The effect of modified potato flour substitution on the organoleptic characteristics of toddler biscuit

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Abstract. Toddler biscuit is complementary food given to infants to help meet their nutritional needs. This research was undertaken to develop toddler biscuit with substitution of physically modified potato flour. There were two purposes of the research, first to know the characteristics of physically modification on potato flour; secondly to know biscuit characteristics with modified potato flour substitution. There were two factor analysis in the development of biscuit; first factor was pre heating methods and substitution rate. The research was conducted with experimental method using split plot design. The functional properties on modified potato flour as swelling capacity, water absorption capacity, solubility and viscosity were analyzed. Organoleptic analysis using quality hedonic test showed no interaction between potato starch modification and concentration of modified potato flour. Quality hedonic test showed all toddler biscuit scored in the range of “slightly like” to “like moderately”. Modifying potato starch by boiling and steaming with flour concentration of 30% producing toddler biscuit with organoleptic characteristics acceptable according to the panelists.

1. Introduction
Toddler biscuit is complementary food (solids) given to children from the age of 6 months to help meet the needs of energy and other nutrients. The biscuits should contain the nutrients needed by toddlers, including carbohydrate, proteins and fats, and micronutrients such as vitamins and minerals. Sources of carbohydrates are usually obtained from brown rice or green beans. Wheat has not been widely used for fear of babies’ allergic reaction to the gluten contained in it. Sources of protein can be obtained from milk, while the source of fat from margarine or butter. The addition of milk also helps meet the needs of minerals in infants. Some experts say toddler biscuit can help train toddlers’ motor nerves, especially their ability to hold something and to stimulate the process of chewing.

Biscuit is a food product made of flour with a diameter of 6-10 cm with a square or round shape, which is made by roasting [1]. Biscuit dough does not have to be inflated, so that the flour used as a raw material can be substituted by other materials to add nutritional value or even reduce the consumption of wheat. Some toddler biscuit manufacturers in Indonesia have begun to use materials other than arrowroot flour such as tubers, because it has better digestibility, or flour banana to give flavor and increase the fiber content of food.

One of the potential ingredients from Indonesia is potato tuber, whose production has continued to increase year by year. Potato production in Indonesia in 2010 reached 1,060,805 tons. Potatoes have many sources of species diversity, consisting of a variety of local species and some superior varieties.
Potato starch contains more than 12.5% resistant starch. According to reference number [2], potatoes are a source of resistant starch type 2, i.e. starch that is naturally present in plants. Resistant starch cannot be digested and absorbed in the small intestine of healthy individuals and is resistant to hydrolysis enzyme amylase.

According to reference number [3], the potato is one food that contains phenolic compounds so susceptible to enzymatic browning when experiencing physical treatments such as peeling, slicing, or bumping. Some ways to prevent browning is to avoid contact with oxygen, using a metal chelating compound or inactivating polyphenol oxidase enzymes by means of heating. According to reference number [4], enzymatic browning occurs when food containing phenolic compounds undergoes enzyme polyphenol oxidase wounding, so the substrates of the phenolic compounds produce brown quinone compound. The presence of oxygen and metal ions accelerates the enzymatic browning. Reference number [5] shows that the potato variety of granola that is extracted using distilled water by 10% contains resistant starch of approximately 56% of the amount of the starch. According reference number [6], warming causes changes in the type of potato resistant starch in potatoes of type 2 and type 3. In terms of quality, resistant starch type 3 is more resistant to digestive enzymes that act better as a prebiotic.

Based on the above explanations, the researchers intend to conduct research on the effect of pre-cooked potato starch on potato biscuit-making through experimental design method using Split Plot Design, focusing on two things: modification of potato starch and the substitution rate of potato flour used.

2. Research Method

This research was carried out for 8 months since the signing of the contract in the Laboratory of Study Program Education on Agro-Industry Technology, Faculty of Technology and Vocational Education, UPI. Materials used are potato that bought from local farmer, distilled water, butter, milk, sugar, flour were procured from local market.

