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The Effect of Addition Moringa Leaves (*Moringa oleifera)* on the Nutritional Content and Sensory Characteristic of Crackers

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A B S T R A C T

The leaves of *M oleifera* contain high protein and crude fiber. Thus the addition of *M oleifera* leaves is expected to increase protein levels and crude fiber levels of crackers produced. This study aimed to determine the effect of the addition moringa leaves on the characteristics of crackers and the addition of the moringa leaves to product crackers on characteristics acceptable to panelists based on sensory analysis. This study used a Completely Randomized Design with 5 treatments, that was the addition of leaves A (4%), B (6%), C (8%), D (10%), E (12%), and 3 replications. The data were analyzed using ANOVA and continued with Duncan's New Multiple Range Test (DNMRT) at a significant level of 5%. The results show that the addition of moringa leaves a significant effect on moisture content, protein content, fat content, ash content, carbohydrates, crude fiber, but does not significantly affect on color, aroma, taste, and texture of the crackers. Based on nutritional content and sensory test, the crackers of treatment E (the addition of moringa leaves 12%) with the characteristics moisture content of 4.67%; protein content of 14.18%; fat content of 22.52%; ash content of 1.67%; carbohydrates of 56.96%; crude fiber of 15.50%; calories of 456.42 kcal/100g; the color of 3.43 (Neither like or dislike); aroma of 3.83 (likes); a taste of 3.17 (Neither like nor dislike); and texture of 3.30 (Neither like nor dislike). The crackers meet the SNI (Indonesian National Standard).

1. INTRODUCTION

1.1. Research Background

Moringa oleifera is a type of non-timber forest that has a strategic position to develop. *M. oleifera* is one type of tropical plant that is easy to breed because it does not require intensive care and has a high drought tolerance. With these properties, moringa plants allow being cultivated on marginal lands to optimize land use. In addition, various parts of the Moringa plant contain good nutrition and are widely beneficial in various fields such as food, health, beauty, and the environment, so it is very natural to get the nickname Tree For Life [1]. The utilization of these leaves in food consumption is still very limited. In some regions in Indonesia, especially eastern Indonesia moringa is consumed as one of the vegetable menu [2]. The addition of *M oleifera* to dry food processing is one of the efforts to diversify products and increase the value for *M. Oleifera*

High nutritional content and antioxidants in moringa leaves have an opportunity in the diversification of moringa leaves as a source of nutrients and functional substances. Antioxidants are needed in the manufacture of crackers because they can prevent oxidation.

Crackers are foods that belong to the biscuit group that people like in various age groups. The main raw material of crackers is wheat flour that contains carbohydrates. The addition of *M. oleifera* to the cracker's dough will enrich the nutrients of the crackers produced. The leaves of *M oleifera* contain protein and coarse fiber that is quite high. The proximal content in the leaves is influenced by the growing environment. Fresh Moringa leaves contain water by 71.6 – 74.5%; protein 9.1 – 13.6%; fat 1.0 – 1.7%; ash 1.8 – 3.0%; coarse fiber 3.3 - 4.5%, and energy 82.1 – 9.4 Calories. Thus the addition of Moringa is expected to increase protein levels and crude fiber content of crackers produced [3]. However, antioxidants also have the disadvantage of being easily oxidized due to the heating process. The addition of moringa leaves to the production of crackers through the process of mixing, fermentation, weaning, printing, and roasting. Based on the above mentioned, the research has been conducted on the effect of the addition of Moringa leaves on the nutritional content and sensory characteristic of crackers.

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1.2. Literature Review

Crackers are one of the foods of flat-shaped biscuits that are fermented and look like pieces of layers if broken. Unsweetened crackers can be used as a diet food because of the popular type that can be consumed instead of bread. Crackers are biscuits that have a less sweet, salty, and flat-shaped taste, and have crispy tour cuttings. There are several types of crackers, namely; (1) Cream crackers are squares with large ones with a soft flake structure (2) Hotel crackers, which have the same structure as cream crackers but with smaller size; (3) Soda crackers, are salty crackers, usually, square-shaped smaller sizes than cream crackers. Made by the sponge method and with a large amount of sodium bicarbonate added in the dough for a higher pH than cream crackers; (4) Puff biscuits are crackers with a layered structure that is clearer than cream crackers and with a much higher fat content. Puff biscuits are used as shells for cream sandwiches; (5) Savoury or snack crackers, These are a group of crackers type biscuits that are marinated, flavored, and sprayed with various fats after baking. The main basic ingredients in the manufacture of crackers are wheat flour, fat, salt, water, and yeast [4].

