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Improving Non-wheat Flour Quality As a Form of Local Food Conservation

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Abstract

The growth rate of Indonesian population increases the community's dependence on wheat flour which is wholly made from imported wheat. Local carbohydrate sources that can function strategically as food reserves are Indonesian traditional tubers and roots. Tubers and roots also contain some bioactive compounds that have physiological effects as antioxidants. The bioactive compounds found in these inferior local tubers are dioscorin, diosgenin, and phenol. These three types of bioactive compounds have been shown to have the ability to ward off free radicals. This study aims to develop tuber products and increase added value through the utilization of appropriate technology and diversification of processed products. The study used sixteen types of traditional Indonesian tubers. The method used is to reduce the size of the tubers using crystallization method and utilize the blower system to create the wind for drying system. The blowing facilitates the process of reducing the water content to improve the durability of the flour. The research applied the mixed method approach. The study was carried out in the laboratory. Data were analyzed using proximate analysis to determine moisture content, ash content, carbohydrate content, protein content and fat content. The results showed that the chemical content of Suweg flour with pregelatinization method at 70 °C for 60 min had the highest water, ash, and fiber content at 5.79%, 2.49%, and 43.73%, respectively; while the highest carbohydrate content obtained by heating for 10 minutes at 25.80%. In conclusion, traditional tuber flours are sufficient for the use of raw materials for the food industry.

Keywords: traditional Indonesian tubers, non-wheat flours, local food

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1. Introduction

The diversity of processed food products using wheat as the primary material causes the increase of wheat production and its demand in proportion to the level of public consumption and the population growth rate. Based on data from the Indonesian Flour Producers Association (Aptindo), Indonesia has a significant increase in flour consumption from 9.9 kg per capita in 2012 to 17.11 kg per capita in 2017. Indonesia has a wheat import regulation which in 2010 reached a level of 5 million tons. The Indonesian Flour Producers Association (Aptindo) stated that in 2012 the value rose 6 % compared to 2011 which reached 4.7 million tons (Aptindo, 2012)

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Data of Indonesian Central Bureau of Statistics (BPS) show that wheat imports in 2011 have reached 5.4 million tons with Australia's main source of 3.7 million tons, Canada 982,200 tons and US 747,900 tons. While imports of wheat flour in 2011, reached 680,100 tons with a value of 281.7 million US dollars (BPS, 2012). The leading exporter of wheat flour originated from Turkey with 387,400 tons and Sri Lanka with 207,800 tons and the rest from Ukraine, Belgium, and Australia.

The Indonesian Flour Entrepreneurs Association (Aptindo) notes that there are five new flour mill industries starting production in 2014. The new plant will increase production capacity while increasing wheat imports as wheat flour raw material. The domestic wheat production currently reaches 5.4 million tons per year or equivalent to 7 million tons of wheat per year. With the added investment of the five companies, the wheat imports will increase to 9.7 million tonnes of wheat per year or an increase of 38%. Wheat is food that is 100% imported by Indonesia. (http://finance.detik.com dated 14/04/2014).

To produce a ton of wheat flour requires a seven million tons of wheat imports. The most significant flour consumption is the noodle company who reached 55 percent, while the producers of bread as much as 22 percent and biscuits 18 percent. Majority grain imports are from Australia, Canada, America, Russia, Ukraine, Kazakhstan, India, Pakistan, Brazil, and Argentina. Central Bureau of Statistics (BPS) announced the value of wheat imports in January 2016 was recorded at 443.4 million US dollars or jumped sharply 86.35 percent (Suryamin, 2016).

