
Proximate Analysis of Tempeh Nuggets with the Addition of Oyster Mushroom (*Pleurotus ostreatus*)

Siti Nurlani Harahap¹, Lily Novianty^{2*}, Dewi Novina Sukapiring³

¹Faculty of Health Sciences ^{2,3}Faculty of Agriculture, Nahdlatul Ulama University, North Sumatra

e-mail: *lilynovianty2710@gmail.com

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Abstract

Basic human needs include nutritional needs. There are an increasing number of new and high-quality foods that perform optimally for human activities. Currently consumers prioritize food that is practical and easy to consume, one of which is nuggets. The popular nuggets is chicken nuggets which have a high fat content and cholesterol which is harmful for health. Currently there are developments of high-fiber nugget innovations through the optimization of tempeh and oyster mushrooms. This study aims to analyze the proximate to determine the water content, protein content, carbohydrate content, fat content, and ash content in tempeh nuggets with the addition of oyster mushrooms. The method in this study uses an experimental method carried out in the laboratory by analyzing the water content, carbohydrate content, fat content, ash content, and protein content of the nuggets. Based on the research that has been conducted, the average results of the highest water content of tempeh nuggets combined with oyster mushrooms is in the S3 treatment (51.75%), protein content in the S3 treatment (13.747%), fat content in the S2 treatment (13.69%), ash content in the S1 treatment (6.057%) and carbohydrate content in the S1 treatment (27.113%).

Keywords: *proximate analysis, nutrition, fat, carbohydrates, protein*

1. Introduction

Tempeh is one of the favorite foods in Indonesia. This is in line with BPS data (2024) which reported tempeh consumption of 0.140 kg/capita per week in 2022 and increased to 0.143 kg/capita per week in 2023. Tempeh has now been widely processed into various forms of food, both as the main ingredient and as a food additive, one of which has been processed into nuggets. Nuggets are usually processed products made from ground beef and then seasoned, flour as a binder, then molded into a certain shape, steamed, cut, smeared with flour liquid, and covered with breadcrumbs on the outside (Ariyanti et al., 2022).

Nuggets with tempeh-based ingredients known as tempeh nuggets, have been extensively researched. As reported by Astawan et al., (2014), they conducted a study on tempeh nuggets with several composition formulas and reported that panelists prefer tempeh made from soybeans of variety B formula 1, which is made from a composition of 73% tempeh, tapioca 4%, wheat 4%, sago flour 4%, egg white 8%, and spices as much as 7% based on 100g of raw materials. In addition

to tempeh, oyster mushrooms are also widely reported to be processed into various foods, one of which is a nugget additive.

Oyster mushrooms (*Pleurotus ostreatus*) in Indonesia are the most widely produced mushrooms in Indonesia, followed by merang mushrooms and other mushrooms. Based on BPS data (2024), which reports that oyster mushroom production in Indonesia in 2023 is 59,260 tons, while the production of merang mushrooms is 4,723 tons and other mushrooms are 2,653. Oyster mushrooms have been widely reported as a basic ingredient or additional ingredient for making nuggets, as reported by Sumantri et al., (2015), namely the use of tempeh with oyster mushrooms in making nuggets. Oyster mushrooms have almost the same texture as meat, so they are suitable as a substitute for meat nuggets. Tempeh nuggets with the addition of oyster mushrooms have also been reported to be used as an alternative to meat-based nuggets (Harahap et al., 2023).

Oyster mushrooms have a high protein content, which ranges between 10.5% and 30.4%, as well as a low content of vitamins, minerals, and fats. Therefore, oyster mushrooms are safe to be consumed by people who have cholesterol or lipid metabolism disorders (Pratama, 2013). Based on previous research, Suprihartini et al. (2022) reported the effect of the addition of tempeh and the moisture content of oyster mushroom nuggets by knowing the results of the organoleptic test, and the highest moisture content was in the P2 treatment (15% addition of tempeh) with a value of 37.25%. Oyster mushrooms have many nutritional benefits, with a dry protein content of 30.45% and an unsaturated fat content of 0.33% and 2.3% fresh, respectively. Therefore, oyster mushrooms have a lower amount of fat than nuggets.