Ref. [5] states that crackers are different from biscuits because crackers require yeast as a medium for fermentation and do not use eggs, whereas biscuits use eggs as a developer ingredient and do not require yeast.

Dough crackers are usually made of hard dough that is fermented with yeast using acidic raw materials to modify the dough. Harddoughis a type of dough that has a low fat and sugar content [4]. Various variations in the use of ingredients, the addition of flavor, shape, size, and use of toppings such as spices, oils sprayed on top of the dough, including cracker products that are commonly made in the industry [6].

Crackers are low-sugar foods, most dough fermented with yeast and processed to produce products with dry, layered characters. The fermentation process plays a role in the formation of the flavor of crackers. The most important thing in the fermentation process of crackers is the ideal environmental conditions, temperature, and humidity for the cracker's dough to expand properly. The dough is usually fermented at a temperature of 27- 30 ° C with a humidity of 75-80%. Fermentation can be done on a table and covered with plastic that is first smeared with margarine and inserted in a controlled room [7].

The leaves of *M. Oleifera* in addition to containing macro compounds also contain minerals that are quite high. The mineral content in the leaves will count as ash. In 100 g of fresh leaves contain Ca (847.1 mg); Mg (151.3 mg); K (549.6 mg); Fe (17.5 mg); Zn (1.3 mg); P (111.5 mg) [3].

The ingredients used in the manufacture of crackers are divided into two parts, namely materials that serve as binders and texture softener materials. Strong dough-forming ingredients are wheat flour, water, and salt, while the ingredients that serve as texture softeners are sugar, fat, and leavening agent (baking powder) as a developer material [4].

In the manufacture of crackers, the basic ingredients are wheat flour, salt, fat (margarine), and water. The ingredients used as dust fillings or dough coating materials are flour and salt. Wheat flour is used as a source of skeletal structure because it has the protein content of glutenin and gliadin which affects the elasticity of elasticity so that wheat dough can be made into sheets, milled, and able to hold air due to fermentation so that the dough becomes expanded [8].

1.3. Research Objective

This research aimed to (a) know the effect of the level of difference in the addition of moringa leaves to the characteristics of the crackers; (b) get the best moringa leaf addition in producing crackers that are acceptable to panelists based on sensory characteristics and nutritional content. The expected benefit of the research conducted is that it can maximize the utilization of moringa leaves in the development of functional food products as raw materials for manufacturing crackers.

2. MATERIALS AND METHODS

2.1. Materials

. The ingredients needed for the manufacture of crackers are *M Oleifera* leaves, wheat flour, margarine, bread yeast, and salt. The leaves of *M. oleifera* are taken from around the campus of Andalas University, Padang. Materials for chemical analysis needed are H_2SO_4 0.3 N, NaOH, K_2SO_4 10%, ethanol 95%, selenium mix, H_3BO_3, methyl red, methylene blue, methyl orange, HCl, hexane, HNO_3, distilled water, and Na_2CO_3

2.2. Experimental Design

The study used a Completely Randomized Design (CRD) with 5 treatments of adding slices of *M. oleifera* leaves concentrations of 4%, 6%, 8%, 10%, and 12%, respectively 3 replications. Chemical observation variable data is statistically tested using variance analysis at $\alpha = 5\%$, using DNMRT advanced tests.

2.3. Research Implementation

2.3.1. Basic Formulation

The manufacture of these crackers is done based on its Basic formulation refers to in Ref [9]. The formulation is displayed in Table 1 as a basic reference in the preparation of moringa leaves crackers formulation (Table 2).

