Effect of Moringa (*Moringa oleifera*) Flour on Physical and Chemistry Qualities of Duck Meat Traditional Crackers

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Abstract. The low nutritional content of traditional crackers and typical taste of ordinary crackers is an opportunity to make crackers that have more nutritional value and have a delicious flavour. The aim of this research was to determine the effect of adding moringa flour (Moringa oleifera) on the quality of duck meat traditional crackers in terms of physical and chemical quality. Duck meat traditional crackers were added with moringa flour to improve taste and increase nutrition. The research treatments included P0 (control without adding moringa flour), P1 (addition of 1% moringa flour), P2 (addition of 2% moringa flour), and P3 (addition of 3% moringa flour). The results showed that moringa flour affected the swellability, organoleptic value, water content, fat content, protein content, ash content, crude fiber content, calcium, antioxidant activity and beta-carotene value of the cracker. However, the moringa flour did not affect the breaking strength. After carrying out the De Garmo test, the best treatment based on physicochemical and organoleptic was obtained by adding duck meat to crackers with a concrentration of 2% of addition.

1 Introduction

Crackers or crackers are snacks made from tapioca flour mixture mixed with flavoring ingredients such as meat. Traditional crackers have a crisp texture. Crackers are usually sold in packages that have not been fried (raw crackers) or in packages that have been fried (cooked crackers). There are two types of crackers known to the public, namely crackers with vegetable raw materials (such as cassava crackers, onion crackers, puli crackers, peanut brittle, etc.) and there are also crackers with added animal food ingredients (such as shrimp crackers, fish crackers and skin/*rambak* crackers, etc). The raw materials used must contain high enough starch so that the product can expand in volume during frying, for example by using tapioca flour. Tapioca flour has quite high binding capacity, forms a strong structure, and has the property of absorbing water, so that the dough becomes thick, dries easily and the water content is reduced. Animal raw materials such as meat, shrimp and fish are also often used in making crackers. This aims to add flavor to the processed crackers. The low

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nutritional content and typical taste of ordinary crackers is an opportunity to make crackers that have more nutritional value and have a delicious flavor [1]. The animal raw materials added can be meat such as duck meat.

Ducks are a type of waterfowl which is included in the aves class, whose meat is less popular with the public [2]. Duck meat consumption is still low and processing is limited, such as fried duck products, so duck meat needs to be diversified into other products such as processing into meatballs, sausages, nuggets, beef jerky, shredded meat and other products. The level of productivity of local Indonesian ducks, both eggs and meat, is still low and there is still room for improvement [3]. Duck meat can be processed into several types of interesting and useful products with the aim of extending the shelf life and increasing people's interest in consuming duck meat, one of which is cracker products. Duck meat is a food ingredient that contributes high protein and is more affordable compared to beef. Meat products that are often found in the market are generally made from beef, chicken and fish, while there are still not many products from duck meat, even though duck meat has quite large potential in providing food in Indonesia, but the diversity of processed duck meat is still not yet available. Many are included in making crackers. The addition of duck meat can function as an enhancer of taste and scent and can function to increase the protein content of the crackers. New innovations need to be carried out in order to improve the quality of cracker products and also increase marketability without endangering health, such as by adding several ingredients that have high nutritional content, for example by using and combining vegetables in the processing of crackers. One plant that has high nutritional content is the Moringa plant.

The Moringa plant, known by the Latin name *Moringa oleifera*, which belongs to the Moringaceae family, in various regions in Indonesia is a food ingredient that is rich in nutrients and is often found in traditional markets. Every part of the Moringa plant contains very important contents such as minerals, protein, β-carotene, amino acids, vitamin C and also Vitamin E as an antioxidant. One part that is often used in this plant is the leaves. The leaves still do not have a high selling value, even though Moringa leaves have a lot of nutritional content and are scientifically proven to be a source of medicinal nutrients whose content exceeds that of other plants. Research on the process of making duck meat crackers with the addition of *Moringa Oleifera* flour is still rarely carried out, therefore it is necessary to carry out further research on the effect of adding *Moringa oleifera* flour to the cracker making process on the quality of duck crackers in terms of physical and chemical quality. This research is expected to improve the quality of crackers and the preference value of duck meat crackers.

