The Properties Study of Mangrove Fruit Flour Composited with Taro and White Uwi Tubers

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ABSTRACT

This research is a part of research on the study of the glycemic index value of biscuit products from mangrove fruit flour with flour from various of tubers. The tubers used in this study were taro and white *uwi*. The types of mangrove fruit used were pedada and lindur. The starch content in taro tubers and white *uwi* can be used to make biscuits. It is known that both pedada (*Sonneratia caseolaris*) and lindur (*Bruguiera ghymnorhiza*) flour have anti-diabetic and anti-cholesterol properties. This study aims to analyze the characteristics of the biscuits from the formulation of a mixture of mangrove fruit flour with taro and white *uwi* tubers. This study used a one-factor completely randomized design with 10 levels of treatment, namely the proportion of mangrove fruit flour types of pedada and lindur and taro and *white* uwi tuber flour with the formula 0: 100, 10:90, and 20: 80. Biscuit product analysis parameters include proximate, organoleptic analysis, and glycemic index. Measurement of the glycemic index value was carried out in vivo using 22 respondents normal human, healthy, with a blood glucose of 80-100 mg / dL. Blood draws were carried out for 120 minutes at 30-minute intervals. The best biscuits were obtained in the formulation of pedada fruit : taro flour (20: 80), with criteria 84.07%, of yield, 3.72% of moisture content, 3.45% of ash, 4.33% of protein, 7.16% of fat, carbohydrates of 81.34%, 64.39% of starch, the dietary fiber content of 7.69%. Organoleptic test results showed 5.69 of color, the taste of 6.68, texture of 6.54, aroma of 7.13. In vivo test results obtained glycemic index values of 51.46, and glycemic load of 12.90.

Keywords*: biscuits; pedada; lindur,; taro; uwi putih; glycemic index*

INTRODUCTION

Biscuits are often consumed as a snack that complements the nutrition of the staple foods which also contribute sufficient energy for the body. This causes the various types of biscuits have been recently developed and quality improved. Changes in lifestyle and people's food consumption patterns have an impact on increasing degenerative diseases, such as diabetes mellitus (DM) and hypertension. Thus, some people started to choose a healthy food to consume in daily life, for instance a low glycemic index value-based food (Raghnild, 2004).

Jariyah *et al.* (2014) in the previous result reported that the type of mangrove flour of pedada (*Sonneratia caseolaris*) and the type of lindur (*Bruguiera ghymnorhiza*) showed anti-diabetes and anti-cholesterol properties. Thus, by consuming these mangroves initiated lower blood glucose levels. Therefore, in this paper will study the effect of other flours addition in the mangrove flour namely taro and white uwi tubers on the properties the composite. Taro has the potential to be developed which due to a highly starch content about 70-80%, with 2.69% crude fiber (Suismono, 2011), the glycemic index of taro tubers after peeling and boiling for 30 minutes is 50 (low) (Sundari, 2019). Meanwhile, white uwi flour has a carbohydrate content of 53.70%; 0.32% fat; 2.04% crude fiber (Widowati, 2009), with a glycemic index value of 22.1 (Lukitaningsih *et al.,* 2012).

Other than that, Rimbawan and Siagian (2004) state that the glycemic index of food is the level of food according to its effect on blood sugar levels. The dramaticly increasing of blood sugar

levels showed a high glycemic index. Conversely, foods that raise blood sugar levels slowly showed a low glycemic index. Several factors contribute the glycemic index value of a food product, including processing methods. For example, boiled taro has a lower glycemic index value (50) than taro which is produced into cookies which has a glycemic index value of 79.9 (Sundari *et al.,* 2019). Therefore, this study aims to analyze the characteristics of the biscuits from the formulations of pedada flour, lindur flour, taro flour and white uwi flour.

