

“Otak-Otak” Formulation of Skipjack Tuna (*Katsuwonus Pelamis*) and Moringa Leaves (*Moringa Oleifera*) as an Alternative Additional Feeding for Pregnant Women with Chronic Energy Deficiency

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ABSTRACT

Pregnant women with chronic energy deficiency are in a state of malnutrition, particularly in terms of energy and protein, that lasts for years. One of the causes is inadequate food intake, resulting in nutritional needs, especially energy, not being met daily. The effort to address the nutritional issue is through providing energy-dense and high-protein as an alternative additional feeding according to the nutritional needs of pregnant women, utilizing local foods such as skipjack tuna and moringa leaves. This study analyzes the nutritional quality, organoleptic quality, descriptive tests, and best treatment levels of Otak-Otak with a formulation of skipjack tuna (*Katsuwonus pelamis*) and moringa leaves as an alternative additional feeding for pregnant women with Chronic Energy Deficiency (CED). The type of experimental research with a Completely Randomized Design consists of 3 levels of treatment. The variables being studied are organoleptic quality (hedonic test) and nutritional value (Calculated Value). Next, the best treatment level is determined. The analysis of organoleptic data used the Kruskal-Wallis method with a confidence level of 95%. Skipjack tuna otak-otak with moringa leaves has a good level of preference (like-very much). The treatment levels only significantly affected the energy content and nutrient levels per serving (135 g), which met as an alternative additional feeding for pregnant women with Chronic Energy Deficiency (CED). The best formulation of skipjack tuna fish in treatment 3 (T3) provides a nutritional contribution to the as an alternative additional feeding standards for pregnant women according to the regulation of the Ministry of Health in 2023 with energy at 101%, protein at 129%, fat at 117%, and carbohydrates at 80%.

KEYWORDS: formulation, otak-otak, pregnant women, chronic energy deficiency (CED)

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I. INTRODUCTION

Chronic energy deficiency (CED) in pregnant women is a condition characterized by a lack of nutrition, particularly in energy and protein that persists for years. Characterized by Upper Arm Circumference (UAC) less than 23.5 cm or Body Mass Index (BMI) in the first trimester (gestational age ≤ 12 weeks) below 18.5 kg/m², indicating that the body lacks the fat and muscle reserves needed to support fetal growth.

In a book Nutrition through the Life Cycle by Judith E. Brown (2016), it discusses the causes of chronic energy deficiency (CED) in pregnant women, one of which is inadequate food intake, leading to nutritional needs, especially energy, not being met daily. This can result in fetal malformations, mothers giving birth to low birth weight

(LBW) babies, which one of the factors is contributing to stunting, anemia during pregnancy, bleeding, and neonatal death. The imbalance in the intake of energy and protein nutrients can lead to chronic energy deficiency.

One of the interventions that must be carried out for pregnant women with KEK is the fulfillment of nutritional intake, which can be done through the provision of as an alternative additional feeding (Mulyanti et al., 2023). Supplementary feeding can be provided with a high intake of energy and protein as well as a balanced diet (Al Rahmad AH, 2021). Energy plays a role in pregnant women for the development of the fetus, placenta, and the enhancement of bodily functions during pregnancy, while protein serves as an

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alternative energy source when carbohydrate and fat reserves are insufficient, as well as for building and repairing tissues.

Otak-otak is a food made from minced fish meat wrapped in banana leaves and then grilled or roasted (Wahyuningsih H, 2021). The simple and easy preparation methods and techniques led the researchers to choose otak-otak as an alternative additional feeding for pregnant women with chronic energy deficiency (CED), using locally sourced ingredients such as skipjack tuna and moringa leaves.

II. OBJECTIVE

The purpose of this research is to analyze the nutritional quality, organoleptic and descriptive properties, and determine the best treatment level in the formulation of skipjack tuna and moringa leaves as an alternative additional feeding for pregnant women with chronic energy deficiency (CED).

This research is expected to be beneficial as one of the alternatives for providing supplementary feeding or additional feeding using locally accepted and applicable food ingredients in the community, while also addressing the issue of pregnant women suffering from chronic energy deficiency in Indonesia.

III. MATERIAL AND METHOD

The material used in this research is Otak-otak. The formulation of otak-otak was carried out with 3 treatments. Each treatment has different proportions of skipjack tuna and moringa leaves. In treatment 1, skipjack tuna and moringa leaves (260:40) have a proportion of 60% skipjack tuna and 40% the highest proportion of moringa leaves. In treatment 2, skipjack tuna and moringa leaves (270:30) with a proportion of 70% skipjack tuna and 30% moringa leaves. In treatment 3, skipjack tuna and moringa leaves (280:20) have the highest proportion of 80% of all treatments for skipjack tuna and 20% for moringa leaves.

