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Modification of Purple Sweet Potato Flour Using Hydrogen Rich Water

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ABSTRACT

The increasing need for wheat flour in Indonesia needs to be overcome by looking for alternatives to wheat flour. Wheat flour has the disadvantage of high sugar content, so flour from local tubers is needed, which is healthier, namely purple sweet potatoes. The disadvantage of local tubers if they are used as flour is their flourishing power so they need to be modified. Hydrogen rich water (HRW) is alkaline water that can be used to modify starch in purple sweet potato flour. The purpose of the study was to determine the effect of HRW modification on water content, swelling power, ash content and color. The method used is soaking using variable pH (5.9), soaking time (15, 30 minutes) and compared with citric acid 1% with soaking time 30 minutes. The optimal analysis results were obtained at pH 9, soaking time of 30 minutes using HRW with a moisture content of 6%, swelling power of 4.1 g / g, ash content of 10%, the fat content of 13.5%, color L, a, b respectivelly 65.34; -0.33; 16.03.

1. Introduction

The need for wheat flour in Indonesia is increasing every year, in 2020 it will increase to 2,455 kg/capita. The value of being an imported commodity was also recorded automatically from US$9.95 million in the first semester of 2018 to US$12.43 million. but has some deficiencies as daily food triggers blood sugar, causes allergies by gluten content, reduces mineral absorption by the body, triggers the risk of heart disease [1], [2]. which has great potential in supporting the Indonesian economy is sweet potato. Sweet potato or in Latin known as *Ipomoea batatas* is a plant that belongs to the type of palawija plant, can work as a substitute for staple food because it is a source of carbohydrates. Sweet potato has a high economic value and serves as a raw material for various industries. The potential of sweet potato as a raw material for the food industry is large, considering that the available resources are very abundant due to easy cultivation and a short harvest period, besides that, sweet potato also has high flexibility in processing. The nutritional content is quite complete, even some of them are very important for the body because they work physiologically, namely anthocyanins and carotenoids as anti-oxidants and rapinasa fiber which functions as prebiotics [3], [4].

Based on data from the center of socio-economic and agricultural policy, the export value of sweet potato as flour as of June 2020 was 442 tons, worth Rp. 2.2 billion. As of 2019 the export of sweet potato flour was only 486 tons with a value of IDR 2.1 billion [5]. This value shows an increase. The increasing need for flour in Indonesia needs to be met by finding alternatives using

local tubers, namely purple sweet potato. Purple sweet potatoes were chosen because they are non-gluten. So that sweet potatoes are healthier than wheat, besides that the availability of sweet potatoes is abundant in Indonesia.

Sweet potato can be one of the alternative food crops to accompany rice towards food security. This is based on the consideration that sweet potato is (1) the fourth source of carbohydrates after rice, corn and cassava; (2) has high productivity compared to rice and cassava; (3) has the potential for product diversification which is quite diverse; (4) has the potential for increasing local, regional and export market demand; (5) and has a fairly diverse nutritional content and is not owned by other food crops. Purple sweet potatoes contain beta carotene and anthocyanins. Anthocyanin is one of the antioxidants that causes the purple color of sweet potatoes. Sweet potatoes have a higher crude fiber content than white and orange sweet potatoes [6], [7]. Purple sweet potato contains 123 cal of energy, 1.8 grams of protein, 0.7 grams of fat, 27.9 grams of carbohydrates, 68.5% water, 1.2% crude fiber, 0.4% sugar content, beta carotene 17.42% [8].

Modification of starch is a change in molecular structure that can be done chemically, physically or enzymatically. Natural starch can be made into modified starch or modified starch, with the desired properties or according to needs example for making noddle, bread, etc. Modification can be done by several methods such as physics using heating, acid hydrolysis, enzymatic. However, the previous method has drawbacks, namely heating can damage the nutrients of food while the use of acids from chemicals is less safe for health. Enzyme prices are expensive and difficult to obtain, causing enzymatic modifications to be less desirable [9], [10].

Hydrogen Rich Water is one type of water processed by electrolysis machine technology. From the electrolysis process, large amounts of free hydrogen (H_2) are produced. Hydrogen is the smallest antioxidant on earth, which of course plays a role in the prevention and even healing of various diseases [9], [11]. The high hydrogen content causes hydrogen rich water to ward off cancer-causing free radicals. So that the resulting flour becomes healthier. Several studies on modifications using hydrogen rich water in flour have been carried out, namely potato flour [9], pumpkin flour [12], and kimpul flour [13]. The results obtained by hydrogen rich water give a brighter color and higher swelling power of the flour. However, no one has reviewed the modification of purple sweet potato in previous studies.

