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# Minimally Processed for Cassava Browning Inhibition by **Ascorbic Acid and Oxygen Absorbent**

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Abstract. The objective of this study was to examine the use of ascorbic acid and oxygen absorbent as anti browning agent for minimally processed cassava. The solution of 0% and 1% (w/v) ascorbic acid combined with packaging treatment by adding oxygen absorbent (+OA) and without oxygen absorbent (-OA) were use as anti browning system. Peeled cassava was dipped in the solutions for 30 minutes then packed into polyethylene plastic with packaging treatment and stored at 5°C. The results showed that dipping in 1% ascorbic acid solutions and oxygen absorbent packaging treatment could inhibit oxidation of polyphenol oxidase (PPO) of minimally processed cassava indicated by lower Browning Index.

#### 1. Introduction

Cassava can be classified as functional food for its many health benefits. It contains a bioactive component known as scopoletin or 6-methoxy-7-hydroxy coumarin, an anticancer and antihypertension [1]. Boiled cassava also has glycemic index (GI) of 65, lower than white rice of 123 [2, 3], represents lower sugar absorption in body. Due to these potential, cassava is a beneficial option in the diet of those with obesity, diabetes, or cardiovascular problems [4, 5].

However, it usually sold in whole raw form, in contrary to modern consumer desires for fresh, practical, hygienic, and ready to cook products. Moreover, raw cassava has relatively short shelf-life, 3 -4 days, due to ongoing physiological activity [6]. Therefore, minimally processing can be advantageous since the whole process also minimally affects product's quality, while provides added value and prolong shelf-life [7]. In regard of minimally processed cassava, one of critical challenges is post-peeling browning of cassava surface color, since color may affect consumer's expectation on food product beside safety, flavor, shape, and texture. Color changes in cassava surface into brown can be caused by enzymatic reaction [8]. Peeling and slicing during cassava processing induce opening of vascular tissue cell wall, lead to polyphenol oxidase (PPO) release from the cell, generating o-quinone as indicated by brownish color of the tuber surface when the enzyme reacts with oxygen [9].

Color changing due to polyphenol oxidase (PPO) enzymatic activity must be avoided [6], alternatively by apllication of oxygen absorbent to modify air composition inside package. Oxygen absorbent as well-known active packaging method has been used to control respiration rate of raw material in the package through oxygen residue reduction to minimize oxidation during storage [10]. Oxygen absorbent is used based on iron ( $Fe^{2+}$ ) oxidation principle [11]. Its ability to reduce oxygen in package can be effectively used for fruits and vegetables [12].

Several previous researches reported on the benefit of cassava soaking in acids toward PPO activity. Ascorbic acid (AA) is generally used as food additive in fruit at a concentration of 0.5 - 4%

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[13], in which soaking was reportedly able to prevent o-quinone formation by PPO or other phenolics in potato [14].

This study aimed to evaluate the effect of ascorbic acid and oxygen absorbent utilization on raw cassava during storage.

### 2. Material and Methods

### 2.1 Materials

Study was conducted on Cassava (*Manihotesculenta*) subvar Manggu which harvested 7 months after planting. Color change was observed using Minolta CR-400 chromameterto measure L, a\*, and b\* value. Textural analysis was conducted using WDW 10 Euniversaltestingmachine (UTM) equipped with 5mm in diameter cylinder; the results were expressed in Newton (Nm<sup>-2</sup>). Instruments used for respiration analysis were respiration chamber and gas analyzer.

### 2.2 Methods

Freshly harvested cassava was peeled, cut into 3 cm long pieces then cleanly washed. After soaked for 30 minutes inside either non-ascorbic acid water (AA 0%) or 1% ascorbic acid (b/v) (AA 1%), peeled cassava was put into 0.09 mm thick clear polyethylene (PE) plastic. A sachet of oxygen absorbent (+OA) contained 1.7 g iron powder was put into each treated package, while other non-absorbent (-OA) packages were also prepared. After tight-sealed using hand sealer, all minimally processed cassava packages were stored at 5°C until 50% sample was deteriorated. Response analysis was conducted every 48 hours. The experimental design was a completely randomized design with 2 factors (ascorbic acid and oxygen absorbent).

