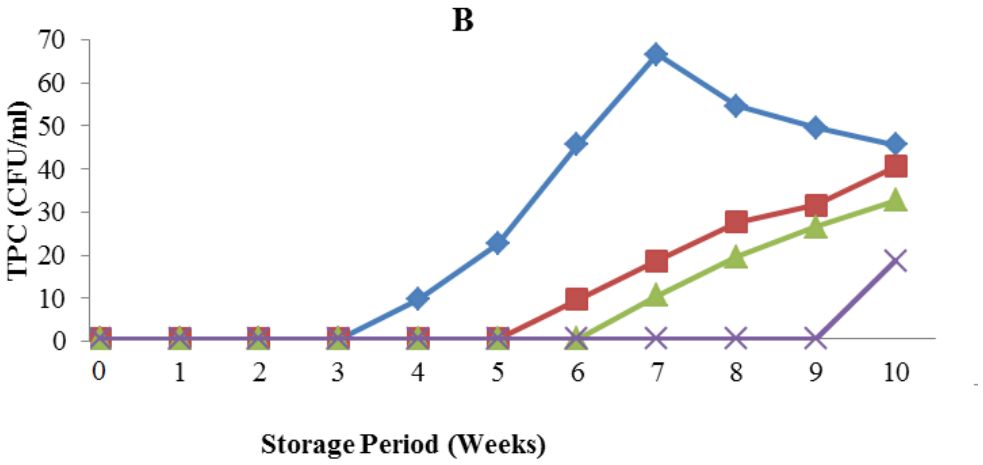


Figure 6: Changes in TPC of sugarcane juice during storage at room temperature (A) and refrigerated temperature (B) conditions. Diamond (◊) represents control, Square (□) represent C_1 (100 ppm), Triangle represent (Δ) C_2 (150 ppm), Cross (x) represent C_3 (200 ppm), ascorbic acid concentrations

According to the yeast and mould count(YMC),the slowest growth of yeast and mould (Figure 7) was observed in the sugarcane juice sample treated with 200 ppm ascorbic acid, and stored under refrigerated condition, and YMC was in the standard limit (absent in one millilitre) of the 8 weeks of storage period.

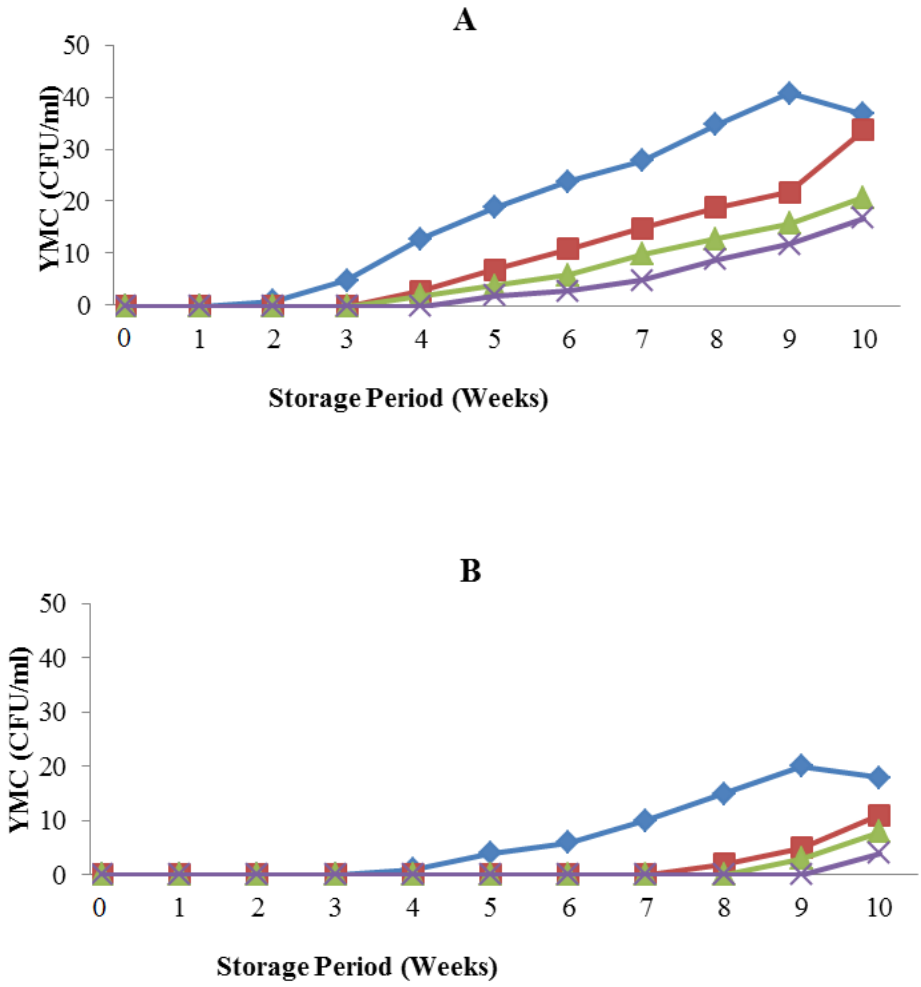


Figure 7: Changes in YMC of sugarcane juice during storage at room temperature (A) and refrigerated temperature (B) conditions. Diamond (◊) represents control, Square (□) represent C_1 (100 ppm), Triangle represent (Δ) C_2 (150 ppm), Cross (x) represent C_3 (200 ppm), ascorbic acid concentrations

