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CHARACTERISTICS OF ANALOG JERKY FROM MORINGA LEAVES (*MORINGA OLEIFERA* L.) WITH THE ADDITION OF WHITE OYSTER MUSHROOM (*PLEUROTUS OSTREATUS*) POWDER

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ABSTRACT

This study aims to determine the effect of differences of white oyster mushroom powder addition to the characteristic of beef jerky analog from Moringa leaves and to determine the best beef jerky analogs of moringa leaves with white oyster mushroom powder addition based on chemical, physical, and organoleptic analysis. This research used a Completely Randomized Design (CRD) with 4 treatments (the addition of white oyster mushroom 0%, 40%, 50%, and 60%) with 5 replications. The research data were analyzed using ANOVA and if it had significantly different, continued with Duncan's New Multiple Range Test (DNMRT) at a 5% significance level. The observation showed that the addition of white oyster mushroom powder had a significant effect on water content, ash content, fat content, protein content, crude fiber content, yield, and organoleptic on color, aroma, and taste, but it has no significant effect on the hardness and organoleptic texture. The best beef jerky analogs of moringa leave with white oyster mushroom powders based on chemical, physical, and organoleptic was beef jerky of D treatment (addition white oyster mushroom powder 60%) with characteristics of average yield 68.87%, hardness 39.01 %, water content 3.63%, ash content 6.38%, fat content 14.25%, protein content 15.01%, crude fiber content 8.14%, organoleptic of color 4.05 (like), aroma 3,90 (like), taste 3,35 (neutral), and texture 3,85 (like).

Keywords: *White oyster mushroom, Characteristic, Moringa leaves, Beef jerky analog*

INTRODUCTION

Jerky is a food product in the form of plates made from sliced meat that has been seasoned and dried. Jerky is generally made from beef. According to Firdausni and Anova (2015) beef is preferred in making beef jerky because it has a soft texture, but there is some beef jerky that has a hard texture so they are difficult to consume by people who have problems with teeth. The use of beef as a staple in the manufacture of beef jerky also has several other obstacles for the community, such as the relatively expensive price and some people having a vegetarian lifestyle. Therefore, innovation in processing beef

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jerky has been made by making analog jerky from vegetables that have a high nutritional content so that it can resemble the nutritional content of beef jerky.

Analog beef jerky is beef jerky that resembles beef jerky but does not use meat at all during its processing. In a study conducted by Febri (2019), an analog of beef jerky was made from Moringa (Moringa oleifera L.) leaves. According to Krisnadi (2015), Moringa leaves contain lots of antioxidants, vitamins, minerals, essential and non-essential amino acids, anti-inflammatory, and other important compounds.

High protein in Moringa leaves, which is about 27% in dry leaves, is expected to meet the nutritional content of analog jerky. In a study conducted by Febri (2019), it turns out that the analog of beef jerky protein from Moringa leaves has not been able to resemble the protein content of beef jerky. One way to increase the protein content of beef jerky is to add other ingredients that contain high protein. In this study, the material added was powdered white oyster mushroom (Pleurotus ostreatus).

White oyster mushroom is a food that is easily decomposed so post-harvest handling must be carried out. Oyster mushroom is one of the foodstuffs that contain a source of vegetable protein. According to Suriawiria (2002), the protein content in oyster mushrooms ranges from 19%-35% of the dry weight. In addition, oyster mushrooms also contain several vitamins such as vitamin B1, vitamin B2, niacin, biotin, vitamin C, and provitamin D2, and contain high crude fiber. Oyster mushrooms contain -glucan which has biopharmacological effects that are beneficial for body health, including as an immunological ingredient (Christopher, 2005; Synytsya et al., 2009; Oleke et al., 2014) such as antidiabetic, antibacterial, anticholesterol, antiarthritic, antioxidant. , anticancer, eye health, antiviral activity (Deepalakshmi and Karan, 2014), and can reduce blood sugar concentrations (Jakubik et al., 2012). The use of white oyster mushrooms in food products is expected to increase the nutritional value and produce products that are beneficial to the health of the body.

Moringa leaf jerky is relatively safer for groups who are not allowed to eat meat or because of certain diseases. Moringa leaves have a good protein content compared to other vegetables, but when compared to protein in beef jerky, the protein contained in Moringa leaf jerky is still lacking. To increase the protein content in moringa leaf jerky, it is necessary to add white oyster mushroom powder. On this basis, the author conducted a study on "Characteristics of Analog Jerky from Moringa Leaves (Moringa oleifera L.) with the Addition of White Oyster Mushroom (Pleurotus ostreatus) Powder".

RESEARCH METHODS

A. Place and time

The research was conducted at the Laboratory of Chemistry, Biochemistry of Agricultural Products and Food Nutrition, Laboratory of Technology and Process Engineering of Agricultural Products, and Central Instrumentation Laboratory of the Faculty of Agricultural Technology, Andalas University, Padang. This research was conducted in May – July 2021.

B. Materials and Tools

The main ingredients used in this study were Moringa leaves, white oyster mushrooms, tapioca flour, shallots, garlic, coriander, ginger, pepper, kencur, salt, kaffir lime leaves, and eggs.

The materials used in the chemical analysis were acetic acid, boric acid, distilled water, chloroform, concentrated H2SO4, 0.02 N HCl, Conway indicator, pp indicator, 50% NaOH, hexane, neutral alcohol, saturated KI solution, Na2S2O3, starch solution 1 %, and selenium mix.

The equipment used during the study were stoves, pots, cauldrons, blenders, spatulas, knives, cutting boards, filters, clear plastic, plastic pouches, aluminum foil, and label paper. Meanwhile, for chemical analysis used boiling stone, aluminum cup, porcelain dish, desiccator, Kjedahl distillate, Erlenmeyer, 250 ml beaker, oven, whatman paper No. 42, filter paper, Kjeldahl flask, Soxhlet flask, 100 ml volumetric flask, kiln, texture analyzer, analytical balance, and dropper.

