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Inhibition Test of Browning Reaction in Apple (*Malus domestica* Borkh.) by Low NaCl Concentration

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Abstract

Reaction of enzymatic browning in fruit is a reaction that occurs due to the oxidation of phenol and involves the enzyme polyphenol oxidase (PPO). Prevention of browning reactions can be done by inhibiting PPO activity, one of alternative is to use NaCl. The purpose of this study was to determine the ability of low NaCl concentration to inhibit the browning reaction based on the color change of L* value. Apple peels was dipped in phosphate buffer pH 7.0 containing 0.1 M NaCl and incubated at room temperature for 6 hours. The result indicated the hindrance of NaCl in the development browning color that was detected by L* value. In conclusion, NaCl may inhibit the process of browning apple in room temperature.

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Introduction

Apple is one of the most popular fruits because it has the potential as a source of antioxidants (Eissa *et al.*, 2006; Adyanthaya *et al.*, 2008). In addition apples contain many essential vitamins and minerals for humans such as vitamin A, B1, C, and several types of minerals such as calcium, phosphorus, and iron (Gebhardt *et al.*, 2002). Phenolic content provides anti-diabetic (Adyanthaya *et al.*, 2009) and antioxidant effect (Sun *et al.,* 2002).

Browning reactions on fruit are a common reaction in fruits, especially apples (Valentines *et al.* 2005) which occur due to enzymatic phenol oxidation (Manzocco *et al.*, 2001) and involve the enzyme polyphenol oxidase (PPO) (Eissa *et al.*, 2006) with polyphenolic substrates such as catechins, caffeic acid, pyrochecol/catechol and chlorogenic acid (Garcia and Barret, 2002). This reaction can change sensory properties, reduce nutritional quality (Cortez-Vega *et al.*, 2008), and reduce consumer acceptance (Queiroz *et al.*, 2011; Purwanto and Effendi, 2016). The brown colour generated from the enzymatic browning reaction occurs because of the appearance of quinones that are long dark brown (Cheng and Crisosto, 2005; Aprillia and Susanto, 2014).

The PPO inactivation method to inhibit browning reactions can be done through thermal processes but causes softening of the tissue (Tortoe *et al.*, 2007). The use of modified atmospheric packaging can also be used to prevent browning reactions (Ghidelli *et al.*, 2013). Chemical methods using ascorbic acid, cysteine, citric acid, sodium chloride, and benzoic acid also have the opportunity to do but can have a negative impact on taste (Altunkaya and Gokmen, 2009; Husaini *et al.,* 2007). Until now, research to prevent browning reactions that do not cause negative impacts continues. The mechanism of action in inhibiting browning reactions also needs to be carried out in order to determine the right type of inhibitor for optimal results.

NaCl is a well-known compound as enzyme inhibitor but no research has focused yet on the study of the ability to inhibit browning reactions in apples. Therefore, this study aims to determine the ability of NaCl to inhibit browning reactions based on discoloration. The benefit of this research is to find out information on the ability to inhibit the browning reaction.

Materials and Methods

The material used in this study is Red Delicious apples obtained from modern markets in the Tembalang area, Semarang. NaCl was obtained from Merck, Germany. The measuring cup, cup glass, knife (stainless steel), micro tube, vortex (Scilogex MX-5), Apple digital colormeter (US) software were used as equipment.

The study was conducted for approximately 3 months, starting on November 14, 2017 until January 23, 2018 at the Central Laboratory for Research and Services Diponegoro University (CORES DU).

Apple preparation

The preparation procedure for apples carried out refers to the method of Lu *et al.* (2009) with the following procedure: apples were cleaned from their skin using a stainless steel knife. Latex gloves were used in this process to prevent direct skin contact to fruit. The peeled apple was then cut to a size of 1.0 x 1.0 x 0.5 cm. Cut apples were then prepared for the immersion stage and L * color change analysis.

NaCl Preparation

The process of making 0.1 M NaCl solution was done by dissolving 58.5 mg NaCl in 10 ml of distilled water. Before use, all solutions were filtered using a syringe filter (with a pore size of 0.22 μm) and carried out aseptically.