Table 1. *Crackers* Basic Formulation

Ingredients	Total
Flour	300 g
Salt	0.6 gram
Water	100 mL
Margarine	100 g

2.3.2. Preparation of Slices of M. oleifera Leaves

Moringa leaves are taken from the tree and then separated from the branches. Moringa leaves that have been separated are washed thoroughly with water and then sliced using a knife into small or about 1-2 mm size.

2.3.3. Crackers Manufacturing Process

The process of making crackers refers to Ref's research. [9]. Wheat flour, salt, yeast, and slices of moringa leaves that have been prepared coupled with water little by little until the dough is

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formed. Then add the margarine. Mix until rinsed. The dough is left for ± 30 minutes for the fermentation process. Baking was carried out at a temperature of 175°C for 15 minutes.

Table 2. Formulation of addition of moringa leaf

Ingredients	Moringa leaves addition (g)				
	A	B	C	D	E
Moringa Leaves (g)	18	27	36	45	54
Wheat flour (g)	300	300	300	300	300
Salt (g)	0.6	0.6	0.6	0.6	0.6
Yeast (g)	2	2	2	2	2
Water (ml)	100	100	100	100	100
Margarine (g)	50	50	50	50	50

Description: addition of slices of moringa leaves based on the total weight of the entire ingredient.

A = 4% addition of moringa leaf slices
B = 6% addition of moringa leaf slices
C = 8% addition of moringa leaf slices
D = 10% addition of moringa leaf slices
E = 12% addition of moringa leaf slices

2.4. Observation

2.4.1. Nutritional Content [10,11]

Observations were made on crackers that included water content, protein, fat, ash, carbohydrate, energy values, and crude fiber content.

2.4.2. Sensory Characteristic [12]

Sensory analysis is a method of human action using the five senses, namely the eyes, nose, mouth, hands, and ears. These five senses have been widely used in research to be able to assess the sensory attributes of a product such as an aroma, taste, color, and texture. In this study, the test used was a hedonic test (test based on the level of preferences) with untrained panelists numbering 30 people. The scale of panelist preference in the assessment with a range of 1-5 includes: 1) Dislike very much, 2) Dislike slightly, 3) Neither like nor dislike, 4) Likes moderately 5) Like Very Much.

3. RESULT AND DISCUSSION

3.1. Nutritional Content Analysis

3.1.1. Moisture Content

After being tested statistically using an analysis of variance at the rate of 5% and continued with further tests DNMRT showed that the addition of leaf slices produces a real different moisture content between treatments (Table 2). The average moisture content in crackers with the addition of *M. oleifera* leaves ranges from 2.67 – 4.67%, with the lowest value on crackers with the addition of leaf slices as much as 4% and the highest in crackers with the addition of leaf slices as much as 12%. The higher the addition of leaf slices resulting in higher moisture content of crackers. Crackers belong to the biscuit group, therefore the Indonesian National Standard (SNI) used is SNI biscuit. The moisture content of these crackers still meets SNI 2973-2018, which is a maximum of 5%.

Table 3. Water content of crackers with the addition of *M. oleifera* leaves

Treatments	Water content (%) ± SD
A (4%)	2.67 ± 0.00 a
B (6%)	3.00 ± 0.00 a b
C (8%)	3.33 ± 0.34 b
D (10%)	4.11 ± 0.38 c
E (12%)	4.67 ± 0.00 d

The numbers on the same column and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT).

Increased moisture content by increasing the number of slices added to the crackers dough is influenced by the high fiber in crackers (Table 3) derived from the leaves of *M. oleifera.* This is supported by a study that has reported that an increase in insoluble fiber in noodles results in an increasing amount of unbound water in noodles [13].

3.1.2. Crude Fiber Content Crackers

Crude fiber is a residue from food or agricultural materials after being treated with boiling acids and alkalis and consists of cellulose with little lignin and pentosan [14]. Based on a variant analysis at the level of 5% showed that the coarse fiber in crackers plus different leaf slices showed a different level of crude fiber. (Table 4).