The dependence of the Indonesian people on imported wheat will gradually shift the consumption of local food besides rice. Local carbohydrate sources which function strategically as food to support national food security is the traditional tubers which are increasingly feared to be more neglected. Local tubers are promising to substitute the need for wheat in the industry. Local tubers such as *gembili, gadung*, yam, arrowroot, and *kimpul* are inferior local tubers widely available in Indonesia, but the availability is not directly proportional to their utilization. Inferior local tubers in addition to containing high carbohydrates also contain a number of bioactive compounds that have physiological effects as antioxidants. The bioactive compounds found in these inferior local tubers are dioscorin, diosgenin, and phenol. These three types of bioactive compounds have been shown to have the ability to ward off free radicals (Mar'atirrosyidah, 2015)

There are 44 types of traditional food made from tubers distributed in Yogyakarta City. The average nutrient content (energy, protein, and fat) of traditional food made from each serving size is energy (88 to 502 kcal), protein (0.60 to 5.60 g), and fat (0.30 to 28.10 g), respectively.

However, it has some problems such as tuber as the substitute for rice or flour is less preferred for consumption even though the price is low because it looks unattractive, uncomfortable, and limited in its processing. Also, it has an abundant water content especially when tubers are harvested usually reach ± 65%, make it easily damaged and lead to the appearance of blackish blue spots, browning, soft texture, moldy tubers and eventually become rotten. Lastly, not all tubers show physiochemical content corresponding to the number of carbohydrates required by the body.

By these issues, the research on improving the quality of non-wheat flour is needed with the aim of (1) improving the quality of physiochemical content of tuber flour as required; and (2) improve the siege process through the utilization of appropriate technology. Research is expected to be beneficial to improve the nutritional status and national food security on the one side, and on the other side, the utilization of local resources as raw materials of the food industry will be improved as well.

2. Materials and Methods

In this study 16 types of local tubers were used to determine the nutritional value of tuber chips, i.e., bentoel, garut, ganyong, gadung, kimpul, black potato, potato, cassava, taro, yellow sweet potato, white sweet potato, purple sweet potato, Ubi, sorghum, and breadfruit obtained from the local market.

The experiment used an experimental approach to develop dryers and laboratory tests. Tuber flour dryer is designed by integrating the blower system, temperature, and heat quantity from the stove. The dryer operating system operates automatically to set the fire and blower levels to adjust the desired temperature, and it has an automatic on-off system to maintain the safety.

Equipment used includes cabinet dryer, grinder, and sieve size of 80 mesh. Weighing bottle, analytical scale, oven, desiccator were used for determination of moisture content. An analytical scale, filter paper, oven, a set of soxhlet extraction tool were used for the determination of fat content using. The stove, gooch crank, furnace, analytical scale were employed for the determination of ash content.

The water content analysis technique was determined directly with a sample of 3-5 g of tubers, weighed, dried by the oven at 105 °C for 6 h and then cooled to be known to the fixed weight.

Analysis of protein content using Micro-Kjeldahl method. First, the sample is weighed and put into a Kjeldahl flask, then 50 mg HgO, 2 mg K2SO4, 2 ml H2SO4, boiling stone, and boiled for 1.5 h until the clear liquid was obtained. After the solution was cooled and diluted with distilled water, the sample was distilled off with the addition of 8-10 ml NaOH-Na2S2O3 solution. Distillate detention product with Erlenmeyer containing 5 ml of H3BO3 and 2-4 drops indicator (the mixture of 2 parts methyl red 0.2% in alcohol and 1 part methyl blue 0.2% in alcohol). The resulting distillate was then titrated with a 0.02 N HCl solution until a discoloration from green to gray occurs. The same treatment was done against the blank. The results obtained were in total N, which was then expressed in the conversion factor of 6.25. The following formula can calculate the value as follows:

$$\text{Protein (\%)} = (\text{ml HCl} \times \text{ml Blank})\ \text{N HCl} \times 14.007 \times 100 \times 6.25$$

The fat content was analyzed using Soxhlet method. 5 g of sample was weighed and wrapped with filter paper. Then, it was included in the Soxhlet extraction refluxed for 6 hours until the diethyl ether descends back into the clear flask. The solvent in the fat flask was distilled; then, the flask containing the extraction results was heated in an oven at 105 °C until the solvent evaporated. Once cooled in a desiccator, the fat flask was weighed until it obtains a constant weight.

