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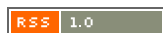
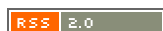
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Utilization of Lindur Fruit Flour and Tempeh Flour as a Healthy Snack Alternative for Diabetic

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ABSTRACT

Background: The prevalence of diabetes in Indonesia continuously increased. It is caused by many factors; one of them is a dietary pattern. To avoiding the occurrence of blood glucose, it is necessary to control the amount of food intake. Unfortunately, Indonesia has lack varian of snack for diabetic. Hence, the functional food such as lindur-fruit and tempeh started to be utilized as alternative snack for diabetic.

Objective: The objective of this study to was to determine the difference in the level of preference and also seen the difference on the fiber content of the product cracker combination of lindur fruit flour and tempeh flour.

Materials and Methods: This research is an experimental research which directed on developing products. This study involved by thirty untrained panelists.

Result: Kruskal–Wallis test showed that based on the level of preference, there were differences in taste (0.001) and color (0.002) among three cracker products. Further tests by Mann–Whitney test showed that there is no difference in color between f1 and f2 cracker products (0.252) also there is no difference in taste between f2 and f3 cracker products (0.266). The most favored cracker by all the panelists was f1 cracker product. Analysis of fiber contents showed that there was no big difference between the three products cracker.

Conclusion: There were differences of color and flavor among the three products cracker. There was no big difference of the fiber content of each cracker.

Key words: Cracker, Fiber content, Level of preference, Lindur fruit, Tempeh

INTRODUCTION

Diabetic in Indonesia grows each day. Not only in urban but also in rural areas, diabetic is also increasing. In Indonesia increased 5.7% in 2007 to 6.9% in 2013.^{1,2} A diabetic should implement a healthy lifestyle to avoid a rise in blood glucose. One of the healthy lifestyles that can be applied is to follow the three guidelines, such as eating healthy foods with an appropriate amount and well scheduled.³

The important thing that considerably influence on the increase of blood glucose is to eat a snack. Both the diabetic and their family generally do not notice kind of snack that appropriate for diabetic. Yet it is undeniable that snack accounted for about 10%-15% of total energy needs. This happens due to the possibility of a lack of knowledge of the snack for diabetic.

Nowadays, the development of food products by utilizing the functional foods is more intensively to do, especially in food manufacturing for health. Literally, the functional food is a food that has functional traits such as bioactive compound or beside their nutrients component can provide health benefits.⁴ The physiological traits of functional food are determined by their bioactive compound therein such as dietary fiber, inulin, phytochemical compounds that behave as antioxidants (includes flavonoid, isoflavones, terpenoids, steroids, and saponins), fructooligosaccharides, polyunsaturated fatty acid, prebiotic, and probiotic. Functional food generally has sensory properties that can be accepted by the community.

The existence of functional foods in Indonesia is abundant. Foodstuffs that contain antioxidants, complex carbohydrates,

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and high fiber can be obtained from tubers, legumes, cereals, vegetables, and fruits that grow both on land and in mangrove areas. Until now, this has been done many studies to look at the potential of mangrove ecosystem, one of them is the potential of lindur fruit (*Bruguiera gymnorrhiza*).

Based on research, the lindur fruit flour contained carbohydrates by 82.09%, 5.59% protein, 1.79% fat, 8.7% crude fiber, and 0.1% tannin.⁵ In lindur fruit also contained bioactive compounds such as flavonoids, quinone, polyphenols, and saponins which traits as antioxidants and antidiabetic.⁶ Another food that is also a functional food is tempeh. In the tempeh contains various nutrients, such as carbohydrates, protein, fat, fiber, and B12 vitamin.⁷ In addition, also contained isoflavones that traits as antioxidants and antidiabetic.

The existence of phytochemical compounds in functional foods is expected to be an alternative food for people with non-communicable diseases such as diabetes mellitus, obesity, stroke, cancer, and coronary heart disease. One of the food products with sugar and low fat are cracker. Cracker is a type of dry food products made from hard dough by the addition of yeast, through fermentation or ripening, flattened shape with a taste toward more salty and crunchy, and when broken cross-section cut in layers.⁹ The utilization of lindur fruit flour and tempeh flour as cracker have never done. The existence of high nutrient content as well as bioactive components in these two materials is expected to be a healthy snack alternative for diabetic.

