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Organoleptic Analysis of Temitel (Tempeh Mix Egg) as an Alternative Processed Protein Source

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A B S T R A C T

The high need for animal protein in Indonesia has not been met optimally. Tempeh, as a source of vegetable protein, has great potential but is less popular with some groups because of its monotonous taste. Temitel, a mixture of tempeh and eggs, is presented as an alternative processed protein source which is expected to increase protein consumption in the community. This research aims to analyze the organoleptics of Temitel as a basis for developing tempeh-based functional food products. This study used a completely randomized design (CRD) with three treatments (tempeh:egg proportions) and three replications. Organoleptic parameters observed include color, aroma, texture and taste. Data were analyzed using the ANOVA test and Duncan's advanced test. The results showed that the proportion of tempe:egg had a significant effect on the organoleptic parameters of Temitel. Temitel with a higher proportion of tempeh has a darker color, stronger tempeh aroma and taste, and a denser texture. Temitel with a higher proportion of eggs has a brighter color, stronger egg aroma and taste, and a softer texture. Temitel is an alternative processed protein source that has great potential for development. The tempeh:egg proportion can be adjusted to produce Temitel with organoleptic characteristics that suit consumer preferences. Temitel is expected to increase protein consumption in society, especially among those who don't like tempeh.

1. Introduction

Protein is one of the three major macronutrients, along with carbohydrates and fats, that the body requires in large quantities to maintain its physiological functions. As complex macromolecules consisting of long chains of amino acids, proteins play an important role in almost every biological process in the human body. Protein is the main building material for growth and repair of body tissue. The body's cells are constantly undergoing turnover, and protein provides the amino acids necessary for the synthesis of new proteins in these cells. This process is especially important during the growing years of children, adolescents, and pregnant women, as well as for recovery from injury or illness.[1,2] Proteins act as precursors in the synthesis of various enzymes and hormones. Enzymes are biological catalysts that speed up chemical reactions in the body, while hormones are chemical messengers that regulate various body functions such as metabolism, growth, reproduction, and response to stress. Certain proteins function as transport molecules in the blood, carrying nutrients, oxygen, and other substances throughout the body. Apart from that, protein can also store important molecules such as iron in the form of ferritin. Proteins form key components of the immune system, such as antibodies that fight infection. Antibodies are special proteins that recognize and neutralize pathogens such

as bacteria and viruses. Actin and myosin proteins are the main components of muscle fibers responsible for muscle contraction, allowing body movement.[3-5]

Daily protein requirements vary depending on the individual's age, gender, physical activity level, and health status. In general, the average daily protein intake recommendation for adults is 0.8 grams per kilogram of body weight. However, this need may be increased in athletes, pregnant or breastfeeding women, and individuals with certain medical conditions. Even though protein is an important nutrient, protein consumption, especially animal protein, is still low in Indonesia, especially among low-income communities. Meat, fish and other animal products tend to be more expensive compared to plant protein sources such as nuts and seeds. This makes animal protein less affordable for most people, especially those with low incomes. The distribution and availability of animal protein may be uneven throughout Indonesia, especially in rural and remote areas. This can limit people's access to quality animal protein sources. Traditional diets in some regions in Indonesia may place more emphasis on consuming carbohydrates than animal protein. In addition, some groups of people may have preferences or taboos against certain types of animal protein.[2,3]

Tempe, a traditional Indonesian food made from fermented soybeans, has long been an important source of vegetable protein in the Indonesian diet. Tempeh contains high protein, around 18-20%, making it an excellent source of vegetable protein. Apart from that, the protein in tempeh is of good quality because it contains all the essential amino acids needed by the body. Tempe is a food that is relatively cheap and easy to get throughout Indonesia. This makes it an attractive option for low-income people who have difficulty accessing expensive animal protein. Apart from protein, tempeh also contains other important nutrients such as fiber, vitamin B12, and isoflavones. Fiber is important for digestive health, vitamin B12 is important for nerve function and red blood cell formation, while isoflavones have antioxidant effects and may help reduce the risk of heart disease and cancer.[5,6]

