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STUDY OF THE EFFECT OF TOFU DUMP AND OKRA FLOUR SUBSTITUTION ON THE CONTENT OF PROTEIN, FIBER, FAT, CARBOHYDRATE AND ORGANOLEPTIC PROPERTIES OF CHICKEN NUGGET

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Abstract

The use of alternative plant-based food ingredients in processed meat products has the potential to increase nutritional value while diversifying raw materials . This study aims to analyze the effect of tofu dregs and okra flour substitution on the chemical and organoleptic characteristics of chicken nuggets and determine the best formulation based on effectiveness testing. The study was conducted as a laboratory experiment using a Completely Randomized Design (CRD) with four levels of substitution of tofu dregs and okra flour (0%, 25%, 50%, and 75%), each repeated three times. The chemical parameters analyzed included protein (Kjeldahl), fat (Soxhlet), fiber (gravimetric), and carbohydrate (by difference) levels . Organoleptic tests were conducted using the hedonic method by 20 trained panelists on color, aroma, taste, and texture attributes. Chemical data were analyzed using ANOVA at the 5% level and further tests, while organoleptic data were analyzed using the Friedman test. The results showed that the substitution of tofu dregs and okra flour significantly affected the chemical and organoleptic characteristics of chicken nuggets. Increasing the substitution level significantly increased protein and fiber levels and decreased fat and carbohydrate levels, but decreased the level of panelist acceptance of sensory attributes. Based on the effectiveness test, the treatment with the highest substitution showed the best total effectiveness value due to the superiority of nutritional parameters, although the control treatment had the highest organoleptic acceptance. Thus, the substitution of tofu dregs and okra flour has the potential to be used to increase the nutritional value of chicken nuggets, while still paying attention to formulation optimization to maintain the sensory quality of the product.

Keywords : chicken nuggets, tofu dregs, okra flour, chemical characteristics, organoleptic

INTRODUCTION

Chicken nuggets are a form of innovative processed meat product developed as an alternative to chicken meat processing with a longer shelf life and practical serving. Nuggets are defined as processed products made from ground chicken that have been separated from the coarse fibers, seasoned, molded, cooked, and frozen with the addition of permitted food additives (Syaiful & Utami, 2020). The quality characteristics of chicken nuggets refer to SNI 01-6638-2002, which stipulates a maximum water content of 60%, a minimum protein content of 12%, a maximum fat content of 20%, a maximum carbohydrate content of 25%, and a maximum calcium content of 30%. Nida Ul Haq et al. (2025) reported that organoleptic is a method of evaluating product quality based on sensory responses such as taste, aroma, texture, color, and appearance. This assessment is conducted by trained panelists or consumers to assess product preferences and acceptance. This testing is important in the food industry to understand consumer perceptions, support product development, quality improvement, and quality control.

Tofu dregs are a byproduct of the tofu production process that still contain quite high nutritional value, but their use as a food ingredient is still limited and is generally used as animal feed. In fact, in 100 g of dry matter, tofu dregs contain 4.1% protein, 2.1% fat, and 10.7% carbohydrates (Directorate of Nutrition, Ministry of Health of the Republic of Indonesia, 2017). In addition, tofu dregs also contain crude protein and dietary fiber, although they have a relatively high water content , requiring further processing to stabilize and add value (Yustina, 2012). Okra (*Abelmoschus esculentus*) is known to have a fairly complete nutritional content, including vitamins C and E, protein, carbohydrates, fiber, and minerals such as calcium, iron, and magnesium. The addition of okra to food products has been reported to increase fiber content and provide functional properties as a natural thickener (Rini

et al., 2021). Therefore, the combination of tofu dregs and okra flour has the potential to be used in chicken nugget formulations to improve the nutritional quality and product characteristics. Tofu dregs act as a source of protein and vegetable fiber, while okra flour functions as a source of soluble fiber and a natural thickening agent that can improve the texture of nuggets (Sari, 2020). Although previous studies have proven the potential of tofu dregs and okra separately in food products, studies that combine the two simultaneously in chicken nugget products, especially in *frozen food form* , are still limited. In addition, the effect of variations in the proportion of tofu dregs and okra flour on the chemical and organoleptic quality of chicken nuggets and their compliance with the SNI 01-6638-2002 standard has not been widely reported. Therefore, research is needed that systematically examines the effect of tofu dregs and okra flour substitution on the chemical and organoleptic quality of chicken nuggets in order to obtain an optimal formulation that has higher nutritional value and remains acceptable to consumers.

