International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2022; 10(1): 40-44

Received: 13-11-2021
Accepted: 27-12-2021

**Mridu Megha Dalai**
M.Tech, Department of Agricultural Processing and Food Engineering, College of Agricultural Engineering and Technology, OUAT, Bhubaneswar, Odisha, India

**Manoj Kumar Panda**
Professor and Research Engineer, AICRP on PHET, Department of Agricultural Processing and Food Engineering, College of Agricultural Engineering and Technology, OUAT, Bhubaneswar, Odisha, India

**Corresponding Author:**
**Mridu Megha Dalai**
M.Tech, Department of Agricultural Processing and Food Engineering, College of Agricultural Engineering and Technology, OUAT, Bhubaneswar, Odisha, India

# Storage studies on pasteurized sugarcane juice

**Mridu Megha Dalai and Manoj Kumar Panda**

**Abstract**
Storage study was conducted to observe the shelf life of sugarcane juice by effect of pasteurization treatment at 90 °C for holding time 90s. Pasteurization treatment at 90 °C for holding time 90 sec have quality attributes like color change (15.6), TSS (14°Brix), titrable acidity (0.143%), total phenolic content (27 mg GAE/100ml), reducing sugar (2.54%), polyphenol oxidase activity (0.91unit of ppo/ml), microbial load (3.5 log cfu/ml) and sensory evaluation (8.66). The effects on different quality parameters of the product such as color, TSS, titrable acidity, phenolic content, reducing sugar, PPO activity, microbial load and sensory evaluation were studied at every 7 days interval. The storage studies of pasteurized treated juice indicate that the juice could be stored at refrigerated condition up to 15 days. Under the ambient condition, the treated juice gets spoiled within two days, therefore it was kept under refrigerated condition. Thus, it was found that pasteurized treated sugarcane juice at 90 °C for 90 sec can be stored under refrigerated condition (8-10 °C) up to 15 days.

**Keywords:** Sugarcane juice, pasteurization treatment, storage, color, TSS, reducing sugar, polyphenol oxidase activity, microbial load

## Introduction
Sugarcane (*Saccharum offcinarum*) is one of the most important commodity in food sector. In India sugarcane is cultivated mainly for sugar and for direct consumption of juice. Sugarcane produces long sword like shape which has a height ranges to 10-24 feet. One of the most sought after thing from sugarcane is its fresh juice extracted from pressed sugarcane through expeller.

Sugarcane provides raw materials in food industry to produce sugar, jaggery, khandsari, building materials, spirit and other agro industrial products. Mainly sucrose is extracted and purified and used as raw material in food industry or is fermented to produce ethanol while the juice is the liquid extracted from crusher. Sugarcane juice is highly beneficial when taken fresh. It is kind of like energy booster full of carbohydrates and iron, medically juice is useful for the treatment of enlarged prostate, reduce acidity, ailments like cystites, nephritis and gonorrhea. For better results it should be used with coconut water, ginger juice and lime juice. Its regular use can help to gain weight to under nutrition person (Kalpana *et al.*, 2013).

Sugarcane juice after extraction cannot be stored on more than 24 hours with its original taste and aroma even in a chilled condition that is the reason why we see expellers everywhere all the year. There is no way out but to consume juice fresh. It is important to increase the shelf of juice by which it can be consumed any time. The problem associated with it is after extraction it get spoiled due to the fast fermentation is it contains about 0.5% reducing sugar, 15-18% sucrose, mineral salts and adequate amount of organic nitrogen for microbial growth (Qudsieh *et al*., 2002). The browning reactions that contribute to the deterioration of juice are triggered by both enzymatic (polyphenol oxidase and peroxidase) and nonenzymatic mechanisms (*Maillard* reaction, caramelization, thermal degradation reactions and condensation of sugars) **(**Bucheli & Robson, 1994) [2].