2 Materials and Methods

The material for this research was crackers made from the addition of duck meat and moringa flour. Equipment for making crackers includes choppers, knives, analytical scales, labels, stirrers, PE plastic (*polyethylene*), baking pan, oven and bowl. The ingredients used in making these crackers are tapioca flour, wheat flour, duck meat, moringa flour, water, eggs, salt and garlic. This research used Completely Randomized Design (CRD). The research treatments were the addition of the percentage of moringa flour (Moringa oleifera) as followed: P0 (without adding moringa flour), P1 (addition of 1% moringa flour), P2 (addition of 2% moringa flour), and P3 (addition of 3% moringa flour). This research aims to analyze the addition of Moringa flour to duck crackers in terms of swelling power, breaking strength, organoleptic tests, water content tests, protein, fat, ash, calcium, crude fiber, antioxidant activity, and beta-carotene value.

2.1 Sample Preparation

Making crackers with the addition of Moringa flour can be done by cutting clean duck breast meat into small pieces, then grinding the cut duck meat, after grinding you can add tapioca flour and wheat flour, eggs, garlic, salt. The next step is to weigh the flour of moringa with the percentage (0%, 1%, 2% and 3%), then add water little by little and knead until smooth. After the dough is smooth, the dough is formed into a cylinder with a diameter of approximately 5cm and a length of 15cm. Steam the dough until cooked, then lift and drain. After it has cooled, the dough can be put in the refrigerator for 24 hours. After cooling, the dough can be sliced thinly, approximately 2mm thick and dried using an oven until dry at 65°C for 8 hours, then crackers. Can be fried in oil at 150°C. Ripe crackers are drained and their physical and chemical qualities are analyzed.

2.2 Analysis Procedure

Making crackers with the addition of Moringa flour can be done by cutting clean duck breast meat into small pieces, then grinding the cut duck meat, after grinding you can add tapioca flour and wheat flour, eggs, garlic, salt. The process of adding moringa flour with percentage (0%, 1%, 2% and 3%), then add water little by little and knead until smooth. After the dough is smooth, the dough is formed into a cylinder with a diameter of approximately 5cm and a length of 15cm. Steam the dough until cooked, then lift and drain. After it has cooled, the dough can be put in the refrigerator for 24 hours. After cooling, the dough can be sliced thinly, approximately 2mm thick and dried using an oven until dry at 65oC for 8 hours, then crackers. Can be fried in oil at 150OC. Ripe crackers are drained and their physical and chemical qualities are analyzed.

Test procedure includes scent, taste and color using the descriptive test method (panelists), swelling strength testing procedure using quartz sand, fracture strength testing procedure using method with Texture Analyzer (Crisp Fracture Support Rig), the water content testing procedure uses the thermogravimetri method, the protein content testing procedure uses the Kjeldahl,fat content testing procedure using the Soxhlet method, the ash content testing procedure uses the Tanur method, the calcium content testing procedure uses the AAS method,crude fiber content testing procedure using the Gravimetric method, the antioxidant activity testing procedure uses the DPPH method, the beta-carotene testing procedure uses HPLC method

2.3 Data Analysis

The data obtained were subjected to ANOVA (Analysis of Variance) with a Completely Randomized Design (CRD) if in the ANOVA analysis there were treatments that had significant effect, testing was carried out between treatments using Duncan test.

3 Results and discussion

This research aims to analyze the addition of Moringa flour to duck crackers in terms of physico-chemical aspects which include swelling power, breaking strength, organoleptic tests, water, protein, fat, ash content tests, crude fiber tests, beta-carotene tests, calcium tests, and antioxidant activity tests.

3.1 Effect of Adding Moringa Flour to Duck Crackers on Swelling Power

The average value of swelling power and breaking strength of the crackers in table 1 as follows:

Table 1. Average Value of Expanding Strength and Breaking Strength of Duck Crackers with Addition of Moringa Flour

Treatment	Swelling Power(%)	Breaking Strength(N)
P0	19.03 ± 1.70^{a}	7.72 ± 3.39
P1	24.33 ± 2.03^{b}	5.58 ± 2.05
P2	22.33 ± 1.16^{b}	5.78 ± 1.39
P3	21.05 ± 1.38^{a}	5.04 ± 1.27

Superscripts a,b,c with different notations in the mean column show results with very significant differences ($P<0.01$).