LITERATURE REVIEW

Chicken Nuggets as a Processed Food Product

Chicken nuggets are a processed meat-based food product made from ground chicken mixed with binders, spices, and other additional ingredients, then shaped, coated, and cooked. Chicken nuggets are popular among various groups because they have a distinctive taste, soft texture, and are easy to serve. This product falls into the processed food category, the nutritional value of which is greatly influenced by the composition of the ingredients and processing techniques (Lawrie & Ledward, 2021). In general, chicken nuggets have a relatively high protein content, but their dietary fiber content is relatively low. Therefore, developing chicken nuggets with the addition of plant-based ingredients is one strategy to improve the nutritional quality of the product, especially in terms of fiber and vegetable protein content. Several recent studies have shown that substituting plant-based ingredients in nugget products can improve the nutritional profile without significantly reducing sensory quality when used at the right levels (Putri et al., 2021; Rahmawati & Huda, 2023).

Tofu Dregs as a Food Substitute

Tofu dregs are a byproduct of the tofu-making process that still contain significant nutrients, particularly protein, dietary fiber, and carbohydrates. Tofu dregs are often considered waste, yet nutritionally they still have significant potential as a substitute ingredient in processed food products. The protein content of tofu dregs is reported to range between 20–30% (dry basis), while the crude fiber content is relatively high compared to conventional fillers (Widowati et al., 2020). The use of tofu dregs as a substitute ingredient in chicken nuggets has been widely studied in recent years. Research shows that adding tofu dregs can increase the protein and fiber content of the product, while reducing the fat content as the proportion of substitution increases. However, excessively high substitution levels can affect the organoleptic properties, particularly the texture and aroma of the product (Sari et al., 2021; Hidayat et al., 2022).

In addition to increasing nutritional value, the use of tofu dregs also contributes to the concept of *zero waste* and food sustainability, making it relevant to the development of locally resource-based and environmentally friendly food products (Utami & Pratama, 2023).

Okra Flour as a Functional Ingredient

Okra (*Abelmoschus esculentus L.*) is a horticultural crop known for its high fiber, vitamins, minerals, and bioactive compounds such as flavonoids and polyphenols. Okra is often categorized as a functional food due to its potential health benefits, including helping control blood sugar levels and improving digestive health (Kumar et al., 2021). Processing okra into flour aims to extend its shelf life and facilitate its application in various food products. Okra flour has a high soluble fiber content and natural hydrocolloid properties that can act as a water binder and texture former in processed meat products. Research shows that the addition of okra flour to processed products can increase dietary fiber content and affect the physical and sensory characteristics of the product (Aminah et al., 2022; Ningsih et al., 2023). As a functional ingredient, okra flour has the potential to increase the health value of chicken nuggets while providing positive effects on product texture and stability, especially in formulations with combinations of other plant-based ingredients.

Combination of Tofu Dregs and Okra Flour in Chicken Nuggets

The combination of tofu dregs and okra flour in chicken nugget formulation is an innovative approach to improving the nutritional quality of products through the use of local plant-based ingredients. Tofu dregs serve as a source of protein and insoluble fiber, while okra flour contributes soluble fiber and bioactive compounds. The

synergy of these two ingredients is expected to produce chicken nuggets with a more balanced nutritional profile than conventional nuggets. Several studies have shown that using a combination of plant-based ingredients in nugget products can significantly increase protein and fiber content, while modifying the product's fat and carbohydrate content . However, proper formulation is essential to ensure that sensory characteristics such as taste, aroma, color, and texture remain acceptable to consumers (Prakoso et al., 2021; Lestari & Yuliana, 2024). This approach is in line with the trend of developing functional food products and high-value-added processed foods that are not only oriented towards taste, but also towards health and sustainability aspects.

