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Effect of Storage on Quality Parameters of Bottled Sugarcane Juice

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ABSTRACT

The study was conducted to control the sediments during storage for the production of good quality bottled pasteurized sugarcane juice. Work was carried out at Regional Agricultural Research Station, Anakapalli, with different treatments (Pasteurization, Stabilizing gum and Packing material) to study the characteristics in terms of TSS, pH, RS, TS, TA and Turbidity. Fresh sugarcane juice was extracted from the Variety 93A145 and preheated to 60 ^{0}C for 10 minutes. After cooling, stabilizing gum @ 1g/L was added and homogenized for 15 min, also kept for 1 h for settling and sodium benzoate @ 125 ppm was added to clear juice and the juice was sealed in bottles. The bottled juice was again pasteurized at 80 ^{0}C for 10 minutes. The samples were kept for storage studies at refrigerated (4 ± 2 °C) conditions. The result revealed that the quality of the juice can be maintained up to 90 days at refrigerated (4 ± 2 °C) conditions.

Keywords: *Pasteurization, Reduced sugar, Shelf life, Total soluble solids.*

Sugarcane (*Saccharum officinarum L.*) belonging to the family *Graminae*, is a commercial cash crop widely grown in the world. It is the second most important agro-industrial crop of the country and is the only raw material for nearly 526 sugar mills (2015-16) producing about 25.1 million MT of sugar annually apart from being the predominant source of potable alcohol, industrial alcohol and fuel-ethanol. India is the largest consumer and second largest producer of sugar in the world next to Brazil. Sugarcane cultivation in Andhra Pradesh spreads over an area of 1.23 lakh ha in 2015-16, which is roughly 2.46% of cane acreage in the country. Sugarcane has been used as a sweetener for millennia and now a days refined sugar is used in copious quantities in the preparation of sweets, bakery products etc., and also particularly in the preparation of juices, candies and other value added products to supplement the natural sugar found in fruits and vegetables. In India sugarcane is grown mainly for producing sweeteners such as sugar, jaggery and khandasari. Sugarcane juice is a type of drink commonly found in South-East Asia, South Asia and Latin America and also in other countries where sugarcane is grown commercially.

Sugarcane juice is very popular delicious drink and it is rarely available in commercial packaged form. It is extracted by crushing sugarcane between roller crusher and consumed with (or) without blend of ice crystals. A one hundred (100) ml of sugarcane juice provides 40 Kcal of energy, 10 mg of iron and 6 ìg of carotene. It contains water (75-85%), reducing sugar (0.3-3.0%), and non-reducing sugar (10-21%). Sugarcane juice is a great preventive and healing source for sore throat, cold and flu. It hydrates the body quickly when exposed to prolonged heat and physical activity. It is an excellent substitute for aerated drinks. Owing to its commercial importance, it is envisaged that sugarcane juice production can become a profitable business provided efforts are made to preserve its fresh quality during storage. Sugarcane juice has low acidity, high water activity, and high sucrose content therefore deteriorates rapidly even when refrigerated. Poor sanitary conditions during extraction also contribute to faster deterioration in quality which leads to changes in appearance and flavour. The industrialization of sugar cane juice has proven to be a lucrative business for both domestic market and export, but it is required to obtain a process aiming its stabilization. In general, sugarcane juice is spoiled quickly soon after extraction due to presence of simple sugars, and also juice gets very dark color by oxidation of its components (Chlorophyll and Poly phenols). Biodegradation is mainly caused by microorgan-isms mainly *Leuconostoc* sp. (*L.mesenteroides* and *L. dextra-nium*). Appreciable studies have been carried out on sugarcane juice process to increase its shelf life by using pasteurization technique with various temperature-time combinations. viz., 65 ^{0}C for 50 min, 70 ^{0}C for 10 min, 80 ^{0}C for 10 min and also by adding chemical preservatives i.e., citric acid, ascorbic acid, sodium benzoate and potassium metabisulphite in adequate proportions. An attempt was made at Post Harvest Engineering and Technology (PHET) Centre, TNAU Coimbatore and RARS, Anakapalle to standardize the process for the preservation of sugarcane juice by pasteurization to improve the shelf-life up to three months. They reported that, formation of sediments at the bottom of storage container is a major problem to transfer the technology to the entrepreneurs. The information on use of stabilizing gums and mechanical filtration to control the sediments during storage is practically non-existent. In view of this, the present study was conducted to explore the use of stabilizing gum (Gelatin) to control the sediments during storage for the production of good quality bottled pasteurized sugarcane juice. This was carried out at Regional Agricultural Research Station, Anakapalli. An attempt was made to develop process technology for improving shelf life of sugarcane juice with different treatments.

