Preserving the Quality of Trimmed Young Coconut (*Cocos nucifera* (*L.*)) Using Sodium Metabisulfite and Citric Acid

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Abstract. Trimmed Young Coconut (TYC) is one of the most Indonesia's favourite tropical fruit. High demand of TYC brings to the development of TYC preservation in Indonesia. However, postharvest handling that have not been optimally operated impede the development of TYC agroindustry due to its damage. In addition, it can cause problems in the form of quality degradation such as the appearance of mold, decay, shell cracking, and browning of TYC. The solution to prevent damage and extend the shelf life of trimmed young coconut (TYC) is by applying sodium metabisulfite (SMS) and citric acid (CA). In this study of sodium metabisulfite (SMS) and citric acid (CA) with identical concentrations of 2% was carried out to keep the TYC quality for a long-term storage. This study used 15 TYCs produced by coconut local farmers. Then, the TYC were kept at cold temperature of 15 ± 0.5 °C. Physiological changes parameters such as carbon dioxide (CO2) production, color changes, texture, shell color, brix, and acidity were analyzed everyday for 7 days of storage. Statistical analysis was implemented to test the SMS and CA effect on TYC for each parameter. This study has a conclusion that TYC with Sodium Metabisulfite 2% 15 min treatment of antibrowning solution gives the best results.

Keywords: Postharvest · Browning · Respiration · Quality · Shelf-life

1 Introduction

Trimmed young coconut or TYC (Cocos nucifera (L.) is one of the tropical fruits that is great in demand on both domestic and world market. Badan Pusat Statistik Indonesia (BPS) shows that the total area of Indonesian coconut plantations in 2021 is more than 3.3 million hectares. According to information from the Ministry of Industry of the Republic of Indonesia (2021), the production of coconut from coconut plantations in Indonesia is 18 million tons per year. One of the characteristics of coconuts is that they have a fresh taste of water and pulp [1]. In general, coconuts sold in supermarkets have their standards, such as how to cut and pack the product. Some of the coconut husks are cutted neatly to produce a coconut shape with a conical top, a cylindrical body or middle, and a flat at the bottom [2]. The goal is to increase selling value based on physical or

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visual appearance and make it easier for consumers. This piece of coir causes a color change in the form of browning in the remaining part of the coir so that it can reduce the visual quality. In addition, cutting also triggers the growth of fungi in the coconut mesocarp and results in the shorter shelf life of the product [3].

Browning process was caused by the enzymatic oxidation process of phenolic compounds. The enzymatic oxidation allows the polyphenol oxidase (PPO) to turn into o-quinones. This enzymatic oxidation is highly reactive to produce brown polymers [4]. The formation reaction requires oxygen as a co-substrate. This reaction was activated by PPO [5]. It indicates that environmental factors such as temperature and humidity affect the browning reaction. The browning process is cramped by applying the appropriate postharvest methods such as dipping using an anti-browning solution so that the product remains of high physical and chemical quality and has a long shelf life [6].

There are several types of chemicals that can be put to use as an anti-browning solution. Sodium metabisulfite (Na2S2O5) and citric acid (C6H8O7) are chemical substances that are inhibitors for enzymatic reaction such as browning. The effect of anti-browning applications based on sodium metabisulfite (SMS) and citric acid (AS) on fresh coconut commodities can slow down the process of damage and browning [3]. Dipping with SMS with a concentration of 2% is often done for 5–10 min [3]. While dipping with AS usually is carried out at a concentration of 2–5% with a soaking time of 10–15 min.

2 Materials and Methods

2.1 Experiment Design and Treatments

This research was conducted at the Postharvest Engineering Laboratory, Department of Agricultural and Biosystem Engineering, Faculty of Agricultural Technology, Gadjah Mada University. This study requires 15 coconuts. The study was conducted from August to September 2022.

This study used a completely randomized block design by each treatment having three replications. The study used two variations of treatments, such as the type of chemical compounds and the dipping time. The chemicals used are sodium metabisulfite and citric acid. While the dipping time applied was 5 and 15 min. The research stage begins with cutting some of the coconut fibre. Then, the coconuts that have been trimmed are given an application according to the treatment. A total of 5 treatments were applied, including control, SMS dipping for 5 min, SMS dipping for 15 min, AS dipping for 5 min, and AS dipping for 15 min. After applying chemical treatment, samples were stored in cold storage at a temperature of 14–15°C and RH 95–99%.