Based on previous research, Harahap et al. (2023) reported organoleptic tests on the taste, texture, aroma, fragility, and color of tempeh nuggets with the addition of oyster mushrooms. with the highest level of preference is the P2 treatment (nuggets with a 50% tempeh formula and 50% oyster mushrooms), and the P2 product is the best formulation of tempeh nuggets compared to other treatments. After the organoleptic test, there needs to be novelty in this study. By conducting further research, it is necessary to carry out a proximate analysis test of tempeh nuggets with the addition of oyster mushrooms so that it is suitable for marketing later. The results of the research by Sumantri et al. (2015) reported the difference in the formula for making nuggets, with this study concluding that the results of chemical analysis and organoleptic assessment showed that the combination of tempeh nuggets with 5% oyster mushrooms TJ1 (95% tempeh and 5% oyster tamur) was the best of the four treatments.

The proximate analysis test is an analysis to find out the content of carbohydrates, proteins, water content, ash content, and fat content in a food ingredient. Research on proximate analysis tests on various food ingredients has been widely reported, such as the proximate analysis of jeruju leaf crackers (Harahap, et al., 2023). Sari et al. (2021) have reported the results of the chemical analysis test of banana nuggets. Keliat et al. (2018) also conducted a proximate analysis test on sulfur kale chips. Therefore, it is necessary to conduct proximate analysis research to determine the content of carbohydrates, protein content, water content, fat content, and ash content in tempeh nuggets with the addition of oyster mushrooms. The purpose of this study is to find out the percentage of water content, carbohydrates, proteins, and ash content in tempeh nuggets with the addition of oyster mushrooms.

2. Methods

The method in this study is an experimental method with four stages of treatment. This experiment involves making oyster mushroom tempeh nuggets with various amounts of treatment using raw

materials in the form of oyster mushrooms and tempeh. This research was carried out in February 2024 and was carried out at the Basic Laboratory of Nahdlatul Ulama University of North Sumatra and the Laboratory of Agricultural Product Technology of the University of Muhammadiyah North Sumatra.

Tools and Materials

The tools used in this study are knives, stoves, baking pans, blenders, basins, steamers, storage containers, and spoons. Meanwhile, the materials used in this study are oyster mushrooms, tempeh, eggs, wheat flour, garlic, gas, cooking oil, tapioca flour, pepper, salt, sugar, celery leaves, prey leaves, butter, and water.

Research Procedure

A. Making Tempeh Nuggets

In this study, tempeh nuggets are made using the main raw materials, namely tempeh and oyster mushrooms. As for the formulation of tempeh nuggets with the addition of oyster mushrooms, there are four treatments, namely:

S1 treatment with formula 100 % tempeh : 0 % oyster mushroom

S2 treatment with formula 75% tempeh : 25% oyster mushroom

S3 treatment with formula 50% tempeh : 50% oyster mushroom

S4 treatment with formula 25% tempeh : 75% oyster mushroom

The making of nuggets in this study refers to Alfiana (2014), which has been modified. The process begins with steaming tempeh and oyster mushrooms for 5 minutes, then letting them sit for a few moments, drained and mashed. Then the 10% garlic is puréed. Wash and cut into small pieces 1.5% celery leaves and 1.5% prey onions. The ingredients are mixed together, and 25% tapioca flour is added to it, along with 25% wheat flour, 5% sugar, 3% salt, and 1% pepper powder. The percentage of ingredients needed to make nuggets in this study refers to each treatment (S1, S2, S3, and S4). The amount of ingredients used in each treatment in this study was consistent. Prepare a round baking sheet that has been evenly greased with butter. After all the ingredients are well mixed, the dough is poured into the pan. Then steam for 15 minutes. Once the level of doneness is confirmed, the tempeh nuggets are removed and cooled at room temperature for \pm 5 minutes. Once cooled, the nuggets are ready to be cut into pieces and dipped in wheat flour that has been dissolved with water and sprinkled with breadcrumbs. Once done, the tempeh nuggets are stored in the freezer for 12 hours (Harahap et al., 2023).