Analysis of variance carried out on data from observations of swelling power showed that differences in the percentage of added moringa flour to the duck meat crackers used had a very real effect ($P<0.01$) on the rising power of the crackers produced. The lowest swelling power value was found in sample P0 (control treatment or without the addition of Moringa flour), while the lowest swelling power value was obtained by sample P3 (duck crackers + 3% Moringa flour) or the treatment with the addition of the highest percentage of Moringa flour, so that more was added. The greater the percentage of moringa flour added to the crackers, the more the crackers' swelling ability will decrease. The quality of crackers is also determined by the swellability of the crackers, because the swellability of the crackers will affect consumer acceptance. Consumers will be more interested in crackers that have good swelling power. As a result of the observations that have been made, the value of the swelling power of the duck crackers produced is still not included in the value of the swelling power of commercial crackers. The swelling power of commercial crackers is between 38% - 145% [4], so further research still needs to be done to produce duck crackers with the swelling power of commercial crackers.

Several things can influence the swellability of crackers, such as the materials used because the swellability of crackers is related to the starch in the crackers and is also influenced by the process of making the crackers. This is in accordance with the statement by Kusumaningrum [5] which states that the factors that influence the swelling ability of crackers can be seen from amylopectin and stirring. The bound water content must be spread evenly in order to obtain maximum cracker volume expansion, so it is necessary to stir or homogenize the cracker product mixture well so that the water content is evenly distributed and the gelatinization process occurs perfectly.

3.2 Effect of Adding Moringa Flour to Duck Crackers on breaking strength

The average value of breaking strength can be seen in table 1. Analysis of variance carried out on the data from observations of breaking strength showed that the difference in the percentage of added moringa flour to the duck meat crackers used had an insignificant effect ($P>0.05$) on breaking strength. the resulting crackers. Breakability is an important parameter in determining consumer acceptance of duck crackers with moringa flour. The results of the research carried out can be seen that there are several factors causing the addition of Moringa flour which does not have an effect on the duck crackers produced, this is thought to be influenced by the processing process for making crackers such as during steaming and drying which causes some imperfect maturity of the crackers or uneven, which can cause the texture

of the crackers produced to be unequal. Breaking power is related to the volume of crackers expanding and also to the crispness of the crackers produced. Several factors that influence the breakability of duck crackers with the addition of Moringa flour are incomplete starch gelatinization in the dough and a decrease in amylopectin levels. Insufficient gelatinization can cause the pores formed during frying to be smaller, denser, and have relatively fewer and smaller air cavities with a high level of substitution. The layers of starch molecules that surround each other's air cavities also become thicker, thereby increasing the breaking strength value [6].

3.3 Effect of Adding Moringa Flour to Duck Crackers on Organoleptics

The average organoleptic values (scent, taste, color, texture) can be seen in table 2 below:

Table 2. Average Organoleptic Value of Duck Crackers with the Addition of Moringa Flour

Treatment	Scent	Flavor	Color	Texure
P0	1.52 ± 0.51^{a}	1.96 ± 0.68^{a}	1.44 ± 0.51^{a}	2.72 ± 0.94^{a}
P1	2.08 ± 0.70^{b}	2.44 ± 0.87^{b}	1.96 ± 0.35^{b}	2.56 ± 0.77^{b}
P2	2.60 ± 0.76^{c}	2.72 ± 0.61^{bc}	2.28 ± 0.54^{bc}	2.40 ± 0.58^{c}
P3	2.76 ± 0.72^{cd}	3.16 ± 0.75^{c}	2.68 ± 0.51^{c}	2.80 ± 0.58^{cd}

Superscripts a,b,c with different notations in the mean column show results with very significant differences ($P<0.01$).

3.3.1 Scent Test

Analysis of variance carried out on the data from observations scent test has a very significant influence ($P<0.01$) on the scent test of the duck crackers produced. The highest scent test value was found in sample P3 (duck crackers with the addition of 3% moringa flour), while the lowest scent test value was obtained by sample P0 (control treatment or without the addition of moringa flour). The average value of the scent test can be seen in table 2. The scent test has an important function in determining the quality of food products, because the scent of the food will first be smelled by the nose and there are even some foods that can be smelled even though the food product cannot be seen. This is comparable to the statement of Qomaruddin and Afandi [7] who stated that before consuming food, the nose usually smells the scent of the food first. If the scent of a food product is too strong or seems bland, it will discourage consumers from consuming it. The results of the research that has been carried out show that the addition of moringa flour to duck crackers greatly influences the scent of the crackers produced, the greater the percentage of added moringa flour can influence the scent of the crackers to have a pleasant scent or the distinctive smell of moringa leaves.