Storage of sugarcane juice in proper manner can lead to great development in food sector as sugarcane can increase great market value. This study addressed the shelf life evaluation of standardized cane juice stored under ideal, and abuse refrigeration temperatures.

## Materials and Methods
Pasteurized treated sugarcane juice at 90 °C for 90s was filled in sterilized glass bottles. These bottles are then stored under ambient (25 °C) and refrigerated conditions (8±2 °C) for 21 days. The changes in quality parameters were taken in 7 days interval.

**Storability of treated sugarcane juice in packaging material**

Independent and dependent parameters of the study were as follows:

**Table 1:** Study parameters

| Independent variables | Dependent variables |
|---|---|
| • **Packaging material**: Glass bottles<br>• **Storage condition:** ambient, 8-10 °C<br>• **Storage period**: 21 days | • Colour<br>• TSS<br>• Titrable acidity<br>• Microbial load<br>• Total phenolic content<br>• Reducing sugar<br>• PPO inactivation<br>• Sensory quality |

**Methodology adopted for determination of quality parameters of stored juice**

**Color measurement**

The color measurements were performed using a digital colorimeter (CR-20 Konica Minolta, Tokyo, Japan) which shows the values as $L^*$, $a^*$, $b^*$. Total color change (ΔE) was calculated of refrigerated sample in every 7 days interval. It was obtained to know the difference in color of stored sample from treated sample and was calculated by given equation.

$$\Delta E = \sqrt{(L_2-L_1)^2 + (a_2-a_1)^2 + (b_2-b_1)^2}$$

**Total Soluble Solids (TSS)**

The TSS of the sugarcane juice was measured by refractometer which determines the total soluble solids of stored sample and is expressed in degrees Brix.

**Titrable Acidity**

Titrable acidity was calculated of stored sample using sodium hydroxide as titrant. It is calculated by the formula:

$$\text{Titrable acidity}(\%) = \frac{\text{Equivalent wt. of acid X vol. of NaOH required X 0.1}}{\text{10X wt. of sample taken}}$$

**Total Phenolic Content**

The stored sample in refrigeration was taken out in every 7 days interval and phenolic content was calculated and compared with treated sample. The total phenolic content was found by using Folin-Ciocalteu reagent method. In a testube 0.5 ml of stored sample was taken and leveled up by addition of 7.5 ml distilled water. Thereafter 1 ml of 50% Folin-Ciocalteu reagent was added and after 5 min, 1 ml (20%) of $Na_2CO_3$ was added. The absorbance reading was taken after 45 min at room temperature at 720 nm using spectrophotometer.

$$\text{Total phenolic content (mg GAE/100ml)} = \frac{\text{Concentration of sample after absorbance reading}}{\text{wt.of sample taken x 10 x 0.5}}$$

**Reducing Sugar**

In every 7 days interval the stored sample was taken out and reducing sugar was obtained. The reducing sugar was determined by using DNS (3, 5- dinitrosalicyclic acid) solution in which about 0.1 ml of the stored sample of juice was equalized with 5.9 ml of distilled water in testube. 3 ml DNS was added in the sample and the test tubes were heated in boiling water for 5 min. Then test tubes were taken out and while they were warm, 1 ml of Rochelle salt solution was added in it. It was cooled and the absorbance reading was taken at 510 nm.

$$Reducing\ sugar(\%) = \frac{Concentration\ x\ 1}{50\ x\ volume\ of\ sample\ taken}$$

**Polyphenol oxidase (PPO) activity**

PPO activity was calculated by using 0.2 M catechol solution and 50 M phosphate buffer (pH 6.5). In a test tube, a mixture was prepared by addition of 4 ml of phosphate buffer and 2 ml of catechol solution and 1 ml of stored sugarcane juice was added. The absorbance reading was carried out at every 1 min interval at 420 nm. One unit of PPO activity was defined as 0.001DA420/min (Ozoglu & Bayindirli, 2002) [7]. Sample's activity was measured in terms of % residual PPO Activity (RA) as given in the equation.