METHODS

Materials

The research materials included pedada fruit, lindur fruit obtained from mangrove farmers Sawohan Sidoarjo, taro obtained from the Mangga Dua market in Surabaya, white Uwi obtained from the Tuban market. The supporting materials for biscuits (margarine, skim milk, eggs, glucose syrup, baking soda, SSL / sodium stearoyl lactylate) were obtained from the Rungkut market in Surabaya. For analysis materials (sulfuric acid, potassium sulfate, sodium hydroxide, sodium carbonate, hydrochloric acid, hexane, and distilled water) were supplied from the chemical shop CV Vanjaya Surabaya. A set of tools for producing biscuits and glassware for analysis used in this study are available at the Food Processing and Food Analysis laboratory, in vivo tests are carried out in the Biochemistry laboratory under the supervision of doctors and nurses, while for organoleptic tests are available at the sensory test laboratory, Department of Food Technology, Universitas Pembangunan Nasional "Veteran" Jawa Timur.

Analysis Procedure

First of all, the manufacture of pedada fruit flour and lindur fruit flour refers to Jariyah *et al.* (2013) and Sarofa *et al.* (2013), while the manufacture of taro flour and white uwi refers to the procedure (Richana and Sunarti, 2004; Widowati, et al. 2002). The formula for biscuit production is presented in Table 1 which according to the research results of Jariyah *et al.* 2016. The proximate analysis, starch and food fiber identification were carried out for flour and biscuit products (AOAC, 2005). Analysis of the glycemic index of biscuit products was carried out in vivo by using 22 normal human respondent, healthy, 22-25 year old with sugar levels of 80-110 mg/dL. The respondents fasted for 10-12 hours before consuming the test food in the form of biscuits. Their blood was then checked after consuming the biscuits at 0 to 120 minutes with 30 minute intervals. Calculation of the glycemic index using the Incremental Area Under The Blood Glucose Response Curve (IAUC) method (Miller, 1996; Champbell, 2010; Jariyah *et al.* 2016)

The area under the curve was calculated using the trapezoid method:

Triangle area $= \dfrac{Base \ x \ Height}{2}$

Trapezoid area $= \dfrac{parallel \ to \ the \ base}{2} \ x \ height$

Table 1. The formulation of biscuit preparation.

Code	Formulation	Proportion (%)
A	PFF/LFF : Taro	0: 100
B	PFF/LFF: White uwi	0: 100
C	PFF : Taro	10 : 90
D	PFF: Taro	20 : 80
E	PFF: White uwi	10 : 90
F	PFF: White uwi	20 : 80
G	LFF : Taro	10 : 90
H	LFF : Taro	20 : 80
I	LFF : White uwi	10 : 90
J	LFF : White Uwi	20 : 80

Description : T=flour; PFF = Pedada Fruit Floura; LFF = Lindur Fruit Flour

RESULTS AND DISCUSSION

Raw Material Analysis

The analysis of proximate and dietary fiber from raw materials for biscuit production are presented in Table 1.

Table 1. Raw material analysis

Composition	PFF (% dw)	LFF (%dw)	Taro flour (%dw)	White Uwi flour (%dw)
Moisture	9.39	11.41	9.65	7.88
Ash	4.05	2.44	3.56	4.35
Fat	0.28	2.38	1.24	0.78
Protein	4,19	5,29	4,52	5,57
Carbohydrate	82.09	78.48	81.02	81.52
Amylose	-	16.16	18.74	15.81
Starch	-	23.02	86.87	83.85
Yield	7.00	31.34	8.42	8.82
Dietary Fiber	66.56	55.20	8.41	7.94
SDF	17.74	10.85	1.18	1.02
ISDF	48.82	44.35	7.23	6.91

Note : SDF =Soluble dietary fiber ; ISDF =Insoluble dietary fiber

Analysis Result of Biscuit Product
The Yield and Proximate of Biscuits

The analysis results of the yield and proximate biscuits are presented in Table 2, based on the results of statistical analysis declared that the determined formula had no significant effect on biscuit yield ($p \geq 0.05$), but had a significant effect ($p \leq 0.05$) on the proximate analysis of biscuits.

