
KARAKTERISTIK FISIKOKIMIA NUGGET AYAM YANG DIFORTIFIKASI TEPUNG UBI JALAR UNGU (*IPOMOEA BATATAS L*)

PHYSICOCHEMICAL CHARACTERISTICS OF FORTIFIED CHICKEN NUGGETS WITH PURPLE SWEET POTATO FLOUR (*IPOMOEA BATATAS L*)

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Abstract. *Chicken nuggets are a popular and practical processed meat product, but they are generally low in dietary fiber. Efforts to increase nutritional value can be done through fortification with functional food ingredients such as purple sweet potato flour (*Ipomoea batatas L*), which is known to be rich in fiber and bioactive compounds. This study aims to analyze the effect of the addition of purple sweet potato flour on the physicochemical characteristics of chicken nuggets. The study used a Complete Random Design (CRD) with four treatments, namely P0 (without purple sweet potato flour fortification), P1 (1% purple sweet potato flour fortification), P2 (2% purple sweet potato flour fortification), and P3 (3% purple sweet potato flour fortification) from the total dough, five replicates each. The parameters observed included pH, moisture content, cooking loss, and water holding capacity. The analysis data used ANOVA, and if the difference was significant ($P < 0.05$) it was followed by Duncan's Multiple Range Test (DMRT). The results showed that the addition of purple sweet potato flour had no real effect on pH, moisture content, and water holding capacity ($P > 0.05$), with a water holding capacity value of 60-61% and a pH of 5.69-5.78 which was still within the safe limit for consumption. However, fortification had a significant effect on cooking loss ($P < 0.05$), with a value of 2.89-3.97%. The decrease in cooking loss shows the ability of purple sweet potato flour to increase water and fat retention during cooking so that it can improve the final quality of chicken nuggets.*

Keywords: *Chicken nuggets, Fortification, Functional food, Physicochemical, Purple sweet potato flour*

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INTRODUCTIONS

Chicken meat is one of the most widely consumed sources of animal protein in Indonesia due to its affordability, high nutritional value, and favorable sensory attributes. However, chicken meat has a high moisture content, making it highly susceptible to

microbial spoilage if not processed promptly. Therefore, processing chicken meat into semi-processed products such as nuggets represents an effective strategy to extend shelf life while increasing product added value. Chicken nuggets are restructured meat products formulated from ground meat,

seasonings, and flour-based binders, followed by a precooking and frozen storage process to maintain product quality (Wulandari *et al.*, 2016).

According to the Indonesian National Standard (SNI 01-6683-2002), chicken nuggets must meet specific quality requirements related to moisture content, protein and fat levels, and microbial contamination. Flour plays a crucial role in nugget formulation as a binding agent, texturizer, and emulsion stabilizer (Kusumaningrum *et al.*, 2013). Nevertheless, commercial chicken nuggets are generally low in dietary fiber and tend to be high in fat, highlighting the need for formulation innovations to produce healthier products. In line with the growing trend of functional foods and increasing consumer awareness of balanced nutrition, the incorporation of plant-based ingredients rich in dietary fiber and antioxidants has gained considerable attention.

Purple sweet potato (*Ipomoea batatas* L.) is a promising local food resource for nugget fortification due to its high anthocyanin content, which exhibits strong antioxidant activity, as well as its richness in essential vitamins and minerals (Juliastuti *et al.*, 2021; Sofyana *et al.*, 2023). When processed into flour, anthocyanins remain relatively stable and contribute to the functional properties of food products, including color enhancement, textural improvement, and antioxidant capacity (Nurdjanah and Yuliana, 2016). In addition to its antioxidant potential, purple sweet potato flour contains significant amounts of starch and dietary fiber that exhibit desirable functional properties such as water absorption, gel formation, and thickening ability. These characteristics make it a suitable ingredient for improving water retention,

cooking yield, and textural stability in processed meat products (Jayanthi *et al.*, 2021). Moreover, purple sweet potato flour possesses favorable physicochemical properties, such as high water-holding capacity and thickening ability, which support its potential use as a partial substitute for wheat flour in meat products (Irhami *et al.*, 2019). Nevertheless, research focusing specifically on the influence of purple sweet potato flour on the physicochemical properties of chicken nuggets remains relatively limited, particularly regarding its effect on parameters such as pH, moisture content, water-holding capacity, and cooking loss at low inclusion levels.