C. Research Methods

The research design used in this study was a completely randomized design (CRD) with 4 treatments and 5 replications. The data obtained were analyzed statistically using the F test, if the calculated F is greater than the F table, then it is continued with Duncan's New Multiple Range Test (DNMRT) test at a significance level of 5%.

The treatment in this study was the amount of white oyster mushroom powder added in the manufacture of analog jerky from the total weight of the Moringa leaf material.

The treatments that will be carried out in this research are as follows:

A= Addition of 0% white oyster mushroom powder

B= Addition of 40% white oyster mushroom powder

C= Addition of 50% white oyster mushroom powder

D= Addition of 60% white oyster mushroom powder

The formulation for making moringa leaf jerky with the addition of white oyster mushroom powder is based on Febri's research (2019) on making moringa leaf jerky, then modified by adding white oyster mushroom powder. The formulation of moringa leaf jerky with the addition of white oyster mushroom powder according to the treatment is shown in Table 1.

Table 1. Formulation of Moringa Leaf Analog Jerky with Addition of White Oyster Mushroom Powder

Ingredient	Formulation			
	A	B	C	D
Moringa leaves (g)	100	100	100	100
White Oyster Mushroom Powder (%)	0	40	50	60
Tapioca flour (g)	50	50	50	50
Shallots (g)	17.5	17.5	17.5	17.5
Garlic (g)	12.5	12.5	12.5	12.5
Coriander (g)	1	1	1	1
Ginger (g)	0.5	0.5	0.5	0.5
Pepper (g)	1.5	1.5	1.5	1.5
Kencur (g)	0.5	0.5	0.5	0.5
Salt (g)	5	5	5	5
Kaffir lime leaves (g)	0.5	0.5	0.5	0.5
Egg yolk (g)	8	8	8	8

D. Research Implementation

Process of making analog jerky (Febri, 2019):

1) Preparation of analog jerky raw materials, namely Moringa leaves, white oyster mushrooms, tapioca flour, and spices such as shallots, garlic, coriander, ginger, pepper, kencur, salt, kaffir lime leaves, and eggs.

2) Cleaning Moringa leaves from dirt or yellowed leaves.

3) Boiling Moringa leaves at a temperature of 100oC for 1 minute.

4) Make the white oyster mushroom powder by heating in the oven at 50o C for 24 hours or until the white oyster mushroom can be broken, then mashed using a blender.

5) Crushing and mixing all the ingredients to make analog jerky is then printed with a thickness of ±0.3 cm.

6) Steaming the analog jerky dough for 5 minutes, then cut into 4x4 sizes.

7) Drying using an oven at 110o C for 2.5 hours.

8) Frying with deep fat frying method until the bubbles in the oil disappear.

9) The packaging uses PP (Polypropylene) packaging in the form of a standing pouch measuring 10x17 cm.

E. Observation

Some of the analyzes carried out in this research are the analysis of the raw materials of analog moringa leaf jerky and white oyster mushroom powder as well as the analysis of the characteristics of the analog jerky. Observations on the raw materials of Moringa leaves and oyster mushroom powder were observations of water content, ash content, fat, and protein content. The characteristics of fried moringa leaf jerky were analyzed physically, chemically, and organoleptically. Physical analysis carried out is a measurement of yield and hardness test. The chemical analysis includes water content, fat content, protein content, ash content, free fatty acid content, crude fiber content, and peroxide value. The organoleptic analysis consists of texture, color, taste, and aroma.

RESULTS AND DISCUSSION

A. Raw Material Analysis

Analysis of raw materials is carried out to determine changes in nutritional content before and after processing. Chemical analysis carried out was the measurement of water content, ash content, fat content, and protein content of Moringa leaves and white oyster mushroom powder. The results of the analysis of raw materials can be seen in Table 2.

Table 2. Analysis of Analog Jerky Raw Materials

Treatment	Moringa Leaves (Mean ± Standard Deviation)	White Oyster Mushroom Powder (Mean ± Standard Deviation)
Water content (%)	76.17±0.62	11.85±0.81
Ash Content (%)	2.00 ± 0.00	6.58±0.31
Fat level (%)	1.11±0.02	2.41±0.20
Protein Content (%)	7.19±0.70	14.29 ± 2.63

Based on Table 2. it can be seen that the moisture content of Moringa leaves tested was 76.17%. This water content is lower than the moisture content of fresh Moringa leaves which are also used as raw material for analog jerky products in Febri's research (2019), which is 79.67%. The water content of the white oyster mushroom powder tested was 11.85%. This water content is not much different from the research of Guci (2019) which is 11.15%. Generally, the water content will decrease as the drying temperature and air velocity increase (Arici et al., 2016). Powdered products are recommended to have a low water content so that they can be stored for a long time. Low water content in food can inhibit the growth of microorganisms.

The average ash content of Moringa leaves obtained in this study was 2.00%. This ash content is lower than the research by Febri (2019), which is 2.67%. Ash content describes the number of minerals contained in food. Minerals found in fresh Moringa leaves include calcium (Ca), potassium (K), sulfur (S), nickel (Ni), iron (Fe), and other minerals (Manggra and Shofi, 2018). The average ash content of oyster mushroom powder in this study was 6.58%. This level is higher than the research of Guci (2019) which is 2.56%. According to Suriawiria (2001), the ash content of oyster mushrooms in dry weight is 4.1-9.8%. The types of minerals contained in oyster mushrooms are calcium (Ca), potassium (K), sodium (Na), phosphorus (P), and iron (Fe) (Sumarni, 2006).

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Fat is found in almost all foodstuffs with different amounts of content (Winarno, 2004). The results of the analysis of raw materials in the table show the average fat content of fresh Moringa leaves is 1.11%. This fat content is higher than the fat content of cassava leaves used as an analog jerky material in the Guci (2019) study, which is 0.99%. According to Krisnadi (2015), the fat content of fresh Moringa leaves is 1.7%. While the average fat content of the white oyster mushroom powder tested was 2.41%. This result is higher than the fat content of oyster mushroom powder in the Guci (2019) study, which is 0.52%.