MATERIAL AND METHODS

The raw material i.e. sugarcane (variety 93A145) was collected from Regional Agricultural Research Station farm, Anakapalli, Visakhapatnam, Andhra Pradesh. The variety was chosen because of high juice content and also it is grown widely as per the preference of local sugar mills. All the chemicals used in experimentation and analysis were of analytical grade, purchased from standard Indian chemical companies. Glass (200 ml), polyethylene Terepthalate (PET) (200 ml) and poly propylene (PP) (250 ml) for packing of juice obtained from M/S Globe packing solutions Secundrabad, M/S Vishali polymers Kukatpalley, and M/S Vijaya sri polymers Begumpet, Hyderabad respectively. Sugarcane stems with good quality and without any pest or disease infestation were selected and peeled for juice extraction. Gelatin can be used to clarify fruit juices as well as added to the final product to stabilize beta-carotene, which is often used as a coloring agent.

Sugarcane juice crusher

Power operated sugarcane juice crusher consisting of four dust free rollers of food grade stainless steel was used to extract the juice from sugarcane. Once the sugarcane is inserted, quality juice gets extracted automatically without the need to really do any other action. The machine is almost fully covered, ensures that no dust, flies on the rollers and easy to operate.

Table 1: Technical specifications of sugarcane juice crusher

Parameter	Specifications
Height	1350mm
Length	600 mm
Width	480 mm
Weight	90 kg
Cane crushing capacity	60 – 80 kg/h
Juice extraction efficiency	90-95 % (single pass)
Power requirement	1.5 hp

Various changes in physico-chemical, sensory and microbiological properties of sugarcane juice subjected to the following treatments during storage were studied to study the shelf-life of juice.

Treatments:

T_1 = Thermal treatment, addition of preservative, stabilizing agent, homogenization and Filtration cum Pasteurization

T_2 = Thermal treatment, addition of preservative, stabilizing agent, homogenization and Normal Pasteurization

T_3 = Thermal treatment, addition of preservative, Filtration cum pasteurization

T_4 = Thermal treatment, addition of preservative, normal pasteurization

All the above samples of four different treatments were bottled in three different types of bottles (Glass, PET and PP), so the total treatments are twelve and they were stored at refrigerated temperatures of 4±2 °C and quality parameters of sugarcane juice were studied at an interval of 7 days for the refrigerated condition with three months of storage period. The number of replications is three.

Determination of %Brix of processed sugarcane juice

Total soluble solids (TSS) of juice were measured by placing a drop of the sugarcane juice sample on the prism of the Pocket Refractrometer (ATAGO make, Model: PAL-1) and expressed in terms of % Brix (Ranganna, 1986). The TSS of sugarcane juice was measured at an interval of 7 days for the refrigerated samples up to the 90 days of storage period. The changes were recorded for all treatments during the storage period.

Preparation of the sugarcane juice

The process flow chart for the preparation of bottled pasteurized sugarcane juice has been presented in Fig 3.1.

Fresh sugarcane stem

⇩

Grading, washing and peeling of stem

⇩

Juice extraction by power operated juice extractor

⇩

Filteration by muslin cloth

⇩

Clear juice of sugarcane

⇩

Preheating (50 ºC for 10 min)

⇩

Addition of preservative (Sodium benzoate@125 ppm)

⇩

filling of cane juice

⇩

sealing the bottle

⇩

Pasteurization (80 ºC for 10 min)

⇩

Labeling

Fig. 3.1. Flow chart of bottling of sugarcane juice

Determination of pH

The pH measurement was performed using a digital pH meter (OHAUS pH system, Model: STARTER 2100) using a glass electrode. The electrode was dipped in the thoroughly mixed samples of sugarcane juice and the value was registered once it had stabilized (Ranganna, 1986). This pH was measured at an interval of 7 days for refrigerated samples up to the 90 days of storage period. The changes were recorded for all treatments during the storage period.

Determination of Titratable acidity

The acidity was measured in terms % of the predominant acid present in the juice by titration against (0.1 N) NaoH (Ranganna, 1986). The calculations of titratable acidity can be shown below

$$\% \text{ acid} = \frac{\text{mL NaOH used x 0.1 N NaOH x milli equivalent factor x 100}}{\text{grams of sample}}$$

Determination of Total Sugars and Reducing Sugars

Lane and Eynon method (Ranganna, 1986) was used for determination of total and reducing sugars. The principle involved is Copper in the Fehling solution is reduced to red insoluble cuprous oxide in the presence of invert sugars like glucose and fructose. The quantity of sugars solution required for complete neutralization of a known quantity of Fehling mixture is determined by titration using methylene blue as the indicator.

