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Characteristic of Kimpul (*Xanthosoma sagittifolium*) Flour Modified with Hydrogen Rich Water

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Abstract

Kimpul one of tuber that potentially for substitute wheat in Indonesia. The disadvantage of kimpul tubers is that they are easily damaged or not durable because they have a high moisture content. Either method to modify starch is to use hydrogen rich water. The advantages of HRW compared to other modification methods are that HRW is safer, healthier for the body and more economical. The objective of the work was to determine the effect of hydrogen rich water and drying temperature on characteristic kimpul flour. Variables were used in this research pH (3, 6,7,9,11), soaking time (15, 30, 45, 60, and 75 minutes), temperature drying (100,110,120°C). The result is yield maximum obtained 38.67% at pH 7, soaking time 45 minutes and temperature drying 100°C. Swelling power is 0.52%. Structure molecule spherical and, separated. Result of proximate analysis for modified kimpul flour are ash content 4.49%; fat content 0.27%; fiber 4.69%; carbohydrate content 76.25%; protein 4.15%; moisture content 10.14%, energy 313.76 Kal/100 g; reducing sugar 0.78%. Color analysis result L, a and b are 19.63; 1.78 and 9.23 respectively. Hydrogen rich water has a good effect on molecules and color.

Keywords: *flour, kimpul, hydrogen rich water*

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INTRODUCTION

Kimpul (*Xanthosoma sagittifolium*) is one of taro variety that abundant in Indonesia. Kimpul grow in the tropics and sub tropics (Ndukwu, Dirioha, Abam, & Ihediwa, 2017). The biggest kimpul producers in Indonesia are Bogor and Malang. Kimpul has carbohydrate approximately 70-80% (amilopektin 72-83% and amilosa 17-28%). Nutrition in 100 grams fresh kimpul are 1.9 grams of protein, 0.2 grams of lipid, and 23.70 grams of carbohydrate. Kimpul has active compound anticancer, called diosgenin (Elishabeth, 2015). Kimpul has many vitamins A,B,C and minerals such as magnesium, calcium and phosphate (Cahyo, Dewi, Putri, Sri, & Susetyo, 2014). Nowadays, kimpul uses for thickener, binder and stabilizer for cosmetics, pharmacy and food industries (Andrade, Aparecida, Silva, & Nunes, 2020; Yu et al., 2019).

Kimpul is one of tuber that potentially used for wheat substitution in Indonesia. Consumption of wheat imports in Indonesia reached 10 million tons (Badan Pusat Statistik, 2021). If wheat imports are reduced, then Indonesia can achieve domestic food security.

Kimpul moisture content are 60-83% of weight (Ndisya et al., 2020). The disadvantage of kimpul tubers is that they are easily damaged or not durable because they have a high moisture content. Native starch from kimpul have long to processed and not acid resistance (Ndukwu et al., 2017). Therefore, the starch in kimpul needs to be modified. Starch modification is a way to change the hydroxyl groups of starch through chemical reactions or by disrupting the original structure of starch (Hazarika & Sit, 2016).

Modification of starch can be done chemically, physically and enzymatic (Zhu, 2015). Kimpul starch has been physically modified using microwaves and hot air but it can broke nutrition in kimpul (Li et al., 2020). Either method to modify starch is to use hydrogen rich water (HRW). HRW is alkaline water resulting from electrolysis which is rich in antioxidants. HRW could change the distribution of phytochemical in the starch (Guan et al., 2019). The advantages of HRW compared to other chemical solutions for modification are that HRW is safer, healthier for the body and more economical (Budiarti, Wulandari, Mutmaina, & Sulistiawati, 2020).

The objective of the work was to determine the effect of soaking time and drying temperature on characteristic kimpul flour i.e. yield, swelling power, color, molecular structure of kimpul flour and nutrition on kimpul flour modification.

MATERIALS AND METHOD

Material

The materials used in this research were kimpul tubers from Simpang Empat Market, Tangaran, Sambas, West Kalimantan. The chemicals used such as Hydrogen Rich Water (HRW) and other supporting chemicals were obtained from the Chemical Engineering Laboratory of Ahmad Dahlan University. The equipments were used in this research such as a water electrolysis device, slicer, oven, glassware, sieve, centrifuge, analytical scale, SEM.

Sample preparation

Kimpul tubers were peeled, washed and cut into chips. Chips were divided into several samples according to the number of variables. First, kimpul divided into 5 samples, soaked in HRW pH 9 as much as 500 mL for 15, 30, 45, 60, and 75 minutes. Then it was dried in an oven at 100°C for 10 hours. Second, the kimpul was divided into 5 samples, soaked in 500 mL HRW pH 9 for 15 minutes and then dried at 100,110,120°C for 4 hours. Third, the variable used was pH 3, 6,7,9,11. After the sample was dry, it was blended and sieved through an 80-mesh sieve.