The protein content contained in the raw material of fresh Moringa leaves is 7.19%. However, this result is lower than the protein content of fresh Moringa leaves tested in the Febri (2019) study, which was 9.23%. According to Krisnadi (2015), the protein content of fresh Moringa leaves is 6.7%. The protein content of oyster mushroom powder obtained in this study was 14.29%. According to Sumarni (2006), the protein content of wet oyster mushrooms is around 10.5-30.4%. According to Suriawiria (2000), the dry weight of oyster mushrooms contains 19-35% crude protein. Oyster mushroom protein is easy to digest and contains many essential amino acids that the body needs, especially lysine and lutein. The difference in the results of the chemical analysis of the raw material of Moringa leaves and white oyster mushroom powder may be due to the different varieties and different environments. Different environmental conditions can cause differences in the nutrient content of plants (Harris, 1989).

B. Chemical Analysis of Jerky Analog

Moisture Content

Moisture content is the amount of water contained in food ingredients expressed as a percent. Water is an important component in food because it can determine the characteristics of the resulting product such as appearance, texture, and taste (Winarno, 2002). The product that was tested for water content in this study was analog jerky after experiencing the frying process. Based on the variance table, shows that the addition of white oyster mushroom powder to the analog jerky of Moringa leaves has a significant effect at the level of 5% on the water content of the resulting analog jerky. The results of the analysis of the water content of analog jerky can be seen in Table 3.

Table 3. Average Water Content of Jerky Analog

Treatment	Moisture Content (%) ± SD
D (Addition of 60% white oyster mushroom powder)	3.63±0.64 a
C (Addition of 50% white oyster mushroom powder)	4.91 ± 2.03 a b
B (Addition of 40% white oyster mushroom powder)	5.16±2.09 a b
A (Without the addition of white oyster mushroom powder)	7.06 ± 1.20 b
KK = 30.92%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

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Based on Table 3. it is known that the lowest water content of analog jerky is found in treatment D (addition of 60% white oyster mushroom powder) with an average value of 3.63%, while the highest water content is in treatment A (Without the addition of white oyster mushroom powder) with an average value of 7.06%. The water content of this analog beef jerky has met the standard when compared to the water content of beef jerky based on SNI (2908:2013), which is a maximum of 12%.

In Table 3. it can be seen that the addition of white oyster mushroom powder in the manufacture of beef jerky will reduce the water content contained in the jerky product. This decrease in water content is due to the raw material of white oyster mushroom powder having a low water content of about 11.85% so that it attracts the water contained in the analog jerky dough which causes the dough to be drier. Another thing that affects the high and low water content of this analog jerky is the size of the thickness of the jerky made and its position during steaming and drying.

The frying stage in the manufacture of analog jerky also affects the water content of the resulting analog jerky. This is due to the use of oil at high temperatures so that the water contained in the product evaporates. Evaporation of water occurs because the temperature of the oil as a frying medium exceeds the boiling point of water so that the water in the material evaporates (Ratnaningsih, 2007).

Ash Content

The ash content in food products indicates the amount of inorganic residue remaining due to the ashing process or heating at high temperatures (>450^{o} C) and or the process of destroying organic components with strong acids. The product that was tested for its ash content in this study was analog jerky that had been fried. The results of statistical tests on ash content analysis showed that the addition of oyster mushroom powder had a significant effect at the level of 5% on the ash content of the resulting analog jerky. The average value of analogous jerky ash content with the addition of oyster mushroom powder can be seen in Table 4.

Table 4. Average Ash Content of Jerky Analog

Treatment	Ash Content (%) ± SD
A (Without the addition of white oyster mushroom powder)	5.64±0.04 a
B (Addition of 40% white oyster mushroom powder)	6.02±0.13 b
C (Addition of 50% white oyster mushroom powder)	6.15±0.38 b c
D (Addition of 60% white oyster mushroom powder)	6.38±0.19 c
KK = 3.67%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

Based on Table 4. the highest ash content of analog jerky was found in treatment D (addition of 60% white oyster mushroom powder) with an average of 6.38% and the lowest ash content was found in treatment A (without the addition of white oyster mushroom powder) which was an average of 6.38%. the

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average is 5.64%. This ash content is higher than the Guci (2019) study with an average ash content of 6.22% with the addition of 20% oyster mushroom powder.

Based on the data, it can be concluded that the more addition of white oyster mushroom powder to the analog jerky product, the higher the ash content obtained. The increase in ash content was due to the high ash content of the raw material for white oyster mushroom powder used, which was an average of 6.58% so, with the addition of oyster mushroom powder in each treatment, the ash content also increased. When compared with the SNI for beef jerky (SNI 2908: 2013), the ash content of the analog of moringa leaf jerky with the addition of white oyster mushroom powder is much higher. The maximum ash content of beef jerky according to SNI is 0.5%. The high ash content in this analog jerky product indicates the more minerals contained in the product. The minerals contained are derived from the raw materials of Moringa leaves and white oyster mushroom powder. The types of minerals contained in Moringa leaves are calcium (Ca) 603.77 mg/100 g, Potassium (K) 264.96 mg/100 g, Sulfur (S) 23.45 mg/100 g, Nickel (Ni) 22 .60%, Iron (Fe) 20.49 mg/100 g, and other minerals (Manggara and Shofi, 2018). The minerals contained in white oyster mushrooms are potassium, phosphorus, sodium, calcium, iron, manganese, zinc, and magnesium which account for 70% of the total ash.

Fat Content

Fat is an important food substance for the human body and is an effective energy source when compared to carbohydrates and protein because it can produce 9 kcal of energy per gram of fat (Winarno, 2004). Fats can improve taste, improve food texture, and increase calories. Fat is found in almost all foodstuffs with different levels. The product that is tested for fat content is the analog beef jerky that has been fried. The average fat content of jerky analogs with the addition of white oyster mushroom powder can be seen in Table 5.