Skipjack tuna was chosen as the main ingredient for the dish because it has high nutritional value, including a protein content of 18.5 grams per 100 grams of skipjack tuna, tender meat fibers, easy to chew, readily available, affordable, and very suitable for various recipes, such as otak-otak, crackers, or shredded fish. It also has the potential for delicious flavors, making it popular among the public. The protein content in skipjack tuna plays an important role for pregnant women with chronic energy deficiency (CED) in fetal growth and supports the formation of the mother's body tissues, as well as helping to prevent energy deficiency because protein serves as an alternative energy source when carbohydrate and fat reserves are insufficient.

Then the selection of moringa leaves as an additive because they are rich in nutrients such as a source of beta-carotene (vitamin A), vitamin C, iron, and potassium (Hamzah et al., 2019). Moringa leaves are also easily found in the yards of people's homes and readily available in the

market, making them well-known to many people in Indonesia. The nutritional content of moringa leaves that is beneficial for pregnant women KEK like iron helps prevent anemia and increases hemoglobin formation, vitamin A plays a role in fetal eye development and boosts immunity, vitamin C helps with iron absorption and enhances the immune system.

The tools used in the making of skipjack tuna otak-otak are stainless steel bowls, cooper, digital scales, knives, plates, grilling tools, scissors, spoons, cutting boards, bowls, basins, spice blenders, frying pans, stoves, and spatulas.

The type of this research is an experiment with a Completely Randomized Design (CRD) with 3 levels of treatment for skipjack tuna fish cake formulations, repeated once. The research results were analyzed using IBM SPSS Statistics 22, specifically by conducting the Kruskal-Wallis test, analyzing the organoleptic quality of the fish cake, calculating the nutritional quality using the yield factor and retention factor for each treatment, and determining the best formulation treatment. The preference test assessment in this study used a 1-4 Likert scale, where score 1 means Very Dislike, score 2 Dislike, score 3 Like, and score 4 Very Like, based on the level of preference for colour, aroma, taste, and texture. This tool consists of individuals or groups called panelists who are tasked with evaluating the characteristics or quality of food based on subjective impressions. In this study, the panelists used were 30 semi-trained panelists who are students of the Malang Health Polytechnic Nutrition Department. This research was conducted in November 2024 at the UCR Laboratory of Malang Health Polytechnic Nutrition Department.

Formula Processing Procedures:

1. Perform the leaching process, which involves washing and soaking fish meat in a salt solution for 10 minutes, with a solution-to-fish ratio of 4:1. After that, it is ground using meat grinder until it is finely and evenly ground.
2. Wash the moringa leaves thoroughly, then steam blanch them at a temperature of 70-100°C. Then blend until smooth and even.
3. Blanch tempe (fermented soybean) for 10 minutes and blend until smooth
4. Mix coconut milk, egg whites, garlic, shallots, tapioca flour, cornstarch, green onions, salt, and ground pepper with the minced skipjack tuna, moringa leaves, and tempe
5. Place the dough on the cleaned banana leaves and wrap it neatly
6. Grill until cooked

IV. RESULTS

Energy and Nutritional Value of Each Treatment

The quantitative nutritional quality assessment is conducted by considering the empirical nutritional content

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using the Indonesian Food Composition Table (TKPI) based on the analysis of nutrients (energy, protein, fat, carbohydrates, and iron) in skipjack tuna otak-otak and moringa leaves using the Calculated Value method through the calculation of Yield Factor and Retention Factor.

Tabel 1. Nutritional Value of Otak-Otak per serving (135 gram)

Parameter	Nutritional Value of Otak-Otak per serving			
	T1	T2	T3	Regulation of the Ministry of Health in 2023
Energy (kkal)	257.83	258.66	259.30	255
Protein (gram)	14.29	14.61	14.91	11.5
Fat (gram)	11.06	11.12	11.17	9.5
Carbohydrate (gram)	25.27	25.04	24.78	30.87
Iron (gram)	1.69	1.67	1.62	-

Table description: T1 (Treatment 1), T2 (Treatment 2), T3 (Treatment 3)

Based on the results of the research conducted, it was found that the skipjack tuna and moringa leaves caused changes in energy content, namely an increase in energy value that rose along with the increase in the proportion of skipjack tuna and moringa leaves used. The increase in energy is more influenced by the ingredients used in the process of making otak-otak, which has a carbohydrate source, namely tapioca flour. Based on the Technical Guidelines for the Provision of As an alternative additional feeding Using Local Food Ingredients for Toddlers and Pregnant Women from the Ministry of Health of the Republic of Indonesia (2023), specifically for pregnant women with Chronic Energy Deficiency (CED), the energy requirement for one snack in a day on one serving is 255 kkal. The fulfillment of energy needs for one snacks in a day can be met with a recommended consumption of 1 serving, which weighs 135 grams.

