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Browning Prevention of Flour from Freshly Harvested Porang *(Amorphophallus oncophyllus)* Tubers through Immersion in Sodium Metabisulfite at Various Times

Mutia Amyranti

Jurusan Teknik Kimia, Fakultas Teknik, Universitas Islam Syekh Yusuf, Jl. Mulana Yusuf No.10 Tangerang Banten 15118, Indonesia

mutiaamyranti@unis.ac.id

Abstract. *Porang (Amorphophallus oncophillus) tubers contain multifunctional water-soluble heteropolysaccharides, called glucomannan. Therefore, the quality of porang tuber chips is highly depending on its glucomannan content and physical appearance. The presence of considerable amount of carotene, polyphenoloxidases and tannins in these tubers may cause browning of flour during processing. The purpose of this research was to study the effect of enzymatic anti-browning agent (sodium metabisulfite) concentrations (2, 5 and 7.5%) w/w) and immersion times (30, 60, 90, 120, 150 and 180 minutes) on the degree of whiteness. An increase in the concentration of anti-browning agent solution up to 5% w/w caused significant increase the degree of whiteness of porang flour and quality of porang flour. However, further increase in the concentration of anti-browning agent solution exhibited reduction in the degree of whiteness and quality of porang flour. In addition, a longer immersion time also resulted in a higher degree of whiteness of porang tuber chips. The best browning prevention conditions were through immersion of porang tuber chips in 7.5% w/w sodium metabisulfite solution for 150 minutes, from which a highest degree of whiteness was achieved (81.99).*

Keywords: *anti-browning agent, glucomannan, porang flour*

Abstrak. *Umbi porang (Amorphophallus oncophillus) mengandung heteropolysaccharides multi fungsi yang larut dalam air, disebut glukomanan. Oleh karena itu, kualitas keripik umbi porang sangat tergantung pada kandungan glukomanan dan penampilan fisiknya. Kehadiran sejumlah besar karoten, polifenoloksidase dan tanin dalam umbi ini dapat menyebabkan kecoklatan tepung selama pemrosesan. Tujuan dari penelitian ini adalah untuk mempelajari pengaruh konsentrasi enzim anti-kecoklatan enzim (natrium metabisulfit) (2, 5 dan 7,5%) b / b) dan waktu perendaman (30, 60, 90, 120, 150 dan 180 menit) pada tingkat keputihan. Peningkatan konsentrasi larutan agen anti-kecoklatan hingga 5% b / b menyebabkan peningkatan signifikan tingkat putih tepung porang dan kualitas tepung porang. Namun, peningkatan lebih lanjut dalam konsentrasi larutan agen anti-kecoklatan menunjukkan penurunan derajat putih dan kualitas tepung porang. Selain itu, waktu perendaman yang lebih lama juga menghasilkan tingkat keputihan umbi porang yang lebih tinggi. Kondisi pencegahan kecoklatan terbaik adalah melalui perendaman keripik umbi porang dalam larutan natrium metabisulfit 7,5% b / b selama 150 menit, di mana tingkat keputihan tertinggi dicapai (81,99).*

Kata kunci: *agen anti-kecoklatan, glukomanan, tepung porang*

I. Introduction

Porang tubers are one type of plant from the *amorphallus* clan which belongs to the taro tribe (*Araceae*). These plants are only found in the tropical sub-tropical regions, porang tubers contain glucomannan or usually called mannan which is a polymer of D-mannose and D-glucose. Porang tubers are very rarely used for direct consumption because they contain calcium oxalate crystals which cause itching, so that often made cassava or flour. The content of carotene, polyphenoloxidases and tannins in these tubers is high enough to cause the flour produced brownish which is not desired by the user. Mannan flour is flour made from porang tuber which has a higher glucomannan content than other components contained in the flour (Koswara, 2010). Before being produced into flour, porang tubers are made in chips first.