Table 5. Average Fat Content of Jerky Analog

Treatment	Fat Content (%) ± SD		
D (Addition of 60% white oyster mushroom powder)	14.25 ± 1.91	a	
C (Addition of 50% white oyster mushroom powder)	17.84 ± 3.49	a	b
B (Addition of 40% white oyster mushroom powder)	18.71 ± 1.11		b
A (Without the addition of white oyster mushroom powder)	21.74 ± 4.77		b
KK = 17.39%			

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

From Table 5. It is known that the addition of white oyster mushroom powder has a significant effect at the level of 5% on the fat content of the resulting analog jerky. The lowest fat content was in treatment D (addition of 60% white oyster mushroom powder) while the highest average value of fat content was in treatment A (without the addition of white oyster mushroom powder). The results of the

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analysis of fat content showed that the more oyster mushroom powder was added in the manufacture of moringa leaf analog jerky, the fat content obtained would decrease, and vice versa. The high-fat content in analog jerky products is due to the fat content of the raw materials and from the oil used for frying. When viewed from the raw materials used, it is only about 1.11% fat from Moringa leaves and 2.41% fat from white oyster mushroom powder.

The high-fat content of analog beef jerky is caused by the presence of cooking oil that is absorbed by the food during the frying process. The frying process is different from other food processing because, in addition to functioning as a heat conductor, the oil will also be absorbed by the food. According to Muchtadi (2014), foodstuffs with high water content will absorb more oil. This is because the more water that evaporates, it will leave a lot of empty spaces due to water loss. The empty spaces will then be filled with oil so that the oil is absorbed by the food. In this study, it can be seen that the fat content in treatment A (without the addition of white oyster mushroom powder) had the highest fat content. This is because the water content of the dough in treatment A is not added with oyster mushroom powder so that the water content is higher and absorbs a lot of oil when frying. While in treatment D (addition of 60% white oyster mushroom powder) the fat content was the lowest because the amount of white oyster mushroom powder added was the most so the water content of the dough was lower and when frying it absorbed less oil.

Protein Content

Protein is an important nutrient needed by the body because of its function as a building block and body regulator (Winarno, 2004). The protein content of the analog beef jerky was tested after the frying process. The results of the average protein content of Moringa leaf analog jerky products with the addition of white oyster mushroom powder can be seen in Table 6.

Table 6. Average Protein Content of Jerky Analog

Treatment	Protein Content (%) ± SD
A (Without the addition of white oyster mushroom powder)	6.94±0.13 a
B (Addition of 40% white oyster mushroom powder)	10.62±1.30 b
C (Addition of 50% white oyster mushroom powder)	13.17±0.63 c
D (Addition of 60% white oyster mushroom powder)	15.01±1.38 d
KK = 8.76%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

The results of statistical tests of protein content in analog jerky products showed that the addition of white oyster mushroom powder had a significant effect at the level of 5% on the resulting oyster mushroom jerky. Based on Table 6. it can be seen that the highest protein value was in treatment D (Addition of 60% white oyster mushroom powder) which was 15.01% and the lowest value was in treatment A (without the addition of white oyster mushroom powder) with an average of 6.94 %. The protein value of this analog beef jerky is still low compared to the protein content of beef jerky in SNI (2908: 2013) which is at least 18%. The protein content of the Moringa leaf analog beef jerky with the addition of white oyster mushroom powder was higher than the Moringa leaf jerky in Febri's research (2019), which was 8.24%.

From the table, it can be seen that the more oyster mushroom powder added to the analog jerky formula from Moringa leaves, the higher the protein content of the analog jerky. This is influenced by the protein content of the raw material for white oyster mushroom powder, which is an average of 14.26%, while the protein content of Moringa leaves is only 7.19% on average. Protein content decreased from raw material to become analog jerky. This decrease was due to the process of steaming and frying the jerky which caused protein coagulation. Protein will be denatured at a temperature of 70-80oC. According to Sundari (2015), frying can reduce protein content because when frying uses a very high temperature and the protein will be damaged at that high temperature.

Carbohydrate Content

Carbohydrates have the main function as a source of energy for the body and other functions to help the body's metabolism (Winarno, 2004). Based on the variance table, it was found that the addition of white oyster mushroom powder did not have a significant effect at the 5% level on the carbohydrate content of the produced Moringa leaf analog jerky. The average value of the carbohydrate content of the analog of Moringa leaf jerky with the addition of white oyster mushroom powder can be seen in Table 7.

Table 7. Average Carbohydrate Contents of Analog Jerky

Treatment	Carbohydrate Content (%) ± SD
C (Addition of 50% white oyster mushroom powder)	57.92 ± 4.86
A (Without Addition of White Oyster Mushroom Powder)	58.62 ± 3.74
B (Addition of 40% white oyster mushroom powder)	59.50 ± 2.58
D (Addition of 60% white oyster mushroom powder)	60.76 ± 2.13

KK = 5.89%

From Table 7. It is known that the average value of the carbohydrate content of fried jerky analogs is 57.92-60.76%. The lowest carbohydrate content was found in treatment C, which was 57.92% and the highest carbohydrate content was found in treatment D, which was 60.76%. Carbohydrate content in this analog jerky is influenced by the ingredients used that contain carbohydrates. According to the DIY Provincial Food Security and Extension Agency (2012), tapioca flour has a carbohydrate content of 86.9 g in 100 g of ingredients. Moringa leaves contain carbohydrates as much as 12.5 g/100 g ingredients (Krisnadi, 2015), and white oyster mushrooms contain carbohydrates as much as 56.6% (Sumarni, 2006).

Carbohydrates in analog jerky with the addition of white oyster mushroom powder are calculated by difference so that they are influenced by other nutrients, namely water content, ash content, fat content, and protein content. This is following the opinion of Fatkurahman, Atmaka, and Basito (2012) which

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states that the carbohydrate content calculated by difference is influenced by water, ash, fat, and protein, so that the higher the content of other nutrients, the lower the carbohydrate content in the product. The lower the content of other nutrients, the higher the carbohydrate content.