2.2 Coconut Shell Color

Shell color was measured on each fruit with three replications of each treatment using a TES 135A type color meter. The color measurement data are CIE L*, a*, and b* values. The color data is then used as calculation to determine the level of browning or browning index on coconut coir. Browning index was calculated according to Eq. 1,

$$\mathrm{BI} = \frac{x - 0,31}{0,172} \times 100 \tag{1}$$

When $x = (a + 1,75L)/(5,645L + a\text{-}3,012b)$

2.3 TSS and TA Determinations

The measurement of Total Soluble Solids (TSS) and Titrable Acidity (TA) would be executed on each TYC with three replications of each chemical treatment. In this study, TSS was measured by using a refractometer (MASTER-53; Atago; Japan). TSS displays the Brix value and indicates the sweetness and maturation of the coconut water and coconut flesh. Meanwhile, TA was measured by titrating water and coconut flesh with 0.1 M NaOH reagent and phenolphthalein (PP) indicator. Acidity measurement results indicate the percentage of the most dominant type of acid contains in coconut water and coconut flesh.

2.4 °Brix/Acid Ratio

The measurements of the Brix/acid ratio are by dividing the °Brix value by the % titratable acidity. This value is commonly applicate as a sensory indicator in the form of taste which has implications for the value of customer acceptance. The sensory rating indicated that the °Brix/acid ratio is a better predictor as a sensory test compared to °Brix or acidity alone. In this experiment, the value of the °Brix/acid ratio will only be taken as a database. Testing the value of customer acceptance and taste indicators will be tested in the forward experiment.

2.5 Turbidity

Turbidity is the level of turbidity in a solution. The sample tested was coconut water. The measurement of coconut water is for its turbidity level using a turbidity meter (TU-2016 model) by using the Nephelometric Turbidity Unit (NTU) measurement unit.

2.6 Respiration Rate (CO2 Productions)

The measurement of respiration rate both CO_2 production and O2 consumptions was carried out on the same fruit with 3 replications for each treatment. Measurements were made using a 15,2 L capacity glass jar and a portable carbon dioxide sensor AZ7788A (CO2 range: 0–5000 ppm, RH 10–95%, Temperature 0–50 C; AZ Instrument Corp; Taiwan). Measurements were made by inserting a coconut and a CO_2 sensor probe into a jar and closing it tightly. Changes in CO_2 concentration are calculated for an hour and the rate of CO_2 production is calculated using the following equation:

$$R = \frac{dx}{dt} x \frac{V}{W} \tag{2}$$

where:

R = CO_2 production rate
x = CO_2 gas concentration
t = Storage time (hours)
W = Mass of product (g)
V = Free volume of the jar (ml)

2.7 Statistical Analysis

Statistical analysis was performed using SPSS software version 26.0 (SPSS Inc.; Chicago, IL, USA). All data were analyzed by repeated measure one-way (ANOVA). The analysis used a significant difference at $P < 0.05$ determined by Duncan's Multiple Range Tests.

3 Results and Discussion

Based on the results of data collection, the average value of Browning Index, TSS, TA, Brix/Acid Ratio, Turbidity are shown in Table 1, the value obtained from observation during storage at cold temperatures. Mean value is accompanied by standard deviation during data collection. The mean value in each column followed by the same lowercase letter was not statistically different by Duncan's multiple-distance test ($P < 0.05$) (Fig. 1).

3.1 Browning Index

TSS of coconut water is not slightly different for all TYC treatment of SMS and AS ($P < 0.05$) (Fig. 2). On top of that, variations dipping time of 5 min and 15 min also did not significantly affect TSS values of coconut water. The TSS values was in the range of 5,30–5,73°Brix after 7 days of storage at 13–15°C and RH 95–99%.

Effects of the Sodium Metabisulfite (SMS) and Citric Acid (AS) employed on the physical quality of TYC during the experiment, with the average value in each observation time. In accordance with statistical tests, SMS and AS did affect the browning index of TYC, Turbidity, Brix/acid ratio and TA significantly during 7 days of storage but did not significantly affected TSS (°Brix). Browning index of TYC after 7 days of SMS treatment has different averaged value with AS which is shown at Table 1. But, dipping time of 5 min and 15 min for each treatment is not quite different. This browning index usually is effected by oxidation process in the shell which is inhibited by the chemical treatment [9].

