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# Modification Blanching Process of Potato Flour Using Hydrogen-Rich Water

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**Abstract**

*The chemical composition of potatoes includes carbohydrates, protein, fiber, vitamins, and minerals. The composition of vitamins and minerals in potatoes is higher than wheat flour. Brownish color in potato flour has reduced consumer's interest, so it needs to be modified to improve the color and physicochemical properties of flour. Researchers are trying to modify the blanching process using hydrogen-rich water. Because hydrogen-rich water has antioxidants that can prevent the browning process (oxidation) potato flour, cheaper, safer, and healthier than chemical compounds. The purpose of this study was to optimize the blanching process for potato flour modification. Variation of the process used is soaking time at 30, 45, 60, 75, and 90 minutes. The optimal results of water content, ash content, reducing sugar content, protein, color, and swelling power were obtained at 75 minutes are 6.7%, 2.68%, 0.26%, 7.1%, 81.17, and 7 g/g. The quality of the modified potato flour met the physicochemical parameters of the flour according to the SNI standard for flour, except ash content. The quality of potato flour produced almost equals as the quality of wheat flour, so it needs to be considered as a substitute for wheat flour and is friendly for diabetics.*

**Keywords:** *potatoes, modified flour, physicochemical properties, wheat*

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## INTRODUCTION

The world's annual demand for wheat flour increases steadily, and Indonesia is one of the world's largest wheat consumers. Because domestic wheat production is not sufficient to supply the whole nation's needs, Indonesia is highly dependent on imported wheat grain. Then, the wheat grains are milled by a local company to meet the nation's requirements (Andri, 2019). Therefore, other botanical sources are needed to substitute or reduce wheat consumption in Indonesia. Indonesia has many commodities that can be used as a substitute for wheat such as cassava, sweet potato, suweg, canna, and potatoes. Potatoes are one of the locally cultivated tuber plants abundant in Indonesia. Besides, Potatoes also contain several phytochemicals such as

polyphenols and flavonoids which are known as antioxidants, anticancer, anti-hypertension, and so on (Liu, *et al.,* 2016). Potatoes have the potential in a food diversification program (An, *et al.,* 2016). The nutrition composition of potatoes is carbohydrates, proteins, minerals in the form of sodium which has high alkaline levels that work to increase the pH of acids in the body, this mineral can improve the work of the liver. Other potato components are vitamin B and polyphenols such as flavonoids, which are well-known as antioxidants. Polyphenols are compounds that can prevent cancer and heart disease (Liu *et al.,* 2016; Aydin and Gocmen 2015). Several studies have been carried out to process potato starch, among others, for the manufacture of maltodextrin, glucose syrup, and fructose (high fructose syrups). Sugar products from potato starch are used to make various food, textile, and pharmaceutical materials (Yetti *et al.,* 2007). Maltodextrin is the basic material for making films or edible coatings that function as food protectors (Chandanasree, Gul, and Riar 2016). Other benefits of potatoes as an additional ingredient in the fermentation of the "iru" spice plant (Parkiabiglabosa) (Ajayi, *et al.,* 2015). Potatoes besides being used for food are also used in the health sector (Ahmed, 2015). Potato starch can also be used as an adhesive in an insulating material (Muizniece and Blumberga, 2016).

Potato starch consists of a unique phosphate ester group (0.2-0.4% D-glucose unit) covalently connected to the main chain of amylopectin (AP) at C-6 (61%), C-3 position (38%) and a small portion of C-2 positions. The starch structure is the result of differences in starch biosynthesis with different AM / AP ratios. Potato starch granules are broader and more oval-shaped (10-110 µm) (Gomand *et al.,* 2010; Zhu 2015; Nazarian-firouzabadi and Visser 2017). Modified starches are starches whose hydroxyl groups have been altered through a chemical reaction or by disrupting their original structure. Starch is given certain treatment to produce better properties to improve the previous properties or to change some of the previous properties or other properties. This treatment can include the use of heat, acids, alkali, oxidizing agents, or other chemicals that will produce new, chemical groups or changes in the shape, size, and molecular structure of starch (Zhu, 2015).

Brownish color on potato flour causes the flour to be less preferred by consumers (Samekto, 2010). Blanching is a treatment to prevent the browning process on potato flour. The function of blanching is to inactivate catalyze and peroxidase enzymes, prevent unwanted the formation of odors and colors, facilitate the movement of water during drying, prevent the loss of important substances such as carotene in potatoes (Kulkarni, *et al.,* 1996; Lingling, et al, 2018). Currently used blanching process are heating and inhibition with chemicals such as citric acid, ascorbic acid, sulfuric acid, or bisulfite. However, heating high temperatures cause the degradation of nutrition compound in the potato flour, whike heating can decrease swelling power (Zavareze *et al.,* 2012). Modification with the chemical compound is toxic and unhealthy.