Chemical and Organoleptic Quality Test of Chicken Nuggets

Chemical quality testing is a crucial step in evaluating the quality of chicken nuggets, including analysis of protein, fiber, fat, and carbohydrate levels . This analysis aims to determine changes in nutritional composition due to the addition or substitution of certain ingredients. The commonly used method is proximate analysis according to AOAC standards, which is widely applied in meat-based processed food research (AOAC, 2020; Susanto et al., 2022). Apart from chemical quality, organoleptic testing is the main parameter in determining the level of consumer acceptance of chicken nugget products. This test usually includes assessment of color, aroma, taste, texture, and overall liking by the panelists. The results of organoleptic tests are greatly influenced by the type and proportion of substitute ingredients used. Recent studies have shown that moderate substitution of plant-based ingredients is still sensory acceptable and even improves certain characteristics of nugget products (Rahman et al., 2021; Dewi et al., 2023).

RESEARCH METHODS

This research was conducted for three months, namely from October 2025 to January 2026, at the Food Processing Laboratory, Faculty of Food Technology and Fisheries, Dr. Soetomo University Surabaya. The tools used in this study include analytical scales, drying ovens, desiccators, Soxhlet extraction apparatus, Kjeldahl distillation, UV-Vis spectrophotometer or colorimeter, water bath, centrifuge, pH meter, digital thermometer, and laboratory glassware such as flasks, porcelain cups, measuring cylinders, volume pipettes, micropipettes, funnels, and filter paper. Research materials consist of main materials and supporting materials. The main ingredients used are tofu dregs and okra flour, while the supporting ingredients include chicken, tapioca flour, salt, pepper, garlic, chicken powder, and egg white. Chemicals used in the analysis include distilled water, n-hexane or petroleum ether, Fehling or Luff-Schoorl reagent, acid and base solutions, anhydrous $MgSO_4$ or $CaCl_2$, and other proximate analysis support materials.

This study used a laboratory experiment method with a Completely Randomized Design (CRD) consisting of four treatments of okra flour and tofu dregs substitution for tapioca flour and chicken meat, namely 0%, 25%, 50%, and 75%. Each treatment was repeated three times to obtain 12 experimental units with a total dough of 205 grams for each treatment. The research implementation stages include the production of okra flour and chicken nuggets. Okra flour is made through a drying process using an oven at a temperature of 50°C for 7 hours , then ground and sieved using a 60-mesh sieve. The nugget production process is carried out by weighing the ingredients according to the formulation, mixing until homogeneous, molding, steaming at a temperature of 100°C for 25 minutes, cooling, cutting, coating, and frying until golden yellow.

The observed variables included protein content using the Kjeldahl method, fat content using the Soxhlet method, fiber content using the gravimetric method, and carbohydrate content using the by-difference method, which refers to SNI 01-2891-1992. Organoleptic testing was conducted using the hedonic method, involving 20 trained panelists to assess the color, aroma, taste, and texture of the product. Chemical data were analyzed through normality and homogeneity tests, then continued with an ANOVA test at a significance level of 5%. If there is a significant difference, further BNJ, BNT, or DMRT tests are carried out according to the coefficient of diversity value. Organoleptic data was analyzed using the Friedman test, while the determination of the best treatment was carried out using an effectiveness test.

RESULTS AND DISCUSSION

1. Chemical Test

Protein Content

Analysis of the protein content of chicken nuggets due to the substitution of tofu dregs and okra flour in various treatments. The discussion focuses on changes in protein content as a result of the characteristics of the substituted ingredients and their interactions with the main ingredients, along with statistical analysis to determine differences between treatments.

Table 1. Chicken Nugget Protein Content Test Results

Treatment Code	Test			Average (%)
	1	2	3	
A0	9.10	8.98	8.72	$8.93^{a} \pm 0.19$
A1	10:34	10:46	10.64	$10.48^{b} \pm 0.15$
A2	11.23	11.11	11.32	$11.22^{c} \pm 0.11$
A3	13.12	13.60	13.50	$13.41^{d} \pm 0.25$

