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# The Effect of Storage Duration on the pH Stability and Reducing Sugar Content of Liquid Cane Sugar with Brix Concentrations of 65, 66, and 67 Under Room Temperature and Refrigerated Conditions

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**Abstract**

Cane liquid sugar is a form of cane sugar derivative products that are processed through a series of stages, ranging from extraction, refining, to evaporation to obtain a sugar solution with a certain concentration. However, liquid sugar is easily damaged during storage, so it is necessary to carry out a shelf life analysis to ensure product safety and quality. This study aims to determine the effect of the long storage of sugarcane liquid sugar with the concentration of Brix 65, 66, and 67 on the stability of pH and Reducing sugar at room and refrigerator temperature conditions. Samples of cane liquid sugar were stored in 100 ml borosilicate glass bottles for 30 days and then pH and sugar reduction tests were carried out on day 0, day 7, day 14, day 21, and day 30. The results showed that the longer the storage, the more significant changes occurred in the pH and Reducing sugar levels, with the refrigerator storage temperature being more able to maintain stability than the room temperature. Higher Brix concentrations provide better stability to such changes. The longer the storage, the lower the pH and the more the reducing sugar will increase.

## INTRODUCTION

Indonesia is one of the countries with high sugarcane production, but challenges in distribution and storage demand product diversification, one of which is in the form of liquid sugar which is more practical for food, beverage, and pharmaceutical industry applications (Sjarif et al., 2021). Sugarcane or *Liquid Sugar* It is a form of derivative product of cane sugar that is processed through a series of stages, ranging from extraction, purification, to evaporation to obtain a sugar solution with a certain concentration (Azlan et al., 2023; Babu & Adeyeye, 2024; Marasinghege, 2023; Ungureanu et al., 2022). This product is widely used in the food and beverage industry because of its ease of use and relatively high stability compared to crystal sugar (Baroyi et al., 2024; Bause et al., 2024; Benucci et al., 2025; Gomes et al., 2023; Latif et al., 2025). One of the important parameters in the quality of liquid sugar is the pH value and the reduction sugar content, which can change during storage depending on environmental conditions and the length of storage (Hasan et al., 2024; Šopík et al., 2022; Stathas et al., 2023; Tarapoulouzi et al., 2023).

Liquid sugar obtained from the process of refining and condensing cane sugar, has advantages such as ease of application and quality stability, but is still greatly influenced by the conditions and storage time (Murdiati et al., 2008). The main factors that determine the stability of liquid sugar are pH and Reducing sugar levels because a drop in pH and a rising reduction

sugar can indicate the occurrence of sucrose hydrolysis, enzymatic reactions, or chemical changes during storage, especially if temperature conditions are not controlled (Selvi, 2025).

Referring to previous research conducted by Sjarif et al, 2021 and Murdiati et al, 2008 stated that the shelf life and room temperature are known to increase Reducing sugar and lower pH even though higher brix concentrations provide better stability in the quality of sugarcane liquidated sugar. Further testing has also shown that low temperatures such as storage in refrigerators can slow down the reaction of these changes, thus extending shelf life and quality *Liquid Sugar* (Selvi, 2025).

To date, no test studies have been found that specifically compare the relationship between the shelf life of liquid sugar at different temperatures and variations in the concentration of brix in liquid sugar solutions. Thus, the purpose of this study is intended as a basis for scientific knowledge and information in analyzing the effect of the long storage of sugarcane liquid sugar with the concentration of brix 65, 66 and 67 on the stability of pH and reducing sugar in room and refrigerator temperature conditions.

## METHOD

The ISO 17025 standard test laboratory was used as a place for this research which is located in one of the refined sugar factories in Cilegon City, Banten Province. The variation in the concentration of the liquid sugar solution sample was obtained from the results of weighing crystal sugar using an analytical balance and then dissolved using *Shaker*. After that, the brix 65, 66 and 67 concentration solutions were stored and analyzed for pH stabilization and sugar reduction in the 0th, 7th, 14th, 21st and 30th day time periods at room temperature storage conditions and refrigerators. The pH value is tested with a calibrated digital pH meter so that the results of the reading of the tool are guaranteed to be valid, then the reduction sugar is measured using the ICUMSA GS 2/3/9-5 (2011) method with the principle of a sugar solution that has been mixed with *Alkaline Copper Reagent* heated in a water heater or water bath. *Cupric ion* from *Alkaline Copper* will be reduced to *Cuprous oxide* by the reducing sugar contained in the sugar solution and after cooling *Residual Tone Cupric* will be titrated by EDTA using the *Murexide.* This study used ANOVA statistical data analysis (*Analysis of Variance*) on $\alpha$=5%. If the results of the analysis show that the treatment has a significant effect on the observed parameters, then a follow-up test of DMRT is carried out (*Duncan's Multiple Range Test*) at a significance level of 5% to find out the real different treatments.