Moringa leaves have a distinctive scent so they can influence the scent of products that are added with Moringa leaves or Moringa leaf flour, such as duck cracker products with the addition of Moringa flour. According to Cahyaningati and Sulistiyani [8], Moringa leaves have a pleasant odor which can influence the panelists' acceptance of the product, so that the more concentration of Moringa leaf flour is given to the product, the more pronounced the unique scent of Moringa leaves in the product will be. The distinctive unpleasant scent of Moringa leaves is caused by the lipoxidase enzyme contained in Moringa leaves. This enzyme is also found in other green vegetables because this lipoxidase enzyme can hydrolyze or break down fat into compounds that cause the unpleasant odor which belong to the hexanal 7 and hexanol groups.

3.3.2 Taste Test

The analysis showed a very significant influence on the resulting taste test ($P<0.01$). The average taste test value can be seen in table 2. The highest taste test value was found in sample P3 (duck crackers + 3% moringa flour), while the lowest taste test value was obtained by sample P0 (control treatment). As a result of the research carried out, it can be seen that the greater the percentage of Moringa leaf flour added, the more the taste of the crackers will change from savory to more bitter or the distinctive taste of Moringa leaves.

The acceptability of food products by consumers, taste is one of the important sensory properties in the acceptance of a food product. It is known that adding moringa flour to duck crackers can influence and change the taste of duck crackers. According to Hasniar, et al [9] stated that Moringa leaves contain amino acids which act as one of the components that form the scent and taste. Moringa leaves have a distinctive taste because of the tannin content in them. Tannins are anti-nutritional compounds that can cause an astringent taste because when consumed, cross-links are formed between the tannins and proteins or glycoproteins in the oral cavity, causing a feeling of dryness and wrinkles or an astringent taste. The results of the research carried out show that the greater the concentration of Moringa flour added can make the duck cracker product taste more typical of Moringa and also give a bitter taste. This is comparable to the statement by Cahyaningati and Sulistiyani [8] which states that products added with Moringa leaf flour can cause a bitter taste. The bitter taste of Moringa leaf flour is caused by the presence of phenol and alkaloid compounds, so the more Moringa leaf flour is added, the bitter taste of Moringa leaves will also increase or become stronger.

3.3.3 Color Test

Analysis of variance carried out on the data from the color test observations showed that the different percentages of added moringa flour used had a very significant influence ($P<0.01$) on the color test of the duck crackers produced. The highest color test value was found in sample P3 (duck crackers + 3% moringa flour), while the lowest color test value was obtained by sample P0 (control treatment or without the addition of moringa flour). The average value of the color test can be seen in table 2. In selecting a product for consumption, color is a factor that greatly influences consumer acceptability decisions. According to Winarno [10], color really influences someone to choose a product. As a result of the research that has been carried out, it can be seen that the greater the concentration of Moringa leaf flour added to duck crackers, the more green and darker the color of the crackers produced can be. According to Cahyaningati and Sulistiyani [8] stated that the color of Moringa leaves is green so that products that have a white color can change to green, therefore it can be stated that the higher the concentration of adding Moringa leaf flour to a product, the color will be deep green. The green color is because Moringa contains high concentrations of chlorophyll [11]. The duck meat used is also a factor in the color change that occurs, the dark color produced by this cracker product also occurs because of the duck meat used. According to Putri, et al [12] stated that the fat contained in meat can come into contact with air and oxidation occurs resulting in the meat being tougher and the color being quite dark, making it less popular with consumers. The color of a product will influence the level of consumer liking, not all consumers are interested in the same color. This is comparable to the statement by Aprita, et al [13] which states that color pigments influence the panelists' level of preference for consumption.

3.3.4 Texture Test

Analysis of variance carried out on the data from texture test observations showed that differences in the percentage of added Moringa flour used had very significant effect (P<0.01), however, the results of this texture was still good and accepted by the panelists. Texture is an external appearance that can be seen directly by consumers so that it will influence the assessment of the acceptability of the product. One of the factors that can influence the texture of a product is the ingredients and formulation used in manufacturing. Hasniar, et al [9] who stated that good texture is influenced by the basic materials used. Food texture is the result of a tactile sense response to physical stimulation during contact between parts of the oral cavity and food [14]. The addition of Moringa leaf flour can affect the texture of the crackers produced. According to Cahyaningati and Sulistiyani [8], adding Moringa leaves to products can cause a harder texture. The more flour you add, the more water will react with the flour and form a gel, resulting in a harder texture for the product. The higher percentange moringa leaf flour you add to the product, the denser the dough will become.