2.1. Research Procedure

1. Modified potato flour
   The first phase of this research was making modified potato flour using pre heating. The treatment consisted of boiling, steaming and baking. The potato then was mashed into small particle and put in the refrigerator with a temperature of 40°C for 24 hours. After about 2 hours, the potato was then dried using electric oven with a temperature 50°C until the weight became constant.

2. Making Potato biscuit
   The making of potato biscuit was a modification of the method proposed by Herudiyanto and Hudaya (2009).

3. Organoleptic Analysis
   Organoleptic analysis of modified potato biscuit was performed using hedonic quality test with a scale of 1-5, where a value of 1 is very good, 2 is good, 3 is rather good, 4 is rather good, and 5 is very good. The panelists were 15 semi-trained people in the field of toddler biscuits.

2.2 Research Design

The study design employed a Split Plot Design with 2 treatments and 3 replications. The first treatment was the modification of starch consisting of three levels: (a1) boiling (a2) steaming, and (a3) baking. The second treatment was to find the level of substitution modified potato flour covering 4 levels, namely 10% (b1), 20% (b2), 30% (b3), 40% (b4). If the calculated F value is greater than the interaction of the F value in the distribution table at the level of 5%, then Test Least Square design will be conducted. However, there is no interaction Duncan's multiple range test will be carried out.
3. Results and Discussion
New product development is a strategic area of the food industry, where currently consumers desire food products with two functions: To meet the nutritional needs and to have added value for health. Such food product is known as functional food [7]. According reference number [1], the definition of biscuits can refer to the definition given by Samuel Johnson, in which biscuit means a food made from good quality flour with the addition of sugar that has a hard texture with a longer shelf life.

3.1 Variance Analysis of Potato Biscuit Colour
Results of analysis of variance showed that there was no interaction between the substitution rate of starch and modification of starch. Test results of the influence of substitution rate of starch and modification of starch individually on toddler cookies’ colour presented in Table 1.

| Table 1. The effect of flour modification method and substitution rate on Potato Biscuit color |
|-----------------------------------------------|
| Treatment                                      |
| Modification methods | Average | Notation |
| Boiling                                     | 3.74    | a        |
| Steaming                                   | 3.71    | a        |
| Baking                                      | 1.914027| b        |
| Substitution rate                          |
| 10%                                         | 3.55    | a        |
| 20%                                         | 3.17    | a        |
| 30%                                         | 2.87    | a        |
| 40%                                         | 2.69    | b        |

Description: The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan’s multiple range test.

One of the organoleptic characteristics that influence consumer acceptance is the color. Golden brown color indicates that the biscuits are well-cooked. According to reference number [4], brownish yellow color is a result of caramelization process because of the sugar and flour in biscuit dough. The addition of potato starch affects the color of biscuits because, as Eskin (2000) has noted, the potato is one commodity with a high content of phenolase enzyme so susceptible to browning. Reference number [7] added that one way to prevent enzymatic browning in potato is the provision of heat that would inactivate the phenolase enzyme. In addition, according to reference number [6], warming will change the potato’s resistant starch into resistant starch type 2 type 3, that is more resistant to treatment. Toddler biscuit has moisture level of 4.02±0.06%. This is consistent with slow water content of resistant starch digested from banana cookies based on research by reference number [8] which has a water content of 7.7%. According to reference number [4], the color can also be affected by the biscuit dough characteristics, including pH, water content, the presence of sugar and amino acids, as well as temperature and baking time.

According to reference number [1], biscuits have a low water content so as to provide a crunchy texture effect and inhibit the growth of microorganisms, so that the biscuits
have a long shelf life. Ash content of food is affected by the mineral content of the food material. The results show the level of flour substitution was higher than the ash content. It is thought to be influenced by the mineral content in potatoes and wheat used. To produce good and even colour, it is most preferable to use an electric oven that has a stable and measurable temperature. According to reference number [7], the process of heat transfer during roasting takes place by convection, conduction and radiation, with a small size biscuit, the heat on the surface will be the same as that in the core of biscuits. This will lead to the formation of brown colour almost evenly on the biscuit with the highest colour intensity on the outer part of the cookies.

