Formulation High Fiber Cookies Using Modified Banana Flour (*Musa paradisiaca*)

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ABSTRACT

Local food in Mamuju that has the potential as a functional food is banana. Banana that have been made of flour and modified can be used as a substitute for wheat flour in the manufacture of cookies. This research aims to formulate high-fiber cookies substituted with modified banana flour as a functional food. There were four steps of research (modified banana flour, cookies, sensory analysis and physicochemical tests. Completely randomized design (CRD) was applied b involving four factors of kepok banana flour modified which were F0 (0%), F1 (25%), F2 (50%), and F3 (75%). The parameters measured were organoleptic tests (taste, aroma, color, and texture). In addition, carried out physicochemical tests on the best formula. The results showed that the best formula was obtained in the F2 treatment which was 50% banana flour substituted cookies. The selected cookies (F2) contained 4.08% moisture, 43.02% resistant starch, 40.24% starch digestibility, and 15.51% dietary fiber. The selected cookies has good sensory quality and it can be used as a functional food and can be consumed especially to control the weight and people with diabetes mellitus.

Keywords : *Cookies, modified banana flour, funcional food, diatery fiber, resisten starch*

ABSTRAK

Salah satu bahan pangan lokal melimpah di Mamuju yang berpotensi sebagai pangan fungsional adalah pisang. Pisang yang telah dibuat tepung dan dilakukan modifikasi dapat digunakan sebagai bahan penstubsitusi tepung terigu pada pembuatan cookies. Penelitian ini bertujuan untuk memformulasi cookies tinggi serat substitusi tepung pisang termodifikasi sebagai pangan fungisonal. Penelitian ini dilakukan empat tahap, yaitu: pembuatan tepung pisang modifikasi, pembuatan formulasi cookies, analisis organoleptik dan uji fisikokimia. Rancangan penelitian mengunakan rancangan acak lengkap (RAL) dengan empat faktor, yaitu F0 (0%), F1 (25%), F2 (50%), dan F3 (75%). Parameter yang diukur yaitu uji organoleptik (rasa, aroma, warna, dan tekstur) dan dilakukan uji fisikokimia pada formula terbaik. Berdasarkan hasil penelitian, ada pengaruh dari keempat formula terhadap uji organoleptik. Berdasarkan uji ANOVA, ada perlakuan yang berbeda nyata terhadap parameter yang diukur. Formula terbaik diperoleh pada perlakukan F2, yaitu cookies tersubstitusi tepung pisang 50%. Kandungan fisikokimia pada cookies F2, yaitu : kadar air 4.08%, kadar pati resisten 43.02 %, daya cerna pati 40.24 %, dan kadar serat total 15.51 %. Cookies dengan formula terbaik memiliki mutu sensori yang baik sehinga dapat dijadikan sebagai panan fungsional dan dapat dikonsumsi terutama untuk mengontrol berat badan dan penyandang diabetes mellitus.

Kata kunci : Cookies, tepung pisang termodifikasi, pangan fungsional, serat pangan, pati

INTRODUCTION

Kepok banana production in West Sulawesi is very abundant. In 2019, the production of kepok bananas in West Sulawesi was 457885 tons (1). However, the utilization of processed kepok bananas in West Sulawesi is still very limited. One way to increase the quality of bananas is to process them into flour. The advantages of banana flour are increasing yield, effectivness, economicals, easier to process into products, easier to mix with other ingredients, and has a long shelf life (2).