This study discusses the effect of modified purple sweet potato flour using hydrogen rich water. The analysis used was physicochemical flour including starch swelling power, color, ash content, fat and water content.

2. Research Methodology

2.1. Materials

The main instrument used for this research is an oven. supporting instrument used such as chip cutters, ohaus scales. The analytical equipment used was a centrifuge, UV Vis spectrophotometer EMC-11_UV, a muffle furnace for the ash content test, an oven for the moisture content, and a chromamometer Konica Minolta CR400 for the color test. The materials used are purple sweet potato, hydrogen rich water and citric acid.

2.2. Procedures

Weighing 1 kg of purple sweet potato then peeled and cut thinly like chips with a thickness of 1-2 mm. The fermentation process uses citric acid with a concentration of 1% (as a comparison) and hydrogen rich water with a pH of 5, 7, and 9 at soaking times of 15 and 30 minutes. Purple sweet potatoes are oven-dried until they are dry and ready to be floured. After the purple sweet potato flour is finished, perform an analysis of the water content. The results of the best water content were then used to test swelling power, ash content, fat content, protein content, and color. The diagram showed at Figure 1.

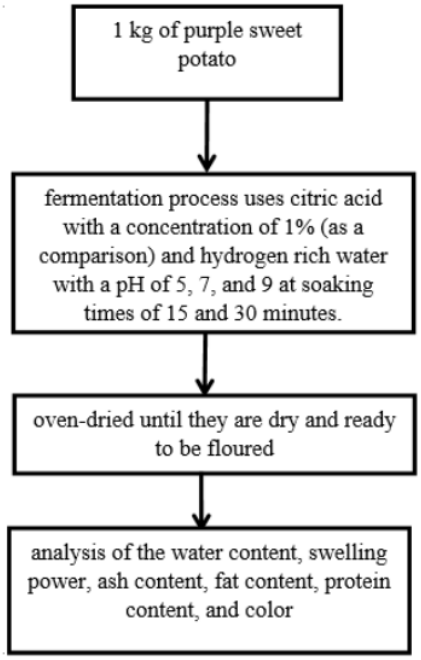

Fig. 1. Flow Diagram of Research Procedure

3. Results and Discussion

Table 1 presents the results of the analysis of water content and swelling power at pH 5, 7, and 9. At pH 5 immersion for 15 minutes the water content was 7%, swelling power was 3.2 g/g. Soaking 30 minutes pH 5 water content obtained was lower, namely 6%, lower swelling power of 2.7 g/g. pH 7 and 9 had water content of 3 and 6% and swelling power of 3 and 2.1 g/g at 15 minutes of immersion. Soaking for 30 minutes showed that the water content of pH 7 was 8% and 6%, while for swelling power it was 2.6 g/g at pH 7 and 4.1 g/g at pH 9.

Moisture content is an important parameter of flour quality. Water content is related to the shelf life of a food ingredient. High water content in foodstuffs causes mold to develop. The standard for flour is SNI 2009 with a maximum water content of 14.5%. Hydrogen Rich Water (HRW) is alkaline water that has more hydrogen content. HRW has an alkaline pH of 9-11. Acidic pH that is below 7 is called alkaline water. The long immersion time causes the water content to increase. The results showed that all variables of pH and immersion time met the water content standard, which was below 14% [14]. The results of the water content obtained in the kimpul modification study using HRW were 10.14% [13]. Research on modification of sweet potato flour using another method, namely roasting drying without soaking, obtained a moisture content of 7.63%, but in this study white sweet potatoes were used [3]. Modification of purple sweet potato flour using a spray dryer with the addition of a combination of maltodextrin and -cyclodextrin resulted in a moisture content of 7.13% [15]. The water content of untreated purple sweet potato flour (control) was lower than that of modified sweet potato flour, this was due to the addition of HRW in the modification [16]. Immersion time affects the interaction time between the flour surface and HRW liquid.