The objective of this study was to determine the differences in the level preference of color, aroma, flavor, and texture of cracker flour fruit lindur and tempeh flour that measured by organoleptic test, determine the differences in fiber content on lindur fruit flour and tempeh flour cracker product, and also measured the number of phytochemical compounds (flavonoids and isoflavones) on cracker product with the best organoleptic assessment.

MATERIALS AND METHODS

This study is an experimental research directed at the product development of the combination of lindur fruit flour and tempeh flour using a completely randomized design. This research was conducted in May-July 2016, held at the faculty of public health nutrition laboratory of the Airlangga University and on panelist residence. The dependent variable in this study is the organoleptic quality (color, aroma, texture, and taste) and also the fiber content and phytochemical compound (flavonoids and isoflavones). The independent variable in this study was the proportion of wheat flour, lindur fruit flour, and tempeh flour. While the control variables in this study are the additional ingredients in the manufacture of cracker, such as cornmeal, sugar, margarine, yeast, salt, egg yolks, and the temperature of the oven is used.

Cracker materials consist of two main components that is the mainly component and additional components. The main ingredient in this research is the lindur fruit and tempeh, while the additional material consists of wheat flour, cornstarch, margarine, sugar, egg yolks, yeast, and salt. Lindur fruit obtained from Mangrove Area in Wonorejo, Surabaya. Tempeh obtained from Rungkut, Surabaya. The tools used in the manufacture of cracker are scales, mixers, pan, and oven.

This study was divided into two stages. These stages include stage of determining formulas and phase of organoleptic testing and measured the nutritional value. Making formula is an early stage to determine the proportion of mainly and additives component in the manufacture of cracker that is presented in Table 1. The last stage is the stage of organoleptic quality test which includes colors, aromas, flavors, textures, and the fiber content of each formula cracker. The test of phytochemical compounds such as flavonoids and isoflavones is only done on the best products.

Organoleptic quality data were collected using a questionnaire, and the test given to thirty untrained panelists. The fiber content and phytochemical compounds collected through laboratory analysis. Organoleptic data were processed by the Kruskal-Wallis test. If there are differences in the level of preference will be tested further using the Mann-Whitney test. Data from the analysis of fiber and phytochemical compounds presented descriptively.

RESULTS

Fondness Level to Color

Based on these data, it can be seen that most untrained panelists claimed like the color of the f1 cracker product with an average value of 3.1 (Figure 1). When viewed by parameter preference level of the color, it can be seen that the f1 cracker product has a value in the range of like to really like. Different

Table 1: The proportion usage of lindur fruit flour and tempeh flour

Ingredient	f1	f2	f3
	w (%)	w (%)	w (%)
Wheat flour	20 (11)	25 (14)	30 (17)
Lindur fruit flour	50 (28)	40 (22)	30 (17)
Tempeh flour	30 (17)	35 (19)	40 (22)
Cornstarch	20 (11)	20 (11)	20 (11)
Margarine	15 (8)	15 (8)	15 (8)
Sugar	10 (6)	10 (6)	10 (6)
Egg yolk	30 (17)	30 (17)	30 (3)
Yeast	4 (2)	4 (2)	4 (2)
Salt	1 (1)	1 (1)	1 (1)
Total	180 (100)	180 (100)	180 (100)