The determination of ash content was determined by weighing the remaining mineral from the combustion of organic material at 550 C. 3-5 g of the sample was weighed until balance. Then, the saucer and sample were burned with the electric heater in the smoke chamber until the sample was not smoky and was ignored on a spraying furnace at a temperature of 550 °C until light gray ash or constant results of weighing. It was again cooled down in the desiccator and weighed as soon as it reaches room temperature.

Carbohydrate Level Analysis was calculated by difference by reducing 100% nutrient content of sample with water content, ash content, protein content, and fat content. The value can be determined using the following formula:

$$\text{Carbohydrate Level(\%)}=100\%-(\text{Water Content}+\text{Ash Content}+\text{Protein Level}+\text{Fat Level})$$

3. Results and Discussion

Based on the data of the Central Agricultural Technology Assessment Center (BPTP) of Central Java Province, there are 13 types of genetic resources specific to potential non-rice crops of Central Java, where ten plants are tubers that have not been optimally utilized as shown in Table 1.

Prabowo *et al.* (2014) says that compared to wheat flour, gembili flour has the same economic level. With the existing technology, gembili can produce the yield by 25%. Gembili can be processed into chips and flour suitable for cake and bread production.

TABLE 1: Specific genetic resources diversity Central Java non-rice food crops.

Local Name	Scientific Name	Geographical Distribution
Ubi Kayu Sulawi	*Manihot utilissima*	Kec Wanayasa, Kab. Banjarnegara
Ubi Kayu Marekan	*Manihot utilissima*	Kec Pagetan, Kab. Banjarnegara
Kedelai Hitam Losari	*Glycine max*	Kec.Losari, Kab. Brebes
Kedelai Grobogan	*Glycine max (L) Merrill*	Kab. Grobogan Jawa Tengah
Jagung Jali	*Coix lachryma-jobi*	Kec Tembarak, Kab. Temanggung
Wilus	*Dioscorea alata*	Kec. Mojogedang, Kab. Karanganyar
Uwi Ungu	*Dioscorea alata*	Kec. Bojong, Kab. Tegal
Uwi Pandan	*Dioscorea alata*	Kec. Pangetan, Kab. Banjarnegara
Gembili	*Dioscorea esculenta*	Kec Bojong, Kab. Tegal
Ganyong	*Canna edulis*	Kec. Jatipuro, Kab. Karanganyar
Garut	*Marantha arundinaceae*	Kec. Jumantono, Kab. Karanganyar
Porang	*Amorphophallus muelleri*	Kec. Jenawi, Kab. Karanganyar
Suweg	*Amorphophallus campanulatus*	Kec. Mojogedang, Kab. Karanganyar
Source: BPTP Central Java Province (2014)		

Another advantage of the gembili tuber is high in carbohydrates and contains bioactive compounds. There are several bioactive compounds such as water-soluble polysaccharides (PLA), dioscorin and diosgenin that can serve as immunomodulators, prevention of metabolic diseases such as hypercholesterolemia, dyslipidemia, diabetes, obesity, inflammation, and cancer.

Tuber as one of the local foodstuff which is an organ of the plant that serves as a storage of certain substances (generally carbohydrates). Tubers usually formed just below the soil surface. The tuber is a generic term in general. In biological terms, tubers are distinguished from basic organs modification. Types of tubers are (1) Bulbus is a tuber formed from a leafy base of leaves, usually produced by the Alliaceae family, Amaryllidaceae, and Liliaceae; (2) Stem tuber is a tuber formed from modified stem, which grows beneath the surface of the soil, enlarged, and contain many starches, usually produced by some species of Solanaceae and Asteraceae; (3) Tuberous root is a tuber formed from root modification (Paramita and Mulwinda, 2012).

tubers that have been cultivated and have economic status are cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*), taro (*Colocasia esculenta*); and which are grouped into vegetable crops are potatoes (*Solanum tuberosum*). Most other types of tubers are only cultivated with subsistence or semi-commercial status such as arrowroot (*Maranta arundinacea*), ganyong (*Cana edulis*), gadung (*Dioscorea hispida*), uwi (*Dioscorea alata*), gembili (*Dioscorea esculenta*), uwi katak (*Dioscorea pentaphyla*), kimpul (*Xanthosoma violeceum*), taro (*Xanthosoma saggitifolium*), suweg (*Amorphophallus companulatus*), each of which has a variety at the species level (Kasno *et al.*, 2006).