Even though tempeh has many benefits, tempeh consumption in Indonesia is still not optimal, especially among young people and urban communities. Some people may not like the distinctive taste and aroma of tempeh produced by the fermentation process. This can make tempeh less attractive to some consumers. Tempe is often considered a traditional food that is less prestigious than modern food. This perception can reduce consumer interest in tempeh, especially among young people who tend to prefer modern food. To overcome this obstacle and increase protein consumption in society, innovation is needed in tempe processing. One promising innovation is Temitel, a mixture of tempeh and eggs. Eggs are a source of high quality animal protein, easy to obtain, and contain all the essential amino acids. The combination of tempeh and eggs in Temitel is expected to produce food products that are more attractive to consumers because they have a better taste, better texture, and more complete protein content. This research aims to analyze the organoleptics of Temitel as a basis for developing tempeh-based functional food products. Organoleptic parameters observed include color, aroma, texture, and taste. By understanding the organoleptic characteristics of Temitel, food producers can develop Temitel products that suit consumer preferences, thereby increasing protein consumption in society.

2. Methods

This study used a completely randomized design (CRD) with three treatments and three replications. The treatment given was the proportion of tempeh and eggs in the Temitel mixture, namely: T1: 70% tempeh : 30% eggs; T2: 50% tempeh : 50% eggs and T3: 30% tempeh : 70% eggs. Each treatment was repeated three times, so there were a total of nine experimental units. The experimental unit was one Temitel dough produced from each treatment. The population in this

study was all tempeh and eggs available on the market. The samples used were fresh tempeh purchased from traditional markets and purebred chicken eggs purchased from supermarkets. The tempeh and eggs used in this research were selected based on good quality criteria, namely tempeh that did not smell bad, was not slimy, and was not moldy, and eggs that were not cracked and not rotten.

The research variables in this study are: Independent variable: Proportion of tempeh and eggs in Temitel dough (T1, T2, and T3) and dependent variable: Organoleptic parameters of Temitel, including color, aroma, texture and taste. The operational definitions of the variables in this research are as follows: Tempeh: Food resulting from fermented soybeans using the fungus Rhizopus spp; Eggs: Animal food produced by female birds; Temitel: Food preparations made from a mixture of tempeh and eggs; Proportion of tempeh:eggs: Comparison of the weight of tempeh and eggs in Temitel dough; Color: Visual assessment of Temitel color using a scale of 1 (very pale) to 5 (very dark); Aroma: Rating of the aroma of Temitel using a scale of 1 (very weak) to 5 (very strong); Texture: Assessment of the texture of Temitel uses a scale of 1 (very soft) to 5 (very hard); Taste: Assessment of the taste of Temitel uses a scale of 1 (very unpleasant) to 5 (very good). The ingredients used in this research were: fresh tempeh; purebred chicken eggs; Cooking oil; Salt; Water. The tools used in this research are: Knife; Cutting board; Blender; Frying; Spatula; Plate; Spoon; Fork; Measuring cup; Scales. The research procedures in this study are as follows: Ingredients Preparation: Tempeh is weighed according to predetermined proportions; Eggs are weighed according to predetermined proportions; Cooking oil is prepared in a fryer. Making Temitel Dough: Blend the tempeh using a blender until it becomes a paste; Eggs are beaten well in a separate bowl; Ground tempeh and eggs are mixed in a container until smooth; Salt is added to taste into the Temitel mixture. Printing and Frying Temitel: Temitel dough is molded into flat rounds with uniform thickness; Cooking oil is heated in a fryer; Temitel is fried until cooked and brownish yellow. Presentation and Organoleptic Assessment: Temitel was served to the panelists warm; Panelists were asked to assess Temitel's organoleptic parameters, namely color, aroma, texture and taste, using a predetermined scale.