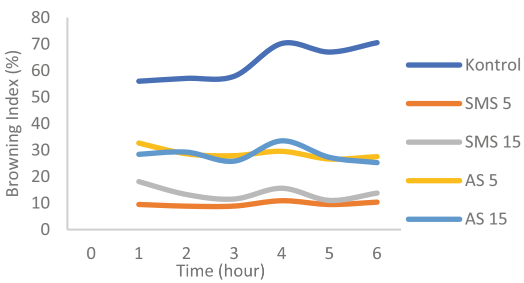

Fig. 1. Effects of the antibrowning treatments employed on the browning index during the experiment, with the average value in each observation.

Table 1. Influences of the treatment applied on the physicochemical characteristics of the fruit

Treatment	Browning Index (%)	TSS (°*Brix*)	TA (%)	Brix/acid ratio	Turbidity
Control	$70{,}54 \pm 4{,}8^{c}$	$5{,}73 \pm 0{,}76^{a}$	$0{,}09 \pm 0{,}01^{ab}$	$64{,}54 \pm 6{,}0^{b}$	$28{,}15 \pm 4{,}72^{b}$
SMS 5 min	$10{,}36 \pm 1{,}92^{a}$	$5{,}57 \pm 0{,}12^{a}$	$0{,}12 \pm 0{,}01^{bc}$	$46{,}72 \pm 4{,}36^{ab}$	$18{,}17 \pm 3{,}59^{a}$
SMS 15 min	$13{,}78 \pm 2{,}96^{a}$	$5{,}33 \pm 0{,}06^{a}$	$0{,}10 \pm 0{,}03^{abc}$	$52{,}95 \pm 11{,}20^{ab}$	$28{,}61 \pm 1{,}78^{b}$
AS 5 min	$27{,}54 \pm 9{,}21^{b}$	$5{,}30 \pm 0{,}20^{a}$	$0{,}09 \pm 0{,}03^{a}$	$62{,}70 \pm 15{,}28^{b}$	$17{,}72 \pm 2{,}12^{a}$
AS 15 min	$25{,}26 \pm 1{,}93^{b}$	$5{,}30 \pm 0{,}61^{a}$	$0{,}13 \pm 0{,}01^{c}$	$43{,}28 \pm 6{,}94^{a}$	$20{,}52 \pm 0{,}28^{a}$

Note: Each value represents a mean ± standard error. Mean values in each column followed by the same lower-case letters are not statistically different by Duncan's multiple range test ($P < 0{,}05$)

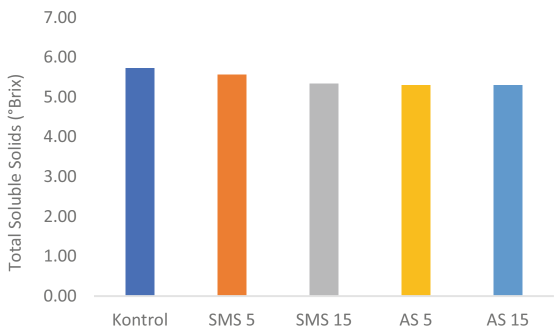

Fig. 2. Effects of the antibrowning treatments employed on the total soluble solids during the experiment, with the average value in each observation time.

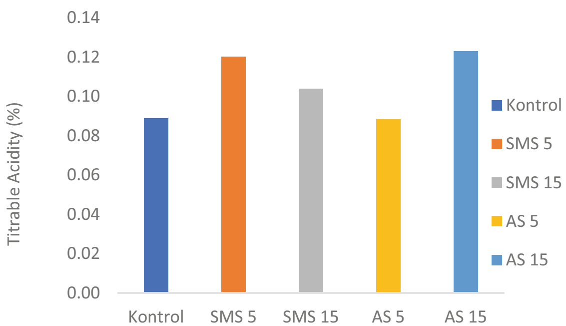

Fig. 3. Effects of the antibrowning treatments employed on the titrable acidity during the experiment, with the average value in each observation time.