## RESULTS AND DISCUSSION

### pH

The results of the variety-based fingerprint analysis (ANOVA) showed that the storage time, storage temperature, and Brix concentration had a significant effect on the pH value of sugarcane liquid sugar (F calculated > F table 5%). This indicates that these three factors have a significant relationship with pH stability during the storage process. The average pH decreased from 6.347 on day 0 to 5.260 on day 30 at room temperature, and from 6.347 to 5.344 at refrigerator temperature.

**Table 1. pH test results of cane liquid sugar storage room temperature storage**

| Storage | Brix Concentration | | | Average |
|---|---|---|---|---|
| | 65 | 66 | 67 | |
| Day 0 | 6,36 | 6,35 | 6,33 | 6,347*a |
| Day 7 | 6,12 | 6,14 | 6,14 | 6,133*b |
| Day 14 | 6,02 | 5,88 | 5,90 | 5,933*c |
| Day 21 | 5,61 | 5,57 | 5,47 | 5,550*d |
| Day 30 | 5,30 | 5,26 | 5,22 | 5,260*e |

Description: *) The numbers followed by different letter notations show that there is a real difference in the sample value based on the duncan test at α=5%

**Table 2. pH test results of cane liquid sugar, refrigerator storage**

| Storage | Brix Concentration | | | Average |
|---|---|---|---|---|
| | 65 | 66 | 67 | |
| Day 0 | 6,36 | 6,35 | 6,33 | 6,347*a |
| Day 7 | 6,30 | 6,31 | 6,32 | 6,310*a |
| Day 14 | 6,21 | 6,24 | 6,27 | 6,240*b |
| Day 21 | 5,72 | 5,86 | 5,88 | 5,820*c |
| Day 30 | 5,44 | 5,48 | 5,41 | 5,443*d |

Description: *) The numbers followed by different letter notations show that there is a real difference in the sample value based on the duncan test at α=5%

Further tests DMRT (*Duncan's Multiple Range Test*) showed that the storage time between storage times showed a noticeable difference ($p < 0.05$), especially between day 0 and day 30. This indicates that pH undergoes a gradual significant change during the storage period. This decrease in pH is caused by the hydrolysis reaction of sucrose which produces organic acids as well as the activity of microorganisms during storage. According to PHatak et al. (2024), the decrease in pH in the cane liquid sugar concentrate during storage is caused by the formation of organic acids due to the degradation of sucrose and microbial metabolism. The acceleration of the chemical reaction rate in room temperature storage is formed due to the increased activity of invertase enzymes due to the high room temperature.

The pH stability is also affected by the brix concentration of the solution, where the brix 67 solution shows a slower pH test value than the brix 65 solution. DMRT follow-up tests also showed significance between brix 65 solution and brix 67 solution, but brix 66 solution and brix 67 solution did not show significance so there was no significant difference. It can be interpreted that brix 67 solution is able to minimize a significant decrease in pH where this is because the solution has a high concentration of solids *Activity Water* Or for short AW is lower which causes microorganisms to be inhibited from growing. In accordance with the findings Neto et al. (2020) The pH stability of cane liquid sugar can be better maintained if water activity is suppressed through increased solids concentration.

Further tests of DMRT at refrigerator temperature showed more stable storage compared to room temperature, meaning that low temperatures were able to prevent pH changes and make the sample more stable. Molecular kinetic energy as well as enzyme activity *Invert* It can drop at low temperatures which causes the process of organic acid formation to take place more slowly. The pH decrease is slower at refrigerator temperature storage with each variation in brix

concentration. This phenomenon explains that the combination of low temperature and high concentration of brix solution can maintain the pH stability of cane liquid sugar at storage for 30 days.