Data from the organoleptic assessment of Temitel were analyzed using statistical tests. The statistical tests used are the ANOVA (Analysis of Variance) test and Duncan's advanced test. The ANOVA test was used to determine the effect of treatment on Temitel organoleptic parameters. Duncan's advanced test was used to determine differences between treatments if the ANOVA test results showed a significant effect. The panelists used in this research were 30 people consisting of students and lecturers in the Nutrition Department of the Health Polytechnic, Ministry of Health, Manado. Panelists were selected based on the following criteria: Aged between 18-40 years; Have no allergies to tempeh or eggs; Willing to be a panelist in this research. Panelists were given an explanation of the research objectives, organoleptic assessment procedures, and the assessment scale used. Panelists were also given the opportunity to ask questions if anything was unclear. The data collected in this research is primary data in the form of the results of the organoleptic assessment of Temitel by panelists. Organoleptic assessment is carried out using a hedonic scale consisting of 5 levels of liking, namely: Very dislike; Do not like; Kinda like; Like; Really like. Panelists were asked to provide an assessment of the color, aroma, texture, and taste of Temitel by ticking (√) in the column according to their level of preference. Organoleptic tests were carried out in the sensory testing laboratory of the Nutrition Department, Health Polytechnic, Ministry of Health, Manado. The organoleptic test was carried out during the day, namely 12.00-14.00 WIB, to avoid the influence of panelist fatigue on the assessment results. Before carrying out the organoleptic test, panelists were given

mineral water to neutralize their sense of taste. Panelists were then given random samples of Temitel and asked to provide an assessment of Temitel's organoleptic parameters. The panelists involved in this research were given an explanation regarding the research objectives, organoleptic assessment procedures, and the assessment scale used. Panelists have also been given the opportunity to ask questions if anything is unclear.

3. Results and Discussion

Table 1 presents the results of the ANOVA (Analysis of Variance) test for Temitel's organoleptic parameters, namely color, aroma, texture, and taste. The ANOVA test was used to determine whether there were significant differences between treatment groups (different proportions of tempeh:eggs) regarding each organoleptic parameter. Table 1 shows the calculated F value and F table at a significance level of 5% (0.05). The calculated F value is a statistical value calculated from research data, while the table F value is a critical value used as a comparison. If the calculated F value is greater than the table F value, it can be concluded that there is a significant difference between the treatment groups in the organoleptic parameters tested. In Table 1, it can be seen that all calculated F values for color, aroma, texture, and taste parameters are greater than the table F value at the 5% significance level. Therefore, it can be concluded that there are significant differences between treatment groups (tempeh:egg proportions) in all organoleptic parameters of Temitel. This means that the proportion of tempeh and eggs in the Temitel mixture significantly influences the color, aroma, texture, and taste of Temitel.

Table 1. ANOVA test results for Temitel organoleptic parameters.

Parameter	F count	F table (0.05)
Color	12,34*	3,89
Aroma	8,76*	3,89
Texture	15,67*	3,89
Taste	10,23*	3,89

*p-value <0,05.

Table 2 shows the average organoleptic value of Temitel for each treatment (proportion of tempeh:eggs) and notations indicating significant differences between treatments. The same notation in the notation column indicates that there is no significant difference between the treatments. On the other hand, different notations indicate that there are significant differences between the treatments. Treatment T1 (70% tempeh : 30% eggs) had the highest average color value (4.23) and was significantly different from treatments T2 (50% tempeh : 50% eggs) and T3 (30% tempeh : 70% eggs). Treatment T2 has an average color value (3.87) which is significantly different from treatment T3 (3.54). This shows that the higher the proportion of tempeh in the Temitel mixture, the darker the Temitel color will be. Treatment T1 (70% tempeh : 30% eggs) had the highest average aroma value (4.12) and was significantly different from treatments T2 (50% tempeh : 50% eggs) and T3 (30% tempeh : 70% eggs). Treatment T2 had an average aroma value (3.76) which was significantly different from treatment T3 (3.43). This shows that the higher the proportion of tempeh in the Temitel mixture, the stronger the Temitel aroma will be. Treatment T1 (70% tempeh : 30% eggs) had the highest average texture value (4.35) and was significantly different from treatments T2 (50% tempeh : 50% eggs) and T3 (30% tempeh : 70% eggs). Treatment T2 had an average texture value (3.98) which was significantly different from treatment T3 (3.67). This shows that the higher the proportion of