Glucomannan is one of the water-soluble heteropolysaccharides commonly found in porang (*Amorphophallus oncophillus*) flour (Dave and Mccarthy, 1997) Glucomannan has several special properties including being able to form a thick solution in water, can expand with a large expanding force, and can form a gel. Based on these traits, mannan has special uses for people who are over nutrition, suffering from stomach ulcers, suffering from high blood pressure and mannan will also give special taste to food and be widely used in the industry (Koswara, 2010). Glucomannan is widely used in the food and pharmaceutical industries, such as administration of drugs, coatings, films and membranes, emulsifiers, surfactants, dietary fiber, lowering blood cholesterol, anti-obesity activity and prebiotic activity (Zhang *et al*., 2005).

Porang bulbs contain needle-shaped ca-oxalate which causes itching and conisine which causes bitter taste. The removal of oxalate in food can be done by physical processes, such as soaking, boiling, and cooking or chemical processes by converting it into a soluble phase (Kumoro *et al*., 2014), porang flour purification can be done by dry, wet (chemical) processes and processes enzymatic (Mulyono, 2010). To obtain good physical and chemical properties of porang flour, producers must prevent browning, hardening and gelatinization cases (Huang, 1994). During processing, browning and hardening cases will affect the color of porang tuber chips, it is necessary to develop research for the prevention of browning on porang tuber chips to produce brownish-free porang flour.

Some bleaching efforts on porang chips have been reported by a food grade inorganic anti-browning agent, namely $NaHSO_4$ (sodium bisulfate) at a concentration of 0.25% (Zhao *et al*., 2010) and $CaCl_2$ (calcium chloride) at 0.1 % (Chua *et al*., 2012), and organic anti-browning agents, namely citric acid 0.1% (Abdulla *et al*, 2014) will be used to prevent discoloration of porang tuber chips during the drying process, Widjanarko et al. (2011b) get the best whiteness degrees (58.91) on the addition of H_2O_2 3%.

The role of sulfite inhibits both enzymatic and non-enzymatic browning reactions, and chloride anion as an enzymatic browning inhibitor, reduces ascorbic acid properties and the acidulant properties of citric acid are expected to prevent browning of porang tuber chips (Kumoro *et al*., 2014). Studies that use sodium metabisulfite as a porang *(Amorphophallus oncophillus)* chip for flour anti-browning agent have never been reported. In addition, comparing the effectiveness of adding sodium metabisulfite concentration in increasing the whiteness degree of porang flour has never been done. Therefore this study will study the conditions of using sodium metabisulfite to improve the whiteness degree of porang flour.

II. Materials And Methods

The materials used were freshly harvested matured tubers (± 9 months old) obtained from farmer under the supervision of PT Perum Perhutani in Kendal Regency, Central Java. Porang tubers were fristly washed, removed from the skin and weighed. For making chips wet, the peeled porang tubers were sliced using a chopper machine with an area of about 15-20 cm2.

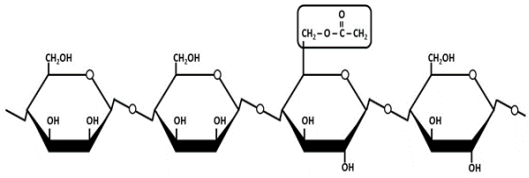

Figure 1. Molecular structure glucomanna

Porang tuber chips soaked in anti-browning solution for 3 hours in a span of every 30 minutes. The anti-browning solution used was sodium metabisulfite ($N_2S_2O_5$) at a concentration of 0% (soaking using Aquades), 2, 5 and 7.5% including the suggestions Zhao (2010) used on the results obtained in use (Zhao *et al*., 2010). the anti-browning. The results of immersion of the chip in an anti browning solution produced achip wet porang, the wet porang chip was then placed on a hollow metal pan to be dried using an oven at a temperature of 60°C until the moisture content was approximately 14%. To make porang flour, slices of dried porang bulbs are then ground using a grinding machine. The porang tuber flour obtained was filtered with a sieve to get the size to pass the size of 80 mesh. Porang flour with 80 mesh then analyzed with whiteness degrees using the Minolta Chroma Meters CR-400.