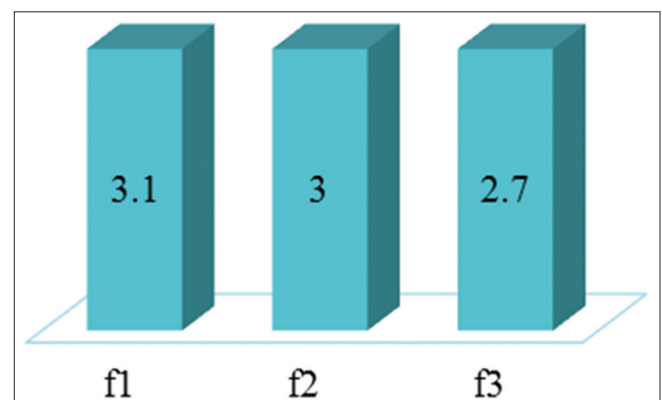


Figure 1: Average value of the preference level of color

test results through the Kruskal–Wallis test showed that there are differences in the level of preference for the color of the three products cracker ($P = 0.002$). After further tested with the Mann–Whitney test, it is known that the color of the f1 and f2 cracker product do not have differences.

Fondness Level to Aroma

Based on the average value of preference level of the aroma, it can be seen that most of the panelists have the same ratings on all three products with the average value of each product about 2.9 (Figure 2). This indicates that most untrained panelists claimed almost like the aroma of the three lidur fruit flour and tempeh flour combination cracker products. Depending on Kruskal–Wallis test showed that there is no significant difference on the aroma of the three cracker products ($P = 0.936$).

Fondness Level to Taste

Figure 3 showed that most untrained panelists claimed like the taste of the f1 cracker product with an average value of 3.1 (Figure 3). When viewed by the value parameter measurement to the level of preference for the taste, it can be seen that the level of preference untrained panelists was in the range like to very like. The different test by Kruskal–Wallis test showed that there were significant differences with $P = 0.001$ of the three lindur fruit flour and tempeh flour combinatio cracker product. After further analysis using the Mann–Whitney test, it can be seen that there is no significant difference between the taste of the f2 and f3 cracker product.

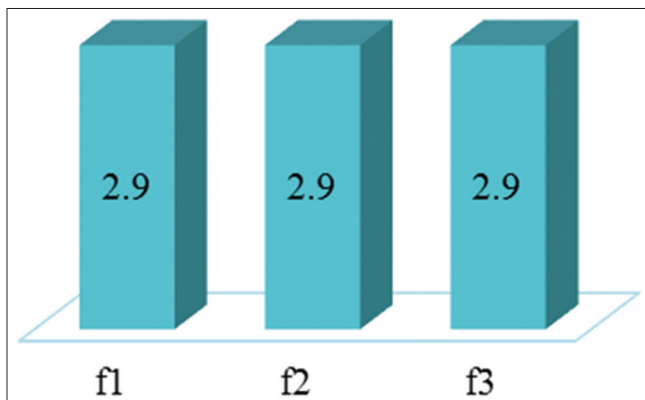


Figure 2: Average value of the preference level of aroma

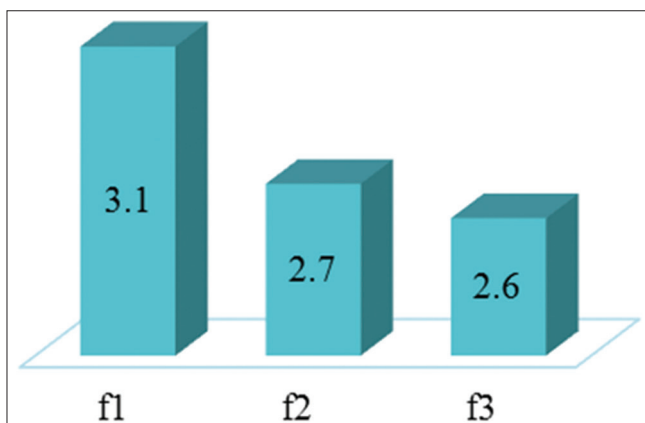


Figure 3: Average value of the preference level of taste

Fondness Level to Texture

Based on Figure 4 can be seen that most untrained panelists claimed like the texture of the f1 cracker product with an average value of 3.0. This means that the average value of untrained panelists on the texture of products is in the range like. The difference test using Kruskal–Wallis test showed that there is no significant difference on all of the texture of three combination cracker products ($P = 0.690$).