3.4 Effect of Adding Moringa Flour to Duck Crackers on Water Content, Protein Content, Fat Content, and Ash Content

The average test of proximate test can be seen in table 3 as follows :

Table 3. Average test values for water content, protein content, fat content and ash content

Treatment	Water content(%)	Protein Content(%)	Fat Content(%)	Ash content(%)
P0	2.01 ± 0.13^{b}	13.74 ± 0.39^{a}	21.27 ± 0.39^{b}	2.79 ± 0.20^{a}
P1	1.14 ± 0.25^{a}	16.30 ± 0.23^{b}	20.03 ± 0.23^{b}	2.91 ± 0.17^{a}
P2	1.00 ± 0.12^{a}	17.53 ± 0.35^{c}	18.62 ± 0.35^{a}	3.20 ± 0.10^{b}
P3	0.97 ± 0.08^{a}	18.58 ± 0.20^{d}	17.86 ± 0.20^{a}	3.53 ± 0.11^{c}

Superscripts a,b,c with different notations in the mean column show results with very significant differences (P<0.01).

3.5 Effect of Moringa Flour to the Water Content

Moringa flour with different percentages in making duck crackers had a very significant influence on the resulting water content value (P<0.01). The average value of the water content test can be seen in table 3. The water content of duck crackers with the addition of moringa flour produced meets the requirements for water content of fish crackers specified in SNI 2713.1:2009, namely the water content of fish crackers is a maximum of 12%. Treatment during the processing of duck crackers with the addition of Moringa flour can affect the water content value. This is comparable to Soeparno's [15] statement which states that treatment during the meat processing process can change the water content value. It can be seen that the highest water content obtained in duck crackers with the addition of moringa flour was 2.01% in treatment P0 (control treatment or without the addition of moringa flour) and the lowest water content in treatment P3 (duck crackers with the addition of 3% moringa flour) was 0.97%.

As a result of the research carried out, it can be seen that the addition of Moringa leaf flour can reduce the water content in the resulting product, apart from that the addition of Moringa flour for all treatments is still quite low. This can also be caused by the frying

process, where during the frying process water evaporates from the dough and causes the water content to decrease. In accordance with Winarno's statement [16] which states that drying is the process of removing water content to obtain a certain water content. According to Muchtar, Hastian, Ruksanan [17] who stated that the frying process causes the transfer of oil into the fried food. The transfer of oil into the food causes a decrease in the water vapor pressure in the food, so that the oil outside enters and fills the pores of the food that were previously filled with water. This transfer process will stop and oil cannot enter the food when the water vapor pressure in the food and on the surface is equal.

3.6 Effect of Moringa Flour to the Protein Levels

Moringa flour with different percentages added in making duck crackers had a very significant influence on the value of protein produced ($P<0.01$). The average value of the protein content test can be seen in table 3. The results of the research carried out show that adding moringa flour to duck crackers can increase the protein content of the crackers produced. The protein content of duck crackers with the addition of moringa flour produced meets the requirements for the protein content of fish crackers specified in SNI 2713.1:2009, namely the protein content of fish crackers is a minimum of 8%. In fact, the results of the research carried out can be seen that the protein content produced exceeds the SNI requirements. The higher the concentration of moringa flour added, the higher the protein content of these moringa flour duck crackers. It can be seen that the lowest protein content of duck crackers with the addition of moringa flour obtained was 13.74% in treatment P0 (control treatment or without the addition of moringa flour) and the highest protein content was in treatment P3 (duck crackers with the addition of 3% moringa flour). 18.57%. The increase in the protein content of these crackers was due to the addition of moringa flour. In general, Moringa leaves contain protein which is also needed by the body, so adding moringa flour to duck crackers can also increase the protein levels produced. According to Teye et al., [18]that the addition of Moringa leaf flour can improve the taste and nutritional value of frankfurter sausages so that they can produce higher crude protein and lower fat content. This is because Moringa leaves contain a lot of protein, which makes them more abundant in frankfurter sausage products.

