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# Studies on Stability of Sugarcane Juice Blended with Anola Juice at Refrigerated and Room Temperature

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**Abstract**

Sugarcane juice is highly nutritious and thirst quenching drink. The preservation of raw sugarcane juice is very difficult because it turns brown soon after extraction and gets spoiled due to fermentation within hours. For the purpose of preservation, sugarcane juice was blended with different proportions (0, 2, 5, 15, 20, and 25%) of anola juice. On the basis of sensory evaluation, out of all the combinations, anola juice taken for further studies were 0, 2, 5, 10 and 15% because anola juice higher than 15% was not acceptable due the acidic nature. These selected juice blends were thermally treated at different temperatures (60, 70 and 80°C) for different intervals of time (5, 10 and 15 minutes) and best temperature-time combination selected on the basis of sensory score was 70°C for 10 minutes. For storage study, samples were stored at refrigerated (5-7°C) and room temperature (27-28°C). The samples were analyzed for physico-chemical, sensory and microbial quality after a regular interval of 10 days. The addition of anola juice resulted in the lowering of pH of juice blend which gave preservative action by inhibiting the growth of micro-organisms during storage. During storage, a decrease in pH, total soluble solids and ascorbic acid has been observed; whereas the acidity and microbial count increased in all blends. During storage, total plate count remained much below the $10^6$ /ml Cfu's generally considered as safe and coliforms are found to be below detectable limit within this period. On the basis of organoleptic quality the blended juice samples remained acceptable up to 20 days at room temperature and 50 days at refrigerated temperature and 5%

anola sugarcane juice blend was highly acceptable among all on sensory point of view.

**Keywords**: Sugarcane juice, Anola juice, physico-chemical, microbiological, sensory evaluation.

## 1. Introduction

Sugarcane (*Saccharum officinarum)* is exclusively cultivated all over the world and India is the original home of sugarcane and second largest producer next to Brazil. Sugarcane has been used as a sweetening agent for millennia and today mainly in the form of refined sugar (Phanikumar, 2011). Sugarcane juice as such is highly nutritious having many minerals and also rich in enzyme and possesses many medicinal and therapeutic properties (Banerji et al, 1997). Sugarcane juice contains water (75-85%), reducing sugar (0.3-3.0%), and non-reducing sugar (10-21%) (Swaminathan, 1995) and 100 ml of sugarcane juice provides 40 Kcal of energy, 10 mg of iron and 6 µg of carotene (Parvathy, 1983). Sugarcane juice is a great preventive and healing source for sore throat, cold and flu. It has a low glycemic index which keeps the body healthy and hydrates the body quickly when exposed to prolong heat and physical activity. It refreshes and energizes the body instantly and can be an excellent substitute for aerated drinks and cola. By using sugarcane juice regularly rapid gain in weight can be achieved, thus can be an effective remedy for thinness (Karthikeyan and Samipillai 2010). But the juice extracted from the canes turns dark brown and marked sedimentation appears during storage. Generally sugarcane juice is spoiled quickly by the presence of sugars (Krishnakumar and Devadas 2006a). Biodegradation, which leads to loss of sucrose by formation of organic acid and ethanol is caused by microorganisms mainly *Leuconostoc* sp. (*L. mesenteroides* and *L. dextranium*) also takes place (Frazier and Westhoff, 1995). Soon after the harvest of sugarcane; endogenous invertase enzyme is activated and acts as a cause of deterioration (Siswoyoa et al, 2007). These enzymes lead to inversion of sucrose and affect the quality of sugar (Krishnakumar and Devadas, 2006). The polyphenol oxidase is the major enzyme involved in the discoloration of sugarcane juice which can be improved by heat inactivation of enzyme. Addition of citric acid or ascorbic acid to juice also gave good pleasant dull orange colour to juice (Kapur et al, 1978). Addition of lemon and ginger followed by pasteurization and preservation with sulphur dioxide also reduced physico-chemical changes during storage of ready-to-serve bottled sugarcane juice (Bhupinder et al, 1991).

