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**Research Article**

# Determining the Age of plant and the Time Delay of Process to Prevent Produced Loss of Sugar Cane

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## ABSTRACT

Sugar cane is a sugar-producing plant. Sugar needs in Indonesia have not been able to meet the needs of the community due to the low yield. The decrease in yield is due to delayed processing and incorrect harvest time. This study aims to determine the age of sugarcane and the delay in the process of reducing yield. The research was arranged in a factorial completely randomized design (CRD) with three replications. The first factor is the process delay time which consists of 0, 12, 24, and 36 hours. The second factor is the age of sugarcane which consists of ages 10, 12, and 14 months. The results showed that delay in processing sugar cane affects briks (%), pol (%), reducing sugar levels, and partial loss of sugar. Age of sugarcane affect briks (%), pol (%), reduce the sugar content, and loss of sugar crystals. The decrease in yield was due to delays in processing and by the age of the plant. The decrease in yield due to processing delays during the 12, 24, and 36 hours delays was 7.20, 6.71, 6.23, and 5.93% compared to direct processing. The decrease in yield due to plant age shows that there is a significant difference. The highest yield was produced by plant age 12, 10, and 14 months with a yield of 7.18, 6.58, and 5.80%. Processing delay causes a decrease in yield, and the age of 12 months is the right time to harvest sugar cane. In the future, it is expected that the yield can be maximum, so there is no delay in processing for too long and the exact age of the plant is 12 months.

**Keywords**: process delay, plant age, yield, sugarcane, losses

## INTRODUCTION

National sugar demand continues to increase reaching 10.3%, but that has not been matched my needs. This situation is caused by difficulties in the supply of raw sugar cane, where only 60% of the available capacity is available. This is supported by the fact that many closed sugar trays do not operate due to a lack of raw material for sugar cane. For example, in Indonesia, direct consumption is 2.5 million tons, and industrial consumption is 0.7 million tons. Meanwhile, the production capacity of around 1.8 million tons or half the installed capacity of sugar factories, or also 72% of the needs of direct household consumption (Supriyadi et al., 2018; Paul and Purwono, 2018). In the sugar cane processing factory, the product affected by raw materials must be of good quality. Without quality raw materials, it is impossible that the quality of the sugar obtained is also good (Vera-Gutiérrez et al., 2019; Xiao et al., 2017). After harvesting sugarcane, some are not processed immediately due to transportation problems, or waiting for processing at the sugar factory (Ningsih et al., 2018; Hunsigi, 1993). Poor maintenance will also cause the plant to produce less sugar, causing inefficiency in the mill grinding sugar cane because the sugar cane which gets dirty will be reduced and the presence of high reducing sugar. The decline in the quality of sugarcane quality directly causes inefficiency of the factory, however, the sugar factory must continue to process the sugar cane, whatever happens, there is no other choice. So that it can be said by the preparation of quality raw materials (good raw material) will cause the acquisition of high sugar yield, and sugar loss before processing can also be reduced to a minimum. According to Mazwan and Masyhuri, (2019); Rum et al. (2019), the quality of raw materials/sugarcane is a problem that is closely related to the yield and quality of the sugar produced. Some factors that can affect the quality of raw materials are sugarcane that is late brought to the factory or sugarcane that is late for processing (Maldaner and Molin, 2020; Rum et al., 2019; Vera-Gutiérrez et al., 2019; Kustiyo and Arkeman, 2019; Hunsigi, 1993). For this reason, a study was conducted with the aim of this study was to find out the percentage of quality degradation and the potential loss of crystalline sugar caused by sugar cane level due to delay in the process and the level of cane to be processed (raw material).

## MATERIALS AND METHODS

Materials and tools: The material used by sugarcane stems in the Jogjakarta region of Indonesia. Chemicals are alcohol, $H_2SO_4$, $Na_2S_2O_3$, starch, potassium oxide standard glucose derived from MERCK. Tools used: refractometer, digital scales, glassware, sugar cane mill, dan spectrophotometer.

Experiment design: This study uses a completely randomized design (CRD), consisting of two factors, the first time the processing delay consists of no processing delay, 12; 24; and 36 hours. The second is the maturity factor of sugarcane stems (based on the age of the plant), consisting of under-maturity (around 10 months), optimal maturity (around 12 months), and over-maturity (around 14 months).

Research procedures: This research starts from determining the location of sugarcane sampling, carrying out sugarcane according to treatment and placing an open place and evaluating observations at a time without delay, delay of 12; 24; and 36 hours, then analyzed by using briks using hand-refractometer, reducing sugar content, pol, and yield.