Banana flour has a higher starch content than fiber content. Modification is one method to increase fiber content in banana flour. Modification of banana flour produces resistant starch. Resistant starch is a fraction of starch that cannot be digested by alfa-amylase enzyme and can pass through the digestive tract to the colon and be fermented by colonic microbes (3). Banana flour with high levels of resistant starch can produce higher fiber content and beneficial for health. Foods with high fiber content role in facilitating the digestive system and reducing the risk of colon cancer (4). In addition, it can increase stool weight, reduce transit time in the gastrointestinal tract, and dietary fiber can control glucose and lipid metabolism (5). Studies in vitro and in vivo explain that there is a relationship between a diet high in resistant starch as a probiotic food and slowing tumor growth in pancreatic cancer (6). Consumption of foods high in resistant starch combined with protein can affect the metabolic system that it can control body weight and blood sugar levels (7). Based on meta-analysis studies in vitro and in vivo on the glycemic index value revealed that there are 2 factors that are significantly responsible on the value of the glycemic index of starchy foods. They are the content of resistant starch and the content of flavonoid compounds (8).

Modification of starch under pressure heating at 121°C followed by autoclaving-cooling can be used to produce resistant starch (9). In the autoclaving-cooling process, the formation of resistant starch occurs by means of starch retrogradation that occurs when starch is stored at cold temperatures. Therefore, high temperature heating (autoclaving) and cooling (cooling) processes were carried out to facilitate the retrogradation process. The autoclaving-cooling process repeatedly causes more retrograded starch to form as indicated by the increasing levels of resistant starch (10).

Modified banana flour can be used as the main ingredient of food based on wheat flour. Substitution of modified banana flour in processed foods can contribute to nutritional adequacy, especially for people with diabetes mellitus and obesity. One of the foods which are liked by almost all ages are cookies. Modified banana flour substitution in the manufacture of cookies can be used as a functional food. The functional value is obtained through changes in the main ingredient. It is the replacement of wheat flour with modified banana flour which has a high fiber content so that it can control glucose and fat levels in the blood. Consumption of high-fiber foods with small and frequent portions can help meet fiber intake and nutritional needs and also help control blood glucose levels.

Based on this explanation, it is necessary to do research on the formulation of cookies with modified banana flour substitution. It is hoped that cookies made from modified banana flour can be an alternative food and functional food that has high fiber content and can control glucose and fat

levels in the blood**.** This research aims to formulate high-fiber cookies substituted with modified banana flour as a functional food.

MATERIAL AND METHOD

The main ingredients used were kepok bananas obtained from the central market of Mamuju. The ingredients for making cookies were flour, margarine, egg yolks, skim milk, baking powder, and salt. The materials used for the analysis were K_2SO_4, HgO, concentrated H_2SO_4, NaOH, H_2BO_3, mixed indicator of methyl red and methylene blue, HCl, hexane, pure glucose, distilled water, 95% ethanol, 1 N acetate solution, iodine solution, phosphate buffer pH 6 and pH 7, and acetate buffer pH 4.75.

The methods used in this research were: manufacture of banana flour (11), modified banana flour (12), analysis of moisture (13), analysis of dietary fiber by enzymatic method (13), analysis of resistant starch (14), and starch digestibility (15), organoleptic test (16).

Preliminary research was started from the manufacture of banana flour. Bananas were peeled, washed with clean water, sliced with a thickness of ± 2 mm, soaked in distilled water in a ratio (1:2). The banana slices were then dried in a drying oven at 60°C for 16 hours. Furthermore, the dried banana slices were mashed with a disc mill and sieved through an 80 mesh. Banana flour was than modified through acid hydrolysis, auto-claving cooling and heat moisture treatment.

The main research were cookies formulation, organoleptic analysis, and physicochemical analysis, The formula for cookies was presented in table 1. Cookies were made by mixing margarine, sugar, salt, baking powder until homogeneous using a mixer. Next add egg yolks and skim milk. In the final stage, flour and modified banana flour were added until they were smooth. Cookies were then molded and baked at 180-200°C for 16-20 minutes.

The experimental design used in this research was a completely randomized design (CRD). The factors used were the substitution of modified banana flour with different proportions for each treatment level. The parameters used were organoleptic tests (taste, aroma, color, and texture). The selected formula of cookies was next measured physicochemical analysis. They were moisture, diatery fiber, resistant starch and starch digestibility.