The sources of high-fat food in the formulation of otak-otak are thick coconut milk, skipjack tuna, and tempe. The amount of fat content is influenced by the difference in the proportion of skipjack tuna in each treatment. The greater the proportion of skipjack tuna added, the higher the fat content of the otak-otak. Based on the research (Litaay et al, 2022), the more skipjack tuna meat is used in noodles, the higher the fat content of the noodles.

Based on the Technical Guidelines for Providing As an alternative additional feeding Made from Local Food for Toddlers and Pregnant Women from the Ministry of Health

of the Republic of Indonesia (2023), specifically for pregnant women with Chronic Energy Deficiency (CED), the fat requirement for a snack in one serving is 9.5 grams. The fulfillment of the fat requirement for snacks in a day can be met with a consumption recommendation of 1 serving, where each serving weighs 135 grams. The low intake of fat will result in a small LILA size (21-22 cm) and very low weight gain during pregnancy, even leading to weight loss.

Protein Quality Analysis

Assessment of protein quality consisting of SAA, Digestibility Quality, NPU, and BV. SAA shows the proportion of essential amino acids utilized by the body compared to those absorbed (Ningsih et al., 2024). Based on the content of essential amino acids, a protein in food can be assessed as either high or low in nutritional value. A protein is said to have high nutritional value if it contains essential amino acids in complete composition and in proportions that meet the body's needs, and these amino acids can be utilized by the body (available). From the results of the SAA calculation, it can also be determined that the main limiting amino acids at all treatment levels are Methionine and Cysteine. The limiting amino acid is the essential amino acid (EAA) that is present in the lowest amount compared to other EAAs (BPOM, 2019).

NPU is the comparison between the amount of nitrogen retained in the body and the amount of nitrogen consumed, so it can be calculated as the product of Biological Value and True Digestibility. NPU can illustrate how the protein consumed can be retained by the body (BPOM, 2019).

Table 2. Analysis Protein Quality of Skipjack Tuna Otak-Otak for Each Treatment

Treatment	Amino Acid Score	Theoretical Digestibility Quality	Net Protein Utilization (NPU)
T1	100	92.11	92.11
T2	100	92.36	92.36
T3	100	92.60	92.60

Table description: T1 (Treatment 1), T2 (Treatment 2), T3 (Treatment 3)

The chemical score is expressed with the lowest amino acid score. In this formulation calculation, the lowest amino acid score is tryptophan, so the value of tryptophan is used to determine the amino acid score for each treatment: treatment 1, treatment 2, and treatment 3. With each amino acid score being P1 165.1, P2 171.00, and P3 177.08, where the calculation results are above 100. This indicates that the limiting amino acids can meet the daily amino acid requirements. This is in line with the theoretical digestibility value of the Otak-otak formulation, which has high numbers with P1 for 92.11, P2 for 92.36, and P3 for 92.60.

In the product of skipjack tuna otak-otak, the NPU values for each treatment level were found to be in the range

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of 92.11-92.60. The biological value is one way to determine the quality of protein compared to the body's needs. This is because the SAA value > 100, so the NPU value is equal to the Theoretical Digestibility Quality value. Food with an NPU value of 70 or more is considered capable of promoting growth when consumed in sufficient quantities and with adequate energy intake. The calculation of an NPU value exceeding 70 means it can describe the quality of protein according to the body's needs.

Protein digestibility is the ability of protein to be hydrolyzed into amino acids by digestive enzymes. The digestibility of protein is the amount of nitrogen fraction from food that can be absorbed by digestive protease enzymes or by the body (Saputra, 2017). Digestibility quality indicates the portion of protein or amino acids that can be absorbed by the body compared to what is consumed. Thus, it can be said that approximately 92.11-92.60% AAE or protein found in the Otak-otak product can be digested by the body.