Proximate Analysis of the Tempeh Nuggets

The analysis was carried out to determine the chemical properties of tempeh nuggets including water content, ash content, fat content, protein content, and carbohydrate content.

Water Content Testing

The water content analysis procedure starts with an empty cup being dried in the oven for 15 minutes, cooled in a desiccator, and then weighed. A sample of 5 grams is weighed, which has been homogenized in a dish. The dish containing the sample is then heated in an oven at a temperature of 100–105 °C for +3 hours and then cooled in a desiccator for 30 minutes. The dish containing the sample is then weighed, and the weight is recorded. It is repeated three times, with the time of each drying being 1 hour, until it obtains a fixed weight (Alfiana, 2017).

Protein Content Testing

The sample to be analyzed was put into a test tube as much as 2 mL, then 5 mL of biurete reagent was added, homogenized, and incubated at a temperature of 37 °C for 10 minutes. The color change that occurred was observed, and then its absorption was measured at a wavelength of 540 nm using spectrophotometry.

Fat Content Testing

The fat content measurement starts with filter paper inserted into the desiccator for 30 minutes, then weighed (A gram). A total of 2 g of samples were weighed on filter paper (B grams). Then the filter paper and material are ovened at a temperature of 60 °C for 24 hours and weighed (C grams). Then the lead containing the sample was put into a filter flask (soxhlet tool) and given 150 mL of petroleum ether solvent, which was then extracted for more than 4 hours. The squash is then dried in the oven at 105 °C for 1 hour. Then it is weighed and recorded (Yuliani, 2017). Then it was extracted with *petloreum benzene* solvent for 4 hours using a soxhlet. Then dry the sample for 24 hours at 60 °C and weigh it until the weight remains (D grams).

Ash Content Testing

The measurement of the ash content of tempeh nuggets is carried out using a prepared ash cup, then burned in a kiln (100–105 °C) for 15 minutes, then cooled in a desiccant and weighed, then weighed as much as 5 grams of sample into the cup, then burned in a gas burner (kiln) at a temperature of 600 °C for +5 hours (until the smoke disappears), then the cup is weighed again, and the weight is recorded (Yuliani, 2017).

Carbohydrate Content Measurement

Determination of carbohydrate content is carried out by reducing 100% of the total components of protein content, fat content, ash content, and water content, or by using the by difference method as follows (Novianti, 2021):

$$\text{Carbohydrates (\%)} = 100\% - (\text{water content} + \text{protein content} + \text{fat content} + \text{ash content}) \%$$

3. Result and Discussion

The proximate analysis carried out in this study includes water content analysis, protein content analysis, fat content analysis, ash content analysis, and carbohydrate content analysis. The following results of the proximate analysis obtained in this study can be shown in the Table 1 below:

Table 1 Proximate Content of Tempeh Nuggets

Treatment	Proximate				
	Water (%)	Proteins (%)	Fats (%)	Ashes (%)	Carbohydrate (%)
S1	42,57	13,41	10,85	6,057	27,113
S2	47,92	12,260	13,69	3,790	22,34
S3	51,75	13,747	8,93	5,630	19,943
S4	47,42	13,139	9,41	3,347	26,684

Information:

S1 = Tempeh nuggets with a formulation of 100% tempeh and 0% oyster mushrooms

S2 = Tempeh nuggets with a formulation of 75% tempeh and 25% oyster mushrooms

S3 = Tempeh nuggets with a formulation of 50% tempeh and 50% oyster mushrooms

S4 = Tempeh nuggets with a formulation of 25% tempeh and 75% oyster mushrooms

Water Content

The average water content produced in four treatments with 3 replicates was in the S1 treatment (100% tempeh control or formula with 0% mushroom combination), S2 treatment (75% tempeh formula with 25% mushroom combination), S3 treatment (50% tempeh formula with 50% mushroom combination), and S4 treatment (25% tempeh formula with 75% mushroom combination), which was 42.57%, 47.92%, 51.75%, and 47.42%. The average water content can be seen in Figure 1 as follows:

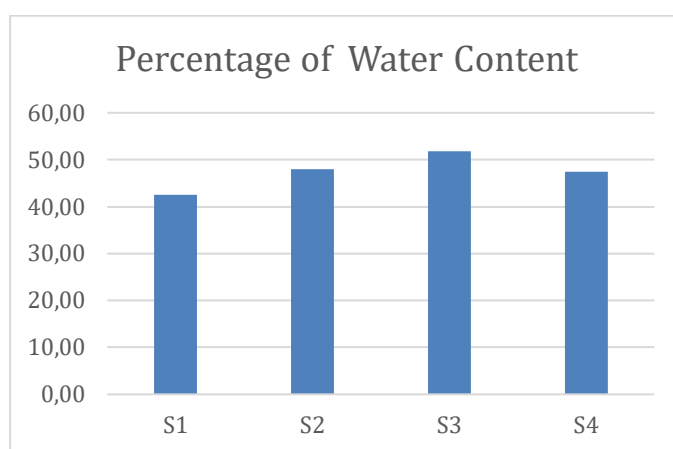


Figure 1. Graph of Water Content in Samples

From Figure 1, it can be seen that the highest water content was obtained in the S3 treatment (50% tempeh addition formula with 50% mushroom combination), which was 51.75% with a standard deviation of 3.47. The lowest water content was obtained in the S1 treatment or control, which was 42.57% with a standard deviation of 1.67.

The water content of tempeh is greater than the water content of chicken meat. The water content of tempeh is 68.3%, and the water content of chicken meat is 55.9%. The maximum water content of chicken nuggets, according to SNI 01-6683-2002, is 60% (Shanti, 2020). The average water content of tempeh nuggets in the study above ranged from 42.57% to 51.75%. This means that the water content of tempeh nuggets combined with mushrooms in this study has met the SNI 01-6683-2002 quality standard.

According to research conducted by Fitriyani et al. (2024) in the formulation study of tempeh nuggets with the addition of ear mushrooms and carrots, the average water content research results were obtained, ranging from 57.30% to 62.06%. The water content in this study met the SNI quality standards for combination chicken nuggets, which have been set at a maximum value of 60%. The amount of mushroom and carrot composition added to the tempeh nugget affects the amount of water content. If more ear mushroom and carrot composition is added to the tempeh nugget, the water content of the tempeh nuggets also increases.

Protein Content

The average protein content obtained from the four treatments was in the S1 treatment (100% tempeh control or formula with 0% mushroom combination), S2 treatment (75% tempeh addition formula with 25% mushroom combination), S3 treatment (50% tempeh addition formula with 50% mushroom combination), and S4 treatment (25% tempeh plus formula with 75% mushroom combination), which was 13.41%, 12,260%, 13,747%, and 13,139%. The average protein content can be seen in Figure 2 as follows:

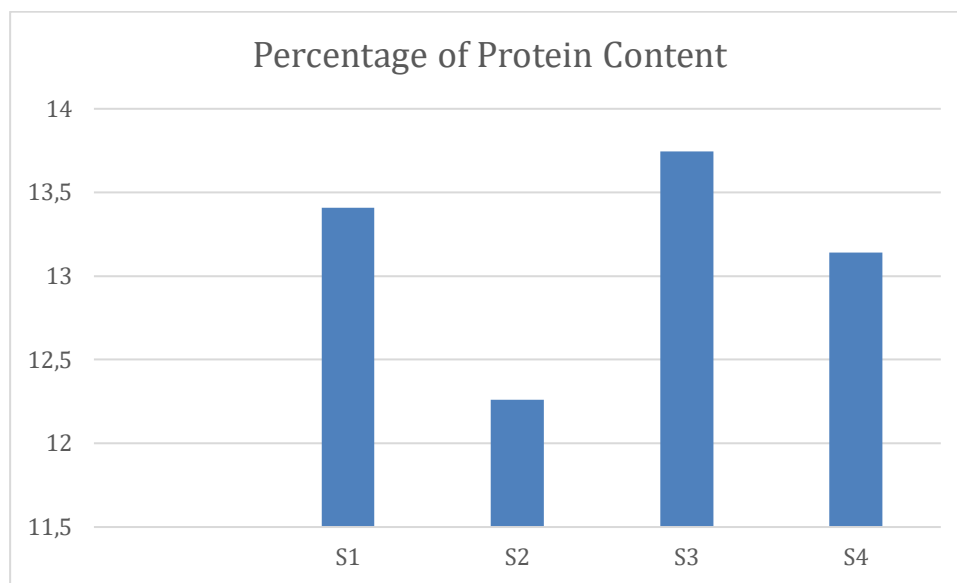


Figure 2. Graph of Protein Content in Samples

From Figure 2, it can be seen that the highest protein content was obtained in the S3 treatment (50% tempeh addition formula with 50% mushroom combination), which was 13.747%. The lowest protein content was obtained in the S4 treatment (25% tempeh addition formula with 75% mushroom combination), which was 13.139%.

Based on SNI 01-6683-2002, the protein content of chicken nuggets is at least 12% (Pujilestari, 2020). In the results of the study, the protein levels in treatments 1–4 ranged from 12,260% to 13,747%. This means that the protein content of tempeh nuggets combined with oyster mushrooms in this study has met the SNI 01-6683-2002 quality standard.

The protein content in nugget products is influenced by the type and content of protein raw materials and the supplies used (Hafid, 2017). According to Haryani (2014), an important component in making nuggets is the binding material, an example of a binding agent added in the making of nuggets is flour. The benefits of binding materials in making nuggets are to increase the binding power of the nuggets, increase the taste, and give the nuggets a bright color. In this tempeh nuggets research, wheat flour and tapioca flour are used in making tempeh nuggets. Wheat flour has a high protein content, this is because wheat flour contains gluten, which provides the necessary binding properties. There was no significant difference in the treatment of soybean tempeh using flour binding agents, namely tapioca flour, cornstarch, and wheat flour, resulting in a result of 21.76%, 22.40%, and 23.70%. The highest protein content is indicated by tempeh nuggets using wheat flour binding agents.

Fat Content

The average fat content obtained from four treatments was in the S1 treatment (100% tempeh control or formula with 0% mushroom combination), S2 treatment (75% tempeh addition formula with 25% mushroom combination), S3 treatment (50% tempeh addition formula with 50% mushroom combination), and S4 treatment (25% tempeh plus formula with 75% mushroom combination), which was 10.85%, 13.69%, 8.93%, and 9.41%, respectively. The average fat content can be seen in Figure 3 as follows:

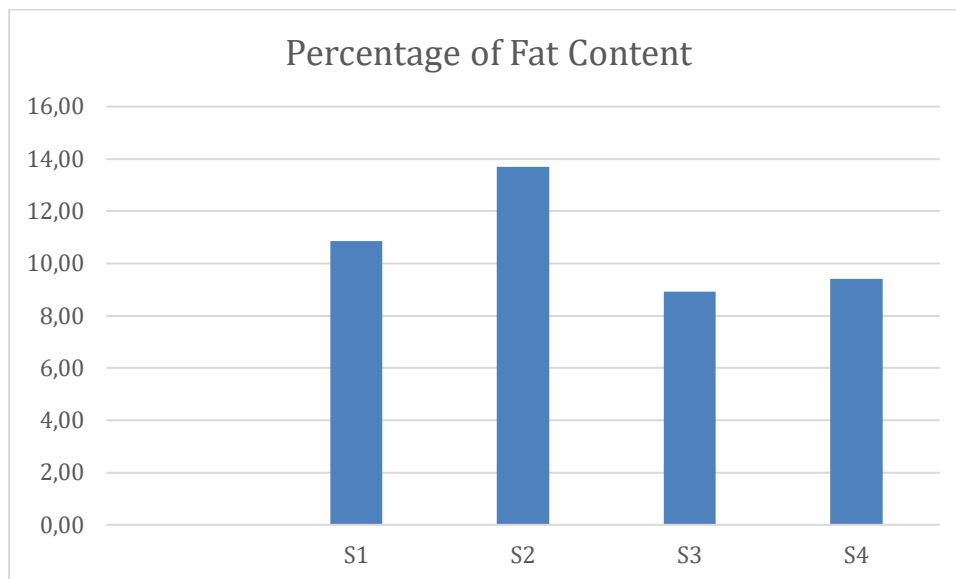


Figure 3 Graph of Fat Content in Samples

From Figure 3, it can be seen that the highest fat content was obtained in the S2 treatment (75% tempeh addition formula with 25% mushroom combination), which was 13.69%. The lowest fat content was obtained in the S3 treatment (formula for adding 50% tempeh with 50% mushroom combination), which was 8.93%.

The fat content, according to the SNI 01-6683-2002 quality standard, is less than 20% (Rahmah, 2018). In the results of the above study, the fat content of the 4 treatments above ranged from 8.93% to 13.69%, which means that the results of the research on the four treatments above have met the SNI 01-6683-2002 quality standard.

The more flour is added, the fat content tends to increase. The increase in fat content also tends to be affected by other ingredients such as cooking oil during the processing process (Rahmah, 2018). Tempeh is a good source of plant-based protein and is low in fat, but the fat content in tempeh can change depending on the additives used in the manufacturing process. For example, if tempeh nuggets are fried in oil, they will have a slightly higher fat content. According to Fitriyani et al. (2024), the average fat content obtained in his research ranged from 16.08% to 21.27%. The fat content decreases with the increasing amount of ear mushroom and carrot composition added to tempeh nuggets. This is also the same as the results of research conducted by Rahman and Dwiani (2020), which state that the more oyster mushrooms are added to the nuggets, the lower the fat

content of the nuggets. The results of Hasanah et al. (2020), also said that the more proportions of tempeh are added, the greater the fat content.

Ash Content

The average ash content obtained from the four treatments was 6.057% in the S1 treatment (100% tempeh control or formula with 0% mushroom combination), 3.790% in S2 treatment (75% tempeh formula with 25% mushroom combination), 5.630% in S3 treatment (50% tempeh formula with 50% mushroom combination), and S4 treatment (25% tempeh formula with 75% mushroom combination), which was 3.347%. The average ash content can be seen in Figure 4 as follows:

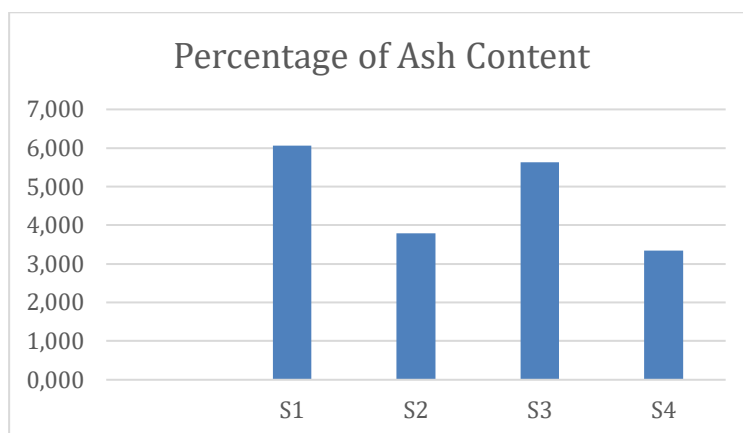


Figure 4. Graph of Ash Content in Samples

From Figure 4, it can be seen that the highest average ash content was obtained in the S1 treatment (100% tempeh addition formula with 0% mushroom combination), which was 6.057%. The lowest fat content was obtained in the S4 treatment (25% tempeh addition formula with 75% mushroom combination), which was 3.347%.