content test of chicken nuggets showed an increase along with the increasing substitution level of tofu dregs and okra flour. The control treatment (A0) had the lowest average protein content of 8.93 % ± 0.19, while treatment A3 produced the highest protein content of 13.41% ± 0.25. Duncan's further test at the 5% level showed significant differences between all treatments, indicating that the substitution of tofu dregs and okra flour had a significant effect on increasing the protein content of chicken nuggets. The increase in protein content is related to the relatively high vegetable protein content in tofu dregs and the contribution of protein and functional compounds from okra flour. The resulting protein content meets the requirements of SNI 01-6683-2002 with a minimum limit of 12%. These results are supported by Sadiah et al. (2025) , who reported that the use of tofu dregs in processed meat products significantly increased protein content , and Widya and Rosiana (2020) , who stated that the addition of fibrous plant materials such as okra also contributes protein and improves the nutritional quality of the product. Thus, the substitution of tofu dregs and okra flour has the potential to increase the protein value of chicken nuggets, especially at high substitution levels, so that it can be used as an alternative plant-based ingredient to produce products with better nutritional quality.

Fat Content

Test results of the fat content of chicken nuggets produced from a combination of tofu dregs and okra flour substitution treatments. The discussion focuses on explaining the effect of ingredient composition on fat content and its implications for product quality.

Table 2. Fat Content Test Results for Chicken Nuggets

Treatment Code	Test			Average (%)
	1	2	3	
A0	9.79	9.84	9.72	$9.78^{a} \pm 0.06$
A1	7.29	8.02	7.40	$7.57^{b} \pm 0.39$
A2	7.78	7.82	8.50	$8.03^{b} \pm 0.4$
A3	9.39	8.43	9.37	$9.06^{a} \pm 0.55$

Based on Table 2, the results of the chicken nugget fat content test showed variations between treatments due to the substitution of tofu dregs and okra flour. The control treatment (A0) had a fat content of 9.78 % ± 0.06 and was not significantly different from treatment A3 at 9.06% ± 0.55. In contrast, treatments A1 and A2 produced lower fat content, at 7.57 % ± 0.39 and 8.03% ± 0.40, respectively , and were significantly different from A0 and A3. The reduction in fat content is related to the relatively high dietary fiber content in tofu dregs and okra flour, as well as the low fat content of the ingredients, thus reducing the fat fraction in the product matrix during processing. Dietary fiber plays a role in increasing water binding capacity and forming a gel structure that limits fat retention. All treatments still meet the requirements of SNI 01-6683-2002 with a maximum fat content limit of 20%. These results are supported by Kurniawati et al. (2021) who reported that the addition of fibrous plant materials to chicken nugget products significantly reduced fat content due to the formation of a fiber-protein matrix that inhibits fat binding. Furthermore, Anwar et al. (2023) stated that substituting some meat ingredients with low-fat plant ingredients effectively reduces the fat content of processed products without reducing consumer acceptance.

Thus, the use of tofu dregs and okra flour at certain levels has the potential to improve the nutritional quality of chicken nuggets by reducing fat content .

Fiber Content

The effect of tofu dregs and okra flour on the fiber content of chicken nuggets was investigated. This discussion aims to determine the increase in fiber content due to ingredient substitution and its relationship to the product's functional characteristics.

Table 3. Chicken Nugget Fiber Content Test Results

Treatment Code	Test			Average (%)
	1	2	3	
A0	3.03	3.01	3.34	$3.13^{a} \pm 0.19$
A1	3.39	3.28	3.48	$3.38^{a} \pm 0.1$
A2	3.51	3.86	3.97	$3.78^{b} \pm 0.24$
A3	4.41	4.45	4.36	$4.41^{c} \pm 0.05$

Based on Table 3, the analysis results show that the substitution of tofu dregs and okra flour significantly affected the fiber content of chicken nuggets, as indicated by the difference in letter notation in the mean value. Treatment A3 produced the highest fiber content of 4.41 % , while treatment A0 showed the lowest fiber content of 3.13%. Treatments A0 and A1 were not significantly different, but both were significantly different compared to treatments A2 and A3. The increase in fiber content is related to the increased proportion of tofu dregs and okra flour and the reduced use of tapioca flour and chicken, which are low in fiber. Tofu dregs and okra flour serve as the primary sources of fiber due to their relatively high dietary fiber content. This is supported by Mawati et al. (2017), who stated that soy- and okra-based ingredients are rich in dietary fiber, which can increase the fiber content and functional properties of processed products. Therefore, increasing the substitution rate of tofu dregs and okra flour has been shown to be effective in significantly increasing the fiber content of chicken nuggets.