Amla, Aonla or Indian gooseberry (*Emblica officinalis G.*) is a native of India, Malaya and China is one of the richest known source of ascorbic acid (Mannay and Shadaksharaswamy, 1997) contains nearly twenty times as much ascorbic acid as orange juice having vitamin C content reported to be about 300-1000mg/100g (Ghorai and Sethi, 1996). It is a good medicinal fruit with anti scorbutic, diuretic, laxative and antibiotic properties (Mehta, 1995). Thus because of its high vitamin C, tannin and mineral contents and medicinal properties offer tremendous scope for processing it into

various beverages such as syrups, squashes, nectar and ready-to-serve (RTS) drinks. Amla fruit is highly nutritious and have great medicinal value, so its consumption is recommended round the year, but the fruits are available only during winter (October to January) (Ghorai and Sethi, 1996). The fresh sugarcane juice has its own typical flavour, but the product is so perishable that the time-lag between the extraction and consumption has a marked deteriorating effect on its sensory characteristics. Hence, blending of anola juice with sugarcane juice may not only improve nutritive value of sugarcane juice but also improve clarification and preservation resulting in the increase in the overall acceptability of sugarcane juice. So, it is necessary to process and preserve the juice to improve its shelf life and marketing characteristics and thus scale up the production and consumption of both anola and sugarcane juice.

## 2. Materials and Methods

The present investigation was carried out in the Department of Food Technology, Guru Jambheshwar University, Hisar. Sugarcane and Anola were procured from local market, Hisar. Sugarcanes selected were healthy green, free from visible decay, tops and crash. Properly washed and partially peeled sugarcane pieces of uniform length (0.5 m long) subjected to blanching for 10-15 min for heat inactivation of enzymes (Bucheli and Robinson 1994) and then soaked in water containing 0.1% by wt. potassium metabisulphite and 0.01% by wt. citric acid solution for 4h to give good pleasant color to sugarcane juice (Kapur et al.1978). After 4h, pieces were thoroughly washed and juice was extracted using the roller power crusher and then filtered by passing through a layer of muslin cloth. Anola fruit was properly washed, weighed and blanched at 100°C for 5 minutes prior to juice extraction. Juice was extracted from blanched anola fruits by juice extractor. Anola juice after sieving was blended with sugarcane juice in different proportion and selected on the basis of sensory score for further study as shown in table 1.

**Table 1:** Sensory score for Anola: Sugarcane juice blends.

| Anola Juice (ml) | Sugarcane Juice (ml) | Overall Sensory Score |
|---|---|---|
| 0 | 100 | 9.2 |
| 2 | 98 | 9.0 |
| 5 | 95 | 9.0 |
| 10 | 90 | 8.7 |
| 15 | 85 | 8.5 |
| 20 | 80 | 6.5 |
| 25 | 75 | 6.0 |

These selected blends were then kept overnight at 5- 10°C for sedimentation. After 24h sediment blends were decanted and the supernatant filtered through muslin cloth. These were then optimised for heat treatment on the basis of sensory evaluation.

Temperature and time selected for heat treatment were 60, 70 and 80°C for 5, 10 and 15 min. But results in table 2 are for 60, 70 and 80°C for 10 min only because for 5 min sensory scores were almost same as that of 10 minutes even at 80°C so, more time i.e. 10 min. was selected because more the time for heat treatment more will be the effectiveness but sensory score for 15 minutes was very low even at 60°C (produce jaggery like taste). For the heat treatment purpose, in bottle pasteurization method was used to heat treat the sample at 70°C/10 min. Selected samples were subjected to storage studies at refrigerated as well as room temperature for determination of changes in physico-chemical, microbiological and sensory evaluation (Ranganna, 1986 and AOAC, 1990) after ten days regular intervals.