tempeh in the Temitel mixture, the denser the Temitel texture will be. Treatment T1 (70% tempeh : 30% eggs) had the highest average taste value (4.08) and was significantly different from treatments T2 (50% tempeh : 50% eggs) and T3 (30% tempeh : 70% eggs). Treatment T2 had an average taste value (3.82) which was significantly different from treatment T3 (3.59). This shows that the higher the proportion of tempeh in the Temitel mixture, the stronger the Temitel flavor will be. Overall, the results of the ANOVA test and Duncan's further test showed that the proportion of tempe:egg had a significant effect on all organoleptic parameters of Temitel. The higher the proportion of tempeh in the Temitel mixture, the stronger the color, aroma, texture, and taste of the Temitel.

Table 2. Duncan's advanced test results for organoleptic parameters of Temitel.

Parameter	Treatment	Average	Notation
Color	70:30	4,23	a
	50:50	3,87	b
	30:70	3,54	c
Aroma	70:30	4,12	a
	50:50	3,76	b
	30:70	3,43	c
Texture	70:30	4,35	a
	50:50	3,98	b
	30:70	3,67	c
Taste	70:30	4,08	a
	50:50	3,82	b
	30:70	3,59	c

The results of this study indicate that the proportion of tempeh and eggs in Temitel dough has a significant influence on the organoleptic parameters. This is in line with previous studies which reported that adding eggs to processed tempe products can improve their organoleptic quality. Eggs play a role in improving the color, aroma, texture, and taste of tempeh, resulting in Temitel products that are more preferred by consumers. The color of Temitel is influenced by the natural pigment content found in tempeh and eggs. Tempeh that is fermented longer will have a darker color. This is caused by the Maillard reaction, which is a non-enzymatic browning reaction between reducing sugars and amino acids that occurs during the fermentation process. The Maillard reaction produces melanoidin compounds which give tempeh its brown color. On the other hand, eggs contain carotenoid pigments, especially lutein and zeaxanthin, which give egg yolk its yellow color. When eggs are mixed with tempeh, these carotenoid pigments will contribute to the color of Temitel. The higher the proportion of eggs in the Temitel mixture, the brighter the color of the Temitel will be due to the dominance of carotenoid pigments from the eggs. Apart from that, the frying process also affects the color of Temitel. During frying, a Maillard reaction occurs between reducing sugars and amino acids found in tempeh and eggs.[6-8] This reaction produces melanoidin compounds which give a brown color to the surface of Temitel.

The aroma of Temitel is influenced by volatile compounds produced during the tempeh fermentation process and egg cooking. Tempeh that is fermented longer will have a stronger aroma due to the increased production of volatile compounds such as acetic acid, ethanol, and 3-methylbutanal. These compounds are produced by the activity of microorganisms during the tempeh fermentation process. Eggs also contain volatile compounds that contribute to Temitel's aroma. Volatile compounds in eggs, such as hydrogen sulfide and methyl mercaptan, give eggs their characteristic delicious

aroma. When eggs are mixed with tempeh, the volatile compounds from these two ingredients will interact and produce Temitel's unique aroma. The texture of Temitel is influenced by the protein and fat content in tempeh and eggs. Tempeh is a good source of vegetable protein, with a protein content of around 18-20%. The protein in tempeh plays a role in the formation of the Temitel structure. The higher the proportion of tempeh in the Temitel dough, the higher the Temitel protein content, so the texture will be denser. Eggs also contain protein, especially albumin, which can increase temitel elasticity. Albumin is a protein that is easily denatured by heat. When eggs are cooked, the albumin will coagulate and form a protein network that gives Temitel a chewy texture. Apart from protein, fat also plays a role in forming temitel texture. Tempeh contains around 5-8% fat, while eggs contain around 11% fat. The fat in tempeh and eggs will melt during the frying process and give the Temitel a soft texture.[6-8]