Table 1. Cookies Formulation Substituted with Modified Kepok Banana Flour

Formulation	F0 (gram)	FI (gram)	F2 (gram)	F3 (gram)
Flour	100	75	50	25
Modified Banana Flour	0	25	50	75
Margarine	50	50	50	50
Yolk	10	10	10	10
Skim Milk	10	10	10	10

*F0(0%), F1 (25%), F2 (50%), F3 (75%)

Data was processed by the SPSS application. The measured parameters were then tested for anlysis of variance (ANOVA) at a 5% confidence interval.

If there was a significant, data were then carried out using the Tuckey test.

RESULT AND DISCUSSION

Formulasi Cookies

Cookies formulation was carried out to obtain the appropriate formula/composition from the comparison of the use of modified banana flour and wheat flour. Formulation aims to have good quality products. The quality requirement of cookies used in this research is organoleptic quality. The best formulation was obtained from the acceptance value that was most preferred by the panelists.

The results of the cookies formulation with the composition of the ingredients are presented in table 1. There are four formulas based on the ratio of the concentration of modified banana flour and wheat flour. The results of the organoleptic test of cookies for each formula are presented in table 2.

Table 2. Result of Analysis Organoleptic Test on Cookies

Factors	Organoleptic atribut			
	Taste	Aroma	Color	Texture
F0	4.10±0.63[a]	4.17±0.79[a]	4.56±0.57[a]	4.28±0.54[a]
F1	4.19±0.65[a]	4.27±0.79[a]	4.60±0.52[a]	4.13±0.65[a]
F2	5.12±0.69[b]	5.26±0.75[b]	5.70±0.56[b]	4.95±0.66[b]
F3	4.06±0.68[a]	4.23±0.77[a]	4.57±0.63[a]	4.26±0.58[a]

*different code shows a significant difference at the 5% level

1= dislike very much, 2= dislike moderately, 3= dislike slightly, 4= neither like or dislike

5= like slightly, 6 = like moderately, 7= like very much

Organoleptic test of modified banana flour substituted cookies aims to determine the acceptability of cookies' sensory attributes such as taste, aroma, color, and texture. Acceptance test in this research is the hedonic test. The hedonic test of a product is a panelist's preference level test that gives a real opinion about the likes or dislikes of a product (17).

Based on the results of the study (table 2), the different formulations used in the study had a significant effect on the measured ogranoleptic attributes (taste, aroma, color, and texture). Based on the ANOVA test at the 5% level, the four formulations gave significant results on each attribute ($p < 0.05$). This explains that there are significantly different treatments for the attributes of taste, aroma, color, and texture. Based on the further test (Tuckey test), the formulation with code F2 gave different results compared to other formulations. Formulation F2 gives the highest score on the attributes of taste, aroma, color, and texture. Formula F2 (banana flour with a concentration of 50%) gives the best acceptability results and it is chosen formula. The best formulation in this study was next carried out physicochemical tests to determine the quality based on the physical and chemical properties of the product. the best formula cookies must have the physical and chemical quality requirements in accordance SNI 2973:2011.

Table 3. Result of Analysis Physicochemical Tests on Selected Formulation

Physicochemical Tests
Moisture content (%)
Resistant starch (%)
Starch digestibility (%)
Dietary fiber (%)

Moisture Content

In food products, the moisture content determines the quality. Moisture content is an important factor in determining the shelf life of a food product. Low water content values tend to have a long shelf life. In cookie products, the water content is related to the resulting texture. In this research, the moisture content produced in the cookies with the best formula was 4.08%. it has met the maximum standard of moisture content according to SNI 2973:2011 (5%) (18).