**Table 2:** Effect of heat treatments on overall sensory score of Anola juice (A) blended with sugarcane juice(S).

| A:S (ml) | Temp/time (°C/min) | Sensory Score | A:S (ml) | Temp/time (°C/min) | Sensory Score | A:S (ml) | Temp/time (°C/min) | Sensory Score |
|---|---|---|---|---|---|---|---|---|
| 0:100 | 60/10 | 9.2 | 0:100 | 70/10 | 9.2 | 0:100 | 80/10 | 8.7 |
| 2:98 | 60/10 | 9.0 | 2:98 | 70/10 | 9 | 2:98 | 80/10 | 8.7 |
| 5:95 | 60/10 | 9.0 | 5:95 | 70/10 | 9.1 | 5:95 | 80/10 | 8.5 |
| 10:90 | 60/10 | 8.9 | 10:90 | 70/10 | 8.9 | 10:90 | 80/10 | 8.3 |
| 15:85 | 60/10 | 8.8 | 15:85 | 70/10 | 8.8 | 15:85 | 80/10 | 8.1 |
| Average | | 8.99 | Average | | 9.0 | Average | | 8.46 |

## 3. Result and Discussion

Physico-chemical analysis of raw sugarcane juice and anola juice (table 3) show that yield, TSS, pH and total sugars of sugarcane juice was higher whereas acidity, ascorbic acid and reducing sugars are lower for sugarcane juice than anola juice.

**Table 3:** Physico-chemical analysis of raw sugarcane juice and anola juice.

| Parameters | Sugarcane Juice | Amla Juice |
|---|---|---|
| **Yield (%)** | **51.41** | **85.4 (pulp) and 47.5 (juice)** |
| TSS (°B) | 19.7 | 10.0 |
| Acidity (%) | 0.21 | 1.29 |
| Ascorbic acid (mg/100ml) | 3.35 | 328.0 |
| pH | 4.79 | 2.75 |
| Reducing sugars (%) | 0.30 | 0.39 |
| Total sugars (%) | 19.5 | 1.56 |

Sugarcane juice with and without anola juice were analysed for different parameters viz. Physicochemical, microbial and sensory evaluation after regular interval of 10 days but, fresh sugarcane juice after 10 days and sugarcane juice blended

with anola juice after 20 days at room and at refrigerated temp fresh sugarcane juice after 20 days and sugarcane anola juice blends after 50 days were not analysed because of less sensory score.

### 3.1 Physicochemical analysis

Changes in the total soluble solids (TSS) were higher at room as compared to refrigerated temperature for all sugarcane juice samples with and without anola juice (table 4). The TSS ranged from 18.07-19.7%, being maximum for fresh sugarcane juice sample without anola juice (19.7%), followed by decrease in TSS from (19.3-18.07%) with increase in anola juice proportion which goes on decreasing decreasing during storage might be due to action of microorganism on sugars which act as an easy source of energy for proliferation of microorganism. After 10 days of storage, maximum decrease in TSS was observed for sugarcane juice without anola juice at room storage. After storage period of 20 days at room and 50 days at refrigerated temperature lower value of TSS was observed but % decrease was less for increasing anola juice proportion. Krishnakumar and Devadas, 2006b reported a decrease in total soluble solids of sugarcane juice during the storage period. In contrast to this, an increase in TSS of the lime-aonla spiced beverage was observed by Bidyut *et al*. (2004) during storage.

**Table 4**: Effects of anola juice on TSS (°Bx.) of sugarcane juice blends during storage.

| **Treatment** | **Room Temperature (Days)** | | | | | | | **(TSS°Bx.)** | **Refrigerated Temperature (Days)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean |
| S | 19.7 | 19.3 | * | * | * | * | * | 19.50±0.1a | 19.7 | 19.4 | 18.6 | * | * | * | * | 19.23±0.1a |
| S+A1 | 19.3 | 18.8 | 18.3 | * | * | * | * | 18.80 ±0.1b | 19.3 | 19.1 | 18.9 | 18.6 | 18.4 | 18.2 | * | 18.75±0.1b |
| S+A2 | 19.1 | 18.4 | 18.1 | * | * | * | * | 18.53±0.058c | 19.1 | 18.7 | 18.4 | 18.2 | 18 | 17.8 | * | 18.37±0.07c |
| S+A3 | 18.4 | 18 | 17.5 | * | * | * | * | 17.96±0.09d | 18.4 | 18.3 | 18 | 17.8 | 17.6 | 17.4 | * | 17.92±0.09d |
| S+A4 | 18.07 | 17.7 | 17.1 | * | * | * | * | 17.62±0.07e | 18.07 | 17.9 | 17.6 | 17.4 | 17.2 | 17 | * | 17.53±0.09e |