Assessment of all the Organoleptic Characteristic

Figure 5 showed that most untrained panelists such as the color, aroma, taste, and texture of f1 cracker product. The color of f1 cracker product was brighter than other cracker products. Most of untrained panelists claimed like the aroma of f1 cracker product because the aroma of tempeh is does not smell. The taste of f1 cracker product was not too bitter that is way the untrained panelists tend to choose f1 cracker product.

The Comparison of Fiber Content on Lindur Fruit Flour and Tempeh Flour Combination Cracker Product

Based on the bellow results (Table 2) can be seen that f1 cracker product have the highest fiber content than other cracker product. However, the fiber content in two other cracker are also quite high so that it can be used as an alternative snack to prevent and or control the risen of blood glucose in diabetic.

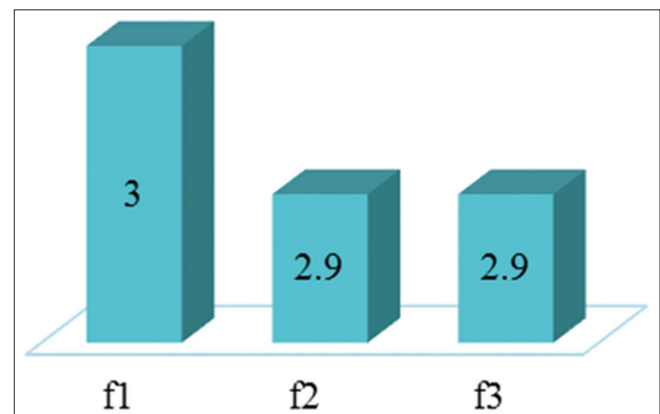


Figure 4: Average value of the preference level of texture

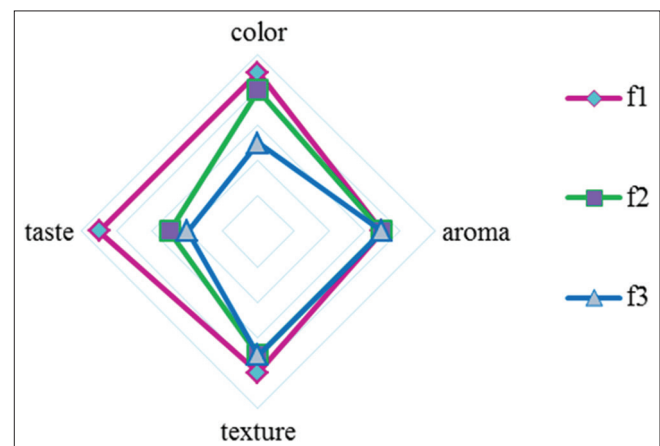


Figure 5: The assessment of untrained panelists toward all of the organoleptic characteristic

Table 2: The fiber content per 100 g cracker

Product	Fiber (g)
f1	14.43
f2	14.31
f3	11.52

DISCUSSION

Fondness Level to Color

Color is one of the components in determining the quality of a product. The right color choice and accordingly will increase the consumer interest and desire to buy a product.⁹ A food will not be considered good if the colors on the display are not so initially attractive although it has high nutritional value.

In general, the color of lindur fruit flour is little bit brown, and the tempeh flour was yellowish brown. The addition of both flours with a difference proportion on each cracker product affects the color formed. The more composition of lindur fruit flour on cracker product, the color of the cracker product will be brighter compared with cracker with more composition of tempeh flour. As seen on f1, f2, and f3 cracker product, it is known that the color of f1 cracker product was lightly browned it is brighter when compared with f2 and f3 cracker products. While the colors of f3 cracker product is dark brown.

In this study, it can be seen that from the earliest observations on the three combination cracker products of lindur fruit flour and tempeh flour through the senses of vision, most of untrained panelists prefer the f1 cracker products which have brighter colors. The difference in color on the three products are not only caused by the base color of the flour but also due to the Maillard reaction and changes of the color pigment resulting from the release of liquid either during processing or heating.

The Maillard reaction (browning non-enzymatic) occurs due to the reaction between the heat with protein and a reducing sugar.¹⁰ The higher the amount of protein and a reducing sugar in the composition, then the Maillard reaction will be more rapid arise when heated. This is consistent with the color of the product arise cracker f3. The high use of the product tempeh flour cracker f3 causes the amount of protein contained in it is also higher. The result is a process of browning or Maillard reaction so that the color generated more brown than other cracker products.