Reducing Sugars

A sample of 20 ml sugarcane juice was taken in a burette then after Fehling mixture (A&B, 5 mL) each was taken in a 250 mL beaker and dilute to 50 mL. After that the beaker was placed in a hot plate and kept for some time (bubble forming) then add 2 to 3 drops juice sample in Fehling solution, then blue color disappeared then add 1 to 2 drops of methylene blue indicator it appeared again blue then titrate against juice sample until required end point was obtained (brick red color).

Reducing sugars (%) $= \frac{(\text{factor } (0.052)^{*}\text{dilution}^{*}100)}{(\text{titre }^{*}\text{wt. of sample})}$

Total sugars (%) = % Reducing sugars+ % Sucrose

Determination of Turbidity

The turbidity was measured using an ELICO Spectrophotometer SL27 VIS (Plate 3.17) at transmittance of 900 nm using a transparent cuvet. The sugarcane juice sample was filled in cuvette, then cuvette was placed in cubicle in the path of light and the value was registered once it had stabilized. This turbidity was measured at an interval of one day for room and 7 days for refrigerated samples up to the 90 days of storage period. The changes were recorded for all treatments during the storage period.

RESULTS AND DISCUSSION

Changes in Total Soluble Solids

Figure 1 show the variation of TSS values of sugarcane juice with storage period of 90 days at refrigerated temperature. All the samples showed similar trends; sharp decrease in TSS with storage period. The TSS of treatment was found to decreased from 24.5 to 20.9; 24.6 to 21.4; 24.5 to 21.4; 23.4 to 19.9; 23.1 to 19.5; 23.4 to 20.5; 24.1 to 21.2; 24.1 to 21.1; 24.2 to 20.8; 23.6 to 21.1; 23.5 to 21.2; and 23.7 to 20.5% Brix for the treatments T_1P_1, T_1P_2, T_1P_3, T_2P_1, T_2P_2, T_2P_3, T_3P_1, T_3P_2, T_3P_3, T_4P_1, T_4P_2 and T_4P_3, respectively. Similar results have been reported by Chauhan *et al*. (2002). The percentage of decrease in TSS is less which may be due to resistance in fermentation process.

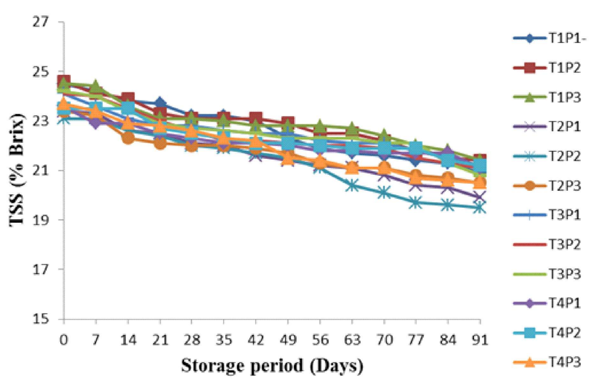

Fig. 1. Variation of TSS Values with Storage Period at Refrigerated Temperature

Changes in pH

Figure 2 shows the variation of pH values of sugarcane juice with storage period of 90 days at refrigerated temperature. All the samples showed similar trends; sharp decrease in pH with storage period. The pH of treatment was found to decrease from 5.67 to 4.98; 5.54 to 4.24; 5.56 to 4.5; 5.52 to 4.95; 5 .78 to 4.4; 5.63 to 4.92; 5.59 to 4.91; 5.55 to 4.9; 5.62 to 4.89; 5.7 to 4.93; 5.64 to 4.5; and 5.63 to 4.88 for the treatments T_1P_1, T_1P_2, T_1P_3, T_2P_1, T_2P_2, T_2P_3, T_3P_1, T_3P_2, T_3P_3, T_4P_1, T_4P_2 and T_4P_3, respectively. The decrease in pH upon storage was might be due to the production of lactic acid and acetic acid during fermentation. Similar observation was made by Krishnakumar and Devadas (2006).