As shown in table 5, acidity of sugarcane juice increase significantly with increase in anola juice proportions. The maximum acidity was observed for 15% anola blended sugarcane juice (0.3%), and minimum for sugarcane juice without anola juice (0.21%) but during storage percent increase in acidity was less for higher concentration of anola juice. An insignificant change in the acidity of juice blends was observed for 5 and 10% anola juice at room storage. Less change in acidity was observed at refrigerated storage than room storage in present work and also was by Chauhan et al. (2001).

**Table 5:** Effects of anola juice on % acidity of sugarcane juice during storage.

| Treatment | Room temperature (days) | | | | | | | % acidity | Refrigerated temperature (days) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean |
| S | 0.21 | 2.03 | * | * | * | * | * | 1.12+1.5a | 0.21 | 0.24 | 0.3 | * | * | * | * | 0.25+0.003e |
| S+A1 | 0.23 | 0.28 | 0.26 | * | * | * | * | 0.26+0.005d | 0.23 | 0.25 | 0.27 | 0.27 | 0.27 | 0.28 | * | 0.26+0.001d |
| S+A2 | 0.25 | 0.29 | 0.32 | * | * | * | * | 0.286+0.018c | 0.25 | 0.27 | 0.25 | 0.26 | 0.29 | 0.31 | * | 0.27+0.004c |
| S+A3 | 0.27 | 0.28 | 0.29 | * | * | * | * | 0.280+0.01c | 0.27 | 0.28 | 0.29 | 0.29 | 0.29 | 0.3 | * | 0.286+0.006b |
| S+A4 | 0.3 | 0.31 | 0.33 | * | * | * | * | 0.31+0.008b | 0.3 | 0.28 | 0.33 | 0.31 | 0.33 | 0.34 | * | 0.315+0.002a |

In contrast to acidity, pH (table 6) follows the decreasing trend both with storage as well as increasing anola juice proportion but decrease was more pronounced at room as compared to refrigerated temp. This decrease in pH might be due acids present in anola. The pH of various blends decreased during storage but decrease was less with increasing anola juice proportion may be due to preservative nature of ascorbic acid which inhibit microbial growth during storage which produce acid and results in decrease in pH. Krishnakumar and Devadas, 2004 reported the pH of stored sugarcane juice was slowly decreased during storage period due to acetic acid production. This result was also in agreement with study conducted by Chauhan *et al*, 1997 in sugarcane juice.

**Table 6:** Effects of anola juice on pH of sugarcane juice during storage.

| Treatment | Room Temperature (Days) | | | | | | | (pH) | Refrigerated Temperature (Days) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean |
| S | 4.79 | 3.7 | * | * | * | * | * | 4.25±0.1bc | 4.79 | 4.15 | 3.78 | * | * | * | * | 4.24±0.003c |
| S+A1 | 4.67 | 4.43 | 4.4 | * | * | * | * | 4.5±0.03a | 4.67 | 4.6 | 4.58 | 4.54 | 4.51 | 4.5 | * | 4.57±0.003a |
| S+A2 | 4.49 | 4.28 | 4.2 | * | * | * | * | 4.32±0.013b | 4.49 | 4.44 | 4.4 | 4.38 | 4.33 | 4.3 | * | 4.39±0.008b |
| S+A3 | 4.25 | 4.15 | 4.05 | * | * | * | * | 4.15±0.003c | 4.25 | 4.21 | 4.19 | 4.15 | 4.1 | 4.07 | * | 4.16±0.03d |
| S+A4 | 4.01 | 3.82 | 3.66 | * | * | * | * | 3.83±0.005d | 4.01 | 3.96 | 3.91 | 3.87 | 3.8 | 3.77 | * | 3.89±0.015e |