**Reducing sugar**

The results of the fingerprint analysis (ANOVA) showed that the storage length, storage temperature, and concentration of Brix had a significant effect on the Reducing sugar value of sugarcane liquid sugar (F calculated > F table 5%). This indicates that these three factors have a significant relationship with the stability of the Reducing sugar during the storage process. The average reduction sugar rises from 0.006 on day 0 to 0.019 on day 30 at room temperature, and from 0.006 to 0.015 at refrigerator temperature. Storage on the 14th day showed an acceleration of the sucrose hydrolysis reaction so that there was a spike in reducing sugar levels in the samples.

**Table 3. Sugar content test results for sugarcane liquid sugar reduction storage room temperature**

| Storage | Brix Concentration | | | Average |
|---|---|---|---|---|
| | 65 | 66 | 67 | |
| Day 0 | 0,006 | 0,006 | 0,006 | 0.006*a |
| Day 7 | 0,01 | 0,01 | 0,01 | 0.01*b |
| Day 14 | 0,014 | 0,014 | 0,014 | 0.014*c |
| Day 21 | 0,018 | 0,02 | 0,02 | 0.019*d |
| Day 30 | 0,022 | 0,028 | 0,028 | 0.025*e |

Description: *) The numbers followed by different letter notations show that there is a real difference in the sample value based on the duncan test at α=5%

**Table 4. Results of sugar content test for Reducing sugarcane liquid sugar, refrigerator storage**

| Storage | Brix Concentration | | | Average |
|---|---|---|---|---|
| | 65 | 66 | 67 | |
| Day 0 | 0,006 | 0,006 | 0,006 | 0.006*a |
| Day 7 | 0,006 | 0,006 | 0,006 | 0.006*a |
| Day 14 | 0,01 | 0,01 | 0,012 | 0.011*b |
| Day 21 | 0,014 | 0,014 | 0,016 | 0.015*c |
| Day 30 | 0,016 | 0,016 | 0,018 | 0.017*d |

Description: *) The numbers followed by different letter notations show that there is a real difference in the sample value based on the duncan test at α=5%

The results of DMRT's follow-up test also showed that the liquid sugar solution with the concentration of Brix 67 had the lowest Reducing sugar content compared to the Brix 65 and 66 concentration solutions. This shows that the higher the concentration of solids, the less water activity (aw), so that the rate of hydrolysis of sucrose into sugar reduction is slower. This condition is in accordance with the results of the study PHatak et al. (2024) which reports that sugar solutions with high viscosity and high solids content are more stable to increased reduction sugars.

The increase in reducing sugar is inversely proportional to pH, the higher the reduction sugar, the lower the pH. According to Khan et al. (2023), the process of hydrolysis of sucrose produces monosaccharides that are reductive and often accompanied by the formation of organic acids, thereby lowering the pH of the solution. The reaction rate increases at room temperature because the temperature is higher and the pH is more acidic while the temperature of the refrigerator can slow down the reaction rate. The storage time affects the reduction sugar increase based on the results of the ANOVA test and the DMRT follow-up test followed by the temperature and brix concentration of the sample solution. The sample solution was more stable at the combination of refrigerator temperature storage and the concentration of brix 67 which showed a lower rate of reduction sugar increase and showed stability of the pH value.

## CONCLUSION

The results showed that the storage length, storage temperature, and concentration of Brix had a significant effect on the pH stability and Reducing sugar content of cane liquid sugar. Based on the results of the fingerprint analysis (ANOVA) and DMRT's follow-up test, the longer the storage, the pH of the sugarcane liquid sugar tends to decrease, while the Reducing sugar content increases significantly. The fastest changes occur at room temperature storage, while storage at refrigerator temperature is able to suppress the rate of pH decline and increase in reducing sugar. Variations in Brix concentrations also play an important role in product stability, where sugarcane liquid sugar with a concentration of Brix 67 shows the most stable pH and the lowest Reducing sugar content compared to Brix 65 and 66. This is due to lower water activity in high-solids solutions that inhibit enzymatic and microbiological activity. Thus, the combination of storage at refrigerator temperature and a Brix concentration of 67% is the best condition to maintain the chemical stability of cane liquid sugar during the 30-day shelf life.

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