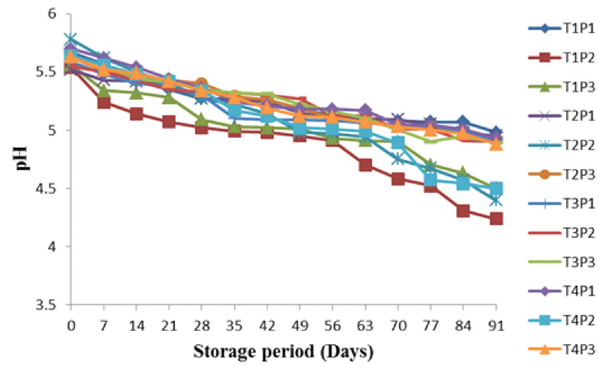

Fig. 2. Variation of pH for Different Treatments of Sugarcane Juice Stored at Refrigerated Temperature

Changes in Titratable Acidity (TA)

Figure 3 shows the variation of TA values of sugarcane juice with storage period of 90 days at refrigerated temperature. All the samples showed similar trends; gradually increase in TA with storage period. The TA of treatment was found to increase from 0.46 to 0.9; 0.37 to 1.08; 0.39 to 1.17; 0.392 to 0.945; 0.41 to 1.08; 0.395 to 0.86; 0.375 to 0.975; 0.397 to 1; 0.381 to 1.095; 0.29 to 0.78; 0.36 to 0.855; and 0.373 to 0.8 for the treatments T_1P_1, T_1P_2, T_1P_3, T_2P_1, T_2P_2, T_2P_3, T_3P_1, T_3P_2, T_3P_3, T_4P_1, T_4P_2 and T_4P_3, respectively. From the fig. 4.3 it was observed that the TA generally increased on storage for all the treatments in the study. Similar observation was made by Krishnakumar and Devadas (2006).

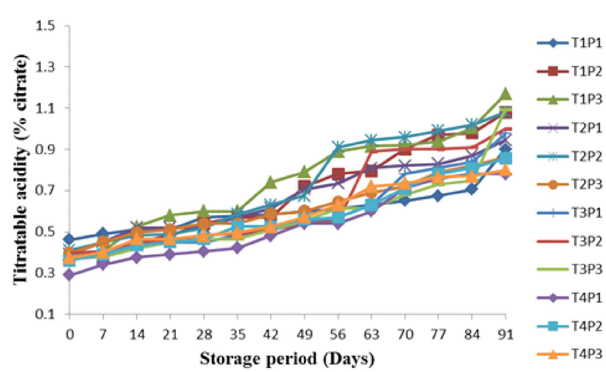

Fig. 3. Variation of TA for Different Treatments of Sugarcane Juice Stored at Refrigerated Temperature

Changes in Reducing Sugars (RS)

Figure 4 shows the variation of RS values of sugarcane juice with storage period of 90 days at refrigerated temperature. All the samples showed similar trends; increase in the % of reducing sugars in all the treatments with storage period. The RS of treatment was found to increase from 0.58 to 2.54; 0.68 to 2.6; 0.62 to 2.166; 0.81 to 2.6; 0.8 to 2.131; 0.59 to 2.363; 0.79 to 1.857; 0.826 to 1.884; 0.752 to 1.83; 0.78 to 1.818; 0.57 to 1.857; and 0.824 to 1.733 for the treatments T_1P_1, T_1P_2, T_1P_3, T_2P_1, T_2P_2, T_2P_3, T_3P_1, T_3P_2, T_3P_3, T_4P_1, T_4P_2 and T_4P_3, respectively.

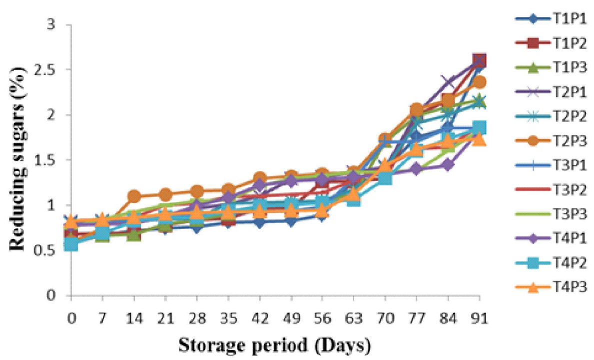

Fig. 4. Variation of RS of Different Treatments of Sugarcane Juice Stored at Refrigerated Temperature

The reducing sugars were found to be increased because of the breakdown of total sugars into reducing sugars because of the hydrolysis of non-reducing sugars to reducing sugars. Similar observations were made by Chauhan *et al*. (2002).