Immersion peeled apple in NaCl

The apple immersion procedure carried out refers to the method of Lu *et al.* (2006). Prepared pieces of apple were immersed in NaCl 0.1 M solution for 10 minutes at room temperature. The soaked pieces were then separated from the solution and then analyzed for color changes for 6 hours using digital color meter software (Macintosh, US).

L*value analysis

Testing of the L* value referred to the method of Quevedo *et al.*, (2009). Samples that were soaked and left in an open room were then tested for L* value for every hour. The test used the CIE L*, a*, b* method and but data in this research was calculated L* value only for the reliability of browning appearance. The treatment was applied in 3 replicates. Data was taken at 3 points measurements on each sample. Data was shown as mean±standard error.

Results and Discussion

Testing for discoloration can be used to detect changes in the quality of food (Leon *et al.*, 2006). Changes in the L* value in the sample of the first 0 hours reached 84.332±0.593. The inhibition of browning reactions on the fruit might be appeared by the presence of inhibitors (Altunkaya and Gokmen, 2008). Brown is an indicator of the change in tyrosinase to L-dopa which then converts the L-dopa to dopa which will eventually form the brown quinone polymer (Lu *et al.*, 2006; Arslan *et al.*, 2004). Because the formation of brown color has a close correlation with enzyme inhibition activity (in this case PPO) so that the brownindicator can also be used as an indicator of enzyme inhibition in the browning of fruit. Based on this initial value, NaCl 0.1 can inhibit about 5% since the final L* value was detected as much as about 79. The greater the decrease in L* value, the more browning reactions that occur (Quevedo *et al.*, 2009). Therefore, NaCl was proven to have ability in inhibiting browning reactions due to the inactivate PPO and degrade oxidative phenol compounds (He *et al.*, 2008).

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References

Adyanthaya, I., Kwon, Y.I., Apostolidis, E., Shetty, K. 2008. Health benefits of apple phenolics from postharvest stages for potential type 2 diabetes management using in vitro models. Journal of Food Biochemistry 34:31-49. DOI: 10.1111/j.1745-4514.2009.00257.x

Adyanthaya, I., Kwon, Y.I., Apostolidis, E., Shetty, K. 2009. Apple post-harvest preservation linked to phenolics and SOD activity. Journal of Food Biochemistry 33:535–556. DOI:10.1111/j.1745-4514.2009.00236.x

Al-Baarri A. N., Ogawa, M., Hayakawa, S. 2010. Application of lactoperoxidase system using bovine whey and the effect of storage condition on lactoperoxidase activity. International Journal of Dairy Science 6:72–78. DOI:10.3923/ijds.2011.72.78

Altunkaya, A. Gokmen, V. 2008. Effect of various inhibitors on enzymatic browning, antioxidant activity and total phenol content of fresh lettuce (lactuca sativa). Journal of Food Chemistry 107:1173-1179. DOI:10.1016/j.foodchem.2007.09.046

Aprillia, D., Susanto, W.H. 2014. Pembuatan sari apel (*Malus sylvestris* mill) dengan ekstraksi metode osmosis (kajian varietas apel dan lama osmosis). Jurnal Pangan dan Agroindustri 1(2):86-96.

Arslan, O., Erzengin, M., Sinan, S., Ozenzoy, O. 2004. Purification of mulberry (*Morus alba* L.) polyphenol oxidase by affinity chromatography and investigation of its kinetic and electrophoretic properties. Food Chemistry 88:479-484. DOI: 10.1016/j.foodchem.2004.04.005.

Cheng, G.W, Crisosto, C.G. 2005. Browning potential, phenolic composition, and polyphenoloxidase activity of buffer extracts of peach and nectarine skin tissue. Journal of the American Society for Horticultural Science 120(5):835-838

Cortez-Vega, W.R., Becerra-Prado, A.M., Soares, J. M., Fonscca, G.G. 2008. Effect of L-ascorbic acid and sodium metabisulfite in the inhibition of the enzymatic browning of minimally processed apple, International Journal of Agricultural Research 3(3):196-201. ISSN: 1816-4897.