#### 2.3 Analysis

Color (L, a\*, b\*) measurement by Hunter method, while Browning Index (BI) was measured using formula (1) and (2) [15].

$$BI = \frac{100(x-0.3)}{0.1752}$$
(1) where  

$$x = \frac{(a+1.75L)}{(5.64L+a-3.012b)}$$
(2)

Respiration rate of peeled cassava was analyzed according to the method used by [16]. Analysis of variance (ANOVA) was used to compare means from duplicate data each taken in triplicate experiment. Significant difference was analyzed using Duncan Multiple Range Test (DMRT) at significance level of p<0.05 by SPSS software version 17.0.

### 3. Results and Discussion

Minimally processed cassava stored at 5°C generally can be maintained for more than 96 hours in all treatments. The freshness can be assessed from the surface color brightness and the texture. Monophenolase enzymes, like PPO, have thermo labile properties [17]. The higher the temperature, the higher the PPO activity in reacting and producing a brownish color. The level of brightness of the surface color is indicated by the L index value as presented in Figure 1.

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Figure 1. The change in L color value (brightness) of minimally processed cassava

Based on Figure 1, it was proved that the addition of ascorbic acid treatment can maintain the brightness level of the sample surface color. The addition of oxygen absorbent can also maintain the brightness level longer. Ascorbic acid works as a chemical reducing agent that captures  $O_2$  before reacting with PPO [18]. As a result, browning reactions can be prevented [7]. However, ascorbic acid can only preserve the commercial quality of processed products for a minimum period of time [17]. Nearing the end of the storage period where ascorbic acid has been oxidized, there is a rapid increase in the color change to brown.

The browning index derived from the calculation of L a b color value. The higher the browning index, the lower the quality of minimally processed cassava. The calculated browning index is presented in Figure 2.



Figure 2. The changes in the browning index of the minimally processed cassava

Previous researches reported that browning index might increase with time [15, 19]. In this study, the fastest increasing index was obtained by minimally processed cassava without AA-soaking (Figure 2). Oxygen absorbent had no significant effect, but its utilization together with 1% ascorbic acid was observed as the best treatment. In the enzymatic browning reaction, ascorbic acid reduces o-quinon so that it transform into o-difenol [20].

The hardness of texture decreased over time but no significant difference was observed in all treatments. (Figure 3 and 4).



Figure 3. The change in the hardness of texture of the minimally processed cassava



Figure 4. Cassava respiration rate at 5 °C storage

 $O_2$  consumption and  $CO_2$  production decreased at 5°C storage. Respiration rate was also stable at low  $CO_2$  and  $O_2$  rate. Cassava hardness decreased but not significant among treatments (Figure 3). Insignificant softening rate of cassava at 5 °C was allegedly caused by slowing down of respiration activity at low temperatures (Figure 4), hence carbohydrates degradation into simple sugars was minimized [7]. In the other hand, respiration rate at room temperature was faster, led to significant fermentation and texture softening. Oxygen absorbent addition was able to maintain cassava texture, as it modified air composition inside the packaging to inhibit respiration. However, the effect of ascorbic acid to prevent texture softening was still unknown [13].

### 4. Conclusion

Immersion with 1% ascorbic acid and the addition of oxygen absorbent can prevent browning on the surface of minimally processed cassava. The treatment is supported by the cool storage at 5 °C. Innovation of minimal processing technology applied in cassava need to be developed through sufficient packaging and preservation method to improve processing efficiency and marketing of cassava products.