Crude Fiber Content

Crude fiber is a food substance that cannot be hydrolyzed by certain chemicals such as sulfuric acid (H2SO4) and sodium hydroxide (NaOH) (Muchtadi, 2001). The analog jerky products in this study were tested for crude fiber content after the product was fried. The average value of crude fiber content analogous to jerky with the addition of white oyster mushroom powder can be seen in Table 8.

Table 8. The average value of crude fiber content of analog jerky

Treatment	Crude Fiber (%) ± SD	
A (Without the addition of white oyster mushroom powder)	5.77±0.76	a
B (Addition of 40% white oyster mushroom powder)	7.46 ± 1.32	b
C (Addition of 50% white oyster mushroom powder)	7.82±0.26	b
D (Addition of 60% white oyster mushroom powder)	8.14±1.29	b
KK = 12.15%		

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

The results of statistical tests of analog jerky products with the addition of white oyster mushroom powder gave a significant effect at the level of 5% on the crude fiber content of the analog jerky produced. The lowest value was obtained in treatment A (without the addition of white oyster mushroom powder) with an average value of 5.77% and the highest level in treatment D (60% addition of white oyster mushroom powder) with an average value of 8.14%. From the results of the study, it can be concluded that the addition of white oyster mushroom powder can increase the crude fiber content of the resulting analog jerky products. The high content of crude fiber is due to the high content of fiber in the raw material. According to Pade's research (2019), the crude fiber content of Moringa leaves ranges from 4.6-5.1%, while the crude fiber content of white oyster mushrooms is around 7.5-8.7% (Sumarni, 2006).

Components of crude fiber do not have nutrients, but these substances can play an important role in facilitating the human digestive process. According to Astawan and Wresdiyati (2004), crude fiber can prevent various diseases such as hemorrhoids, diverticulosis, and colon cancer. Therefore humans need to consume foods that contain fiber. According to Hardinsyah and Tambunan (2004), each person's fiber adequacy rate is different. Adults have an adequate number of fiber as much as 19-30 g/cap/day, while children have as much as 10-14 g/1000 cal. The high fiber content in the analog of Moringa leaf jerky with the addition of white oyster mushroom powder is expected to be able to meet the body's fiber adequacy rate so that it can prevent various diseases.

Peroxide Number of Fried Analog Jerky

Peroxide number is a parameter to determine the level of oil damage due to the oxidation process. The oxidation process occurs when fat or oil reacts with oxygen so that it can cause a change in the smell and aroma of food products to become rancid. In this study, the peroxide value was tested on fried analog jerky to determine the level of damage to analog jerky after being stored for 48 hours. The results of the analysis of the peroxide value of analog jerky products with the addition of white oyster mushroom powder can be seen in Table 9.

Table 9. Average Value of Analog Jerky Peroxide Numbers

Treatment	Peroxide Number (%) ± SD
A (Without the addition of white oyster mushroom powder)	-
B (Addition of 40% white oyster mushroom powder)	-
C (Addition of 50% white oyster mushroom powder)	-
D (Addition of 60% white oyster mushroom powder)	-
KK	

From Table 9. it is known that no peroxide value was detected in the analog of moringa leaf jerky with the addition of white oyster mushroom powder after being stored for 48 hours. This indicates that the oxidation process has not occurred during the storage of the fried jerky analog so that it is safe for consumption. The peroxide value in this study is following the research by Febri (2019) which tested the peroxide value of analog jerky after 24 hours and there was no peroxide value in the product. A food product is said to be unsafe for consumption if the peroxide value exceeds 100 meq/1000 gram and is characterized by the appearance of an unpleasant odor (Ketaren, 2005).

The oxidation reaction of fatty oils can be determined by the presence of the peroxide value of the oil. The more oxidation reactions occur, the more peroxide will be produced. The increasing amount of peroxide in food products results in poor product quality because it has been oxidized and damaged. This oxidation process will produce aldehydes and ketones, which are compounds that cause rancidity in oil (Sari et al., 2018).

According to Sari et al. (2018), the peroxide number can decrease with the addition of antioxidants. Antioxidants are compounds that can ward off free radicals so that they can slow down oxidation reactions caused by free radicals. In the manufacture of this analog beef jerky, raw materials containing antioxidants are used, namely, Moringa leaves and white oyster mushrooms. According to Krisnadi (2015), Moringa leaves have many compounds that act as natural antioxidants including vitamin A, vitamin C, vitamin E, chlorophyll, and polyphenols. According to Erga, et al. (2018), white oyster mushrooms contain antioxidant compounds such as phenolic compounds, ergotine, vitamin C, selenium, and beta-carotene. Phenolic compounds are the components with the greatest antioxidant activity in white oyster mushrooms.

The non-detection of peroxide value in the analog of Moringa leaf jerky with the addition of oyster mushroom powder was also due to the use of cooking oil to make beef jerky. The cooking oil used in the

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analog jerky frying in this study is oil that is still new and not used repeatedly so that the cooking oil absorbed in the product is still not oxidized. The absence of peroxide value in the jerky product after 48 hours indicates that the analog jerky product is still safe for consumption.

Free Fatty Acids Fried Jerky Analog

Free Fatty Acids (ALB) or free fatty acids (FFA) are fatty acids liberated from the hydrolysis of fats. According to Ketaren (2005), the hydrolysis reaction that causes the formation of free fatty acids is caused by the presence of a certain amount of water in the oil or fat. The results of the analysis of the free fatty acids of the analog of Moringa leaf jerky with the addition of white oyster mushroom powder can be seen in Table 10.

Table 10. Average Value of Free Fatty Acids

Treatment	Free Fatty Acids (%) ± SD
A (Without the addition of white oyster mushroom powder)	-
B (Addition of 40% white oyster mushroom powder)	-
C (Addition of 50% white oyster mushroom powder)	-
D (Addition of 60% white oyster mushroom powder)	-
KK	

In Table 10, it can be seen that no free fatty acids were detected in the analog jerky from Moringa leaves with the addition of white oyster mushroom powder after being stored for 48 hours. This is following Febri's research (2019) which tested the free fatty acids of analog jerky products after 24 hours and found no free fatty acids in analog jerky products. The absence of free fatty acids in the product indicates that the product is still safe for consumption after being stored for 48 hours.