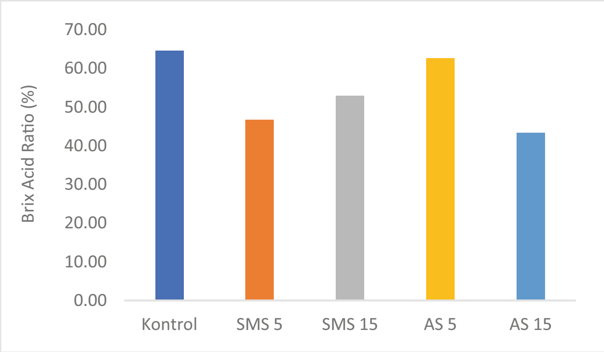

Fig. 4. Effects of the antibrowning treatments employed on the brix/acid ratio during the experiment, with the average value in each observation time.

3.2 Total Soluble Solids (TSS) and Titrable Acidity (TA)

The treatment of SMS and AS did significantly affect titrable acidity (TA) of trimmed young coconut water (Fig. 3) ($P < 0.05$). Moreover, dipping time of 5 min and 15 min also significantly affected TA value of coconut water ($P < 0.05$). As showed in the figure, the highest TA value of coconut water is on TYC which treated by AS treatment with 15 min of dipping time, there was significant different ($P \geq 0.05$) compared with other treatment. The range of titrable acidity value between treatment and non-treatment is 0.09 – 0.13%.

3.3 °Brix/Acid Ratio

The treatment of SMS and AS did significantly affected °Brix/acid ratio of trimmed young coconut water (Fig. 4) ($P < 0.05$). Moreover, dipping time of 5 min and 15 min also significantly affected Brix acid value of coconut water ($P < 0.05$). As showed in the figure, the highest °Brix/acid ratio of coconut water is on TYC which treated by AS treatment with 15 min of dipping time, there was significant different ($P \geq 0.05$) compared with other treatment. The range of °Brix/acid ratio between treatment and non-treatment is 43,28 – 64,54%.

3.4 Turbidity

The treatment of SMS and AS did significantly affected turbidity of trimmed young coconut water (Fig. 5) ($P < 0.05$). Moreover, dipping time of 5 min and 15 min also significantly affected turbidity value of coconut water ($P < 0.05$). As showed in the figure, the highest turbidity of coconut water is on TYC which treated by SMS treatment with 15 min of dipping time, there was significant different ($P \geq 0.05$) compared with other treatment. The range of turbidity between treatment and non-treatment is 28,16 – 17,72 NTU (Fig. 6).

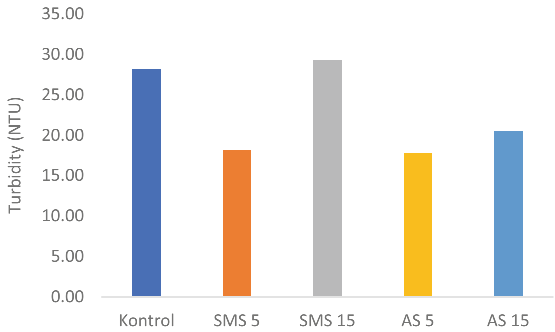

Fig. 5. Effects of the antibrowning treatments employed on the turbidity during the experiment, with the average value in each observation time.

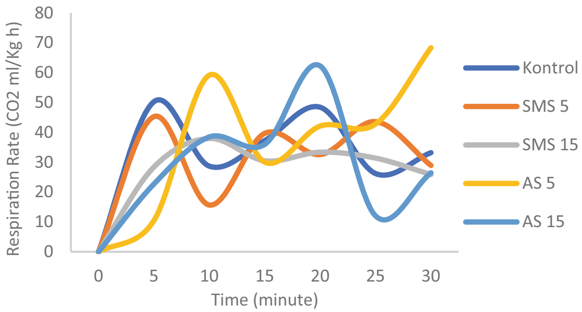

Fig. 6. Effects of the antibrowning treatments employed on the respiration rate during the experiment, with the average value in each observation time.

3.5 Respiration Rate (CO2 Productions)

Based on observation, the CO2 production shows fluctuating trend after treatment for 30 min. The highest CO2 production is on AS 15 treatment after 30 min of observation. Although, the lowest CO2 production is on SMS 5 treatment 10 min after observation.

4 Conclusion

SMS treatment significantly affects the visual quality (browning index value) of Trimmed Young Coconut (TYC). While Citric Acid (AS) did not significantly affect the visual quality of TYC. Meanwhile, the overall quality content of TYC is not affected by SMS and CA treatment. Therefore, further experiment with another chemical treatment, more concentration variations, and dipping time variations for further research is needed. This further research needs to be done with higher concentration and dipping time that may have a significant effect on the visual and quality contents of TYC.

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