Analysis method

The samples were then analyzed for yield. The best results of yield, would analyze for physicochemical properties including: swelling power analysis, reducing sugar analysis, flour morphology analysis (SEM), proximate analysis, color analysis.

RESULT AND DISCUSSION

Yield and moisture content analysis

Yield of kimpul flour modification are shown on Table 1. Generally, yield are increased with the increased soaking time and pH. The increased might be due hydrogen rich water improved them. However, in several data yield decreased, i.e. majority 75 minutes soaking time on all pH. This happen might to due on soaking time 75 minutes. Soaking too long causes a lot of water content in the tubers, so that when heated some were not completely dry, chips were difficult to pond into flour (Budiarti & Sulistiawati, 2019). The highest yield 38.67% was reached at 45 minutes soaking time.

Yield are majority decreased with increased temperature drying. This is may be due to kimpul flour not resistant with high temperature. Temperature normally allowed range 60-70°C (Darmawan, Andreas, Jos, & Sumardiono, 2013)(Reff). Researcher was used 100,110 and 120°C, because pandemic COVID-19, so research used a house tool (oven) which has the minimum temperature level of 100°C scale. Temperature 100°C give the highest yield.

(HRW) have range pH 3-11. Table 1 are shown pH 7 reached the highest yield at 38,67%. There was no correlation between pH and yield. The pH only affect the swelling power and solubility of starch (Budiarti & Sulistiawati, 2019).

Swelling power

Swelling power values are shown ini Table 2. The swelling power modified kimpul flower was lower than native kimpul flour. That might be due to swelling power increased in acidic situation. Meanwhile this modified kimpul flour used netral situation (HRW pH 7), it was cause swelling power decrease. Decrease swelling power also caused by hydrolisis partial during the soaking process. Hydrolysis partial producing starch fraction with low molecule weight, so the ability to swell is limited. The swelling power of starch affects the quality of starch when heated. The high swellability of starch will improve the quality of starch when it is made into processed foods such as bread(Budiarti & Sulistiawati, 2019).

Structure molecular starch

The result of structure molecular starch is shown in Fig.3. The structure of starch kimpul modification showed granules that spherical and more separate than native kimpul flour (Fig.2). Hazarika & Sit (2016) reported that the structure of modified taro starch showed small and medium polyhedral (polygonal) and truncated granules and smooth surfaces with some portions of the surface being irregular. Modification did not make any significant change but make this granule crystals separate. Starch modification causes damage to starch granule (Hazarika & Sit, 2016). Modified kimpul flour starch granules are almost similar to wheat flour (Fig. 1).

Table 1. Yield of kimpul flour modification

pH	Soaking time (min)	Yield (%) Temperature drying (°C)		
		100	110	120
3	15	32	31.33	34
	30	32.67	29.33	28
	45	34	32.67	24.67
	60	37.33	31.33	26.67
	75	28.67	31.33	25.33
6	15	32.67	28	25.33
	30	35.33	30	30.67
	45	31.33	29.33	26.67
	60	32	30.67	28
	75	30.67	29.33	24.67
7	15	26.67	33.33	33.33
	30	34	28.67	33.33
	45	38.67	28	27.33
	60	34	32	26.67
	75	30.67	35.33	36.67
9	15	31.33	28	26
	30	33.33	23.33	30.67
	45	30.67	26.67	29.33
	60	32	31.33	28
	75	34	32.67	26.67
11	15	30.67	32	32.67
	30	37.33	28	28
	45	35.33	33.33	25.33
	60	34.67	32.67	29.33
	75	33.33	30.67	28.67

Table 2. Swelling power of kimpul flour modification

No	Sample	Swelling power (%)
1	Native kimpul flour	4.49
2	Kimpul flour modification	0.52