Carbohydrate Content

Results of an analysis of the carbohydrate content of chicken nuggets as a result of varying ingredient substitution treatments. Changes in carbohydrate content were analyzed based on differences in ingredient composition and their contribution to the product's nutritional value.

Table 4. Chicken Nugget Carbohydrate Content Test Results

Treatment Code	Test			Average (%)
	1	2	3	
A0	40.08	40.17	40.22	$40.16^{a} \pm 0.07$
A1	40.98	40.24	40.48	$40.57^{a} \pm 0.38$
A2	39.42	39.21	38.29	$38.97^{b} \pm 0.6$
A3	35.08	35.53	34.77	$35.13^{c} \pm 0.38$

Based on Table 4, the substitution of tofu dregs and okra flour significantly affected the carbohydrate content of chicken nuggets, as indicated by the difference in letter notation in the mean value. Treatments A0 and A1 were not significantly different, while treatments A2 and A3 were significantly different from the other treatments. The highest carbohydrate content was obtained in treatment A0 at 40.16 % , while the lowest value was found in treatment A3 at 35.13%. The decrease in carbohydrate content with increasing proportions of tofu dregs and okra flour indicates that reducing the use of tapioca flour, as the main source of carbohydrates, directly affects the carbohydrate composition of the product. These results are in line with the research of Wulansari and Haslina (nd) which stated that tapioca flour has a very high carbohydrate content compared to fibrous plant materials. However, this study shows a difference compared to Adhiwono et al. (2024), where the reduction in carbohydrates is not only influenced by the reduction of starchy materials, but also by the increase in fiber content from tofu dregs and okra flour which causes a decrease in carbohydrate levels by *difference* . Thus, the substitution of tofu dregs and okra flour in this study not only reduces the carbohydrate content of chicken nuggets, but also improves the functional nutritional quality of the product by increasing fiber content.

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2. Organoleptic Test

The results of the organoleptic test of chicken nuggets include color, aroma, texture, and taste. The discussion was directed at assessing the level of panelist acceptance of chicken nugget products resulting from the substitution of tofu dregs and okra flour in various treatments.

Color

The results of the color assessment of chicken nuggets as one of the initial parameters for consumer acceptance. The discussion focused on the effect of tofu dregs and okra flour substitution on the color change of chicken nuggets based on panelists' preference levels.

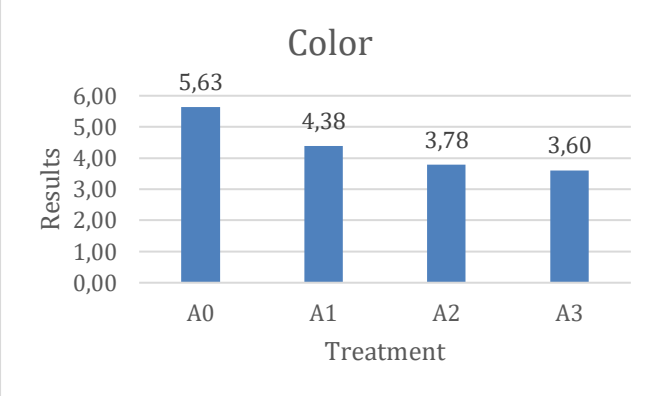

Figure 1. Organoleptic Histogram of Chicken Nugget Color

The results of the organoleptic color test showed that the panelists' level of preference for chicken nuggets decreased with increasing substitution of tofu dregs and okra flour. Treatment A0 obtained the highest value of 5.63 , while the preference value decreased successively in treatments A1 (4.38), A2 (3.78), and the lowest in A3 (3.60). This decrease indicates that increasing the proportion of substitution ingredients affects the visual appearance of chicken nuggets and reduces panelists' acceptance of the product color. The decrease in preference is related to the natural color of tofu dregs and okra flour which tends to be darker or greenish, thus changing the final color of the chicken nuggets. In addition, heating during processing can enhance non-enzymatic browning reactions, especially in formulations with higher plant-based ingredients. These results are in line with research by Septian et al. (2025) which reported that the use of plant-based fiber materials can reduce the level of color preference in processed meat products. Pramesti et al. (2023) also stated that color is an initial sensory attribute that plays an important role in forming product quality perceptions. Thus, the substitution of tofu dregs and okra flour had an effect on the acceptance of the color of chicken nuggets, where the treatment without substitution was the most preferred, while the highest substitution showed the lowest level of preference. This shows the need for formulation adjustments so that increased nutritional value remains balanced with good sensory acceptance.