Whiteness degree analysis was observed using the Minolta Chroma Meters CR-400. The workings of this tool is the interaction between diffus light energy and the atom or molecule of the object being analyzed. In principle, this tool works based on the measurement of color differences produced by the surface of the sample. The reading on the tool immediately shows the values of the parameters L, a and b which are then plotted on the graph to find out the color of the sample (Wardhani *et al*, 2016). Whiteness degree analysis is done to determine the whiteness degree of porang flour based on the L (lightness) value which ranges from 0-100. The more white flour, the L value will be close to 100 (Zubarica *et al*., 2005). The absorbance of the hydrolyzed solution (T) and the absorbance before hydrolysis (To) were read at a wavelength of 550 nm. Glucomannan levels were calculated :

$$GM(\%) = (500f \times (5T - T_0))/m \quad \text{.....(1)}$$

where f is the correction factor, T absorbance after hydrolysis, To absorbance before hydrolysis and m sample weight (200 mg).

III. Results And Discussion

Color is a parameter that affects the sale value of porang flour. Before being processed into flour, porang tubers are first processed into dried porang chips. When processed, porang chips can experience browning. Given that porang tubers contain PPO and tannin enzymes which are phenolic compounds which cause browning (Zhao *et al*., 2010). PPO catalyzes the oxidation reaction of phenolic compounds to quinones which are further polymerized into dark colored melanin pigments (Friedman, 1996). The browning process that occurs enzymatically can be prevented by adding whitening ingredients. In this study the bleaching process is carried out by variable maceration time, concentration of anti-browning agent , and type of anti-browning agent .

Porang tuber chips with anti-browning agent is preliminary in the purification process porang flour but plays a very important role to produce porang flour which is free of browning. After maceration, the wet chips will be dried at 60°C so that they become dry porang chips (Widjanarko *et al*., 2011b). The maximum PPO enzyme work temperature is 70°C (Wu and Zhang, 1994). Arnnok et al, (2010) reported the highest PPO activity occurs at a temperature of 30-40°C, therefore at a temperature of 40°C is still very active PPO enzyme to catalyze the oxidation reaction of phenolic into quinone. If this drying temperature (60 °C) is expected not to be the optimum T for PPO, browning during the usual drying process is reduced in influencing browning on porang chips. Figure 2, shows that the longer maceration time results in an increasing degree of whiteness degree, the whiteness degree is indicated by L.

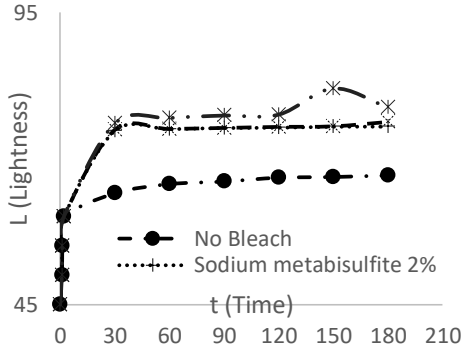

Figure 2. Effect of maceration time on whiteness degree using sodium metabisulfite.

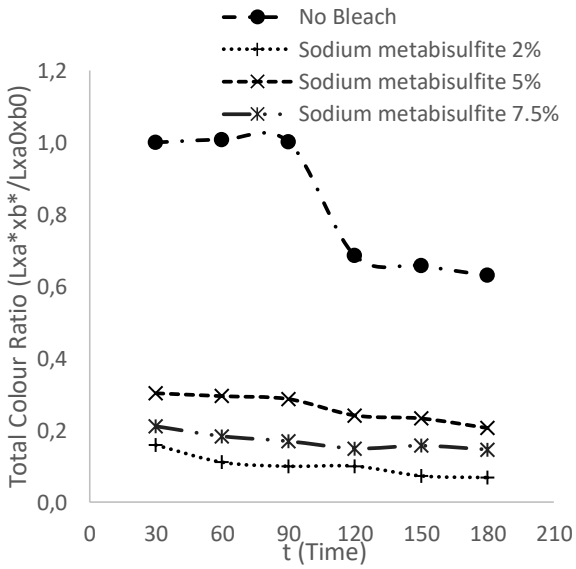

Figure 3. Effect of maceration time on the total value of white color ratio using sodium metabisulfite