Observed parameters: Observed parameters: pol (Xiao et al., 2017; Lamhot, 2006), reducing sugar content (AOAC International, 2005), briks (Lamhot, 2006; Xiao et al., 2017), yield (Lamhot, 2006; Kuswurjanto, 2015), performed 3 times.

Statistical analysis: The observation of data was analyzed using analysis of variance (ANOVA) at 5% significant levels. To find out the difference between treatment was used Duncan's multiple range test (DMRT) at 5% significant levels (Paiman & Effendy, 2020). The data were analyzed using software of SPSS version 25.

## RESULTS AND DISCUSSION

Based on the results of research and statistical analysis on several parameters of observation. The results of DMRT at 5% significance level in all of the parameters can be seen in Table 1.

**Table 1: Relationship delay time process and plant age in all of the parameters**

| Treatment | Parameter | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| delay process | Briks (%) | | | Reduction | | | Pol (%) | | | Yield (%) | | |
| (Hours) | | | | sugar (%) | | | | | | | | |
| 0 | 20.09 | ± | 2.48a | 3.09 | ± | 0.78a | 12.28 | ± | 2.20a | 7.20 | ± | 0.88a |
| 12 | 19.77 | ± | 2.42b | 3.33 | ± | 0.59b | 11.29 | ± | 1.85b | 6.71 | ± | 0.82b |
| 24 | 18.86 | ± | 1.92c | 4.10 | ± | 0.71c | 9.46 | ± | 1.69c | 6.23 | ± | 0.57c |
| 36 | 18.10 | ± | 1.64d | 4.66 | ± | 0.66d | 8.15 | ± | 1.46dp | 5.93 | ± | 0.51d |
| Plant Age | | | | | | | | | | | | |
| (months) | | | | | | | | | | | | |
| 10 | 16.79 | ± | 0.44p | 3.25 | ± | 0.64p | 8.62 | ± | 1.24p | 6.58 | ± | 0.64p |
| 12 | 20.69 | ± | 1.19q | 3.58 | ± | 0.86q | 12.1 | ± | 1.95q | 7.18 | ± | 0.69q |
| 14 | 20.14 | ± | 1.08r | 4.55 | ± | 0.67r | 10.2 | ± | 2.36r | 5.80 | ± | 0.35r |

Numbers followed by different letters in the column indicate significant differences at the 5% level.

### Briks (%)

Briks show the amount of solid including sugar and non-sugar dissolved in the sap (the liquid produced by sugar cane extraction). Table 1. shows the two factors. namely the delay in the process and the age of the plant (maturity level) of sugarcane affect the briks value (%). The longer the processing delay. the lower the briks (%). On the age factor of sugarcane. it also showed an effect on decreasing briks (%).The relationship between briks with the process of delay and age of plants (maturity) can be seen in Figure 1.

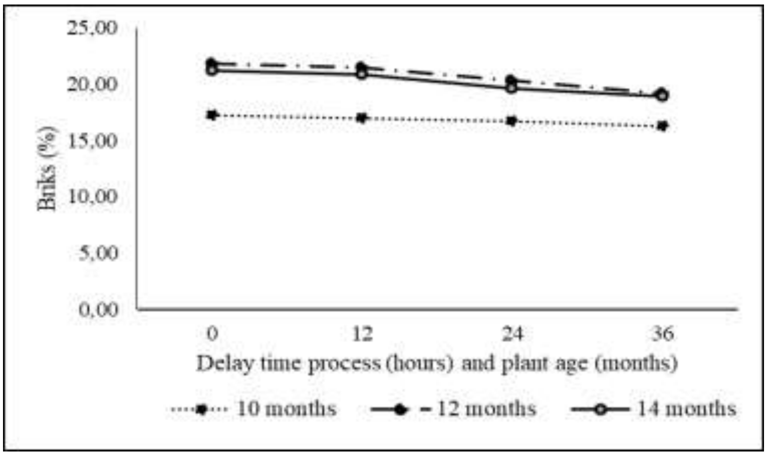


**Fig.1: Relationship between briks and process delay and plant age**

The tendency to decrease briks value (Figure 1). can be caused by some types of saccharose sugars being converted into simple sugars. such as glucose and fructose due to the hydrolysis process. Supriyadi et al.. (2018). that some of the factors that can cause a decrease in the quality and quantity of palm fruit sap are due to raw material in contact with air/oxygen for too long. the presence of water. can also be a temperature that continues to increase. According to Ningsih et al.. (2018); Paul and Purwono. (2018). Sugarcane immature sugar content is lower because it is still in the phase of forming sugar in sugarcane stems from photosynthesis. In sugarcane through cooking there is a decrease due to sugar cane past the maximum formation period. Sataed Rum et al.. (2019); Hunsigi. (1993). that sugar cane when growing is followed by an increase in sugar content as a solid. But after disposal begins. the sugar content in the sugar cane will be used for the process.