Table 4. Crude Fiber Content of crackers with the addition of *M. oleifera* leaves

Treatments	Crude Fiber Content (%) ± SD
A (4%)	8.83 ± 0.29 a
B (6%)	10.00 ± 0.50 b
C (8%)	11.50 ± 0.50 c
D (10%)	13.83 ± 0.58 d
E (12%)	15.00 ± 0.50 e

The numbers on the same column and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT).

Crude fiber crackers range from 8.83 to 15.50%, with the lowest values found in crackers with an addition of 4% and the highest value found in crackers with an addition of 12%. Coarse fiber increases along with the addition of more and more moringa leaf slices. Coarse fiber that is quite high in crackers is obtained from the content of raw materials used, namely *M. oleifera* leaves.

Moringa leaves contain 0.9% fiber in fresh leaves and 12.5% in dried leaves [15]. Other studies that have been conducted show that the addition of *M. oleifera* leaves into skinless banana flour and banana flour with skin can increase the coarse fiber content in mixed flour by 25% and 38% respectively [16].

3.1.3. Protein

Protein crackers range from 9.43 to 14.18%, with the lowest value on the addition of 4% and the highest value on crackers with an addition of 12%. Protein levels increase with the increasing number of leaf slices added. After being tested statistically with a variant analysis at the rate of 5%, showed that the addition of leaf slices resulted in a marked increase in protein crackers (Table 5).

Protein levels in all treatments have qualified for SNI quality because it is higher than SNI 2973-2018, which is a protein

biscuit content of at least 4.5%. The increase in protein crackers levels is in line with the increase in the number of slices of leaves added. It is associated with the protein content of Moringa leaves. It has been reported that the protein content in fresh leaves is 6.7% while in dried leaves it is 29.4% [15].

Table 5. The protein content of crackers with the addition of *M. oleifera* leaves

Treatments	Protein (%) ± SD
A (4%)	9.43 ± 0.31 a
B (6%)	10.53 ± 0.35 b
C (8%)	11.75 ± 0.35 c
D (10%)	12.77 ± 0.00 d
E (12%)	14.18 ± 0.35 e

The numbers on the same column and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT).

3.1.4. Fat Analysis

Fats are nonpolar compounds that are insoluble in water but can be soluble in nonpolar solvents such as ether, hexane, chloroform, benzene, and others. Fat is the most effective source of energy compared to protein and carbohydrates but not as the main energy in the body. Every 1 g of fat will produce 9 kcal while protein and carbohydrates produce calories of 4 kcal.

Table 6. The fat content of crackers with the addition of *M. oleifera* leaves

Treatments	Fat Content (%) ± SD
C (8%)	19.50 ± 0.11 a
B (6%)	20.02 ± 0.01 a b
D (10%)	21.09 ± 0.68 b
A (4%)	21.21 ± 0.21 b
E (12%)	22.52 ± 1.29 c

The numbers on the same column and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT).

The results of the fat analysis of crackers showed that the average content ranged from 19.50 to 22.52% (Table 6). The results of a variety analysis at the level of 5% showed that the addition of different slices of moringa leaves had a noticeable influence on the fat content of *crackers*, but there was no significant association between leaf addition and increased fat levels. It is thought that this is because the fat content in fresh leaves is quite low at 1.7% [15]. In other studies showed that fat levels ranged from 1.0 – 1.7% [3].

3.1.5. Ash Content

Ash content describes the total minerals found in foodstuffs. The results of the variance analysis at the level of 5% showed that the treatment of the addition of different slices of *M. oleifera* leaves had a real effect on the ash levels of crackers produced. The average value of ash crackers can be seen in Table 7.

Table 7 shows that ash content increase along with the increase in the addition of *M. oleifera* leaf slices. which range from 0.67 – 1.67%. with the lowest value being at the addition of 4% while the highest value is in the addition of 12%. According to SNI 01-2973 that crackers products produced all treatments that meet the standard which is a maximum limit of 2%. This ash content increases because of the mineral content in the raw materials used.

M. oleifera is rich in minerals that can be seen from its ash content. The ash levels in *M. oleifera* leaves differ according to the type of cultivar. Studies conducted on 5 cultivars show that the ash levels in *M. oleifera* dry leaf powder range from 8.05 to 10.38%. The mineral contained in the leaves is Ca (1.72 - 2.64%). P (0.18 – 0.3%) and K (1.32 – 2.02%). More and more leaves are added to the cracker. The ash will also be higher.