Changes in Total Sugars (TS)

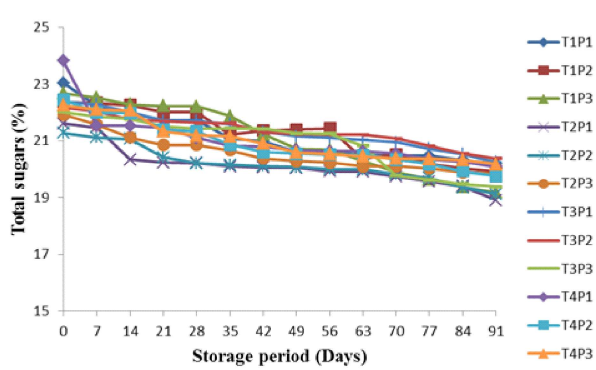

Figure 5 shows the variation of TS values of sugarcane juice with storage period of 90 days at refrigerated temperature. All the samples showed similar trends; decrease in the % of total sugars in all the treatments with storage period. The TS of treatment was found to decreased from 23.03 to 20.19; 22.36 to 19.92; 22.68 to 19.18; 21.61 to 18.91; 21.28 to 19.11; 21.93 to 19.83; 22.39 to 20.24; 22.16 to 20.37; 22.02 to 19.38; 23.82 to 20.08; 22.46 to 19.75; and 22.25 to 20.18 for the treatments T_1P_1, T_1P_2, T_1P_3, T_2P_1, T_2P_2, T_2P_3, T_3P_1, T_3P_2, T_3P_3, T_4P_1, T_4P_2 and T_4P_3, respectively. It was observed that TS generally decreased on storage for all the treatments in the study. Similar observations were made by Chauhan *et al*. (2002).

Changes in Turbidity

Turbidity is inversely related to light transmission values. Figure 6 shows the variation of turbidity values of sugarcane juice with storage period of 90 days at refrigerated temperature. All the samples showed similar trends; sharp decrease in turbidity with storage period. The turbidity of treatment was found to decreased from 80.2 to 53.21; 79.9 to 51.4; 80.1 to 53.17; 79.7 to 49.34; 79.1 to 47.62; 79.4 to 46.42; 76 to 37.14; 74.2 to 34.52; 75.7 to 36.91; 75.8 to 35.41; 74.1 to 35.32; and74.6 to 35.4 for the treatments T_1P_1, T_1P_2, T_1P_3, T_2P_1, T_2P_2, T_2P_3, T_3P_1, T_3P_2, T_3P_3, T_4P_1, T_4P_2 and T_4P_3, respectively. It is observed that % of transmittance generally decreased on storage for all the treatments in the study similar observations were made by Patricia and Roberto (2010)

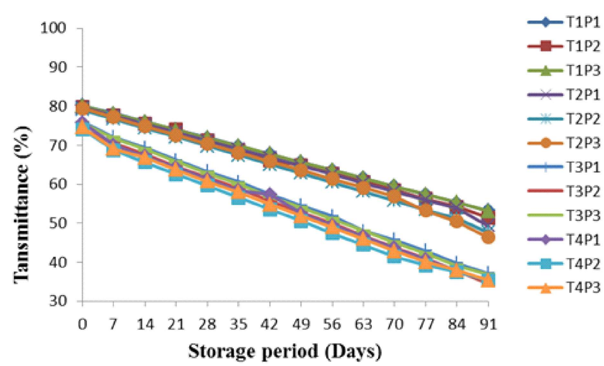

Fig. 6. Variation of Transmittance (%) of Different Treatments of Sugarcane Juice Stored at Refrigerated Temperature

CONCLUSIONS

The percentage of decrease in TSS is less may be due to resistance in fermentation proces. The decrease in pH upon storage might be due to the production of lactic acid and acetic acid during fermentation. The TA generally increased on storage for all the treatments in the study. The reducing sugars increased because of the breakdown of total sugars into reducing sugars because of the hydrolysis of non-reducing sugars to reducing sugars. TS generally decreased on storage for all the treatments in the study. It is observed that % of transmittance generally decreased on storage for all the treatments.

LITERATURE CITED

Anonymous. 2016. Indian Sugar. *The Complete Sugar Journal*. LXVI(12): 40-45.

Chauhan O P, Dheer S, Tyagi S M and Balyan D K 2002 Studies on preservation of sugarcane juice. *International journal of food properties*. 5(1): 217-229.

Krishnakumar T and Devadas C T 2006 Quality changes in sugarcane juice by delayed extraction and storage. *Beverage and Food World.* 33(2): 76-78.

Patricia P and Roberto H M 2010 Study of clarification process of sugar cane juice for consumption. *Ciencia e Tecnologia de Alimentos*. 30(3): 776-783.

Ranganna S 1986 Hand book analysis and quality control for fruit and vegetable products. *Publisher –Tata McGraew-Hill, New Delhi.* 182-189.

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