The level of free fatty acids contained in a product can be one of the parameters determining the quality of products containing oil. The free fatty acids of a product are influenced by the amount of fat contained in the product. In this analog beef jerky product, the fat content after frying is quite high, namely 14.25-21.74%. However, the water content in this product is low so it does not trigger the hydrolysis reaction of the oil. The water and fat content contained in food products can cause hydrolysis to form free fatty acids (Rauf, 2015).

Another factor that affects the value of free fatty acids is the length of storage of the product. During storage, fats or oils will undergo physical and chemical changes caused by oxidation and hydrolysis processes. Storage for a long time and in an inappropriate way can trigger the breakdown of the triglyceride bonds in the oil to form glycerol and free fatty acids (Sutiah et al, 2008). Storage of this analog jerky product uses closed packaging to reduce the levels of fatty acids formed. In addition, the frying method used is deep fat frying, which uses a high temperature so that the evaporation process will take place faster. With this frying method, the shelf life of the product will be longer.

C. Physics Analysis

Yield

Yield calculation is intended to determine the percentage of the amount of analog jerky that can be consumed. Yield is important to be calculated to know the economic value and effectiveness of a product or material. According to Amiarso (2003), the higher the percentage of the product, the higher the economic value of the product. The analog jerky products in this study were weighed in total after the product was fried. The average value of the yield of this analog jerky can be seen in Table 11.

Table 11. Average Yield Value of Analog Jerky

Treatment	Yield (%) ± SD	
A (Without the addition of white oyster mushroom powder)	63.35±2.74	a
B (Addition of 40% white oyster mushroom powder)	67.09 ± 2.88	b
C (Addition of 50% white oyster mushroom powder)	68.02 ± 2.56	b
D (Addition of 60% white oyster mushroom powder)	68.87 ± 2.75	b
KK = 4.09%		

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

The results of statistical analysis of the yield of analog jerky products with the addition of white oyster mushroom powder showed that the addition of white oyster mushroom powder had a significant effect on 5% of the analog jerky yield. In Table 11. it is found that the average yield of moringa leaf jerky with the addition of white oyster mushroom powder is 63.35-68.87%. The lowest yield was in treatment A (without the addition of white oyster mushroom powder) while the highest was in treatment D (60% addition of white oyster mushroom powder). This shows that the more oyster mushroom powder added to the analog jerky dough, the higher the yield. The shrinkage in weight of analog jerky from raw materials into the dough to become analog jerky products that can be consumed is due to a reduction in water content such as during the oven and frying process. Of course, the higher the addition of oyster mushroom powder to the analog jerky dough, the more the weight of the beef jerky produced.

Hardness

The hardness value is one of the parameters of consumer acceptance of a product. According to Febri (2019), generally, the preferred analog jerky product is jerky which is crispy and easily broken. The analog beef jerky product that was tested for its hardness value in this study was an analog beef jerky product that had been fried. The average value of the hardness test can be seen in Table 12.

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Table 12. Average Hardness of Analog Kendeng

Treatment	Hardness (N/cm2) ± SD
C (Addition of 50% white oyster mushroom powder)	28.26± 6.21
B (Addition of 40% white oyster mushroom powder)	34.80 ± 9.07
D (Addition of 60% white oyster mushroom powder)	39.01±7.60
A (Without the addition of white oyster mushroom powder)	42.06±9.56
KK = 24.20%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

From Table 12, it was found that the highest average yield value was found in treatment A (without the addition of white oyster mushroom powder) at 42.06 N/cm2 and the lowest hardness value was in treatment C (50% addition of white oyster mushroom powder) with an average 28.26 N/cm2. Based on these results, it can be concluded that the addition of white oyster mushroom powder to the jerky analog of Moringa leaves has no significant effect at the 5% level on the hardness value of the resulting analog jerky.

Jerky analog with the addition of white oyster mushroom powder is made with a thickness of 0.3 cm. The hardness of the analog jerky is influenced by tapioca flour and white oyster mushroom powder which are added to the dough. In making this analog of moringa leaf jerky, tapioca flour is used as a raw material. Tapioca flour contains a lot of amylopectins which affect the developmental properties of a food product. During the steaming process, tapioca starch will undergo gelatinization so that the starch will bind to water in the environment. Gelatinization is the process of breaking bonds between starch molecules due to the presence of water and heat and allows starch molecules to absorb more water (Kartikasari, 2016). In the gelatinization process, the starch gel will undergo a dehydration process so that the gel forms a solid framework and causes the resulting texture to be hard. After that, a frying process is carried out which causes the water in the jerky product to decrease and causes air cavities so that the resulting analog jerky product becomes crispy. The more the addition of oyster mushroom powder to the analog jerky dough, the lower the tapioca content in the analog jerky, causing the texture of the analog jerky product to be crunchier.

The hardness of analog jerky products is also influenced by the crude fiber contained in the product. According to Intan (2004), the higher the crude fiber content in the product, the higher the hardness value of the product, and the lower the crude fiber content, the lower the hardness value. The crude fiber content of the product can be seen in Table 10. where the crude fiber content of treatment D is higher than treatment B and C, so it can be concluded that the more addition of white oyster mushroom powder, the crude fiber content of the product will increase it will affect the hardness of the product.

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D. Organoleptic Test

Organoleptic tests with hedonic methods need to be carried out to determine the quality of the product and the panelists' preference for the product to get an idea of when the product is marketed. The organoleptic test on the analog of moringa leaf jerky with the addition of white oyster mushroom powder was carried out by 20 panelists on the color, aroma, taste, and texture of the analog jerky product.

Color

The color organoleptic test was intended to determine the panelists' favorite color for the moringa leaf jerky product with the addition of white oyster mushroom powder produced. The average value of preference for analog jerky colors can be seen in Table 13.