Table 7. Ash content of crackers with the addition of *M. oleifera* leaves

Treatments	Ash Content (%) ± SD
A (4%)	0.67 ± 0.01 a
B (6%)	0.99 ± 0.01 b
C (8%)	1.33 ± 0.00 c
D (10%)	1.44 ± 0.20 c
E (12%)	1.67 ± 0.00 d

The numbers on the same column and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT).

3.1.6. Carbohydrate

The results of the variance analysis at the level of 5% showed that the addition of different slices of moringa leaves had a real effect on the levels of carbohydrate *crackers*. The higher the addition of leaf slices, the lower the carbohydrate content of crackers resulting. The average value of carbohydrates on *crackers* can be seen in Table 8.

Table 8. Carbohydrate content of crackers with the addition of *M. oleifera* leaves

Treatments	Carbohydrate (%) ± SD
E (12%)	56.96 ± 1.01 a
D (10%)	60.59 ± 0.20 b
C (8%)	64.08 ± 0.23 c
B (6%)	65.46 ± 0.35 d
A (4%)	66.03 ± 0.52 d

The numbers on the same column and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT).

Carbohydrate *crackers* range from 56.96% to 66.03%. The highest carbohydrate content is found in treatment A, namely with the addition of 4% moringa leaf slices, while the lowest carbohydrate level is in the E treatment, namely with the addition of 12% moringa leaf slices. This decrease in carbohydrate levels is influenced by other nutrient components, namely water content, protein levels, fat levels, and ash levels that increase so that carbohydrates are lower, and conversely, if the components of other nutrients are lower then the carbohydrate content is higher.

3.1.7. Energy Value

The energy value contained in the product is generated from the burning of carbohydrates, fats, and proteins. The results of the analysis of the energy value of crackers resulting from each treatment can be seen in Table 9.

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Table 9. Energy value of crackers with the addition of *M. oleifera* leaves

Treatments	Energy Value (%) ± SD
A (4%)	456.68
B (6%)	451.67
C (8%)	464.87
D (10%)	456.03
E (12%)	456.42

The numbers on the same column and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT).

Table 8 shows that the energy value of each moringa leaf slice addition treatment on crackers ranges from 451.67 to 464.87 kcal/100g. The energy content of the product has met the requirements of SNI, which according to SNI 01-2973 the energy content requirement in biscuits is at least 400 kcal / 100g. Carbohydrates and proteins each produce 4 kcal/g, while fats produce energy of 9 kcal/g or about 2.25 times the energy of carbohydrates and proteins. Research has been conducted by Sultana, the energy content in 5 cultivars of *M. oleifera* powder leaves ranges from 353 – 368 kcal / 100 g [17].

3.2. Sensory Analysis of Crackers

Sensory analysis is a sensory test using human sensory tools to find out the level of preference of panelists to moringa leaf crackers products. Panelists provide assessment by using a hedonic scale of numbers 1 through 5. The number of the panelist was 30. Sensory testing was conducted by giving personal responses to products with their parameters of color, aroma, taste, and texture. The results of sensory analysis of color, aroma, taste, and texture attributes at the level of 5% showed that the treatment of moringa leaves addition had no significant effect on the sensory properties of crackers (Table 10). Visually the resulting cracker product can be seen in Figure 1.