3.7 Effect of Moringa Flour to the Fat Content

The results of the analysis showed that the different percentages of added Moringa flour used in making duck crackers had a very significant influence on the resulting fat content ($P<0.01$). The average value of the fat content test can be seen in table 3. The results of the research carried out show that the addition of moringa flour to duck crackers has a very real effect. The more concentration of Moringa flour added, the lower the fat content of the crackers produced. It can be seen that the highest fat content obtained in duck crackers with the addition of moringa flour was 21.27% in treatment P0 (control treatment or without the addition of moringa flour) and the lowest fat content in treatment P3 (duck crackers with the addition of 3% moringa flour) was 17.86%. In previous research, conducted by Prabowo, et al [19], it was found that treatment by adding 12% Moringa leaf flour could reduce the fat content in meat by 55.83%. This is also comparable to the statement of Tonga et al. [20] who stated that supplementation of 12% moringa leaf flour in broiler chicken rations could reduce the subcutaneous fat content of the upper thigh. The decrease in fat levels that occurs is thought to be caused by the fiber in the product, based on research conducted by Sutardi [21] which states that fiber can reduce fat absorption, so that fat deposition into the chicken's body can be suppressed.

The decrease that occurred was not comparable to research by Fahdliansyah, et al [22] which stated that in research using beef crackers, the addition of Moringa leaf extract with different percentages had no effect on the fat content of beef crackers. The effect of adding moringa flour on the fat content of a particular food product can produce different values. This can be influenced by the type of food product and the concentration of moringa flour used. Making duck crackers with the addition of Moringa flour is still done conventionally. The fat content produced can also be influenced by several causes, one of which is in the process of making Moringa flour duck crackers until cooked, at the frying stage using cooking oil which allows the oil to absorb into the ingredients so that it can increase the fat content of the crackers. This is in accordance with the statement of Sukatno et al. [23] which states that there is absorption of cooking oil in crackers during the frying process and the frying procedure can change the fat content of the crackers. The drying process of Moringa flour duck crackers can also affect the fat content produced. This is comparable to the statement by Yuniarti, 2007 [24] which states that the length and temperature of the drying process causes the fat content of the material to increase while the air content decreases.

3.8 Effect of Moringa Flour to the Ash Content

The results of the analysis showed that the different percentages of added moringa flour used in making duck crackers had a very significant influence on the resulting ash content value ($P<0.01$). The average value of the ash content test can be seen in table 3. The results of the research carried out show that the greater the concentration of moringa flour added can increase the ash content of the crackers produced. It can be seen that the lowest ash content obtained in duck crackers with the addition of moringa flour was 2.79% in treatment P0 (control treatment or without the addition of moringa flour) and the highest ash content in treatment P3 (duck crackers with the addition of 3% moringa flour) was 3.53%. Moringa leaf flour has ash content that varies depending on the source. According to Kantja, et al.[25] stated that based on research conducted in Uedele Village, Tojo District, Tojo Una-Una Regency, Moringa leaf flour had an ash content of 9.45%. The higher the ash content, the higher the mineral content in the food. Mineral elements are organic substances or what is commonly known as ash content. The ash content in Moringa leaf flour contains minerals such as calcium, magnesium and phosphorus which are important for healthy bones and teeth. The mineral content will remain stable during heating so it tends not to change during the roasting process [26]. The ash content contained in a food product is influenced by the type of material, method of ashing, time and temperature used when frying. If the ingredients are processed through a frying process, the longer the time and the higher the frying temperature, the ash content will increase, because the greater the amount of water that comes out of the ingredients [27].

3.9 Effect of Moringa Flour to the Crude Fiber Content

The analysis results showed that the different percentages of added moringa flour used in making duck crackers had a very significant influence on the crude fiber value produced ($P<0.01$). The average value of crude fiber can be seen in table 4.