Drying is the process of transferring heat from the dryer air to the material and evaporation of the water content from the material into the dryer air simultaneously. Heat transfer can take place by convection, conduction, and radiation. Drying using a drying apparatus has several advantages, the material can be more durable, thus more resistant during storage and the volume of the material becomes smaller making it more accessible and save packing and transport space.

The results showed that to obtain dry chips material with tuber base color unchanged takes 8 hours. The condition can be indicated that the nutrient content of flour has not changed much.

Figure 1: Automatic drying machine.

One of the parameters that determine the nutritional value of food is the amount and variety of nutrients contained in the food. Proximate analysis is a method of chemical analysis to identify the content of a food substance from a feed or food ingredient. Nutritional type of flour of local tuber which analyzed is the macronutrient (carbohydrate, protein, fat, water) and micronutrient (ash content test). The results showed that the protic content of tuber flour is shown in Table 2.

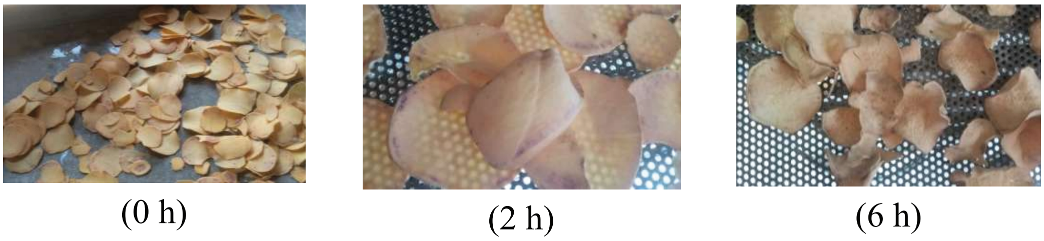

Figure 2: Tuber chips drying.

Based on the results of the proximate analysis, the average moisture content of the suweg flour is lower than that of the other tuber. Conversely, black potato flour and potato flour have high water content compared with other flour which is 13.7% and 13.0%, respectively. In fact, the non-wheat flour of tubers with low moisture content have more extended storage capacity. The existence or presence of water in a foodstuff is the primary parameter involved in most foodstuff destruction reactions. It is supported by the opinion of Winarno (2002) which explains that water content is a factor affecting the appearance, texture, taste of food, product endurance, freshness and consumer acceptance.

Table 2: Proximate analysis results of tuber flours.

Name	Water Content (%)	Ash Content (%)	Protein (%)	Fat (%)	Carbohydrate (%)
Bentoel	5.61	3.46	0.86	4.62	85.45
Garut	7.22	1.27	0.67	3.54	87.31
Ganyong	7.42	1.37	0.44	6.43	84.34
Gadung	6.06	0.55	6.32	14.23	60.80
Kimpul	6.91	3.61	0.58	2.48	86.42
Black potato	13.78	2.08	4.21	13.04	85.7
Potato	13	0.4	0.3	0.1	85.6
Cassava	9.1	1.3	1.6	0.5	88.2
Suweg	5.13	1.63	0.55	5.48	87.22
Talas	10.72	2.63	4.74	12.44	58.14
Yellow sweet potato	10.17	4.71	4.22	0.91	83.19
White sweet potato	10.99	3.14	4.46	1.02	84.83
Purple sweet potato	7.28	5.31	2.79	0.81	83.81
Uwi	7.14	2.36	0.8	3.64	85.59
Sorghum	11.65	1.21	3.68	21.8	48.95
Sukun	15	2	3.6	0.8	78.90
Source: Research Data					

The results also showed that the average sample proximate analysis of ash content on tuber flour was better than wheat flour which was only 0.59%. The average concentration of starch ash (3.16%) was higher than bentoel flour (3.46%) and uwi flour (2.36%). The purposes of the measurement of ash content in foodstuffs are to determine the index of purity of flour; to determine the index of purity; to detect forgery and as a parameter of cleanliness of contamination. Ash content in a foodstuff, indicating the presence of mineral content inorganic minerals that have a high enough resistance to cooking temperature. Ash is an inorganic residue of burning organic matter. The main components commonly found in natural organic compounds are potassium, sodium, calcium, magnesium, manganese, and iron. Ash content describes the total mineral content of macro and micro foodstuffs (Hulan, 1992).