Hydrogen gas is a gas that has high antioxidant ability, non-toxic and cheap. The advantage of this hydrogen-rich water is that it can be anti-inflammatory and antioxidant (Zhao, *et al.,* 2016; Tian, *et al.,* 2016). Alkaline water or hydrogen-rich water has abundant levels of antioxidants. Antioxidants are a very important role in neutralizing various free radicals that enter our bodies every day (Shirahata, *et al.,* 2012). The use of hydrogen-rich water is very broad, especially in the health sector such as cancer drugs, cholesterol, stroke, and treating Alzheimer's disease, etc. (Zhao *et al.,* 2016). Therefore, hydrogen-rich water potential to modify the blanching process. The purpose of this study was to investigate the quality of potato flour resulted after the blanching process with hydrogen-rich water in comparation with the quality of wheat flour according to SNI parameters.

## MATERIALS AND METHOD

### Materials

The materials used in this study, potato matured tubers from the traditional market of Yogyakarta which were cleaned, peeled, and sliced ±2 mm thick, prior the process and Hydrogen Rich Water pH 9 made using electrolysis equipment (Leveluk SD501).

### Modified Hydrogen-Rich Water Method

Potato slices soaked in 100 ml hydrogen-rich water with a variation of time 30, 45, 60, 75, and 90 minutes. The sample then dried in an electric oven, groundend and sieved with 80 mesh sieves.

### Analysis

The nutrition composition analysis was performed to ensure the flour quality following SNI 3751: 2009. The analysis included: water content, ash content, protein, reducing sugars, the color of potato starch and potato flour swelling power.

## RESULTS AND DISCUSSION

### Swelling power

Swelling power is the ability of starch to fully expand in water. It is influenced by the amylose content in starch and intermolecular hydrogen bonds in starch (Sumardiono, *et al.,* 2015). The effect of hydrogen-rich water on swelling power potato flour shows in Figure 1. Swelling power modified potato flour obtained 7 g/g-13.9 g/g. The swelling power trend increased along soaking time, but at 45 minutes until 75 minutes decreased, then increased again at 90 minutes. The decreased swelling power in hydrogen-rich water is due to the strengthening of hydrogen bonds in starch due to the addition of hydrogen (Zhu,2015). It increased significantly in 30 minutes and 90 minutes due to hydrogen-rich water pH 9 and dried in temperature 60°C. In temperature 60°C and the soaking hydrogen-rich water, the bonds stabilizing the semi-crystalline structure of the starch break and

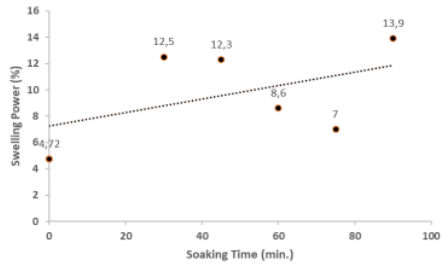


Figure 1. The Effect of Soaking Time on Swelling Power

replaced by water molecules, causing the granules to swell. The high-value swelling power related to high pH (Klang, *et al.,* 2019). Swelling power potato flour modified was higher than control (4.2 g/g). The swelling power of the modified potato flour obtained was higher than that of wheat flour, which is 5.5 g/g. Standard swelling power on Korean wheat is 7.3-8.5 g/g and American wheat is 6.9-7.9 g/g. The value of swelling power that falls within the standard range of swelling power outside Korea and America at the time of soaking 75 minutes (7 g/g).

**Color of Potato Flour**

The color of the flour can be seen from the degree of white or brightness denoted by the letter L. Color data of potato flour modified was presented in Figure 2. The result of color modified potato flour obtained was 70.04 to 81.59. The value of lightness decreased in 30 minutes and 75 minutes, but insignificant. The results showed that the color of the modified potato starch mostly was brighter than the color of the control of potato starch (without treatment). It was due to hydrogen-rich water that can prevent the browning process in tuber slices. An antioxidant compound in the hydrogen-rich water can inhibit oxidation in potatoes. The brightest flour color was obtained on soaking using hydrogen-rich water for 60 minutes with an L value of 81.75. Hydrogen (atoms and molecules), mineral nanoparticles, and mineral nanoparticles are hybrids that can electrochemically or naturally capture reactive oxygen compounds (free radicals) in cell culture experiments

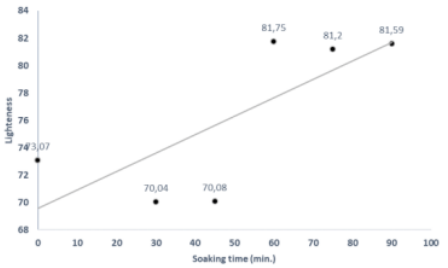


Figure 2. Effect of Soaking Time on Lightness

(Shirahata, *et al.,* 2012). The advantages of using hydrogen-rich water are environmentally friendly and safe for consumption.

**Water Content**

Water content is very important for the storability of flour. A lower water content, the flour will last longer. The results of the water content obtained in the range of 6.8% to 13%. Water content modified flour using hydrogen-rich water still within SNI standard flour 3751: 2009 limit (14.5%). The water content obtained was not a too significant difference, only at 45 minutes significantly increase (13%). Water content was influenced by drying temperature, soaking time, and drying time. In this case, temperature, and drying time constant. During soaking the hydrogen-rich water enters the flour. The longer soaking more water enters the flour, so affected the higher water content. The best water content is obtained when 75 minutes of soaking is 6.7% (Figure 3).