## Pol (%)

Pol shows the amount of saccharose sugar contained in the sap. The results showed the processing delay and the age of the plant (maturity) of sugarcane affect the pol value (Table 1). It can be seen clearly in Figure 2. the longer the process delays the decline in the value of pol (%). at the age of 12 months the highest pol (%).

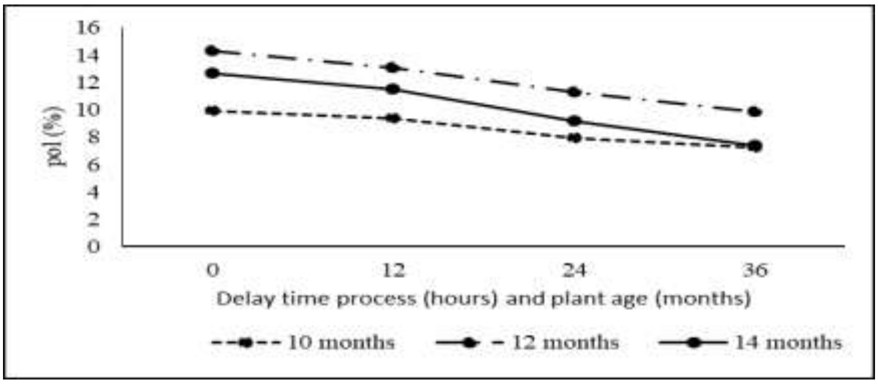


**Fig.2: Relationship between polls with processing delay and plant age**

This is due to the change in saccharose into monosaccharide-reducing sugars such as glucose and fructose. The process of hydrolysis of the saccharose sugar found in the sap that is in the sugar cane can be changed to reduce the sugar (Maldaner and Molin. 2020; Sahu. 2018). In the level of sugarcane maturity level. changes in the value of pol (%) can be caused when cutting before the optimum cooking of the sugar cane plant is still in the process of forming the initial sugar. so the saccharose/pol content is still small. Unlike sugarcane over-maturity (age 14 months). the decrease in pol is not large. due to the flower formation process (Eka et al.. 2016; Mazwan and Masyhuri. 2019). The sugar that is in the sugar cane in the ripe cane is used for flowering activities/processes so that there is a decrease in sugar content or the value of saccharose (pol) (%) is decreased.

## Reducing sugar content (%).

The two factors. namely the processing delay and the age of the sugarcane plant affect the reducing sugar levels. This can also be seen in Figure 3 below. Due to the delay in the process of making the sugar contained in sugar cane stems break down by hydrolysis which makes sugars into monosaccharide sugars especially reducing sugars namely glucose and fructose (Waclawovsky et al., 2010; Xiao et al., 2017;Praseptiangga et al., 2018). As a result of sugar damage. changes in the saccharose sugar are reduced to monosaccharides. namely glucose and fructose (reducing sugars).

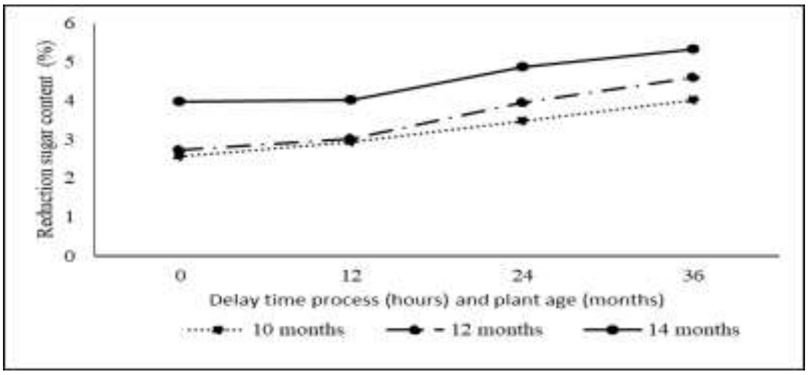


**Fig.3. Relationship of reducing sugar levels with process delay and plant age.**

For the age/sugar cane level factor. the increase in reducing sugar levels is in line with the age of the plant. At the beginning of growth. sugar production will be relatively small. so that the content of monosaccharides is still small. Different levels of optimum maturity (age 12 months) the amount of sugar formed is high. followed by the content of monosaccharide/reduction sugar (Rum et al.. 2019; Ningsih et al.. 2018; Slamet et al., 2019).