Flavor

Organoleptic test results on the taste of chicken nuggets due to various ingredient substitution treatments. The discussion focuses on assessing the level of panelist acceptance of the taste of chicken nuggets and its relationship to the composition of the ingredients.

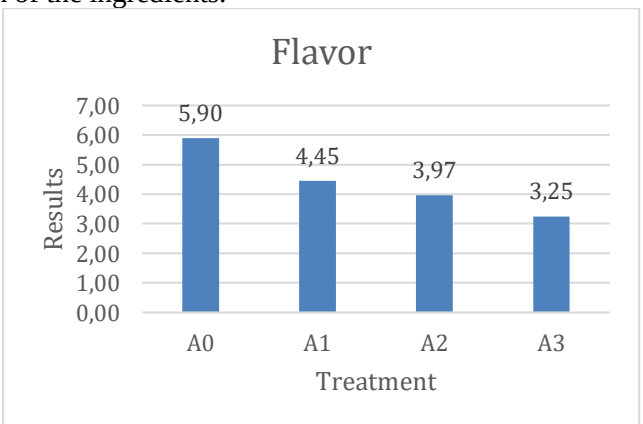

Figure 2. Organoleptic Histogram of Chicken Nugget Flavor

The results of the organoleptic taste test showed that the panelists' level of preference for chicken nuggets decreased with increasing substitution of tofu dregs and okra flour. Treatment A0 obtained the highest value of 5.90 , then decreased in treatments A1 (4.45), A2 (3.97), and reached the lowest value in A3 (3.25). This pattern indicates that increasing the proportion of substitution ingredients affects the taste of chicken nuggets and decreases the level of panelists' acceptance. The decrease in taste preference is related to the sensory characteristics of the substitute ingredients. Tofu dregs can potentially produce a stale taste, while okra flour can produce an unfamiliar taste sensation when used in large quantities. In addition, the reduced proportion of chicken meat in the treatment with greater substitution also reduced the intensity of the distinctive savory taste of chicken nuggets. This finding aligns with research by Riyanto et al. (2022), which states that the use of plant-based ingredients in processed meat products can reduce flavor acceptance if the proportion exceeds the optimal proportion. Ismawati and Putri (2018) also emphasized that taste is the main sensory attribute in determining the level of consumer preference. Thus, the substitution of tofu dregs and okra flour had a significant effect on the taste acceptance of chicken nuggets, where the treatment without substitution was the most preferred, while the highest substitution showed the lowest level of preference. This shows the importance of formulating so that increasing nutritional value remains balanced with a taste that is acceptable to consumers.

Aroma

The results of the aroma assessment of chicken nuggets produced using various substitution treatments. The discussion focuses on the effect of substitution ingredients on aroma characteristics and panelists' level of preference for the product.