Unit of ppo/ml = $(Abs_f - Abs_i)/0.001$* time

**Microbial Load**

It is the most important parameter to know the shelf life of juice. This factor will determine up to how days it lasts. To determine the microbial load media was prepared by suspending 13 mg of nutrient broth in 1000 ml of water with 2% agar powder of the solution for bacteria test. Sterilized media was autoclaved at 121 °C (15 lbs pressure) for 15 minutes. The media was then properly mixed before dispensing into the sterilized petriplates. The petriplates are kept in laminar air flow chambers for 20-25 min under the surveillance of UV light to solidify them. In sterile saline solution of 0.85g/100 ml, the pasteurized juice samples were diluted and were spread in petriplates. The plates were incubated at proper temperature and time i.e at 37 °C for 24 h to obtain bacterial colonies. Thereafter the bacterial colonies were counted in which there were colonies between 30-300. Colonies formed per unit was calculated by formula:

$$\text{CFU/ml} = \frac{\text{Number of colonies x dilution factor}}{\text{Volume of sample plated}}$$

**Sensory Evaluation**

Sensory evaluation was done by 10 panelists through 9-point hedonic rating test method. The color, flavour, taste and overall acceptability were analyzed by the panelist of stored sample.

**Result and Discussions**

In this study the pasteurized sugarcane juice at temperature 90 °C for 90 seconds was stored in glass bottles in ambient and refrigerated conditions for 21 days to study the shelf life of the juice. It was observed that sugarcane juice got spoiled within two days in ambient condition whereas in refrigerated condition (8±2 °C) it had acceptable quality up to 15 days. Different quality attributes such as color, TSS, titrable acidity, phenolic content, reducing sugar. PPO activity, microbial load and sensory evaluation were studied at every 7 days interval.

**Table 3:** Effect on quality parameters of sugarcane juice after pasteurization treatment @ 90 °C, 90s

| Treatment & time (sec.) | Color change (ΔE) | TSS (°brix) | Titrable acidity (%) | Total phenolic (mg of G.A.E /100ml) | Reducing sugar (%) | PPO (unit of ppo /ml of juice) | Microbial load, log(cfu/ml) | Sensory evaluation |
|---|---|---|---|---|---|---|---|---|
| 90°C, 90s | 15.6± 0.19 | 14±0 | 0.14± 0.002 | 26.99±1.59 | 2.54±0.11 | 0.91±0.52 | 3.5± 0.18 | 8.16± 0.28 |

## Color

The effect of storage period on color change of the sample treated with 90 °C for 90s is depicted in fig.1. In 7 days of storage all the color parameters presented higher $L^*$ value (light in color), higher $a^*$ value (reddish tone) and higher $b^*$ value (yellowish tones). Therefore, the change in color decreased to 3.44 (87%). Enzymatic activity after processing may be responsible for the color changes observed.

Similarly, after 15 days and 21 days of storage all the color parameters value increased which led to increase in color change of the juice to 47.38% and 50.4% respectively. Thus, increase in color change indicates at time of storage period group of microorganisms are able to grow which gives the lighter color (higher L* values) resulting reduction in suspended solids. Both a* and b* values also increased i.e. more of red and yellow tones. The similar findings were found by (Queiroz *et al.*, 2018) during the storage period of sugarcane juice.

## TSS

It was observed that TSS of the juice was 14º Brix after treatment. The change in TSS of sugarcane juice during storage period of 21 days is shown in the fig.2. In 7 days of storage, TSS increased to 1.85% with respect to treated sample. Further, in 15 days of storage period it increased to 16.2°Brix (14.02%) and in 21 days of storage, the TSS increased to 20°Brix (23%) due to increase in turbidity during storage period. Balaswamy *et al.* (2011) [1] found the same increasing trend of TSS of different non-carbonated beverages during storage period.