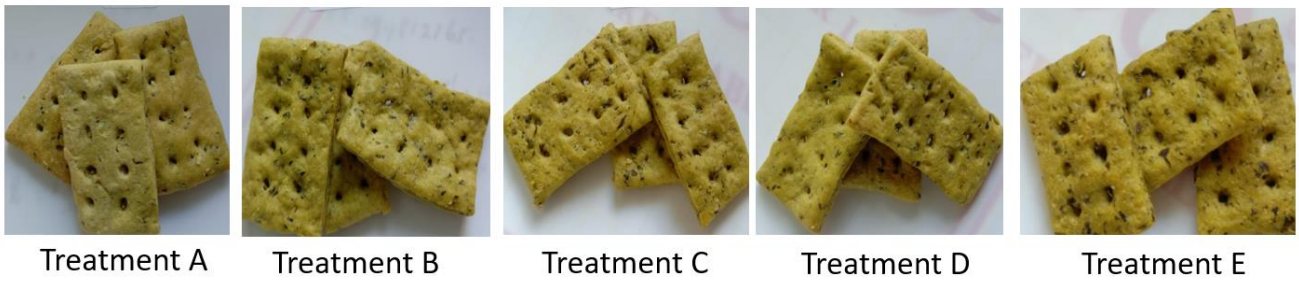

Figure 1. Moringa Leaf crackers of various Treatments

Table 10. Sensory analysis of moringa leaf crackers

Treatments	**Color**	**Aroma**	**Flavor**	**Texture**
A (4%)	3.63	3.37	3.40	**3**.41
B (6%)	3.60	3.63	3.47	3.10
C (8%)	3.93	3.90	3.30	3.40
D(10%)	3.53	3.87	3.20	3.43
E (12%)	3.43	3.83	3.17	3.30
Coefficient of Variation	20.99%	22.58%	17.52%	17.12%

Remark:
1) Dislike very much, 2) Dislike slightly, 3) Neither like nor dislike, 4) Likes moderately 5) Like Very Much.

The panelists' favorability for crackers ranges from 3.43 to 3.93. In the results of organoleptic tests on the color of crackers with the rate of addition of moringa leaf slices to crackers that are increasingly giving a green color pattern. This green color is thought to be derived from green substances (chlorophyll) found in moringa leaves. This is in line with Ref's research. [18] that the higher the proportion of moringa leaves, the darker the color of the dim sum contents. Color is one of the important parameters in organoleptic testing because the color of a product affects consumer attractiveness.

Aroma is an attribute that needs to be considered in organoleptic testing because aroma also affects the level of liking of panelists. According to Ref. [18], in foodstuffs, some substances are volatile (volatile) that will cause the formation of aroma. These substances include protein and fat. If heating occurs, the amino acids in the protein will be degraded and the fat will oxidize so that the active ingredients of both substances decompose and cause aroma [19].

Based on Tabel 10 it can be seen that the results of organoleptic aroma crackers produced range from 3.37 to 3.90. The results of the analysis of various fingerprints at the level of 5% showed that the treatment of the addition of moringa leaf slices had no real effect on the crackers produced. The aroma caused to crackers products is a specific aroma derived from moringa leaves. The aroma of moringa leaves is due to moringa leaves containing lipoxide enzymes and essential oils [20].

Taste is an organ-picking attribute involving the tongue's sense tools. The sense detected is due to the response to the nervous system. Taste is a sensation arising from the combination of specialized taste receptor cells located in the mouth, especially in the flavoring organs (tongue), and is broken down into sweet, sour, salty, bitter, and savory or umami sensations[20]. Based on the results of the variety of fingerprints at the level of 5% indicated that the treatment of the addition of different moringa leaf slices had no real effect on the crackers produced. The average value of organoleptic flavor crackers can be seen in Table 10.

The highest value is in treatment B, namely with the addition of 6% moringa leaf slices, while the lowest value is in the E treatment, namely with the addition of 12% moringa leaf slices. Results on Tabel 10 showed that the higher the percentage of moringa leaves added, the less the panelists' fondness for crackers produced. This is because panelists are not used to consuming moringa leaves, it can be seen that the panelists prefer the taste of B-treatment crackers with a percentage of 6% addition of moringa leaf slices. In addition, the taste can also be influenced by chemical compounds contained in the raw materials used and processing. According to Ref. [21], Moringa leaves have tannin content that when entering the mouth occurs clumping of protein

in the mucosa of the oral cavity so that a taste that is less preferred by panelists.

The texture is an assessment of food ingredients felt by the mouth and has an important influence in determining whether or not a product is worth it to like. However, the level of fondness for texture is difficult to understand because everyone has their taste. The results of a sensory variety of crackers texture at the level of 5% showed that the treatment of adding different slices of moringa leaves had no real effect on the resulting crackers (Table 10).