In Figure 2 the whiteness degree produced by maceration time for 3 hours in the span of 30 to 180 minutes is 7.5% sodium metabisulfite (76.01-81.99), 5% (74.91-76.26) and 2% (74.73-75.45). The magnitude of the whiteness degree value using aquades ranges from 64.05 to 67.11. From the Figure 2, we can see the difference in the degree of whiteness degree from the use of sodium metabisulfite as anti-browning agent compared to using aquades (no bleach). The use of sodium metabisulfite can increase the resulting whiteness degree as indicated by the value of L compared to the use of aquades. From the use of anti-browning agent the biggest whiteness degree value is obtained on the use of 7.5% sodium metabisulfite with a whiteness degree which increases with increasing maceration time. The results of the study show that the longer the maceration time is the better white rationing value of porang tuber chips, which is close to 100. The maceration time can affect the level of browning on porang tuber chips, Ma et al., (1992) concluded that the higher the temperature and the longer maceration time can reduce the level of browning. This has something to do with activities PPO that are getting lower due to heat treatment during drying.

There is no reaction to the sulfite group on sodium metabisulfite which binds to the carbonyl group on the sugar contained in the porang tuber. This will prevent the formation of melanoidin composition (the component forming brown color) so that the resulting color in porang tuber flour becomes better which is issued at a higher level. This causes sulfite to inhibit the browning reaction which is catalyzed by the phenolase enzyme and can inhibit the reaction of the furfural metal hydroxyl composition of D-fix because it is brown in color.

Fenemma (1996) discusses how this is caused by the function of sulfite which can inhibit the browning reaction which is catalyzed by the phenolase enzyme and can inhibit the reaction of the formation of furfural metal hydroxyl compounds from D-contact looking for a brown color. SO2 gas (sulfur dioxide) can be given in the form of sulfite, bisulfite, or metabisulfite, besides being a pale agent, sulfite can also reduce the amount of microbes, can activate enzymes that can cause enzymatic browning, and change non-enzymatic browning, can [also] be used as an agent reducing agent (Huang, 1994). Browning reactions can be prevented by using metabisulfite before the material is dried can be seen in Figure 4.

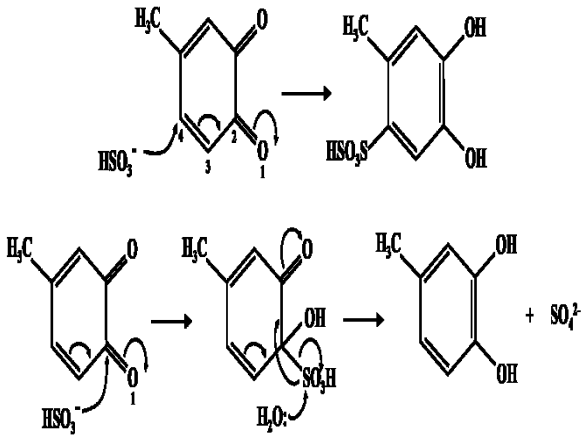

Figure 4. Sulfite reaction in preventing browning (Danilewicz *et al*., 2008)

Sulfite compounds can inhibit enzymatic browning reactions, due to the inhibition of the phenolase enzyme is very high and is irreversible, so it does not allow the regeneration of phenolases (Eskin et al., 1991). The mechanism of inhibiting the non-enzymatic browning reaction by sulfite compounds is the reaction between bisulfite and aldehyde groups from sugar so that the aldehyde group has no chance to react with amino acids (Kumalaningsih et al., 2011). Thus sulfite prevents the conversion of D-glucose to 5-hydroxy-methyl-2-furfural (HMF). This compound is an intermediate compound that will react with amino groups from proteins or amino acids to form the brown pigment melanoidin (Hildayati, 2005). Addition of sodium metabisulfite in addition to preservatives can also prevent browning reactions by interacting with carbonyl groups, where the results of these reactions can bind melanoidin thereby preventing the formation of brown color (Kumalaningsih *et al*., 2011).