Table 4. Average Crude Fiber Value of Duck Crackers with Addition of Moringa Flour

Treatment	Crude Fiber content(%)
P0	0.37 ± 0.08^{a}
P1	0.72 ± 0.09^{b}
P2	0.85 ± 0.05^{b}
P3	0.95 ± 0.06^{b}

Note: Superscripts a,b,c with different notations in the mean column indicate results with very significant differences (P<0.01)

As a result of the research carried out, it can be seen that the more concentration of Moringa flour added, the higher the crude fiber produced, so that the more Moringa leaf flour added can increase the fiber content in a product. It can be seen that the lowest crude fiber obtained for duck crackers with the addition of moringa flour was 0.37% in treatment P0 (control treatment or without the addition of moringa flour) and the highest crude fiber was in treatment P3 (duck crackers with the addition of 3% moringa flour). 0.95%. Crude fiber is a type of fiber that cannot be digested by the human body and can be found in foods such as fruit, vegetables, whole grains and nuts. Crude fiber itself is a type of fiber that is important for the health of the human body, especially in maintaining a healthy digestive system. Some of the benefits of crude fiber for the human body, it can improve digestive health and can help facilitate digestion and prevent constipation. Crude fiber can also help reduce the risk of developing colon disease, and can help maintain heart health. Consuming foods rich in crude fiber can help lower cholesterol levels in the blood, so it can help prevent heart disease, and also consuming crude fiber can maintain a healthy body weight because crude fiber can help make the stomach feel full longer, so it can help reduce appetite, eating and maintaining a healthy weight is also ideal. Therefore, it is important to consume foods that contain sufficient amounts of crude fiber to maintain a healthy body.

Moringa leaves are a type of plant that has a fairly high crude fiber content, this is comparable to the statement by Kantja, et al [24] which states that Moringa leaves have a fairly high crude fiber content, so they can be used as a source of crude fiber, good for the body. The research results showed that Moringa leaf flour had a water content of 10.96%, ash 9.45%, crude protein 24.14%, crude fiber 11.44%, and crude fat 6.11%. The crude fiber content in Moringa leaves makes it potential as a functional food ingredient. One of the efforts made is to use Moringa leaves as a fortification ingredient in food products, such as in making duck crackers with the addition of Moringa flour. In previous research, the combination of seaweed and Moringa leaves with different leaf ages in making seaweed nori could be a type of functional food preparation as a source of vitamin C and crude fiber [28].

3.10 Effect of Moringa Flour to the Calcium Content

The results of the analysis showed that the different percentages of added Moringa flour used in making duck crackers had a very significant influence on the calcium levels produced (P<0.01). The average calcium value can be seen in table 5.

Table 5. Average Calcium Value of Duck Crackers with Addition of Moringa Flour.

Treatment	Calcium (mg/100g)
P0	71.32 ± 7.56^{a}
P1	99.05 ± 6.58^{b}
P2	115.34 ± 5.66^{c}
P3	124.78 ± 2.61^{c}

Note: Superscripts a,b,c with different notations in the mean column indicate results with very significant differences (P<0.01)

As a result of the research carried out, it can be seen that the more concentration of moringa flour added, the higher the calcium produced, so that the addition of moringa flour can increase the calcium content in the resulting product. It can be seen that the lowest calcium value obtained for duck crackers with the addition of moringa flour was 71.32 in treatment P0 (control treatment or without the addition of moringa flour) and the highest calcium was in treatment P3 (duck crackers with the addition of 3% moringa flour) of 124 .78. Moringa leaves have the potential to be a nutrient-rich food ingredient and can be used to improve the nutritional status of various community groups. In accordance with the statement by Mawarno and Lewerissa [29] who stated that Moringa leaves are a food commodity rich in nutrients in the form of protein, fiber, and various vitamins and minerals such as vitamin C, beta-carotene, iron and calcium. The results of the research carried out showed that the addition of Moringa flour to duck crackers was able to increase the calcium levels in them, this is comparable to previous research from Purnasari and Muf seenin [30] which stated that research at Modisco showed that the addition of Moringa leaf flour by 2.5% could increase energy, protein, iron and calcium content in modisco (*modified dietetic skim & cotton sheet oil*), Moringa leaf flour can increase the calcium content to 249 mg in 100 ml of product. Moringa leaves contain calcium and can be a good alternative source of calcium, in accordance with research conducted by Sholikhah [31] which states that Moringa leaves can be an alternative to milk as a source of calcium. The results of the research show that the concentrated extract of Moringa leaves has greater bioavailability of calcium. better compared to powder and water extract of Moringa leaves.

3.11 Effect of Moringa Flour to the Antioxidant Activity content

The results of the analysis showed that the different percentages of added Moringa flour used in making duck crackers had a very significant influence on the resulting antioxidant activity value (P<0.01). The average value of crude fiber can be seen in table 6.