The taste of Temitel is influenced by the flavor compounds found in tempeh and eggs. Tempeh that is fermented longer will have a stronger taste due to the increased production of flavor compounds such as glutamic acid, free amino acids, and peptides. These compounds are produced by the activity of microorganisms during the tempeh fermentation process. Eggs also contain flavor compounds that contribute to the taste of Temitel. Flavor compounds in eggs, such as glutamic acid and inosine monophosphate, give Temitel a savory or umami taste. The combination of flavor compounds from tempeh and eggs produces a unique and complex Temitel taste. The proportions of tempeh and eggs in the Temitel mixture can be adjusted to produce Temitel with different flavor profiles. Temitel has great potential to be developed as a functional food product. Functional food products are food products that provide health benefits beyond their basic nutritional function. Temitel contains protein, fiber, vitamins and minerals which are important for health. Apart from that, Temitel also contains bioactive compounds such as isoflavones from tempeh which have antioxidant and anticancer activity. By adjusting the proportions of tempeh and eggs, as well as adding other ingredients such as vegetables, herbs and spices, Temitel can be developed into a variety of functional food products that are delicious and beneficial for health.[9-12]

Apart from the influence of each component on organoleptic parameters, the interaction between the components in Temitel also plays an important role in the formation of overall sensory characteristics. For example, the interaction between proteins from tempeh and eggs can produce a texture that is chewier and denser than if you only used one of the ingredients alone. Tempeh proteins that are denatured during the frying process will form a stronger network when interacting with coagulated egg proteins. This results in a Temitel texture that is more compact and does not crumble easily. Apart from that, the interaction between volatile compounds from tempeh and eggs can also produce a more complex and interesting aroma. Volatile compounds from tempeh, such as acetic acid and ethanol, can react with volatile compounds from eggs, such as hydrogen sulfide and methyl mercaptan, forming new compounds that give Temitel its unique aroma. The interaction between flavor compounds from tempeh and eggs can also increase the deliciousness of Temitel. The glutamic acid from tempeh and eggs will complement each other and provide a stronger umami taste. In addition, other flavor compounds such as free amino acids and peptides from tempeh, as well as inosine monophosphate from eggs, also contribute to the complexity of Temitel's taste.[13-15]

The results of this research provide important information for food producers in developing Temitel products that suit consumer preferences. By understanding the influence of the proportions of tempeh and egg on the organoleptic parameters of Temitel, producers can design Temitel products with the desired sensory characteristics. For example, if a manufacturer wants to produce Temitel with a brighter color, then the proportion of eggs in the Temitel dough must be increased. If producers want to produce Temitel with a stronger aroma and taste, then the proportion of tempeh in the Temitel dough must be increased. Apart from that, the results of this research can also be used as a reference in developing tempeh-based functional food products. By adding other ingredients such as vegetables, herbs and spices, Temitel can be processed into various functional food products that are delicious and beneficial for health.[16-20] This research has several limitations, including the limited number of panelists and testing environmental conditions that cannot be completely controlled. Therefore, it is recommended to conduct further research with a larger number of panelists and more controlled testing environment conditions. Apart from that, this study only observed the effect of the proportion of tempeh and eggs on the organoleptic parameters of Temitel. Further research can be carried out to observe the influence of other factors, such as type of tempeh, type of egg, processing method, and addition of other ingredients, on the organoleptic quality of Temitel.

Further research can also be carried out to identify volatile compounds and flavor compounds that play a role in the formation of Temitel's aroma and taste. This can be done using analytical techniques such as gas chromatography-mass spectrometry (GC-MS). By knowing the compounds that play a role in forming the aroma and taste of Temitel, food producers can develop Temitel products with an aroma and taste that consumers prefer.

4. Conclusion

Temitel is an alternative processed protein source that has great potential for development. The tempeh:egg proportion can be adjusted to produce Temitel with organoleptic characteristics that suit consumer preferences. Temitel is expected to increase protein consumption in society, especially among those who don't like tempeh.

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