# 5. References

- [1] Aviana T and Pohan H G 2012 The effect of cassava (Manihot esculenta Crantz) processing on scopoletin content *J. Agro-Bas. Indust.* **29** (2) pp 1–10
- [2] Powell K F, Holt S H A, and Miller J C B 2002 International table of glycemic index and glycemic load values J. Clini. Nutrit.76 (1) pp 45-56
- [3] Purwani E Y, Yuliani S, Indrasari S D, Nugraha S, and Thahir R 2007 Physico-Chemical Properties Of Rice And Its Glycemic Index *J. Teknol. Ind. Pert*.73 pp 59-66
- [4] Marsono Y 2008 Prospects for functional food development J. Tek. Pang. Giz.7 (1) pp 19-27
- [5] Arif A B and HoerudinA B2013 Glicemic Index of Foods and Its Affecting Factors J. Lit. Pert. 32 (3) pp 91-99
- [6] Sanchez T, Dufour D, Moreno J L, Pizzaro M, Aragon I J, Dominguez M, and Ceballos H 2013 Changes in extended shelf life of cassava root during storage in ambient conditions *Postharv*. *Biol. Technol.* 86 pp 520-528
- [7] Ohlsson 2000 Minimal processing technologies in the food industry (UK: CRC)
- [8] Sanchez T, Ceballos H, Dufour D, Ortiz D, Morante N, Calle N, Felde T Z, Dominguez M, and Davrieux F 2013 Prediction of carotenoids, cyanide and dry matter contents in fresh cassava root using NIRS and hunter color techniques *J. Food Chem.* 151 pp 444-451
- [9] Mesquita V L V and Queiroz C 2013 Enzymatic Browning in *Biochemistry of Foods (3 ed)* (UK: Academic Press) ed N A Eskin and F Shahidi pp 387-418
- [10] Aday M S, Caner C, and Rahvah F 2011 Effect of oxygen and carbon dioxide absorbers on strawberry quality *Postharv Biol. Technol.* 62 pp 179-187
- [11] Maxis S F, Chouliara E, and Kontominas M G 2012 Shelf life extension of ground chicken meat using an oxygen absorber and a citrus extract *J LWT* **49** pp 21-27
- [12] Kartal S, Aday M S, and Carner C 2012 Use of microperforated films and oxygen scavengers to maintain storage stability of fresh strawberries *Postharv. Bio Technol.* **71** pp 32-40
- [13] Sovgar O B, Saba M K, and Emamifar A 2016 Aloe vera and ascorbic acid coating maintain postharvest quality and reduce microbial load of strawberry fruit *Postharv. Biol. Technol.*114 pp 29 – 35
- [14] Rocculi P, Galindo FG, Mendoza F, Wadso L, Romani S, Rosa MD, and Sjoholm I 2007 Effect of the application or antbrowning substance on the metabolic activity and sugar composition of fresh cut potato *Postharv. Biol Technol.* **43** pp 151-157
- [15] Li X, Li W, Jiang Y, Ding Y, Yun J, Tang Y, and Zhang P 2011 Effect of nano-ZnO-coated active packaging on quality of fresh-cut 'Fuji' apple Int. J. Food.Sci. Technol.46 pp 1947– 1955
- [16] Hasbullah R 2008 Respiration rate measurement of horticultural product under controlled atmospheric condition *JTEP* 22 (1) pp 63-68
- [17] Jang J H and Moon K D 2011 Inhibition of polyphenol oxidase and peroxidase activities on freshcut apple by simultaneous treatment of ultrasound and ascorbic acid J. Food. Chem. 124 pp 444 – 449
- [18] Colak A, Sahin E, Yildirim M, and Sesli E 2007. Polyphenol oxidase potential of three wild mushroom species harvested from Liser High Plateu, Trabzon J. Food Chem. 103 pp 1426 – 1433
- [19] Marpaung M, Ahmad U, and Edhi N 2015 Edible Coating Nanocomposites to Maintain Quality of Minimally-Processed Snake Fruit *JTEP* **3** (1) pp 73-80
- [20] Gil M I and Kader A A 2008 *Health-Promoting Properties of Fruit and Vegetable Products* (US: Davis) pp 475 504

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