Fondness Level to Aroma

Aroma is another supporting factor in the assessment of a product. Someone may know the delicious flavor of a food that has not seen only by the smell it from a distance.¹¹ Nonetheless, the aroma is one of the sensory properties of the most difficult to classify clearly due to the manifold so large.¹²

Aroma of tempeh flour gives slightly unpleasant impression on cracker product. The more the composition of tempeh flour used in the manufacture of cracker, then the unpleasant aroma produced even clearer. The aroma of tempeh produced from the fermented soybeans by *Rhizopus oligosporus* molds. The addition of these fungi species in the manufacture of tempeh can affect the high activity of protease and lipase, low amilolitik, produce antioksidan, and produced the unpleasant aroma.¹³

In this research can be seen that from the three cracker products, there was no significant difference on the aroma. This

occurs as a result of the addition of the tempeh flour to the three cracker products. The amount of flour added is different to each cracker. Nevertheless, the untrained panelists tend to like the aroma of the f1 cracker product. This is caused by the amount of flour is added to the f1 cracker product is fewer than other products. As a result, unpleasant aroma is not too obvious arising.

Fondness Level to Taste

The taste is the main factor that most determines the consumer acceptance of the product. The taste of a product is influenced by the presence of the chemical compound, temperature, consistency, and food interactions with other flavor components, as well as the type and duration of ripening. In this study, an acquired taste not only from lindur fruit flour and tempeh flour but also other ingredients such as wheat flour, cornstarch, margarine, sugar, salt, yeast, and egg yolks.

Lindur fruit flour has a distinctive taste and strangers when the possibility is still perceived by the public while the tempeh flour has a slightly bitter taste. The addition of lindur fruit flour and tempeh flour with different proportions will produce different taste. The higher the proportion of these two materials when compared with other additives will be able to covered the flavor of the other ingredients.

In this research showed that there is a significant difference to the taste of the three cracker products. The difference in taste of each cracker product is caused by the difference in the proportion of lindur fruit flour and tempeh flour. It is known that tempe has a distinctive taste (such as bitter), and the taste quite familiar to the people in Indonesia. Nevertheless, panelists that tasted the cracker product prefer to choose the f1 cracker product. This is caused by the higher tempe flour composition used in the manufacture of the cracker product causes more bitter taste of the cracker product.

Fondness Level to Texture

Texture is a sensory properties that are important in determining the quality of a product. The texture and consistency of a foodstuff will affect the flavor caused. Crispy or crunchy texture to a product produced will provide its own influence on the taste of food. Texture cracker generated in this study is very dependent on the type of flour used in making the product. Flour with higher gluten content generally produce a crisper texture than flour with low gluten content. Gluten function in binding the CO₂ gas produced by the yeast when fermenting. The more CO₂ trapped in the dough will produce more air cavities. More air cavity is formed, it will be increasingly tenuous dough structure so that after the cooking process will be more crunchy texture of the product.¹⁴ Wheat flour contains high gluten while the lindur fruit flour and tempeh flour does not contain gluten. The proportion of wheat flour is relatively few in the combination cracker product of lindur fruit flour and tempeh flour so that the cavity produced fewer and texture of each product cracker are not too crispy when compared with cracker made by only using wheat flour as basic materials.

Overall, when viewed from the characteristic color, aroma, flavor, and texture, it can be seen that most of the panelists tend to choose f1 cracker product. The color of f1 cracker product was brighter than other cracker product, and the aroma of f1 cracker product is not too unpleasant. Although not as crunchy

as commercial cracker, but the texture of f1 cracker product can still be accepted by the panelists.