Table 6. Average Value of Antioxidant Activity of Duck Crackers with Addition of Moringa Flour

Treatment	Antioxidant Activity content(%)
P0	$1,85 \pm 0,31^{a}$
P1	$4,65 \pm 0,48^{b}$
P2	$6,16 \pm 0,51^{c}$
P3	$8,73 \pm 0,75^{d}$

Note: Superscripts a,b,c with different notations in the mean column indicate results with very significant differences (P<0.01)

The results of the research carried out show that the addition of moringa flour to duck crackers can provide high antioxidant activity. The greater the concentration of moringa leaf flour added to duck crackers, the more the antioxidant activity increases, this is because the moringa plant is one type of plant that is used as an antioxidant. This is comparable to the statement by Nurrohman, et al [32] that antioxidant activity increases with the addition of Moringa leaves. Alimsyah et al [33] research on the antioxidant test of Moringa leaf extract using the DPPH method shows that Moringa leaf extract is a strong antioxidant because it has an IC 50 value of 79 ppm. Moringa leaf extract contains strong antioxidant compounds such as flavonoids, namely quercetin and beta carotene, which have large amounts of H atoms which can be donated to neutralize oxidants so that they provide high antioxidant activity. According to Kurniasih [34] stated that the active substances contained in Moringa leaves which have the potential as antioxidants are various types of vitamins (A, C, E, K, B1, B2, B3, B6), flavonoids, alkaloids, saponins, tannins and terpenoids. According to Kasolo et al., [35] stated that from phytochemical tests of Moringa leaves it was discovered that there were tannins, alkaloids, flavonoids, anthraquinone saponins, steroids and triterpenoids which act as antioxidants from Moringa. Flavonoids have antioxidant activity by capturing DPPH free radicals, where DPPH is reduced to non-radical compounds. Susanty et al [36] regarding the antioxidant activity test of Moringa oleifera leaf extract stated that the extract had an IC 50 value of 4,289 ppm, which shows that it has a very strong value of antioxidant activity.

3.12 Effect of Moringa Flour to the Beta-Carotene Content

Different percentages of added moringa flour used in making duck crackers had a very significant influence on the value of beta-carotene produced ($P<0.01$). The average value of beta-carotene can be seen in table 7.

Table 7. Average Beta-carotene Value of Duck Crackers with the Addition of Moringa Flour

Treatment	Beta-carotene Content($\mu g/g$)
P0	0.00 ± 0.00^{a}
P1	0.52 ± 0.03^{b}
P2	0.77 ± 0.04^{c}
P3	1.01 ± 0.09^{d}

Note: Superscripts a,b,c,d with different notations in the mean column indicate results with very significant differences ($P<0.01$)

As a result of the research carried out, it can be seen that the higher concentration of moringa flour used, can imcrease beta-carotene value produced, whereas in the control treatment or without the addition of moringa flour the beta-carotene value could not be read. It can be seen that the lowest beta-carotene value obtained for duck crackers with the addition of moringa flour was 0.52% in treatment P1 (duck crackers +1% moringa flour) and the highest beta-carotene value was in treatment P3 (duck crackers+3% moringa flour). amounting to 1.017%. This icaused the flour has a high beta-carotene content. Moringa leaves contain β-carotene of 6.80 mg when fresh, while in flour form they contain β-carotene of 16.3 mg [8]. One compound that can function as an antioxidant is beta-carotene. According to Satriyani [37], the antioxidant compounds contained in Moringa leaves are beta-carotene and flavonoids. Beta carotene is a red, orange and yellow pigment found in Moringa leaves. Beta carotene has a reliable ability to reduce free radicals, especially singlet oxygen radicals [38]. Beta carotene is insoluble in water, soluble in fat, and is easily damaged because it is oxidized at high temperatures. The beta-carotene content is very beneficial for body health,

this is comparable to the statement by Kusbandari and Susanti [39] which states that beta-carotene can reduce the risk of cancer and heart disease.

4 Conclusion

The addition of Moringa flour to duck crackers with different concentrations showed results that affected the swellability of the crackers, organoleptic values. With a adding moringa flour can also increase protein content, ash content, crude fiber content, calcium, antioxidant activity, and beta-carotene value, while the addition of moringa flour to crackers can reduce water content and fat content, but had no effect on the crackers' breaking strength. In this study, it is recommended to use 2% Moringa leaf flour for duck crackers to reduce the fat content and increase the antioxidant activity of the crackers.

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