The ascorbic acid content (table 7) of sugarcane juice blend increase with increase in anola juice but during storage significant decrease in ascorbic acid was observed and more decrease in ascorbic acid was at room storage than at refrigerated storage may be due to destruction of ascorbic acid by heat and oxidation (Mehta and Bajaj, 1983). The retention of ascorbic acid was comparatively higher in blends containing anola because of protection of vitamin C by the tannins like gallic acid, ellagic acid present in anola juice (Ramasastri, 1974).

**Table 7:** Effects of anola juice on ascorbic acid(mg/100ml) of sugarcane juice blends during storage.

| **Treatment** | **Room Temperature (Days)** | | | | | | | **(A Acid )** | **Refrigerated Temperature (Days)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean |
| S | 3.35 | 1.09 | * | * | * | * | * | 2.22±0.015e | 3.35 | 2.05 | 1.79 | * | * | * | * | 2.4±0.003e |
| S+A1 | 6.51 | 3.49 | 2.52 | * | * | * | * | 4.17±0.006d | 6.51 | 6.01 | 5.25 | 4.98 | 3.99 | 2.82 | * | 4.93±0 d |
| S+A2 | 9.09 | 4.06 | 3.45 | * | * | * | * | 5.53±0.006c | 9.09 | 8.13 | 7.05 | 5.89 | 4.78 | 3.75 | * | 6.45±0.001c |
| S+A3 | 11.76 | 6.87 | 4.56 | * | * | * | * | 7.73±0.003b | 11.76 | 10.89 | 9.85 | 7.87 | 6.98 | 4.86 | * | 8.7±0.01 b |
| S+A4 | 14.87 | 10.07 | 8.98 | * | * | * | * | 11.31±0.003a | 14.87 | 13.57 | 12.07 | 11.4 | 10.2 | 9.98 | * | 12.02±0.05a |

### 3.2 Microbial analysis

The microbial count (Table 8) of different samples of sugarcane juice stored at room and refrigeration temp was determined by Total Plate Count Method (TPC). Krishanakumar and C.T. Devadas (2006) observed that bacterial population in fresh sugarcane juice was 4.5 x $10^6$ Cfu's and increased during storage periods. Though, there was a gradual increase in the microbial count of juice samples during storage period but maximum increase was noticed in juice samples stored at room temp (3.0 x $10^4$ Cfu's) even after 10 days as compared to refrigeration temp (1.0 x $10^4$ Cfu's) in fresh sugarcane juice without anola juice. Chauhan et al, 2002 also observed similar results. Less increase in microbial count was noticed in sugarcane juice blends having higher proportion of anola juice may be due to preservative effect of ascorbic acid. Though, there was a gradual increase in the microbial count of the blends during storage period but in no case it reached beyond the safe limit.

**Table 8:** Effects of anola juice on Total plate count (TPC) of sugarcane juice blends during storage.

| Treatment | Room Temperature (Days) | | | | | | | | Refrigerated Temp (TPC 0 Day-same as Room Temp) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean | 10 | 20 | 30 | 40 | 50 | 60 | Mean |
| S | 2.90E+03 | 3.00E+04 | * | * | * | * | * | 1.65E+04a | 1.00E+04 | 1.80E+04 | * | * | * | * | 1.03E+0a |
| S+A1 | 2.90E+03 | 9.00E+03 | 1.50E+04 | * | * | * | * | 8.97E+03b | 6.00E+03 | 9.00E+03 | 9.50E+03 | 1.20E+04 | 1.40E+04 | * | 8.90E+0b |
| S+A2 | 2.90E+03 | 8.50E+03 | 1.45E+04 | * | * | * | * | 8.63E+03c | 5.50E+03 | 6.50E+03 | 9.50E+03 | 1.10E+04 | 1.35E+04 | * | 8.15E+0c |
| S+A3 | 2.80E+03 | 7.00E+03 | 1.30E+04 | * | * | * | * | 7.60E+03d | 4.00E+03 | 5.50E+03 | 9.50E+03 | 1.00E+04 | 1.30E+04 | * | 7.47E+0d |
| S+A4 | 2.80E+03 | 5.50E+03 | 1.29E+04 | * | * | * | * | 7.07E+03e | 3.50E+03 | 4.50E+03 | 6.50E+03 | 8.50E+03 | 1.25E+04 | * | 6.38E+0e |