Eissa, H.A., Fadel, H.H.M., Ibrahim, G.E., Hassan, I. M., Elrashid, A.A. 2006. Thiol containing compounds as controlling agents of enzymatic browning in some apple products. Food Research International 39: 855-863. DOI: 10.1016/j.foodres. 2006.04.004.

Garcia, E., Barret, D.M. 2002. Preservative Treatments for Fresh-Cut Fruits and Vegetables. California: Dept. of Food Science and Technology.

Ghidelli, C., Argudo, C.R., Mateos, M., Gago, M.B.P. 2013. Effect of antioxidants in controlling enzymatic browning of minimally processed persimmon Rojo brillante. Postharvest Biology and Technology 86: 487-493. DOI:10.1016/ j.postharvbio.2013.07.034.

He, Q., Luo, Y., Chen, P.. 2008. Elucidation of the mechanism of enzymatic browning inhibition by sodium chlorite. Food Chemistry 110:847-851. DOI:10.1016/j.foodchem.2008.02.070.

Husaini, O., Zulkifli, Lande, M.L., Nurcahyani, E. 2017. Karakteristi bahan anti browning dari ekstrak air buah jambu batu (*Psidium gujava* Linn) pada buah apel malang (*Malus sylvestris*(L.)Mill. Jurnal Penelitian Pertanian Terapan 17(2):85-92. DOI: 10.25181/jppt.v17i2.285.

Leon, K., Mery, D., Pedreschi, F., Leon, J. 2006. Color measurement in L*a*b* units from RGB digital images. Food Research International 39: 1084-1091. DOI:10.1016/j.foodres.2006.03.006.

Lu, S., Y. Luo, Turner, E., Feng, H. 2006. Efficacy of sodium chlorite as an inhibitor of enzymatic browning in apple slices. Food Chemistry 104: 824–829. DOI: 10.1016/ j.foodchem.2006.12.050.

Manzocco, L., Calligaris, S., Mastrocola, D., Nicoli, M.C., Lerici, C.R. 2001. Review of non-enzymatic browning and antioxidant capacity in processed foods. Trends in Food Science and Technology 11:340-346. DOI:10.1016/S0924-2244(01) 00014-0.

Pandey, V.P., Dwivedi, U.N. 2011. Purification and characterization of peroxidase from *Leucaena leucocephala*, a tree legume. Journal of Molecular Catalysis B: Enzymatic 68:168–173.

Queiroz, C., Silva, A.J.R.D., Lopes, M.L.M. 2011. Polyphenol oxidase activity, phenolic acid composition and browning in cashew apple (*Anacardium occidentale* L.) after processing. Food Chemistry 125:128-132. DOI: 10.1016/j.foodchem.2010.08.048.

Quevedo, R., Jaramillo, M., Diaz, O., Pedreschi, F., Aguilera, J.M.2009. Quantification of enzymatic browning in apple slices applying the fractal texture fourier image. Journal Food of Engineering 95: 285-290. DOI:10.1016/j.jfoodeng. 2009.05.007.

Sun, J., Chu, Y.F., Wu, X., Liu, R.H. 2002. Antioxidant and antiproliferative activities of common fruits. Journal Agricultural and Food Chemistry 50: 7449-7454. DOI: 10.1021/jf0207530.

Tortoe, C., Orchard, J, Beezer, A. 2007. Prevention of enzymatic browning of apple cylinders using different solutions. Journal of Food Science and Technology. 42:1475-1481. DOI:10.1111/j.1365-2621.2006.01367.x.

Valentines, M.C., Vilaplana, R., Torres, R., Usall, J., Larrigaudiere, C. 2005. Specific roles of enzymatic browning and lignification in apple disease resistance. Postharvest and Technology 36:227-234. DOI:10.1016/j.postharvbio.2005.01.002.