Table 2. Yield and proximate of biscuit product

Code Formulation	Yield (%)	Moiusture (%)	Ash (%)	Fat (%)	Protein (%)	Carb.*by difference* (%)
A	83.62+0.078	3.42+0.21[ab]	2.60+0.04[a]	6.76+0.04[ab]	3.85±0.03a	83.35±0.27[e]
B	84.07+0.064	3.21+0.02[a]	2.92+0.02[b]	6.68+0.01[a]	4.06±0.04[ab]	83.13±0.00[e]
C	84.33+0.028	3.64+0.03[cd]	3.23+0.08[d]	7.04+0.02[d]	4.12±0.04[ab]	81.97±0.05[d]
D	84.70+0.134	3.72+0.07[cd]	3.45+0.04[e]	7.16+0.01[e]	4.33±0.03[b]	81.34±0.13[d]
E	85.21+0.014	3.46+0.02[b]	3.40+0.01[e]	6.81+0.11[b]	4.67±0.11[c]	81.67±0,04[d]

Code Formulation	Yield (%)	Moiusture (%)	Ash (%)	Fat (%)	Protein (%)	Carb.*by difference* (%)
F	85.57±0,078	3.55±0.06[cd]	3.75±0.06[f]	6.93±0.05[c]	4.86±0.03[cd]	80.91±0.19[bc]
G	86.06±0.057	4.35±0.10[f]	2.94±0.02[b]	7.55±0.42[g]	4.94±0.42[de]	80.22±0.27[ab]
H	86.38±0.014	4.68±0.01[g]	3.04±0.10[bc]	7.71±0.06[h]	5.19±0.02[ef]	79.38±0.13[a]
I	87.17±0.014	3.82±0.00[de]	3.08±0.12[c]	7.09±0.04[de]	5.07±0.08[ef]	80.94±0.01[cd]
J	87.53±0.021	3.97±0.01[e]	3.13±0.08[cd]	7.27±0.06[f]	5.32±0.01[f]	80,31±0.00[ab]

Table 2 shows that the moisture, ash, fat and protein content of biscuit products is influenced by the content of the starting material for the biscuits. For example, the highest content in formulation H (LFF: Taro / 20: 80) is 4.68%, due to the starch content of the raw material in the form of amylose in taro flour (18.74%) and LFF (16.16%). The amylose acts to bind the water, thus affecting the water content of biscuits. Kusnandar (2010) reported that amylose easily binds to water, and it also easily releases water. In addition, Kurniawati (2012) mentioned that the high water content in flour is caused by the high starch content where when the starch is gelatinized, water will enter the starch granules. The incoming water then forms hydrogen bonds with amylose and amylopectin. The seeping of water into the granules causes swelling of the starch granules. The granule size start to increase to a certain extent before the starch granules finally burst. The rupture of the granule causes the amylose and amylopectin portions to diffuse out. The process of entering water into the starch causes the granules to expand and eventually break, because the number of hydroxyl groups in the starch molecule is very large, so the ability to absorb water is very large as well**.**

The highest biscuit ash content was 3.75% in formula F, namely PFF: white uwi flour (20: 80) which due to a higher percentage of the raw material for the ash content of PFF and white uwi flour respectively 4.05% (PFF) and 4.35% (white uwi flour) than other flour so that it initiated to increase the ash content in the resulting biscuits. The heating process also affects the high and low ash content of the products produced. According to previous result (Hadipernata *et al.,* 2006), the heating process results in the breakdown of water molecular bond components and also increases the content of sugars, fats, minerals, resulting in an increase in ash content.

There are 3 biscuit formulas whose suits into protein content based on SNI number 03-2973-2011 requirements, namely formulas H 5.19%, I 5.07% and J 5.32%. The low protein content in these biscuit products is due to the low protein content of the initial ingredients. Apart from these factors, low protein content is also influenced by the roasting process that is carried out in the biscuit-making process. According to Ophart (2003), heat initiated hydrogen bonds and non-polar hydrophobic interactions unstable. This occurs because high temperatures increase the kinetic energy and cause the molecules making up the protein to move or vibrate very fast, which breaks the bonds of these molecules then makes the protein damaged.The highest biscuit fat content was 7.71% in formula H, the high fat content in biscuits because the fat content in lindur and taro flour was higher than other flours, namely 2.38% for lindur flour and 1.24% for taro flour so that it could increase the fat content in the resulting biscuits, as well as carbohydrates by difference.