The advantage of skipjack tuna compared to other animal food sources is its richness in threonine (2.08-2.24 mg). This type of essential amino acid plays an important role in maintaining heart and liver health, enhancing the immune system and central nervous system functions in pregnant women, aiding in the synthesis of proteins necessary for the growth and development of fetal organs, including muscles, skin, and bones, and helping to produce mucus in the digestive tract that improves the absorption of nutrients critically needed for pregnant women experiencing chronic energy deficiency (CED).

Hedonic and Descriptive Analysis

Sensory testing is also known as organoleptic testing (Arziyah et al., 2022). The use of organoleptic tests is very important in assessing the quality and safety of food and beverage products. Human senses are the instruments used in organoleptic tests, which include sight, smell, taste, touch, and hearing (Ismanto, 2023). Sensory analysis is very important in food products; if the taste is not good, then its nutritional value cannot be utilized because no one will consume it (Muflihatin et al., 2020). The results of the organoleptic test of the skipjack tuna formula otak-otak are presented in Figure 1.

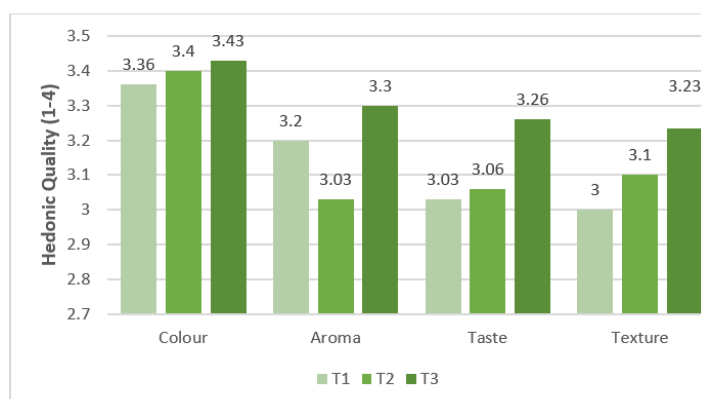


Figure 1. Hedonic Mean Result

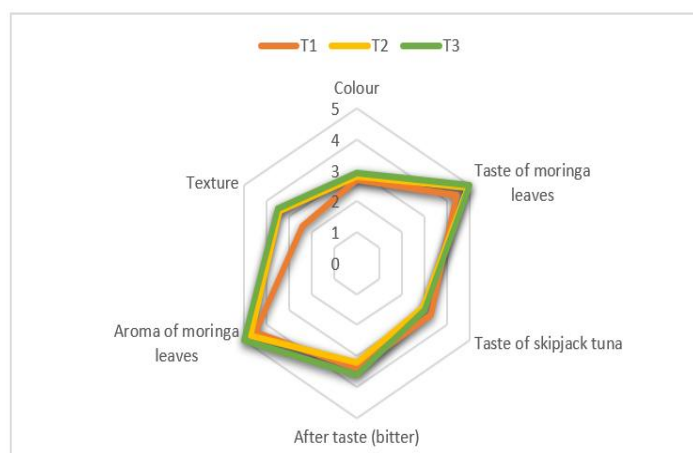


Figure description: T1 (Treatment 1), T2 (Treatment 2), T3 (Treatment 3)

A. Colour

Color is the first impression that appears and is judged by the panelists before recognizing other factors because it uses the sense of sight. An attractive color will entice panelists or consumers to taste the product (Lamusu, 2019). Based on the acceptance test results on the otak-otak formula in terms of color aspect, the highest score was found in treatment T3 with a formulation of skipjack tuna and moringa leaves (280:20) of 3.43 (liked). At the treatment T3, the color was dominated by the gray of the skipjack tuna and a slight green from the moringa leaves. According to Hadiwiyoto in Asy'ari et al. (2019), fish meat contains myoglobin protein which gives color to the fish meat, so during the heating process at high temperatures, the fish meat will undergo a color change. Color changes are also influenced by the use of tapioca flour, salt, and the added fish meat, as well as the cooking process (Talib, 2015). The results of the Kruskal-Wallis test showed no significant differences between the treatments T1, T2, and T3 ($P=0.843$) regarding the color aspect of the skipjack tuna and moringa leaves.

B. Aroma

The aroma released by food is a very strong attraction and can stimulate the sense of smell, thereby awakening the appetite. The emergence of food aromas is caused by the formation of volatile compounds as a result of enzymatic reactions or can also form without the aid of enzymatic reactions. Then, the aroma components are closely related to the concentration of those aroma components in the vapor phase in the mouth (Dewi A, 2022). The results of the Kruskal-Wallis test showed no significant differences between the treatments T1, T2, and T3 ($P=0.260$) regarding the aroma aspect of skipjack otak-otak and moringa leaves.