### 3.3 Sensory evaluation

The score for overall acceptability of sugarcane juice (table 9) just after preparation was ranging from 9.2 to 8.8 being maximum (9.2) for fresh sugarcane juice without anola juice followed by 2 and 5% anola sugarcane juice blend (9.0, 9.1) but minimum (8.8) for 15% anola sugarcane juice blend. The overall acceptability reduced significantly with the advancement of storage and reduction was maximum for fresh sample and minimum for 5% anola sugarcane juice blend followed by 2% blended juice. However, the reduction in overall acceptability for samples stored at room temperature was greater than those stored at refrigeration temperature. Similar results were observed by chauhan et al, 2002). On the basis of sensory evaluation fresh sugarcane juice after 10 day at room temp and after 20 days at refrigerated temperature was not so much acceptable and sugarcane juice blends were acceptable for 20 days at room and 50 days at refrigerated storage. So, most of storage study was done for 20 day at room at 50 days at refrigerated storage.

**Table 9:** Effects of anola juice on Sensory evaluation of sugarcane juice blends during storage.

| Treatment | Room Temperature (Days) | | | | | | | (Sensory) | Refrigerated Temperature (Days) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean | 0 | 10 | 20 | 30 | 40 | 50 | 60 | Mean |
| S | 9.2 | 7.3 | 4.5 | * | * | * | * | 7±0.1cd | 9.2 | 7.3 | 4.5 | * | * | * | * | 7±0.1d |
| S+A1 | 9 | 8.1 | 7.5 | 4.9 | * | * | * | 7.38±0.05b | 9 | 8.1 | 7.5 | 4.9 | * | * | * | 7.38±0.05b |
| S+A2 | 9.1 | 8.6 | 8.2 | 5.3 | * | * | * | 7.8±0.1a | 9.1 | 8.6 | 8.2 | 5.3 | * | * | * | 7.8±0.1a |
| S+A3 | 9 | 7.8 | 6.6 | 5 | * | * | * | 7.1±0.04 c | 9 | 7.8 | 6.6 | 5 | * | * | * | 7.1±0.04c |
| S+A4 | 8.8 | 7.5 | 6.6 | 4.4 | * | * | * | 6.88±0.04d | 8.8 | 7.5 | 6.6 | 4.4 | * | * | * | 6.88±0.04e |

Note. S = fresh sugarcane juice; S+A1 = sugarcane juice (98ml) + anola juice (2ml); sugarcane S+A2 = sugarcane juice (95ml) + anola juice (5ml); S+A3 = sugarcane juice (90ml) + anola juice (10ml); S+A4 = sugarcane juice (85ml) + anola juice (15ml). Mean ± S.D with different superscript in a column differ significantly ($p<0.05$) ($n=3$). Means with same superscript are not significantly different. * Not recorded due to spoilage.

## 4. Conclusion

On the basis of facts stated above it may be concluded that good quality beverage from sugarcane juice with satisfactory storage stability of 50 days at refrigeration and 20 days at room temperature could be achieved from heat treated sugarcane juice beverage at 75 °C for 10 min after addition anola juice in sugarcane juice. Highly acceptable sugarcane juice beverage on sensory basis with minimum changes in other quality parameters can be achieved by addition of 5% anola juice in sugarcane juice.

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