Resistant Starch

Resistant starch is a fraction of starch that cannot be digested by digestive enzymes (α-amylase) in the human small intestine but can still be fermented by the intestinal microflora (19). Resistant starch is classified into four types as follows: RS1 (starch that is physically trapped in plant cells and the matrix in foodstuffs, such as grains and coarsely ground cereals), RS2 (native granules or ungelatinized starch, such as starch). raw potato and banana starch); RS3 (retrograded starch processed from gelatinized starch stored at cold temperatures); and RS4 (starch produced from the chemical modification process). Hydrolysis of starch using the enzyme amylosucrase can produce resistant starch which produces starch that is difficult to digest and has a low glycemic index value (20). Among the four types of resistant starch, RS3 starch is the most widely developed and has the potential to be applied in food products.

In this study, the content of resistant starch in cookies formulation (F2) was 43.02%. This value indicates that, in 100 grams of cookies, there are 43.02 grams of digestible starch. The higher the level of resistant starch, the more starch that cannot be digested. Food products that contain high levels of resistant starch can more easily control blood sugar so that they are safe for consumption by people with diabetes mellitus.

Resistant starch content in the product is influenced by the substitute that is modified banana flour. Modifications are carried out by heating and cooling treatments. Resistant starch content can be increased by repeated heating and cooling. Nurhayati et al., (2014) reported that Modification of Banana Flour which was carried out through a spontaneous fermentation process for 24 hours and a heating cycle was able to increase the levels of resistant starch in banana flour by four times (from 10.32% to 42.68%) (21).

Starch Digestibility

Digestibility of starch is the level of ease of a type of starch to be hydrolyzed by enzymes that break down starch into smaller units. The higher the digestibility value of starch, the easier the starch is digested by digestive enzymes into simple sugars and

increases the risk of increasing blood sugar levels. Meanwhile, the lower the digestibility of starch, the more difficult it is for the starch to be digested by digestive enzymes into simple sugars so that it can control blood sugar levels and reduce the risk of increasing blood sugar levels (22).

In this study, the digestibility of starch in cookies (formula F2) was 40.24%. The value of starch digestibility of cookies is influenced by the composition of banana flour used. Based on Syafii's research (2019) Modified banana flour has a starch digestibility value of 22.40% (2). Modification of banana flour by heating and cooling processes can reduce the value of starch digestibility. During the heating and cooling process, the starch structure becomes more compact and hydrogen bonds are formed (retrodegradation of starch) so that it is difficult to digest by digestive enzymes so that it can reduce the digestibility value of starch. According to Nurhayati et al. (2014), the digestibility of starch in vitro in banana flour produced from the fermentation treatment and the combination of heating and cooling can decrease up to 50% (21) Based on research by Lumba et al (2017), modified banana flour using a fermentation and heating process has starch digestibility values ranging from 21.94% to 49.04% (23). Claudia et al (2016) also reported in a study that the digestibility of biscuit starch ranged from 22.21% to 74.41% (22).

Diatery Fiber

Dietary fiber is a non-starch carbohydrate that cannot be digested by the alpha amylase enzyme. Dietary fiber does not produce energy. Foods that are rich fiber are good for consumption to control blood sugar levels, lose weight and can facilitate the digestive system. In this study, dietary fiber produced from cookies with the F2 formulation was 15.51%. The fiber content of the resulting food is higher than the fiber content of commercial cookies in general. Consumption of cookies with high dietary fiber content is suitable for a diet with sufficient fiber which causes complex carbohydrates and fiber to occur, so that the digestibility of carbohydrates is reduced. This situation is able to reduce the increase in blood glucose and keep it under control (24).

CONCLUSION

The best Formula on manufacture of high-fiber cookies is F2 treatment which was 50% banana flour substituted cookies. Formulation F2 gives a significantly different value and has the highest value based on the acceptability test for the attributes of taste, aroma, color, and texture. The best formula of cookies have good sensory quality. It can be used as functional food and can be consumed especially for weight control and people with diabetes mellitus. The results of the physicochemical test for the best formulation cookies were 4.08% water content, 43.02% resistant starch content, 40.24% starch digestibility, and 15.51 % total fiber content. The results of the

physicochemical test gave a good quality of cookies in accordance with the standards of SNI cookies.

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