Table 13. Average Organoleptic Value of Analog Jerky Color

Treatment	Color ± SD
A (Without the addition of white oyster mushroom powder)	3.20±1.00 a
B (Addition of 40% white oyster mushroom powder)	3.90±0.85 b
C (Addition of 50% white oyster mushroom powder)	3.90±0.85 b
D (Addition of 60% white oyster mushroom powder)	4.05±0.83 b
KK = 23.56%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

Based on statistical analysis, the results obtained for the color organoleptic, namely the addition of white oyster mushroom powder had a significant effect at the 5% level on the organoleptic color of the resulting analog jerky. From Table 13, it is known that the preference value for the color of analog jerky with the addition of white oyster mushroom powder is the highest in treatment D (addition of 60% white oyster mushroom powder) with an average of 4.05 (likes) with a blackish brown color. While the lowest value for color preference was treatment A (without the addition of white oyster mushroom powder) with an average value of 3.20 (ordinary).

The color of the jerky is analogous to the addition of white oyster mushroom powder is influenced by the browning reaction that occurs during processing. The browning reaction that occurs is the Maillard reaction between amino acids and reducing sugar from moringa leaf jerky and added oyster mushroom powder due to the frying process during processing. In the Maillard reaction, the carbonate group of glucose reacts with the nucleophilic amino group of protein to produce a distinctive color (brown) and aroma caused by melanoidin compounds (Winarno, 2004). Maillard reaction is what causes the color of the analog jerky to brown. In treatment A (without the addition of white oyster mushroom powder) a greenish color was still visible from the chlorophyll of Moringa leaves.

Aroma

The organoleptic test of aroma aims to determine the most preferred analog of jerky aroma by the panelists. The results of statistical analysis showed that the addition of white oyster mushroom powder to the analog jerky gave a significant effect at the level of 5% on the analog jerky aroma. The average value of the panelists' favorite aroma can be seen in Table 14.

Table 14. Average Organoleptic Value of the Aromatic Jerky Analog

Treatment	Aroma ± SD	
A (Without the addition of white oyster mushroom powder)	2.90±0.72	a
C (Addition of 50% white oyster mushroom powder)	3.75±0.64	b
B (Addition of 40% white oyster mushroom powder)	3.80±0.62	b
D (Addition of 60% white oyster mushroom powder)	3.90±0.55	b
KK = 24.71%		

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

Based on Table 14, the lowest preference value for aroma was treatment A (without the addition of white oyster mushroom powder), while the highest preference was in treatment D (60% addition of white oyster mushroom powder). From the results of the study, it can be concluded that the addition of white oyster mushroom powder can affect the increase in the aroma of jerky analogs produced.

The aroma of the jerky analog of Moringa leaves with the addition of white oyster mushroom powder is influenced by the volatile compounds contained in white oyster mushrooms. The volatile compounds found in white oyster mushrooms include 2-pentanone, 3-pentanone, 2-methyl-3-pentanol, 3-octanone, 1-octen-3-one, and 1-octen-3-ol. According to Surono et al.(2016), white oyster mushrooms have a distinctive aroma caused by the volatile compound 1-octen-3-ol, where the higher the percentage of white oyster mushrooms added, the sharper the aroma produced. The aroma of analog jerky produced is like beef jerky, coupled with the distinctive aroma of oyster mushrooms

The aroma produced by food products is one of the determinants of the delicacy of the food ingredients. The aroma can be formed because the protein is hydrolyzed into amino acids. Maillard reaction can also affect the aroma of food products due to the presence of melanoidin compounds. Protein and fat will also turn into precursors that can affect the aroma of the analog jerky. In addition, the added spices and seasonings also affect the aroma of analog jerky products.

Taste

Taste is an organoleptic attribute that is tested using the five senses of taste or tongue. The results of the analysis of moringa leaf analog jerky with the addition of white oyster mushroom powder gave no significant difference at the level of 5% to the analog jerky taste. The average value of preference for the taste of analog jerky with the addition of white oyster mushroom powder can be seen in Table 15.

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Table 15. Average Organoleptic Value of Analog Jerky Taste

Treatment	Taste ± SD	
A (Without the addition of white oyster mushroom powder)	3.10 ± 1.12	a
D (Addition of 60% white oyster mushroom powder)	3.35±0.81	ab
C (Addition of 50% white oyster mushroom powder)	3.70±0.92	ab
B (Addition of 40% white oyster mushroom powder)	3.95±0.76	b
KK = 27.29%		

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level

Based on the results of the study, the panelists stated that the most preferred taste was beef jerky in treatment B (addition of 40% white oyster mushroom powder) with an average value of 3.75 (like). The lowest panelist acceptance was in treatment A (without the addition of white oyster mushroom powder) with an average of 3.10 (usual). This shows that the jerky analog with the addition of white oyster mushroom powder is preferable to the jerky that is not added with white oyster mushroom powder.

The taste of jerky is analogous to the addition of white oyster mushroom powder which is influenced by glutamic acid (0.94% wt.) contained in white oyster mushrooms. The savory and delicious taste that arises because of this glutamic acid can increase the level of panelists' preference for the taste of moringa leaf analog jerky products. According to Surono et al. (2016), the protein contained in oyster mushrooms is rich in glutamic acid which can increase the taste of food. Therefore, the oyster mushroom powder is usually widely used as a flavoring dish. The taste of beef jerky is analogous to the addition of white oyster mushroom powder, which is almost similar to beef jerky, which is savory and delicious with the added oyster mushroom powder.

Texture

The desired analog jerky texture is savory and crunchy like dried beef jerky. This texture is influenced by the thickness of the resulting jerky. The results of testing the analog jerky texture of Moringa leaves with the addition of white oyster mushroom powder can be seen in Table 16.