Ash content is influenced by the minerals contained in the raw materials and the fillers used. The more flour formulations are added to the making of tempeh nuggets, the higher the ash content produced in tempeh nuggets (Arbie, 2019).

The results in Fitriyani et al. (2024) showed the average ash content in the study was 1.32% to 1.18%. This shows that the average ash content decreases with the increasing number of ear mushrooms and carrots added to the tempeh nuggets. Sumantri et al. (2014) also said that the fewer oyster mushrooms are added to the tempeh nuggets, the higher the ash content of the tempeh nuggets. According to Wibowo et al. (2014), the ash content of the nuggets increases if the carrots added are less and more tempeh is added in the making of tempeh nuggets.

Carbohydrate Content

The average carbohydrate content obtained from the four treatments was 27.113% in the S1 treatment (100% tempeh formula with 0% mushroom combination), 22.34% in the S2 treatment (75% tempeh formula with 25% mushroom combination), 19.943% in the S3 treatment (50% tempeh formula with 50% mushroom combination), and 26.684% in the S4 treatment (25% tempeh formula with 75% mushroom combination). The average carbohydrate content can be seen in Figure 5 as follows:

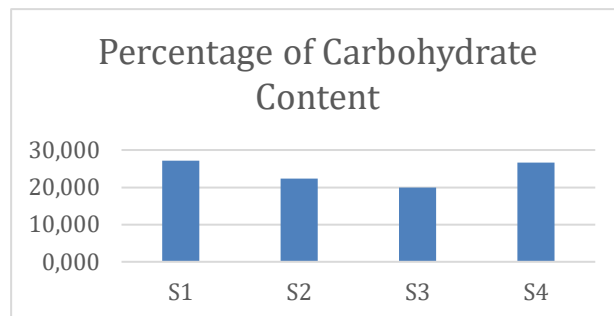


Figure 5. Graph of Carbohydrate Content in Samples

From Figure 5, it can be seen that the highest average carbohydrate content was obtained in the S1 treatment (100% tempeh addition formula with 0% mushroom combination), which was 27.113%. The lowest average carbohydrate content was obtained in the S3 treatment (50% tempeh addition formula with 50% mushroom combination), which was 19.943%.

The carbohydrate content based on the SNI 01-6683-2002 quality standard is a maximum of 25% (Rahmah, 2018). Based on the results of the research obtained, only two treatments had carbohydrate levels in accordance with the SNI 01-6683-2002 quality standard, namely S2 and S3 treatments, while the other two treatments did not meet the requirements of the SNI 01-6683-2002 quality standard.

The carbohydrate content in tempeh nuggets comes from the flour used, which is a source of carbohydrates. Flour has a carbohydrate content of 88.2% (Pujilestari, 2020). Making tempeh nuggets using binding materials such as wheat flour can increase the carbohydrate content of the tempeh nuggets. Flour is a type of complex carbohydrate that has a long chain of carbohydrates. The carbohydrate content of wheat flour is lower than the carbohydrate content found in tapioca flour (Amertaningtyas et al., 2021).

The determination of carbohydrate content in this study was done using the carbohydrate difference method. According to Syadiah et al. (2022), the carbohydrate by difference analysis method is a reduction of the 100% with total protein content, water content, fat content, and ash content so that higher carbohydrate content results are obtained.

4. Conclusion

Based on the results of the study, it can be concluded that tempeh nuggets with the addition of oyster mushrooms (*Pleurotus ostreatus*) have water content, protein content, fat content, and ash content in accordance with SNI 01-6683-2022. For the carbohydrate content, only S2 and S3 samples are in accordance with SNI 01-6683-2022.

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