Concentration enzymatic browning occurs in fruits and vegetables during bruising during handling or transportation, or when the products continue to be exposed to air in a cutting state, slicing, or crushed, or when thawed after freezing. This of course is a process that is very undesirable and must be prevented. High PPO activities such as those found in some types of flour can cause darkening of bread or pasta products. The effect of giving sodium metabisulfite concentration on chips with maceration for 3 hours can be seen in Figure 5. From Figure 5 of the analysis of the effect of the concentration of browning prevention agents on the value of the white degree obtained the higher the concentration, the lower the browning reaction. This is due to the use of high concentrations of sodium metabisulfite and ascorbic acid each of which can play an effective role as a metal binder and antioxidant.

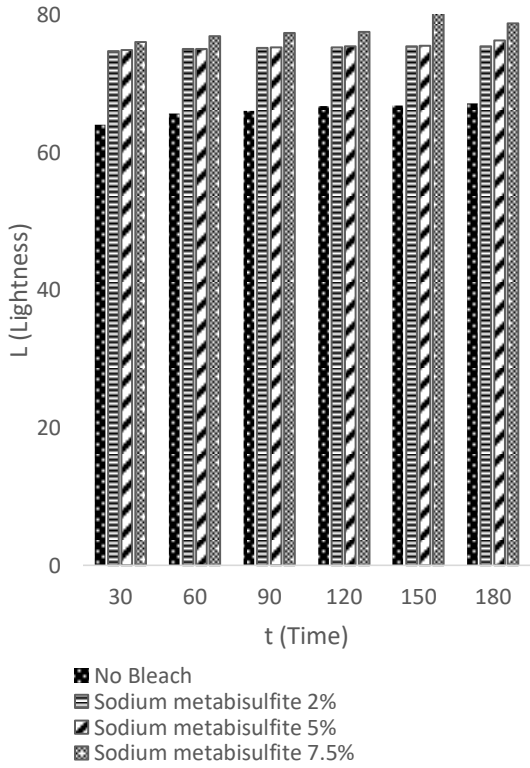

Figure 5. Effect of browning agent concentration on white degrees using sodium metabisulfite

Sodium metabisulfite concentration selected in this study includes the concentration of the use of organic anti-browning agents, namely suggested sodium metabisulfite used (Zhao *et al*., 2010). The higher the sodium metabisulfite concentration, the chips resulting porang will become white. Whiteness degree value obtained by the addition of Sodium metabisulfite 2, 5 and 7.5% is 75.45; 76.26; and 81.99. According to Zhao et al, the use of concentrations of organic anti-browning agents such as ascorbic cid was used up to 6%. After doing research and analysis using sodium metabisulfite levels exceeding 2% that is 7.5%, the results obtained

for the whiteness degree values of theuse of sodium metabisulfite have decreased so that the best results of the whiteness degree value of theacid is at a concentration of 7.5%. PPO enzymes will catalyze the oxidation process of phenol compounds to quinones which will further polymerize to form brown pigments (Mosneaguta, 2012). The concentration of sodium metabisulfite chosen in this study includes the concentration of the use of an inorganic browning prevention agent recommended for use (Chua *et al*., 2012).

In connection with PPO enzymes, especially with enzymatic browning phenomena. The main products of oxidative reactions are catalyzed by enzymes, o-quinones, (a) react with each other to form high molecular weight polymers, (b) form macromolecular complexes with amino acids or proteins, and (c) oxidize compounds from reduced oxidation potential lower. Non-enzyme reactions (a) and (b) lead to the formation of brown pigments, darker colors the higher the molecular mass; reaction product type (c) is colorless. Very undesirable is the result of reactions belonging to group (c) where the quinone formed by the PPO oxidizes lower oxidation-reduction potential compounds, which are again reduced to dihydroxyphenol at the same time. This is how sodium metabisulfite is followed by quinone and one reason why this compound is able to prevent the appearance of discoloration (Vamos and Haard, 1981).