The sensory value of texture of moringa crackers ranges from 3.10 to 3.43. The highest level of the average organoleptic texture value is found in treatment D, namely with the addition of 10% moringa leaf slices, while the average value of organoleptic texture is lowest in treatment B, namely with the addition of 6% moringa leaf slices. This suggests the panelists prefer the texture of crackers to the B treatment. [22].

Based on organoleptic tests that the level of texture in the resulting crackers is increasingly brittle and crunchy. Increasingly fragile crackers are generally characterized by the formation of air cavity pores during the processing process. The more pores of the air cavity that is formed, the higher the braking power. The texture is also influenced by the use of high-fiber raw materials in product manufacturing formulations. Fiber tightly binding to water, so that during water treatment bound to fiber is not easily released and the impact of texture becomes not soft [23].

Based on the sensory analysis result the addition of moringa leaf slices is acceptable by panelists. However, overall, treatment E is the best treatment because the nutritional content is the best which consist of 4.67% water content; protein content 14.18%; fat content 22.52%; ash content 1.67%; carbohydrates 56.96%; crude fiber 15.50%; energy value 456.42 kcal/100g; number peroxide 1.18 mgEq/kg; the color of 3.43 (Neither like or dislike); aroma of 3.83 (likes); a taste of 3.17 (Neither like or dislike); and texture of 3.30 (Neither like or dislike). The crackers meet the SNI (Indonesian National Standard).

4. CONCLUSION

The results show that the addition of moringa leaves a significant effect on moisture content, protein content, fat content, ash content, carbohydrates, crude fiber, but does not significantly affect on color, aroma, taste, and texture of the crackers. Based on nutritional content and sensory test, the crackers of treatment E (the addition of moringa leaves 12%) with the characteristics moisture content of 4.67%; protein content of 14.18%; fat content of 22.52%; ash content of 1.67%; carbohydrates of 56.96%; crude fiber of 15.50%; calories of 456.42 kcal/100g; the color of 3.43 (Neither like or dislike); aroma of 3.83 (likes); a taste of 3.17 (Neither like or dislike); and texture of 3.30 (Neither like or dislike). The crackers meet the SNI (Indonesian National Standard).

REFERENCE

[1] Isnan, W., & Nurhaedah, M. (2017). Ragam Manfaat Tanaman Kelor (Moringa oleifera Lamk) Bagi Masyarakat. Info Teknis EBONI, 14(1), 63–75.

[2] Aminah, S., Ramdhan, T., & Yanis, M. (2015). Kandungan Nutrisi dan Sifat Fungsional Tanam an Kelor (*Moringa oleifera*). Buletin Pertanian Perkotaan, 5(30), 35–44.

[3] Yameogo, C. W., Bengaly, M. D., Savadogo, A., Nikiema, P. A., & Traore, S. A. (2011). Determination of chemical composition and nutritional values of Moringa oleifera leaves. Pakistan Journal of Nutrition, 10(3), 264–268. https://doi.org/10.3923/pjn.2011.264.268

[4] Manley, D. (2001). Biscuit, cracker and cookie recipes for the food industry. In Biscuit, cracker and cookie recipes for the food industry. https://doi.org/10.1533/9781855736269

[5] Ferazuma, H., Marliyati, S. A., & Amalia, L. (2011). Substitusi Tepung Kepala Ikan Lele Dumbo (Clarias Gariepinus sp) Untuk Meningkatkan Kandungan Kalsium Crackers. Jurnal Gizi Dan Pangan.

[6] Ayustaningwarno, F. 2014. Teknologi Pangan: Teori Praktis dan Aplikasi. Graha Ilmu. Yogyakarta. Hal 76-91.

[7] Budiman, F., Gozali, T., & Suliasih, N. (2017). Pengaruh Konsentrasi Enzim Papain (Carica Papaya L) Dan Suhu Fermentasi Terhadap Karakteristik Crackers. Undergraduates thesis. Universitas Pasundan. Indonesia.

[8] Afianti, F dan Indrayani,V. 2015. Pengaruh Penambahan Tepung Ikan Gabus (Ophiocephalus striatus) dan Air terhadap Sifat Organoleptik Crackers. Jurnal Boga 4(1):46-55.