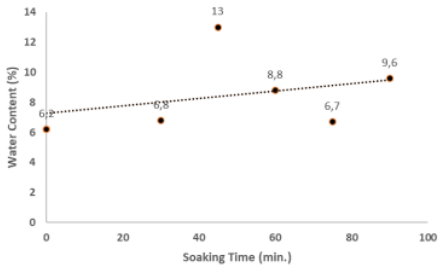


Figure 3. Effect of Soaking Time on Water Content

**Protein Content**

The protein content is one of the SNI parameters, the minimum standard is 7%. Protein content modified flour with hydrogen-rich water was 7.07% to 7.37%. (Figure 4). Soaking time has no effect on protein content.

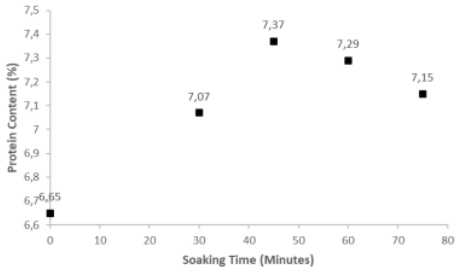


Figure 4. Effect of Soaking Time on Protein Content

The analysis shows that the protein content produced was the same for all modifications, mostly 7%. Protein content potato modified lower than wheat flour

(9.18%). Potato unmodified has lower protein than wheat because wheat has gluten. Antioxidants in the hydrogen-rich water can improve the protein content (Zhang, *et al.*, 2019). In fact, the protein content potato flour increase from 6.65% (without hydrogen-rich water) to 7.07%. The highest value of protein content was 7.37% at 45 minutes.

**Ash Content**

The obtained ash content does not meet SNI standards, which is a minimum of 0.7%. Ash content in hydrogen-rich water modified flour ranged from 2.75 to 4.36%. Ash content in potato starch is higher than wheat flour (0.80). The Ash content of steamed bread containing potato flour was 0.60%- 2.58%. Potato flour has higher ash content than wheat flour (Xing-Li, *et al.*, 2016). This is due to the process of purification of potato starch that has not been maximized. The lowest ash content was obtained at 90 minutes soaking using hydrogen-rich water which was 2.75% (Figure 5).

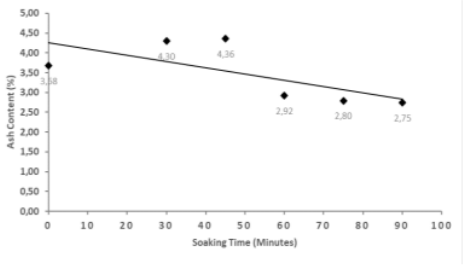


Figure 5. Effect of Soaking Time on Ash Content

**Total sugar and reducing sugar**

The results showed total sugar and reducing sugar modified using hydrogen-rich water was smaller than potato flour unmodified. Value of total sugar content and reducing sugar for modification with hydrogen-rich water, ranging from 4.7% to 6.3% (reducing sugar) and about 0.3% (reducing sugar). This is because potatoes have low sugar compared to flour.

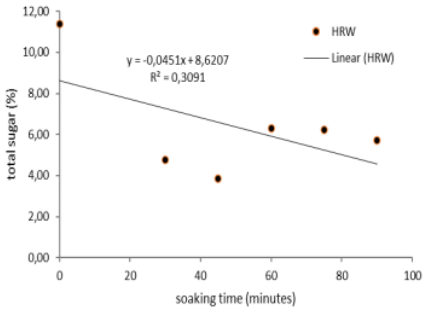


Figure 6. Effect of Soaking Time on Total Sugar

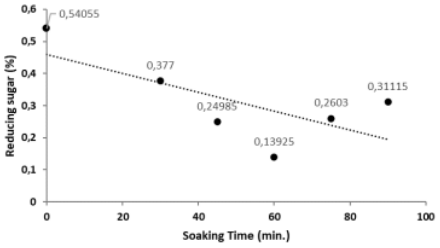


Figure 7. Effect of Soaking Time on Reducing Sugar

Reducing sugar are compounds with OH groups on their surfaces. These polar groups can form hydrogen bonds with water and retain them (Klang, *et al.*, 2019). Total sugar is all sugar in the flour, not only The immersion time affects the total sugar content (Figure 6) and reducing sugar (Figure 7). The blanching process (soaking time and temperature) reduced the value of reducing sugar and total sugar, these result in Klang research (2016). Low sugar levels in potato starch were due to the absence of gluten potato tuber. Therefore, potato flour is good for diabetics.

**CONCLUSION**

Based on the research, we concluded that the physicochemical properties of modified potato starch using hydrogen-rich water meet the SNI criteria for flour 3751: 2009 except ash content. Modified potato flour swelling power values are following flour swelling power standards. The physicochemical properties of potato starch were enhanced by modifications. The optimal results were obtained when 75 minutes of soaking. Therefore, modified potato starch should be considered as an alternative to flour.

**ACKNOWLEDGMENT**

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