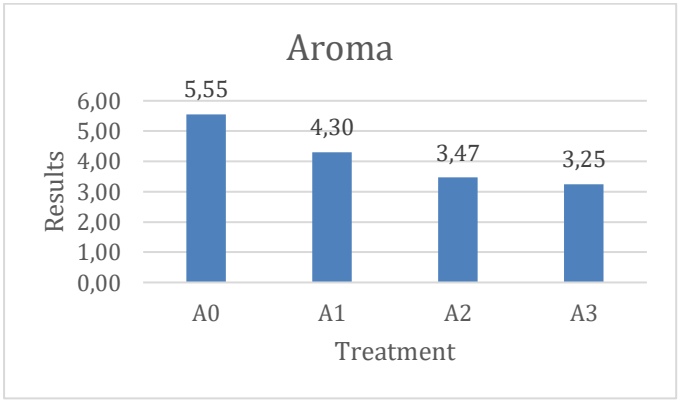

Figure 3. Organoleptic Histogram of Chicken Nugget Aroma

The results of the organoleptic aroma test showed that the panelists' level of preference for chicken nuggets decreased with increasing substitution of tofu dregs and okra flour. Treatment A0 obtained the highest value of 5.55 , then decreased in treatments A1 (4.30), A2 (3.47), and reached the lowest value in A3 (3.25). This pattern indicates that increasing the proportion of substitution ingredients affects the aroma characteristics of chicken nuggets and has an impact on panelists' acceptance. The decrease in aroma preference is related to the volatile characteristics of the substitute material. Tofu dregs can potentially produce an unpleasant aroma when used in large quantities, while okra flour contains aromatic compounds that can alter the distinctive aroma of chicken nuggets. Furthermore, the reduced proportion of chicken meat in the high-substitution treatment also reduced the intensity of the savory aroma formed during the heating process. These results align with research by Septian et al. (2025), which states that the use of fibrous plant-based ingredients in processed meat products can reduce aroma acceptance if the proportion is not optimally controlled. Thus, the substitution of tofu dregs and okra flour had a significant effect on the acceptance of the aroma of chicken nuggets, where the treatment without substitution was the most preferred, while the highest substitution showed the lowest level of preference. This emphasizes the importance of formulating to maintain a balance between increasing nutritional value and sensory quality of the product.

Texture

Organoleptic test results on chicken nugget texture are an important parameter in determining product quality. The discussion focuses on the effect of tofu dregs and okra flour substitution on the chewiness, softness, and panelists' preference for the chicken nugget texture.

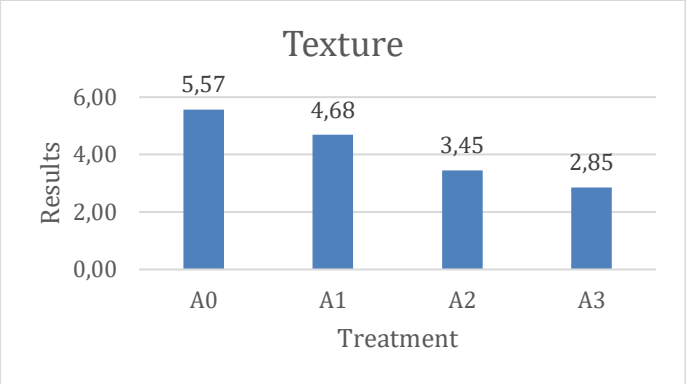

Figure 4. Organoleptic Histogram of Chicken Nugget Texture

The results of the organoleptic texture test showed a decrease in the level of panelist preference along with the change in treatment. Treatment A0 obtained the highest value of 5.57 , followed by A1 (4.68), A2 (3.45), and the lowest value at A3 (2.85). This pattern indicates that treatment A0 produced the most preferred texture, while increasing the treatment to A3 decreased panelist acceptance of the product texture. A decrease in texture value is related to changes in the physical structure of the product, such as increased hardness, brittleness, or reduced elasticity due to changes in the composition of the material. This finding is supported by Sofyan et al. (2018) who stated that formulation modifications have a significant effect on the texture characteristics of food products. Shahira et al. (2023) also reported that increasing the level of treatment, including material substitution, can disrupt the bonds of the constituent matrix thereby reducing the texture quality. In addition, texture is a sensory attribute that is very sensitive to changes in formulation (Adawiyah et al., 2024). Thus, the treatment had a significant effect on the organoleptic quality of the texture, where A0 produced the best texture, while A3 showed the lowest level of preference. This emphasizes the importance of treatment settings to maintain texture quality so that it remains acceptable to consumers.

3. Determination of Best Treatment (effectiveness test)

Treatment effectiveness analysis to determine the best treatment based on observed chemical and organoleptic parameters. Effectiveness is determined by considering the balance between increased nutritional value and product acceptability.