The Amount of Test Food

To determine the glycemic index value and glycemic load of biscuit products, it is necessary to determine the starch content, total sugar and available carbohydrate. The amount of test food is determined using a calculation of 50 grams divided by available carbohydrate multiplied by 100. Available carbohydrate is obtained by adding up the total sugar with the addition of multiplying 1.10 with starch. For the number of test foods for each biscuit formula is presented in Table 3, as a reference for comparison is pure glucose. The amount of this test food is used as the basis for giving the number of biscuits given to the respondent in determining the glycemic index test.

Table 3. The determination of the amount of test food

		Amount of test food		
Code formulation	Starch (%)	Total sugar (%)	*Available Carbohydrate* (gram)	Test food (gram)
Glucose	--	94.53	94.53	52.89
A	69.44	30.63	107.01	46.72
B	66.84	33.86	107.38	46.56
C	65.65	28.36	100.58	49.71
D	64.39	29.43	100.26	49.87
E	62.82	32.74	101.84	49.10
F	61.21	32.13	99.46	50.27
G	73.39	28.50	109.23	45.78
H	74.73	28.23	110.43	45.28
I	71.59	33.33	112.08	44.61
J	72.56	32.25	112.07	44.62

Glycemic Index and Glycemic Load

Based on the results of the variety analysis, it can be seen that there is a significant difference ($p \leq 0.05$) in the biscuit formula against the glycemic index value, these results can be seen in Table 4, the average value of the glycemic index for biscuits ranged from 51.46% - 65.39% . There is a difference in the glycemic index value of taro tubers boiled by Sundari (2019), namely 50. According to Lukitaningsih (2012), white uwi has a glycemic index value of 22.1. The difference in the results of the glycemic index value for the same foodstuff can occur because one of the factors that affect the glycemic index value of a food product is the processing method.

Foster-Powell and Miller (2002) showed that food of the same type declared different glycemic index values when processed and cooked in different ways. Processing change the structure and composition of the nutrients food. According to Jenkins et al. (2002), the cooking or processing process makes carbohydrates easier to digest so that increase the value of the glycemic index.

The biscuits formulated with pedada flour with a mixture of taro flour and white uwi flour had a lower glycemic index value compared to the biscuits formulated with pedada flour with a mixture of taro flour and white uwi flour. It is assumed that the dietary fiber content in pedada flour (66.56%) is greater than lindur flour (55.20%), which is a factor that influence it.

The low glycemic index value in the biscuit formulation of pedada flour: taro flour with a proportion of 20: 80, due to the ratio of amylose and amylopectin content in the ingredients. The amylose content of lindur flour, taro flour, and white uwi flour was 16.16%; 18.74% and 15.81%, so that it affects the amylose content of the biscuits. This amylose content contributes significantly to changes in the strength of the hydrogen bonds so that starch requires more energy for gelatinization, which makes it more difficult to digest. Arif, *et al.* (2013) stated that a higher amylose content causes slower digestion because amylose is a glucose polymer that has an unbranched structure. Amylose also has stronger hydrogen bonds than amylopectin, making it more difficult for digestive enzymes to hydrolyze it (Behall and Hallfrisch, 2002).

Pedada flour biscuits: taro flour with a proportion of 20: 80 has a higher glycemic index value than the taro flour glycemic index, which is 50.This is because in the process of making taro flour biscuits, the size of the biscuit particles becomes smaller and the biscuit structure becomes larger. soft, easy to digest and absorb. Rapid absorption results in hunger. Foods that are easily digested and absorbed raise blood glucose levels rapidly. This rapid increase in blood glucose levels forces the pancreas to secrete more insulin. Therefore, high blood glucose levels also increase insulin response (Rimbawa and Siagian, 2004).