Table 16. Average Organoleptic Value of Analog Jerky Texture

Treatment	Texture ± SD
A (Without the addition of white oyster mushroom powder)	3.80±1.15
B (Addition of 40% white oyster mushroom powder)	4.15±0.59
C (Addition of 50% white oyster mushroom powder)	4.00 ± 0.86
D (Addition of 60% white oyster mushroom powder)	3.85±0.74
KK : 21.93%	

The results of the analysis showed that there was no significant effect of adding the white oyster mushroom powder to the moringa leaf analog jerky which had been produced at a 5% significance level.

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Panelists stated that the highest preference was in treatment B (addition of 40% white oyster mushroom powder) with an average of 4.15 (like) and the lowest rating in treatment A (without the addition of white oyster mushroom powder) with an average of 3.80 (liked).). The texture that is created when biting the analog beef jerky is crispy, crumbly, and has fibers like dried beef jerky.

The analogous jerky texture of Moringa leaves with the addition of white oyster mushroom powder is influenced by the water content in the ingredients. The lower the water content of the product, the drier the product will be, causing the texture to be more crunchy. The more white oyster mushroom powder is added, the less water content in the dough. The water content will decrease after the frying process so that the product will be more crispy and tend to be hard like the texture of dry beef jerky.

The average organoleptic value of all tests (color, aroma, taste, and texture) on moringa leaf analog jerky with the addition of white oyster mushroom powder can be seen in Figure 1. below.

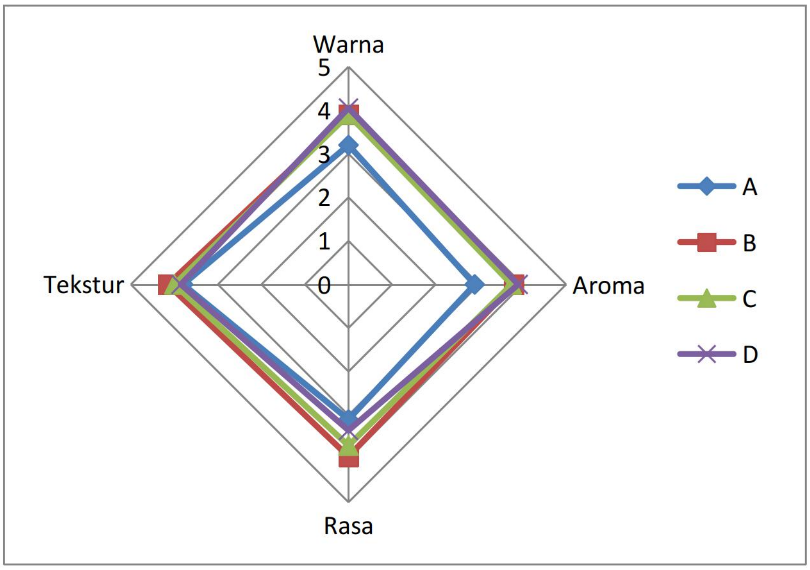

Figure 1. Analogs jerky organoleptic scoring radar chart

From the radar chart above, in general, the most preferred analog beef jerky by the panelists was analog beef jerky in treatment B with the addition of 40% white oyster mushroom powder. However, when viewed from the overall quality characteristics, the researcher concludes that the analog of moringa leaf jerky in treatment D (addition of 60% oyster mushroom powder) is still acceptable because, from the perspective of panelists acceptance of analog beef jerky in treatment D, they get a favorable rating in terms of color, aroma, and texture. while in terms of taste is quite ordinary.

The analogue of moringa leaf jerky with the addition of white oyster mushroom powder can be seen in Figure 2.

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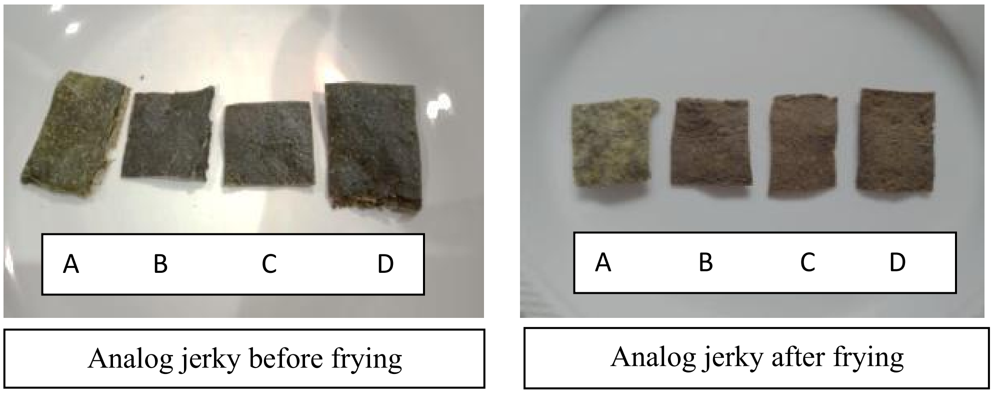

Figure 2. Analog Jerky

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the results of research that has been carried out, it can be concluded that

1) The organoleptic test showed that all the analog jerky treatments from Moringa leaves with the addition of white oyster mushroom powder were at the liking level by 20 panelists.

2) The difference in the comparison of the addition of white oyster mushroom powder has a significant effect at the level of 5% on the physical and chemical properties of the analog of Moringa beef jerky, including water content, ash content, fat content, protein content, crude fiber content, and analog jerky yield.

3) The comparison of the addition of white oyster mushroom powder to the best moringa leaf analog jerky according to chemical, physical, and organoleptic tests was found in treatment D (60% addition of white oyster mushroom powder), with an average value of 3.63% water content, 6 ash content, 38%, fat content 14.25%, protein content 15.01%, carbohydrate content 60.76%, crude fiber content 8.14%, yield 68.87%, hardness 39.01% and the average test value organoleptic color 4.05 (like), aroma 3.90 (like), taste 3.35 (regular), and texture 3.85 (like).

Suggestions

Suggestions from this study are to do research on the shelf life of analog jerky with the addition of white oyster mushroom powder to the best treatment (the addition of 60% white oyster mushroom powder) and research with shredded white oyster mushroom treatment so that the texture of analog jerky can resemble beef jerky.

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