The average protein content of tuber flour is much lower than wheat flour (13.5%). There is no gliadin and glutenin which form gluten in wheat flour in traditional tubers (Rufaidah, 2000); therefore, tuber flour is potential as a raw material product that does not require the development process (Winarno, 2002). Traditional tubers have the low protein content. Tuber powder can be used as an alternative food processed raw material through food nutrification until the value of processed food protein from tuber flour increases, such as fortification, or protein supplementation.

Yu *et al*. (2006) explain that the drying process will cause protein damage such as denaturation, aggregation structure, and reduced rehydration enzyme activity. In addition, protein damage is characterized by changes in the entire secondary structure of the protein.

Fat content in food is a complex component. Therefore the analysis of the fat constituent components becomes very complicated. Fat is classified in the lipid group where its characteristic is insoluble in water solvents, but this component tends to dissolve in organic solvents such as benzene, ether, and chloroform. Winarno (2002) argues that fat is a more important source of energy than proteins and carbohydrates because one gram of oil or fat can produce 9 kcal of energy, while protein and carbohydrate produce only 4 kcal. In the test of the fatty acid content of tubers, the result showed that fat content of potato, cassava, and sweet potato tubers had the lowest fat content of 1 - 1.1%; while the other tubers have higher fat content than wheat flour content of only 1.07%.

A material carbohydrate is a polyhydroxy aldehyde or polyhydroxy ketone which plays an essential role in nature because it is the primary source of energy for humans and animals (Hulan, 1992). Carbohydrates belong to the nutrient composition that is the primary source of energy suppliers for the body. The average carbohydrate content of tubers of tubers above 48%. Moreover, most carbohydrate levels of the tuber flour are in the range of 82-88%. Tubers are one of the ingredients of food group of carbohydrate source after rice and corn. Processed tuber form of flour with high carbohydrate content give opportunity diversification of raw material of foodstuff processed source of carbohydrate, which can, i.e., into processed form according to physical characteristics and physiochemistry of each flour (Nainggolan and Aritonang, 2017).

Tuber farming business is feasible to be developed. The income of tuber growers in Totikum Selatan Sub-district per year per plant was approximately IDR 7,667,487.30 ha with an average production amount of 2,006.46 kg. Also, the average income per hectare was IDR 24,733,830.01 /ha and the average production at 6,472.44 kg with the value of R/C Ratio > 1 or 2.02 (Sunandar, 2016). Timber farmers are chosen by the community because the maintenance process is easy and does not require intensive attention, the marketing is simple, and the chain is short so that the producers can obtain the most significant share of margin. There is a close and not continuous relationship between the subsystems of production facilities providers with farmers and the continuous relationships in the production, marketing, and processing subsystems as there is a mutually beneficial relationship.

4. Conclusions

The results of the study using 16 types of traditional tuber flour showed its physio-chemical contents, i.e., 1) low water content; (2) ash content of tuber flour is better than wheat flour (0.59%); (3) the average protein content of local tuber flour is much lower than wheat flour (13.5%); (4) fat content of tubers is more than wheat flour which is at 1-7%; (5) average carbohydrate content of local tubers is above 48%. Moreover, most carbohydrate levels of the tuber flour are in the range of 82-88%.

We recommend that (1) Flour tubers should be processed and used as a substitute for rice and wheat flour and can be consumed every day; (2) It should be further studied in the use of tuber flour in non-food industries to increase the economic value of traditional tubers; and (3) It needs a government policy to increase quantity, quality & continuity of tuber supply as raw material for food and non-food industry by involving related stakeholders.

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