Sensory evaluation

By considering all the physico-chemical and microbiological characteristics, addition of ascorbic acid at a concentration of 200 ppm, followed by storage at refrigerated temperature for a period

of 8 weeks can be considered as the best condition to improve the shelf-life of sugarcane juice. However, it is important to examine the effect of the added ascorbic content on organoleptic properties of the sugarcane juice to determine the final treatment condition. Thus, sugarcane juices with three different ascorbic acid concentrations, stored at refrigerated temperature were analysed for their sensory qualities.

The results of the sensory evaluation are given in Table 2. According to the results, the sample with 200 ppm ascorbic acid (C3T2) has obtained the highest acceptability for all the tested sensory attributes, and a significant difference was observed among all the treatments. Thus, 200 ppm of ascorbic acid level was selected as the best, and according to SLS recommendation, the level of added ascorbic acid was within the standard level of (100 ppm to 250 ppm) that could be added to a fruit juice.

Table 2: Mean rank values for the sensory parameters of the refrigerated samples

Sensory Attribute	Mean Score			
	Control	C1T2	C2T2	C3T2
Taste	19.33^{c}	70.93^{ab}	61.95^{b}	89.78^{a}
Colour	23.10^{b}	64.47^{a}	67.87^{a}	86.57^{a}
Flavour	42.70^{b}	55.20^{b}	48.00^{b}	96.10^{a}
Appearance	37.60^{c}	53.97^{bc}	61.78^{b}	88.65^{a}
Overall acceptability	23.28^{c}	60.75^{b}	68.45^{ab}	89.52^{a}

Furthermore, the acceptability of the sugarcane juice stored at refrigerated temperature for eight weeks was also examined for the confirmation of the results (Table 3). According to the results, the selected sugarcane juice (with 200 ppm ascorbic acid) showed significantly higher preference

for all the tested sensory parameters than other samples Thus, addition of 200 ppm of ascorbic acid will not change the consumer preference even after the storage of two months.

Table 3: Mean rank values for the samples

Sensory Attribute	Mean Score	
	C2T2	C3T2
Taste	24.42[b]	36.58[a]
Colour	22.82[b]	38.18[a]
Flavour	28.17[a]	32.83[a]
Appearance	28.77[a]	32.23[a]
Overall acceptability	23.17[b]	37.83[a]

In order to determine the consumer preference on the selected product over the available juices in the market, another sensory evaluation was conducted between the sugarcane juice developed and the mixed fruit juice available in the (Figure.8). The sugarcane juice mix developed got obtained the highest acceptability on all the tested sensory parameters than mixed fruit juice that is already available in the market. Furthermore, the results of the statistical analysis revealed that the sugarcane juice was having significantly higher consumer acceptability over the market product. Thus, the sugarcane mixed juice developed can be introduced to the local market as a novel fruit beverage successfully.

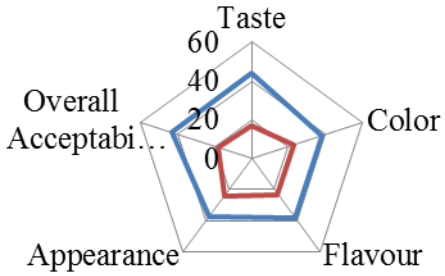


Figure 8: Sensory profile for sugarcane juice with mixed fruit juice. Blue color lines represent the sugarcane juice (C_3T_2), and red colour lines represent the mixed fruit juice

Proximate Analysis

The results of the analysis of the proximate composition of the selected product are shown in Table 4. According to the results, the sugarcane fruit juice mix will give 80.95 ± 3 kcal of energy to the consumer

Table 4: Nutritional composition of the best sugarcane juice sample

Nutritional composition	Amount (%)
Moisture	78.8 ± 2
Ash	1.2 ± 0.1
Crude Fat	0.19 ± 0.2
Crude Protein	2.3 ± 0.1
Total Carbohydrates	17.51 ± 0.2
Energy	80.95 ± 3 kcal

CONCLUSIONS

According to the results, addition of ascorbic acid up to 200 ppm concentration improves the shelf-life of the sugarcane juice without adversely affecting the consumer acceptability. Storage of sugarcane juice under refrigerated temperature, together with 200ppm ascorbic acid increases the shelf-life of the product up to two months. The results revealed that formulation of sugarcane pineapple and lime-blend mixed juice beverage satisfies the consumer taste and preferences. Sugarcane juice is an alternative energy-dense beverage for the mixed-fruit juice already available in the market.

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