3.2 Variance Analysis on Potato Biscuit Taste

Potato flour does not have a distinct flavor, so the addition of butter and milk helps improve the flavor of the biscuit. Butter and milk provide the savory flavor for the biscuits and provide additional nutrients of fat and protein. Differences in the composition of the biscuit dough affect the fat content and protein of the biscuits produced. The addition of butter and milk causes potato biscuits to have higher levels of fat and protein content, which is higher than the slowly digested cookies in the research of Aparacio-Saguilan et al. (2006), where the fat content was 12.7 ± 0.1% and protein level of 5.09 ± 0.1%. The addition of milk may also cause the Maillard reaction which will affect the resulted color biscuits.

Results of analysis of variance showed that there was no interaction between the substitution rate of starch and modification of starch. Test results of the influence of substitution rate of starch and modification methods of starch individually on the flavor of toddler cookies are presented in Table 2.

| Treatment         | Modified methods | Average | notation |
|-------------------|------------------|---------|----------|
|                   | Boiling          | 3.638596| a        |
|                   | Steaming         | 3.610621| a        |
|                   | Baking           | 2.540871| a        |
| Substitution rate | rata-rata        |         |          |
| 10%               |                  | 3.75543 | a        |
| 20%               |                  | 3.26761 | a        |
| 30%               |                  | 3.087653| a        |
| 40%               |                  | 2.896013| b        |

Description: The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test.

Table 2 shows that the substitution of modified potato flour and flour level substitution effect was not significantly different in terms of their effects on potato biscuit taste. This is in line with the finding of Aparacio-Saguilan et al. (2006) which showed that the flavor of cookies with and without the addition of resistant starch was not significantly different. Cookies with the addition of 35% resistant starch was still acceptable for the panelists, although the highest level of acceptance of the cookies is an addition of 15% resistant starch.
3.3 Variance Analysis on Potato Biscuit after Taste

Results of analysis of variance showed that there was no interaction between the way the flour is modified and the potato flour substitution rate. Test results of the influence of flour modification methods and flour substitution rate on toddler biscuits after-taste are presented in Table 3.

Table 3 The effect of flour modification method and substitution rate on Potato Biscuit after-Taste

| Treatment | Modified methods | Average notation |
|-----------|------------------|-----------------|
| Boiling   | 3.418946         | a               |
| Steaming  | 3.412443         | a               |
| Baking    | 2.633714         | a               |
| Substitution rate | Average notation |               |
| 10%       | 3.651002         | a               |
| 20%       | 3.174184         | a               |
| 30%       | 3.011018         | a               |
| 40%       | 2.773019         | a               |

Description: The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test.

Table 3 indicates that the effects of substitution of modified potato flour and the level of substitution on potato biscuit after-taste were not significantly different. The after-taste can affect the level of consumer acceptance. According to Waring (2005), resistant starch content of the potato can help strengthen the butter flavor; it can also affect the after-taste of potato biscuits. This buttery nature is often used in the manufacture of low-fat food products, in which the resistant starch is used to reduce the use of fat.

3.4 Variance Analysis of Potato Biscuit Crispiness

Results of analysis of variance showed that there was no interaction between the ways starch is modified and the substitution rate of the starch. In addition, the results of the analysis of each factor showed no significant results that further analysis is not needed.

Crispiness is one of the characteristics that greatly affect the level of consumer acceptance of cookies. The level of biscuit crispiness in terms of the substitution of modified potato starch ranged from grades 3-4, meaning that the panelists could still receive the crispiness of the biscuits. According to Waring (2000), one of the ways to ensure the public are getting enough dietary fiber intake is to fortify dietary fiber in foods, where dietary fiber resistant starch groups can help improve the texture and crispiness of the biscuit. Crispy biscuits are influenced by the raw materials used. As put forward by Manley (2000), the use of butter, in addition to affecting the flavor, increases crispiness. The butter to be used should be frozen, so that during the mixing the batter will spread evenly and melt when baked. This
method will make a crunchy biscuit. The process of rolling and folding the dough biscuits will also affect the crispiness of biscuits.

4. Conclusions
1. Potato biscuits with 30% substitution of flour modification characteristic shave acceptable organoleptic characteristics according to the panelists.
2. Potato flour biscuits with the addition of physical modification at 30% substitution level contained fat and protein for 28% and 9%, respectively.

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