Swelling power is the ability of starch to swell. The swelling power is important to know if the flour will be processed into bread. The swelling power of starch is influenced by starch damage due to the entry of water into the structure. Swelling power is closely related to the ability of starch to become gelatin. Swelling power is influenced by the drying process, especially temperature [17], [18]. In this study using a drying temperature between 60-70 °C. This temperature was chosen

because the nutritional content and color of purple sweet potatoes will be damaged at high temperatures. Modification using HRW at pH 9 can increase the swelling power of potato starch [9]. This is evident in the results of the study, pH 9 showed the highest swelling power of 4.1 g/g. The increase occurred from 1.9 g/g in the control flour to 4.1 g/g at pH 9. Overall there was an increase in all variables of pH and soaking time of the control.

Table 1. Results of Analysis of Moisture Content and Swelling Power of Modified Hydrogen Rich Water

pH HRW	Soaking time HRW (min)	Test Parameter	
		Water content (%)	*Swelling Power (g/g)*
control	-	4	1.9
5	15	7	3.2
	30	6	2.7
7	15	3	3
	30	8	2.6
9	15	6	2.1
	30	6	4.1

Table 2. Comparison of Moisture Content and Swelling on Modified HRW and Citric Acid

Treatment	Soaking time (min)	Water content (%)	Swelling power (g/g)
HRW pH 9	30	6	4.1
Citric acid 1%	30	7	2.4

Table 2. presents the comparison of modifications with optimal HRW in Table 1 with citric acid at the same immersion time. The results of the water content showed a higher HRW modification than citric acid. This is because HRW is easier to evaporate than citric acid, the boiling point of HRW or water is 100 ºC, while citric acid is 153 ºC. Swelling power at alkaline pH is higher than in acidic conditions, due to the interaction of protein and starch which has a positive charge, causing an increase in swelling power [19]. The results of the modified study using HRW reported that pH 9 gave a high value of swelling power [12]. The longer the soaking time, the more liquid that enters the flour, so the longer evaporation occurs. The immersion time also affects the swelling power, the longer the HRW interaction with starch, the liquid will enter and break the starch crystals so that the swelling power increases [16].

The results of the analysis of ash content, fat (Table 3) and color are presented in Table 4.

Table 3. Analysis of ash and fat content of HRW

Variable	Ash content (%)	Lipid Content (%)
SNI	max. 0.7	-
Control	1.60	0.39
Flour modification	10	13.5

Table 4. Color Analysis of HRW Modified Flour

Variable	Color parameters		
	L	*a*	*b*
Control	64.93	1.05	16.63
Flour modification	65.34	-0.33	16.03

The ash content of modified flour is still high, not in accordance with SNI flour. This is due to the drying process carried out in the oven, the temperature is 60-70 ºC and the uneven cutting causes uneven drying so that some parts of the sweet potato may turn into ashes. Unclean washing and cutting can cause a lot of dirt to turn into ashes. Previous research using an oven without modification has an ash content of 1.60%, the ash content is already low, but not in accordance with SNI. Drying in previous studies also used an oven [20].

The fat content of modified flour is high compared to the fat content in the study of Rijal, et.al., [20]. HRW can increase the fat content in sweet potatoes, probably due to the hydrolysis process that occurs. In the previous study, no modification was used, only using the drying method using an oven so that the fat content in sweet potatoes was small. The fat content in purple sweet potato itself is 0.7 grams.

Color is an important parameter for foodstuffs. The original color of purple sweet potatoes is purple from anthocyanins. The color analysis that has been carried out shows that there is an increase in flour brightness (L). Modification of HRW reported in previous studies can lighten flour, because the antioxidants in HRW prevent oxidation reactions, for example in potato starch research [9]. Another color parameter is a, namely red and green, the results of the analysis show that the red color in the modified flour decreases or is more towards green because the number indicates -0.325, while the control flour tends to be slightly red at 1.05. The original colors of purple sweet potatoes are red and blue (purple). Blue and yellow colors are indicated by the value of b. The results of the analysis showed that the control and modified flour showed a value towards yellow, the difference in the value of b for the control and modified flour was not very significant.

4. Conclusion

Based on the research that has been done, it can be concluded that hydrogen rich water can be used to modify sweet potato flour. The best modified results were obtained at pH 9 with an immersion time of 30 minutes. The results of the analysis of water content 6%, swelling power 4.1 g/g, ash content 10%, fat content 13.5%, brighter color than control flour. The results of the analysis obtained have met the SNI standard for flour, except for the ash content. Further research is needed to reduce the ash content, so that purple sweet potato flour is suitable for use as a substitute for flour.

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