[9] Sayuti, K., Permata, D. A., & Novita, O. (2019). The effect of the addition of "Senduduk" leaves (Melastoma malabthricum) on the characteristic of crackers. International Journal on Advanced Science, Engineering and Information Technology, 9(5), 1676–1680. https://doi.org/10.18517/ijaseit.9.5.10247

[10] AAOC. (1995). Official Methods of Analysis of the Association of Official Analytical Chemist 16th ed. Association of Official Analytical Chemist. In Journal of Chemical Information and Modeling. https://doi.org/10.1017/CBO9781107415324.004

[11] Yenrina, R., Yuliana, dan Rasymida, D. 2010. Metode Analisis Bahan Pangan. Universitas Andalas Press. Padang. 112 hal.

[12] Setyaningsih, D. Apriyanto, A dan Sari, P.M. 2010. Analisis Sensori untuk Industri Pangan dan Agro. IPB. Bogor. Hal: 59-60.

[13] Lei, M., Huang, J., Tian, X., Zhou, P., Zhu, Q., Li, L., Li, L., Ma, S., & Wang, X. (2021). Effects of insoluble dietary fiber from wheat bran on noodle quality. Grain & Oil Science and Technology, 4(1), 1–9. https://doi.org/10.1016/j.gaost.2020.11.002

[14] Yenrina, R. 2015. Metode Analisis Bahan Pangan dan Komponen Bioaktif. Andalas University Press. Padang. 159 hal

[15] Gopalakrishnan, L., Doriya, K., & Kumar, D. S. (2016). Moringa oleifera: A review on nutritive importance and its medicinal application. In Food Science and Human Wellness (Vol. 5, Issue 2, pp. 49–56). Elsevier B.V. https://doi.org/10.1016/j.fshw.2016.04.001

[16] Badejo, A. A., Osunlakin, A. P., Famakinwa, A., Idowu, A. O., & Fagbemi, T. N. (2017). Cogent Food & Agriculture under a Creative Commons Attribution (CC-BY) 4.0 license PUBLIC INTEREST STATEMENT. 3, 1278871. https://doi.org/10.1080/23311932.2017.1278871

[17] Sultana, S. (2020). Nutritional and functional properties of Moringa oleifera. Metabolism Open, 8. https://doi.org/10.1016/j.metop.2020.100061

[18] Ardhanareswari, N.P. 2019. Daya Terima Dan Kandungan Gizi Dim Sum Yang Disubstitusi Ikan Patin (Pangasius Sp.) Dan Pure Kelor (Moringa Oleifera) Sebagai Snack Balita Media Gizi Indonesia. 14 (2) 123–131. doi.org/10.204736/mgi.v14i2.123–131

[19] Mutiara, E., Adikahriani, & Wahidah, S. (2012). Pengembangan Formula Biskuit Daun Katuk Untuk Meningkatkan Asi. Jurnal Falkutas Teknik Universitas Negeri Medan.

[20] Ulfa, S., & Ismawati, R. (2016). Pengaruh Penambahan Jumlah dan Perlakuan Awal Daun Kelor Terhadap Sifat Organoleptik Bakso. E-Journal Boga, 5(3).

[21] Muchtadi, T.R., Sugiyono. 2013. Prinsip dan Proses Teknologi Pangan. Alfabeta : Bandung. Hal : 24

[22] Kustini, A., Kusharto, C. M., dan Damayanthi, E. 2017. Pengembangan crackers Sumber Protein dan Mineral Dengan Penambahan Tepung Daun Kelor (Moringa oleifera) Dan Tepung Badan-Kelapa Ikan Lele Dumbo (Claris gariepinus). Ekologi Manusia, IPB. Nutri-sains. Vol. I. Edisi 1.

[23] Darmawan, E. 2017. Daya Terima Konsumen Terhadap Bakpao Yang DIperkaya Sifat Fungsional Serat dan Antioksidan Berbasis Daun Kelor (Moringa oleifera). AGROTECH, Vol 2, No. 1 November 2017.