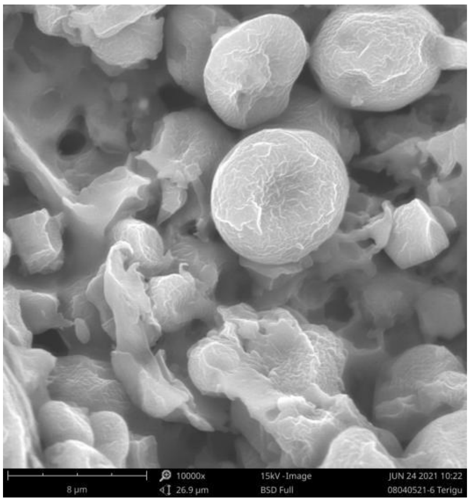

Figure 1. Molecular structure of wheat starch granules

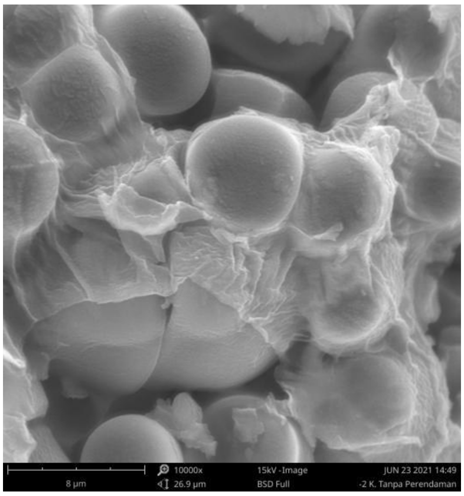

Figure 2. Molecular structure of native kimpul starch granules

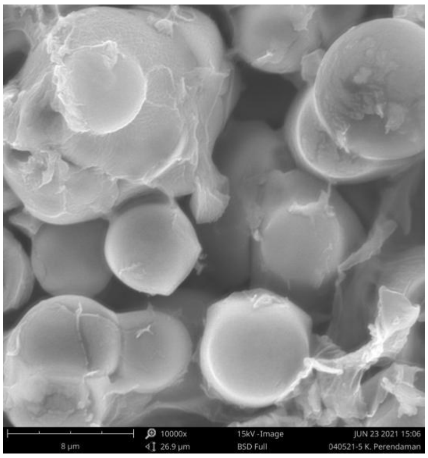

Figure 3. Molecular structure of modified kimpul starch granules

Table 3. Proximate analysis modified kimpul flour

No	Sample	Ash content (%)	Fat content (%)	Fiber (%)	Carbohydrate content (%)	Protein content (%)	Moisture content (%)	Energy (Cal/100 g)	Reducing sugar (%)
1	Native kimpul flour	3.80	0.31	5.81	76.85	4.81	8.41	319.27	0.31
2	Kimpul flour modification	4.49	0.27	4.69	76.25	4.15	10.14	313.76	0.78
3	Wheat Flour	0.72	0.15	2.11	76.55	8.69	11.78	333.16	0.70

Proximate Analysis

Proximate analysis included analysis moisture, fat, protein, ash, fiber, and carbohydrate content, energy and reducing sugar. Proximate analysis result is shown in Table 3. The result showed fat, fiber, carbohydrate, protein content modified kimpul flour lower then native kimpul flour, excepted ash content. This may be due to they dissolve a lot during the soaking process (Astuti, Andarwulan, Fardiaz, & Purnomo, 2017). In addition, the decrease nutrition modified kimpul flour was caused by the drying process at high temperature 100°C. The nutrition, such as protein, vitamins is not resistance to high temperature. The fiber content of kimpul flour is higher than wheat flour, so kimpul flour good for diet. Ash content kimpul flour is higher than wheat flour due to drying process. Carbohydrate in modified flour is lowest, so it good for diet. Reducing sugar in kimpul flour modification is highest, reducing sugar gives a sweet taste so it is preferred. Moisture content modified kimpul flour (10.14%) is higher than native kimpul flour (8.41%). This is due to soaking process, so many water content in the flour. Modified and native kimpul flour still accepted SNI for moisture content maximum? 14.5%.

Table 4. Color analysis result

No	Sample	L	a	b
1	Native kimpul flour	78.02	2.05	12.17
2	Kimpul flour modification	79.63	1.78	9.23
3	Wheat Flour	86.26	0.28	8.13

Color Analysis

Color is important for people who consume food product, including flour. Result of color analysis is shown in Table 4. It is shown in light (L), red (a) and yellow (b) value. The result showed that modified kimpul flour brighter than native kimpul flour. The brightness in kimpul reported 92% closer to wheat HRW modification more healthy than chemicals modification. The abundant hydrogen content as an antioxidant that can prevent oxidation reaction in kimpul, in addition to brightening the color of flour, HRW is also healthier(Budiarti & Sulistiawati, 2019)..

CONCLUSION

Based on the research, can be concluded that yield maximum obtained 38.67% at pH 7, soaking time 45 minutes and temperature drying 100°C. Swelling power is 0.52%. Structure molecule spherical and, separated. Result of proximate analysis for modified kimpul flour are ash content 4.49%; fat content 0.27%; fiber 4.69%; carbohydrate content 76.25%; protein 4.15%; moisture content 10.14%, energy 313.76 Kal/100 g; reducing sugar 0.78%. Color analysis result L, a and b are 19.63; 1.78 and 9.23 repectively. Hydrogen rich water has a good effect on molecules and color. Color is important for food products. Color is a visual profile that becomes the first impression of consumers in assessing a product and increasing appetite (Santosa, Winata, & Sulistiawati, 2016).

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