Fiber Content

Dietary fiber is an important component of plant that are resistant to hydrolysis by enzymes in the human digestive system. Most of the components of dietary fiber found in plant cell walls. These components include structural compounds such as cellulose, hemicellulose, pectin, and lignin.¹⁵

Fiber is generally very good for health. The presence of fiber in food intake can help expedite the process of defecation. The diabetic are encouraged to eat foods with high fiber. When consuming foods that have a lot of soluble fiber, the fiber in their stomach will dissolve with water and form a gel. The gel will make the stomach feel full and sends a signal to the brain that the stomach is already fully charged or satiety.¹⁶ So for diabetic, is recommended to consume high fiber, it given its function in reducing the incidence of hunger. Lindur fruit also contains fiber food that is highly enough. Similarly, in tempeh flour, it is known that there is a pretty good fiber content. The laboratory analysis showed that there was high fiber content of the three cracker product. f1 cracker product have the highest fiber content than other cracker products.

This is caused by the proportion of flour that used in the manufacture of cracker. f1 cracker products consist of more lindur fruit flour than tempeh flour. Lindur fruit flour known to have relatively high-fiber content. Therefore, the more the proportion of lindur fruit flour is used, the greater the value of fiber content. Conversely, the less lindur fruit flour is added to the cracker products, lower the value of the fiber content. The high-fiber content in the f1 cracker product also comes from the fiber content in tempeh flour.

Flavonoid and Isoflavone Compound of f1 Cracker Product

The flavonoid compound in lindur fruit has a strong role as an antioxidant. Flavonoids are a large group of phytochemicals that are found in many plants. Flavonoids are often known as bioflavonoids which act as antioxidants. Antioxidants can neutralize or inactivate the unstable or unusual reactions to molecules known as free radicals that can attack the cells of the body at any time.¹⁷ There are several types of flavonoids, and each plays a role in maintaining health. In addition to its nature as antioxidants, flavonoids also have properties antidiabetic related to its effect in reducing the occurrence of apoptosis, increases cell proliferation β -pancreas and increases insulin secretion, regulation of glucose metabolism in hepatocytes, decrease insulin resistance, lowering oxidative stress and inflammation of the adipose tissues and skeletal muscle, as well as increasing glucose uptake in muscle and adipose tissue.¹⁸

There was an antioxidant substance in the form of isoflavones on tempeh which can neutralize the reaction of free radical. In tempeh, there were three type of isoflavones such as daidzein, glisitein, and genistein and also contain an antioxidant factor II (6,7,4-trihydroxy isoflavone), which has the most powerful antioxidant properties than the isoflavones in soybean. As an antioxidant, isoflavones expected to reduce or eliminate the free radicals are increased in hyperglycemic conditions. In addition, the function of isoflavones is to prevent lipid peroxidation.¹⁹ In addition to traits as an antioxidant, isoflavones (genistein, daidzein, and glisitein) are also useful

as antiobesity, antidiabetic, decrease menopausal symptoms, prevent cardiovascular disease, osteoporosis, breast cancer, and prostate cancer.⁸

Based on the two main components, such lindur fruit flour and tempeh flour, it can be seen that it contains phytochemical compounds such as flavonoids and isoflavones. Both types of phytochemical compounds are very good for health as it function as an antidiabetic and antioxidant. Testing levels of flavonoids and isoflavones only done by the f1 cracker product which has the best value in level of preference. Laboratory analysis showed that the f1 cracker product contained of flavonoids and isoflavones, respectively 83.8 mg/100 and 65.4 mg/100 g. With their high nutrient content, this cracker product can be used as a healthy snack alternative for diabetic.

CONCLUSION

Based on these results, we can conclude that there are significant differences in the acceptance of untrained panelists to color and taste of each cracker product. Further tests showed that there is no difference in color between f1 and f2 cracker product. Meanwhile, there is no difference between the taste of the f2 and f3 cracker products. The more the proportion of lindur fruit flour in it, and the lower the usage wheat flour and the addition of tempeh flour, the higher the acceptance of panelist for color, aroma, texture, and taste. The highest fiber content is also owned by f1 cracker product. Therefore, the most optimum cracker products are f1 cracker product. The existence of the flavonoid and isoflavone high enough on cracker combination lindur fruit flour and tempeh flour makes it able to serve as a healthy snack alternative for diabetic.

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