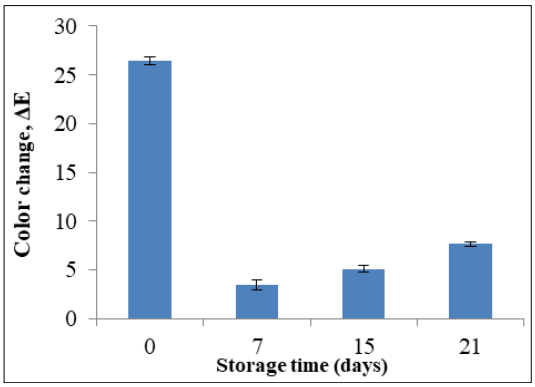


**Fig 1:** Change in color of sugarcane juice during storage

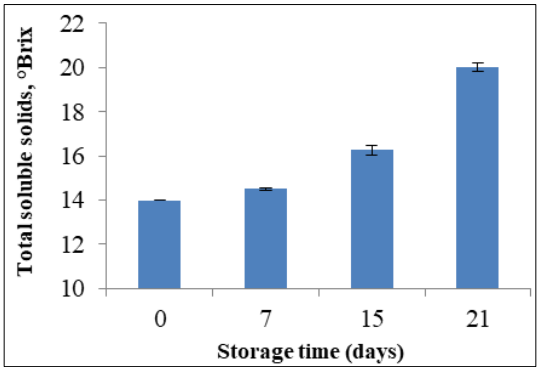


**Fig 2:** Change in TSS of sugarcane juice during storage

## Titrable acidity

The acidity of the juice presented slight increase during the storage period as shown in fig.3. The titrable acidity after treatment was 0.143%. In 7 days of storage period the acidity increased to 0.155% i.e. 8.39% with respect to treated sample. Similarly, after 15 days of storage period the acidity increased to 0.185% (19.35%). But after 21 days juice was spoiled which led to increase in acidity to 0.25% (39%). Similar findings were made by Sahota *et al.* (2010) [8] in various low alcoholic beverages during storage.

## Total Phenolic Content

Total phenolic content of sugarcane juice stored in glass bottles during storage period of 21 days is shown in fig.4. The phenolic content of sugarcane juice after treatment was 27 mg GAE/100ml. In 7 days of storage phenolic content reduced to 19.47% (21.74mg GAE/100ml) with respect to treated sample. Similarly, after 15 days of storage, the phenolic content reduced to 25% (16.31mg GAE/100ml). In 21 days of storage, the phenolic content again decreased to 10.22 mg GAE/100ml (37.33%). The phenolic compounds decreased during the storage as the phenolics undergo oxidative cleavage and its polymerization with proteins resulted in reduction of phenolic contents as suggested by Cao *et al.* (2011) [3].