The increase in reducing sugars is because a lot of sugars are converted into monosaccharides including fructose and their glucose is a group of reducing sugars as well. Sugar cane will start the process of forming sugar from young plants whereas when it goes beyond the harvest period the type of sugar monosaccharide increases (Velásquez et al.. 2019; Vera-Gutiérrez et al.. 2019).

### Yield (%).

Loss of sugar crystals based on the difference in yield (%). Table 1 shows that the processing delay and plant age (maturity) affect the sugar yield (%). it appears that the longer the processing delay. there is a decrease in sugar yield and the age of 12 months the highest yield (Figure 4).

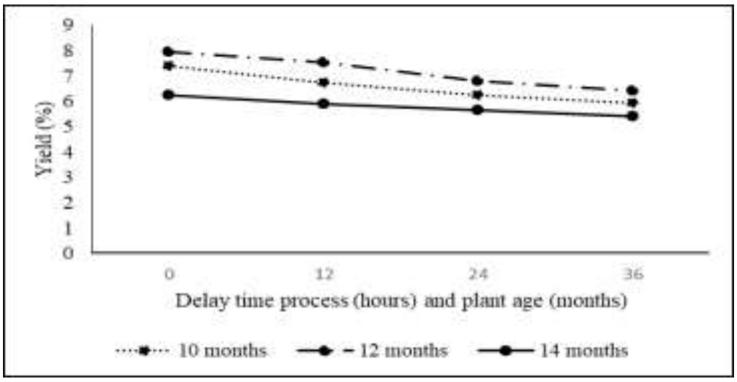


**Fig.4: Relationship between yields and processing delay and plant age.**

The loss of sugar crystals based on the 12-hour late yield is 0.49%. the 24-hour late sugar loss is 0.97% and the 36-hour process delay reaches 1.27%. Reduced yield due to the presence of saccharose sugar hydrolyzed into monosaccharides, especially reducing sugars (glucose and fructose). Xiao et al., (2017; Maldaner & Molin. (2020). there is damage to saccharose sugar due to the hydrolysis process. which changes to reducing sugar so that the sugar crystal decreases. due to reducing sugar it is difficult to become sugar crystal.

According to Kuswurjanto. (2015); Eka et al. (2016); Maldaner & Molin. (2020). changes in yield are in line with the level of plant age. At the beginning of the growth of sugar cane plants will produce sugar stored in stems which are relatively small in number. so that the content of disaccharides is still small.

Different things are seen in optimum chemistry. here the amount of saccharose sugar formed is high so that the yield increases. In sugarcane over maturity. sugar yield decreases because a lot of saccharose sugar in the sugar cane is used flowering. The potential loss of sugar crystals due to different levels of maturity at harvest (Table 1). calculated by looking at the difference in yield sugarcane is not ripe (age 10 months) there is a loss of sugar crystals of 0.60%. If the harvest is late (age 14 months) then the sugar loss reaches 1.38%. Eka et al. (2016); Vera-Gutiérrez et al. (2019); Kuswurjanto (2015). that the formation of sugar in sugar cane starts when the plant is carrying out the process of photosynthesis while when its age exceeds the harvest period there will be a decrease in its sugar content because it is used for the process of flower formation. So the sugar yield will also decrease later.

## CONCLUSION

Based on the results of research and discussion and observations that have been made. it can be concluded that delay in processing sugar cane affects briks (%). pol (%). reducing sugar levels and partial loss of sugar. Age of sugarcane affects briks (%). pol (%). lower sugar content. and loss of sugar crystals. The decrease in yield was due to delays in processing and by the age of the plant. The decrease in yield due to processing delays during the 12. 24. and 36 hours delays was 7.20. 6.71. 6.23. and 5.93% compared to direct processing. The decrease in yield due to plant age shows that there is a significant difference. The highest yield was produced by plant age 12. 10. 14 months with a yield of 7.18. 6.58. and 5.80%. Processing delay causes a decrease in yield and the age of 12 months is the right time to harvest sugar cane. In the future. it is expected that the yield can be maximum so there is no delay in processing for too long and the exact age of the plant is 12 months.

Conflict of Interest: The authors declare no conflict of interest, financial or otherwise.

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