Table 5. Chicken Nugget Effectiveness Test Results

Parameter	Yield Value (NH) of Treatment			
	A0	**A1**	**A2**	**A3**
K. Protein	0.02	0.03	0.03	0.05
K. Fiber	0.00	0.00	0.00	0.01
Flavor	0.01	0.00	0.00	0.00
K. Fat	0.02	0.01	0.02	0.02
K. Carbohydrates	0.12	0.12	0.12	0.12
Texture	0.01	0.00	0.00	0.00
Color	0.01	0.00	0.00	0.00
Aroma	0.01	0.00	0.00	0.00
Total	0.20	0.18	0.17	0.20

The results of the effectiveness test showed variations in total values between treatments, with the highest values obtained in treatments A0 and A3 at 0.20, while treatments A1 and A2 had values of 0.18 and 0.17, respectively. The high effectiveness value in treatment A3 was mainly influenced by chemical parameters, especially protein and fiber content , although the organoleptic value was relatively lower than the control treatment.

Partially, treatment A3 showed the highest values in protein (0.05) and fiber (0.01), reflecting the contribution of tofu dregs and okra flour substitution to increasing the nutritional value of the product. Meanwhile, the carbohydrate content was relatively similar in all treatments (0.12) , so it was not a major differentiator in determining effectiveness. This condition indicates a compromise between improving nutritional quality and sensory acceptance. A similar thing was reported by Rahman et al. (2022) and Handarini et al. (2023) stated that the use of fibrous plant materials in processed meat products can increase protein and fiber content, but can reduce the level of sensory preference if used in high proportions. Considering the balance between chemical and organoleptic quality, A3 treatment is recommended as the most effective formulation to produce chicken nuggets with better nutritional value, although formulation optimization is still needed to improve sensory acceptance. The following image shows the appearance of chicken nuggets in each treatment based on the results of the effectiveness test. The formulation variations showed differences in product characteristics reflecting the balance between nutritional quality and sensory acceptability. Treatment A3, recommended as the most effective formulation, demonstrated superior protein and fiber content due to the substitution of tofu dregs and okra flour, although sensory attributes still require further optimization.

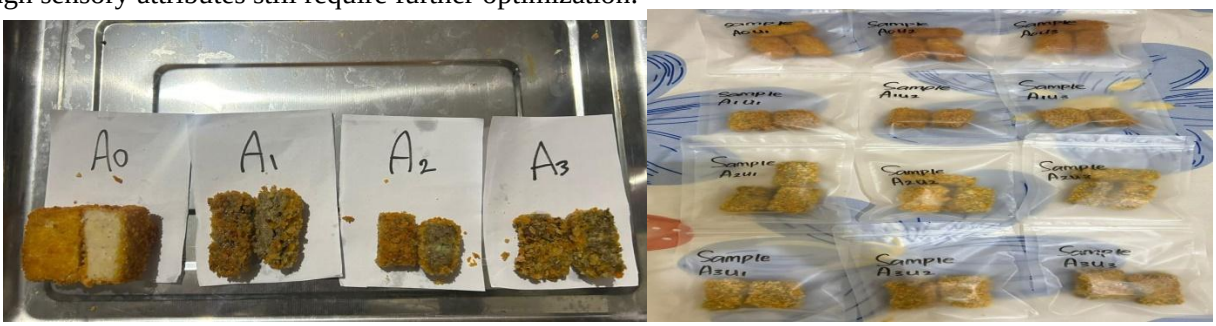

Figure 5. Appearance of Chicken Nuggets at Various Levels of Tofu Dregs and Okra Flour Substitution

CONCLUSION

Based on the research results and discussion, it can be concluded that variations in the concentration of tofu dregs and okra flour significantly affect the chemical and organoleptic characteristics of chicken nuggets. Increasing the substitution level is proven to be able to increase protein and fiber content and reduce fat and carbohydrate content to a certain level, but on the other hand causes a decrease in the level of panelist acceptance of sensory attributes such as color, taste, aroma, and texture. Determination of the best treatment is based on the balance between chemical and organoleptic quality, where the treatment with the highest substitution level (A3) provides the most optimal results in increasing nutritional value, especially protein and fiber, although the control treatment (A0) shows the highest level of preference organoleptically. Thus, the A3 treatment is recommended if the main objective of product development is to increase the nutritional value of chicken nuggets, with the note that formulation improvements are still needed to improve sensory acceptance.

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