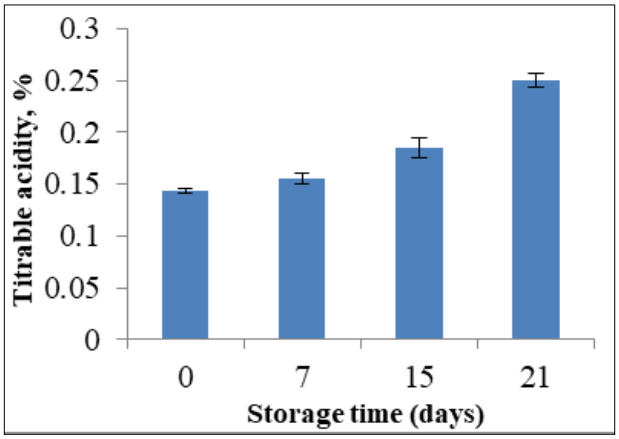


**Fig 3:** Change in titrable acidity of sugarcane during storage

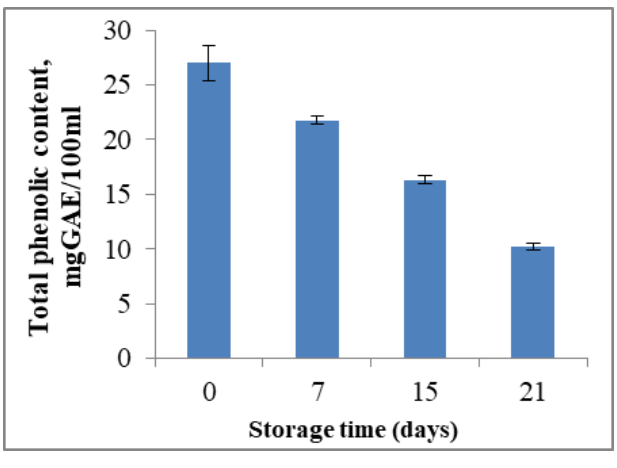


**Fig 4:** Changes in total phenolic content in sugarcane juice during storage

**Reducing Sugar**

Reducing sugar of cane juice during 21 days of storage period is shown in the fig.5. From the figure, it is clear that reducing sugar increased during storage period. In 7 days of storage, reducing sugar increased 2.77% with respect to treated sample and in 15 days of storage period it increased 3.37%. Reddy (2004) found similar results in watermelon RTS beverage and sapota juice respectively. In 21 days of storage duration, reducing sugar increased to 5.3%. Thus, it was found that juice was fermented completely within 21 days of storage which led to the spoilage.

**PPO activity**

PPO activity during storage of sugarcane juice is shown in fig.6. PPO activity decreased significantly after treatment and it's important that it could be maintained during the storage period. In 7 days of storage period PPO increased from 0.91to 1.38 (51.64%) unit of ppo/ml of juice. Further, after 15 days of storage period PPO activity increased to 1.68 unit of ppo/ml of juice (21.73%). There was browning of the juice after 21 days of storage period due to increase in PPO activity to 2.67 unit of ppo/ml of juice (60%). The browning of the juice was due to the enzymatic (PPO) oxidation of phenolic compounds in the presence of oxygen which converted to dark insoluble compounds. The similar findings were reported by Eissa *et al.* (2010) [5].