IV. Conclusion

The best conditions for prevention of browning in chips porang for porang flour with maceration time from 30 minutes to 180 minutes using organic anti-browning agents (sodium metabisulfite) were obtained at 150 minutes. The effect of adding concentration levels on chips has porang effect on the whiteness degree with the highest level of 7.5% (81.99).

References

Abdulla G, El-Shourbagy G A and Sitohy M Z 2014 *Effect of Pre-Drying, Blanching, and Citric Acid Treatment of the Quality of Fried Sweet Potato Chips*, *American Journal of Food Technology* pp 39-48.

Chua M, Chan K, Hocking T J, Williams P A, Perry C J and Baldwin,T C 2012 *Methodologies for the Extraction and Analysis ff Konjac Glucomannan from Corms of Amorphophallus konjac K. Koch, Carbohydrate Polymers* chapter 87 pp 2202– 2210

Dave V and McCarthy S P 1997 *Review of Konjac Glucomannan* pp 237–241

Friedman M 1996 *Food Browning and Its Prevention* pp 631-653

Huang Z W 1994 *Processing Technique of Dried Konjac Flakes Practical Engineering Technique in Countryside* chapter 12 p 32

Kumalaningsih, S., Harijono., Amir, Y. F., 2011, Pencegahan Pencoklatan Umbi Ubi Jalar (Ipomoea batatas (L). Lam) untuk Pembuatan Tepung Pengaruh Kombinasi Konsentrasi Asam Askorbat dan Sodium Acis Pyrophosphate, Universitas Brawijaya, Malang

Koswara S, 2010 *Ebook Pangan : Iles-ilesdan Hasil Olahannya* (Bogor: Balai Besar Litbang Pascapanen Pertanian Bogor)

Kumoro A C, Budiyati C S and Retnowati D S 2014 *Calcium Oxalate Reduction During Soaking of Giant Taro (Alocasia Macrorrhiza (L.) Schott) corm chips in sodium bicarbonate solution* pp 1583-1588

Mosneaguta R 2012 *The Effect of Chemical Preservatives on Inhibition of Potato Browning, Volatile Organic Compounds Profile, and Microbial Inhibition* (Ohio: The Ohio State University)

Mulyono, E 2010 *Peningkatan Mutu Iles-Iles (Amorphophallus onchophyllus) Food Grade (glukomanan 80%) Melalui Teknologi Pencucian Bertingkat dan Enzimatis* (Bogor: Balai Besar Litbang Pascapanen Pertanian Bogor)

Vamos-Vigyazo L and Haard N F 1981 *Polyphenol oxidases and peroxidases in fruits and vegetables* (*C R C Critical Reviews in Food Science and Nutrition* 15, 1, pp 49-127)

Wardhani D H, Atmadja A A and Nugraha C R 2016 *Pencegahan Pencoklatan Enzimatik pada Porang Kuning* (*Reaktor* vol 17 pp 104-110)

Widjanarko S B, Sutrisno A, and Faridah, A 2011b *Effect of Hydrogen Peroxide on Physicochemical Properties of Common Konjac (Amorphophallus oncophyllus) Flour by Maceration and Ultrasonic Methods* (*Jurnal Teknologi Pertanian*) pp 143-152

Wu W X and Zhang Z L 1994 *The Report Of Production Engineering Of Konjac Flour* (*Science and Technology of Food Industry* vol 4) pp 25-28

Zarubica A R, Miljković M N, Purenović M M and Tomić V B 2005 *Colour Parameters Whiteness Indices and Physical Features of Marking Paints for Horizontal Signalization* pp 205-216

Zhang Y Q, Xie B J, and Gan X 2005 *Advance in the Applications of Konjac Glucomannan and its Derivatives Carbohydrate Polymers* pp 27-31.

Zhao J, Zhang D, Srzednicki G, Kanlayanarat S and Borompichaichartkul C 2010 *Development of a low-cost two-stage technique for production of low-sulphur purified konjac flour, International Food Research Journal* chapter 17 pp 1113-1124.