Table 4. Glycemic Index and Glycemic Load of Biscuits

Code formulation	Glycemic Index	Glycemic Load
A	60.00 ± 0.50^{cd}	16.05 ± 0.08^{cd}
B	65.39 ± 1.67^{f}	17.55 ± 0.44^{e}
C	55.94 ± 1.22^{b}	14.07 ± 0.32^{ab}
D	51.46 ± 0.70^{a}	12.90 ± 0.42^{a}
E	61.63 ± 2.81^{de}	15.69 ± 0.66^{cd}
F	61.06 ± 0.16^{cd}	15.20 ± 0.03^{c}
G	$57.04 \pm 1,34^{c}$	17.00 ± 0.41^{b}
H	$55.59 \pm 0,36^{b}$	15.36 ± 0.09^{a}
I	$63.70 \pm 0,71^{ef}$	17.85 ± 0.19^{e}
J	$62.51 \pm 2,77^{e}$	17.51 ± 0.86^{d}

Based on Table 4 shows that the formulation of pedada flour biscuits: taro flour with the proportion of 20: 80 has the lowest glycemic load value. The glycemic load (GL) is used to measure the potential impact of food on blood glucose. The purpose of calculating the value of the glycemic load is to assess the impact of carbohydrate consumption by taking into account the food glycemic index value. Foods may have a high glycemic index but do not contain as many carbohydrates per average serving, there will be little impact on blood glucose. The calculation of the glycemic load of food, which is switching the glycemic index by the number of carbohydrates in one portion, then dividing it by 100. The glycemic load numbers of 20 and above are categorized as high, 10-19 in the medium category and less than 10 indicates a low GL value (Kindo, 2011) .

Organoleptic Test

The biscuit organoleptic test results of 25 panelists using the Freidment test are presented in Table 5, which includes taste, aroma, color, texture.

Table 5. The Organoleptic Test Result of the Biscuits

Code Formulation	Taste	Aroma	Color	Texstur
A	8.33	8.17	8.14	6.64
B	7.80	8.21	8.12	5.93
C	7.20	8.42	6.84	6.34
D	6.68	7.13	5.69	6.54
E	5.15	8.48	7.92	6.84
F	4.98	6.63	6.94	7.23
G	5.75	6.19	7.16	5.63
H	3.55	4.64	6.19	5.23
I	3.48	6.83	7.70	5.88
J	2.60	5.69	7.14	5.43

Table 5 shows that the panelists like the taste of formula A biscuits rather than formula J. It is due to the formula A has a sweet taste compared to other formulations, it is assumed that the taste comes from taro flour, white uwi flour. With the addition of PFF and LFF, the panelists liked it a bit because it was slightly acidic. The aroma of formula E biscuit products is preferable to formula H. In formula E biscuit products have a savory aroma than other formulas. The formula H biscuits have a distinctive aroma of taro and the aroma of lindur is a bit unpleasant so that it is not liked by the panelists.

The color of formula A biscuit products is preferable to formula D, this is because it produces a slightly brownish yellow color compared to others, this formulation is preferable in color because it has a higher taro flour composition, thus making the resulting biscuit products a slightly brownish yellow color.

The texture of formula F biscuit products is preferable to formula H, because formula F has a crunchy texture compared to other formulas which caused by the ratio of amylose and amylopectin that affects the texture of biscuits. Amylopectin in food ingredients produces an adhesive ability that causes the biscuit structure to become stronger. Another factor that can affect the texture is the addition of margarine, which has the function of improving the texture of biscuit products.

CONCLUSIONS

In this study, the characteristics of different composite-based as the raw material for healthy biscuits production has been successfully investigated. The best biscuit products can be achieved using formula D (TBP: T. Taro, 20: 80), which produced yield of 84.07 %, a low moisture level of 3.72%, ash percentage of 3.45%, protein of 4.33%, fat of 7.16%, carbohydrate of 81.34%, starch of 64.39%. In addition, the organoleptic test showed a color score of 5.69, taste 6.68, texture 6.54, and flavor 7.13, while the food fiber showed 7.69%, glycemic index 51.46, and glycemic load 12.90. Thus, it potential to be used as the raw material for healthy biscuits.

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