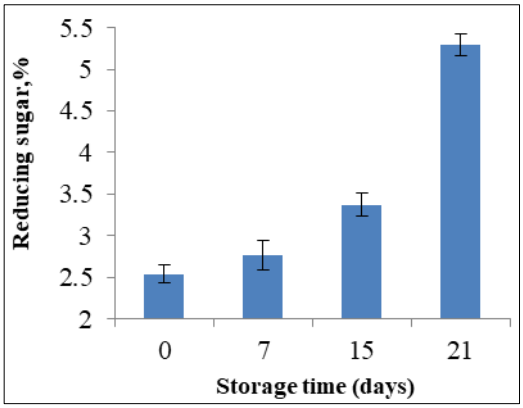


**Fig 5:** Change in reducing sugar of sugarcane during storage

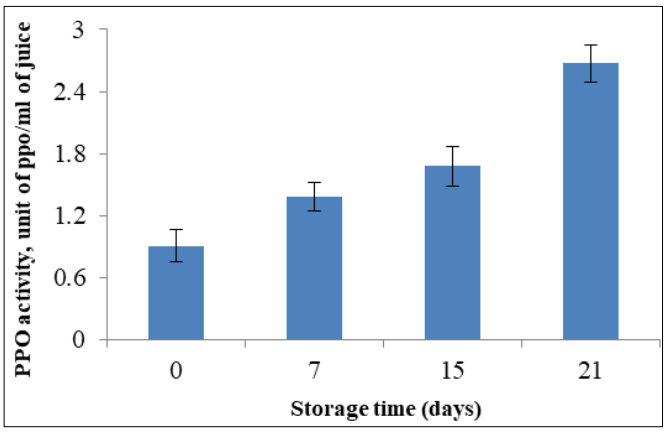


**Fig 6:** Change in PPO activity of sugarcane during storage

**Microbial Load**

The changes in microbial load during storage period of sugarcane juice are shown in the fig.7. In 7 days of storage, microbial load increased from 3.5 to 4.16 log cfu/ml i.e. 18.85% with respect to treated sample. After 15 days of storage period, it increased 3.84% (4.32 log cfu/ml). The sugarcane juice was spoiled after 21 days of storage period which resulted in increase in microbial load to 6.2 log cfu/ml (43.5%). Karmakar *et al.* (2011) [6] reported that sugarcane juice can be microbiologically safe and stable for 25 days when pasteurized at 90 °C for 5 min and stored at refrigerated condition (4 °C).

**Sensory Evaluation**

The change in sensory evaluation during the storage period of 21 days is shown in the fig. 8. In 7 days of storage the sensory scores decreased to 12.79% i.e. from 8.6 to 7.5. There was no significant change in taste, color and flavor of the juice in 7 days of storage period. But in 15 days of storage, the sensory scores decreased to 6.5 (13.33%) which was acceptable as the overall acceptability was above 60%. Further, after 21 days of storage period the juice was spoiled as discussed in earlier section, due to which the overall acceptability of the juice decreased to 3.5(46%). Therefore, the sugarcane juice treated with 90°C for 90s was acceptable up to 15 days of storage duration at refrigeration. Sneh Sankhla *et al.* (2012) found similar results during the storage of sugarcane juice.

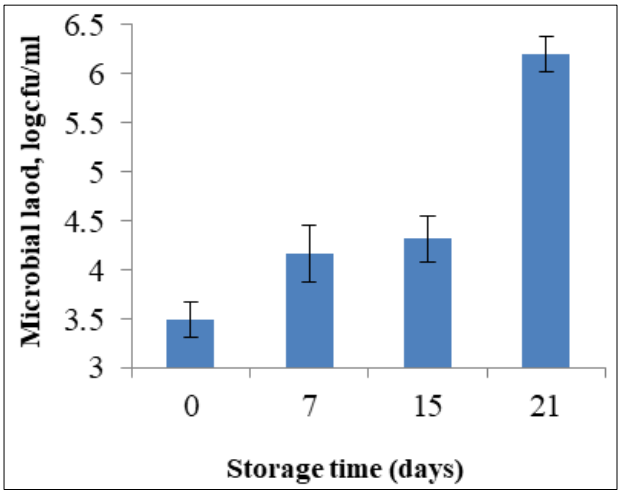


**Fig 7:** Change in microbial load of sugarcane during storage

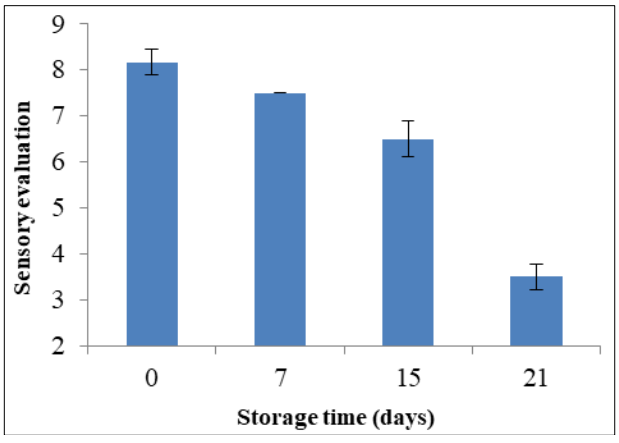


**Fig 8:** Change in sensory evaluation of sugarcane during storage

**Conclusion**

It can be concluded that sugarcane juice stored in glass bottles after pasteurization treatment at 90°C for 90 sec has acceptable quality up to 15 days of storage under refrigerated condition. It was found that juice has acceptable quality parameters.

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