Based on the acceptance test results of the otak-otak formula in terms of aroma, the highest score was found in treatment level T3 with a formulation of skipjack tuna and moringa leaves (280:20) of 3.3 (like). This is influenced by the difference in the proportion of skipjack tuna and moringa leaves in each treatment of the otak-otak product. In T3, the

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use of moringa leaves is only 20%, so it does not produce a rancid aroma. Then, at the treatment T1 and T2, they still fall into the liked category with T2 (270:30) scoring 3.03 and T1 (260:40) scoring 3.2. The lower the addition of moringa leaf proportion, the less the otak-otak will have a rancid aroma. From the results, it is known that the more moringa leaves are added, the stronger the characteristic moringa aroma produced, which is caused by the lipooxygenase enzyme, an enzyme found in green vegetables (Dina P et al., 2023).

C. Taste

Taste can be determined by touch and oral stimulation. The texture and consistency of a substance will affect the flavor produced by that substance, and taste plays an important role in the quality of a food ingredient. Changes in the texture or viscosity of food ingredients can alter the resulting taste because they can affect the stimulation of olfactory receptor cells and salivary glands (Hasani, 2018). Based on the acceptance test results of the otak-otak formula in terms of taste, the highest score was found in treatment T3 with a formulation of skipjack tuna and moringa leaves (280:20), which was 3.26 (liked).

At the P3 treatment level, the use of moringa leaves is only 20%, so it does not cause a rancid taste. The rancid taste comes from antioxidant compounds such as saponins, tannins, and flavonoids (Dina P et al., 2023). The lower the addition of moringa leaf proportion, the less the otak-otak will have an off-flavor. Then, at the treatment T1 and T2, they still fall into the liked category with scores of T2 (270:30) being 3.06 and T1 (260:40) being 3.03. The results of the Kruskal-Wallis test showed no significant difference between the treatments T1, T2, and T3 ($P=0.369$) regarding the taste aspect of skipjack tuna otak-otak and moringa leaves.

D. Texture

Texture is the physical state of a food product that can be perceived by touching it. Usually, the tips of the fingers are used to determine the texture of a food ingredient. Texture includes dry, hard, smooth, rough, oily, and moist (Asy'ari et al., 2019). The results of the Kruskal-Wallis test showed no significant differences between the treatments T1, T2, and T3 ($P=0.364$) regarding the texture aspects of the skipjack tuna fish balls and moringa leaves.

Based on the acceptance test results on the otak-otak formula in terms of texture, the highest score was found in treatment T3 with a formulation of skipjack tuna and moringa leaves (280:20) of 3.23 (liked). The difference influences this in the proportion of skipjack tuna and moringa leaves in each treatment of the otak-otak product. In T3, the use of moringa leaves is only 20%, making it more preferred by the panelists because it has a chewier texture. According to Winarno (2008), fiber is a compound that can bind water, so during processing, the water bound to the fiber does not easily release, resulting in a texture that becomes less chewy. Furthermore, the texture of otak-otak is influenced by the

tapioca flour used as a filler in its preparation. This is supported by Alam A et al (2021) who state that tapioca flour contains amylose and amylopectin that easily absorb water and gelatinize due to the heating process, thereby affecting the texture of the dense and chewy otak-otak.

Best Treatment

Based on the table above, it can be concluded that the best treatment is T3 with a proportion of skipjack tuna and moringa leaves of 280:20, which has an energy content of 259.30 kcal, 14.91 grams of protein, 11.17 grams of fat, 24.78 grams of carbohydrates, and 1.62 mg of iron per 135 grams. Besides treatment T3 as the best treatment level, it is followed by treatment T2 and then T1. The treatment T3 has a grayish-green color, no rancid aroma, no rancid taste, and a slightly bitter and slightly fishy aftertaste.

CONCLUSIONS

The formulation of otak-otak from skipjack tuna and moringa leaves does not show significant differences in colour, aroma, taste, and texture. Otak-otak provides differences in energy value and macro-nutrient quality in each treatment. The best treatment was obtained based on the results of organoleptic tests, descriptive analysis, energy value, and nutrient quality, with the best results achieved in treatment 3 with a proportion of skipjack tuna and moringa leaves of 280:20.

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