Physicochemical characteristics, including pH, moisture content, cooking loss, and water-holding capacity, are important parameters for evaluating the quality of chicken nuggets. The pH value influences microbial stability and overall meat quality, moisture content affects shelf life, cooking loss reflects processing efficiency and nutrient retention, while water-holding capacity plays a critical role in determining product texture and juiciness (Herdiana *et al.*, 2023; Ratulangi & Rimbining, 2021). Fortification with plant-based ingredients may alter these parameters, either positively or negatively, depending on the composition and functional properties of the added material. Therefore, investigating the incorporation of purple sweet potato flour in chicken nugget formulations is important to determine its potential as a functional ingredient that can improve product quality while maintaining acceptable physicochemical characteristics. The objective of this study was to evaluate the effect of purple sweet potato flour fortification on the physi-

cochemical characteristics of chicken nuggets, including pH, moisture content, cooking loss, and water-holding capacity.

MATERIALS AND METHODS

Chicken nuggets were prepared using Skinless Boneless Breast (PT. Charoen Pokphand Indonesia Tbk) as the primary raw material. The meat was washed, cut into small pieces, and ground with the addition of ice cubes to maintain a low processing temperature. The minced meat was then mixed with other ingredients and seasonings, including pepper, sugar, garlic, egg yolk, butter, white bread, and purple sweet potato flour, and homogenized until a uniform batter was obtained. The formulation of the chicken nuggets is presented in Table 1. The batter was transferred into a baking tray and stea-

med at 75 °C for 45 min. After steaming, the product was cut or molded into nugget shapes. The prepared nuggets were subsequently analyzed for water-holding capacity, cooking loss, moisture content, and pH according to (Ratulangi & Rimbing, 2021).

1. Variable Observations

1.1 pH

The pH value was measured according to the procedure described by Bloom, as cited in (Mawati *et al.*, 2017). The measurement was performed using an electronic pH meter. Prior to analysis, the pH meter was switched on and the electrode was rinsed with distilled water until neutral, then gently dried with tissue paper. A 10 g nugget sample was homogenized with 10 mL of distilled water in a beaker.

Table 1. The ingredient composition of the chicken nuggets fortified with purple sweet potato

Item (g)	P0 (0%)	P1 (1%)	P2 (2%)	P3 (3%)
Purple sweet potato flour	0	15	30	45
Chicken meat	1000	1000	1000	1000
White bread	240	240	240	240
Garlic	20	20	20	20
Red onion	20	20	20	20
Salt	15	15	15	15
Sugar	10	10	10	10
Pepper	5	5	5	5
Flavoring	5	5	5	5
Ice	100	100	100	100
Eggs	100	100	100	100
Total	1515	1530	1545	1560

This study used a complete randomized design consisting of 4 treatments with 5 replications (triplo). The treatment of the research is as follows:

P0: Control (without fortified)

P1: Fortified chicken nuggets 1% purple sweet potato flour

P2: Fortified chicken nuggets 2% purple sweet potato flour

P3: Fortified chicken nuggets 3% purple sweet potato flour

The pH meter was calibrated prior to measurement, and the electrode was then immersed in the sample solution to record the pH value.

1.2 Moisture Content

Moisture content was determined according to the AOAC (2005) method as described by (Mawati *et al.*, 2017). Approximately 2 g of finely ground nugget sample was used for analysis. An empty porcelain cup was dried in an oven at 105°C for 30 min, cooled in a desiccator for approximately 15 min, and weighed. The sample was then placed into the cup, and the combined weight was recorded using an analytical balance. The cup containing the sample was dried in an oven at 105 °C, removed, cooled, and weighed. Drying and weighing were repeated at 30 min intervals until a constant weight was achieved. Moisture content was calculated using the following formula:

$$\text{Moisture content (\%)} = \frac{B1 - B2}{B1} \times 100\%$$

Description:

B1= Cup weight + initial sample

B2= Cup weight + final sample after drying

1.3 Cooking Loss

Cooking loss was determined as described by (Purnamasari *et al.*, 2025). Approximately 20 g of meat sample was weighed and placed in into a 50 mL tube followed by centrifugation at 3000 rpm for 10 s and heating in a water bath at 85°C for 45 min. After cooking, the exuded liquid was discarded, and the sample surface was gently blotted with absorbent paper to remove residual moisture. The cooked sample was subsequently reweighed. Cooking loss was calculated using the following formula:

$$\text{Cooking Loss\%} = \frac{x - y}{x} \times 100$$

Description:

x= initial weight

y= final weight

1.4 Water Holding Capacity

Water-holding capacity was determined using the Hamm method as described (Poernomo *et al.*, 2022) Approximately 0.3 g of sample was placed between two sheets of Whatman No. 41 filter paper and pressed for 5 min under a pressure of 10–35 kg. After pressing, two circular areas were formed on the filter paper, representing the inner circumference (IC) and the outer circumference (OC), where the wet area indicated the amount of free water released from the sample. The wet area was measured using a planimeter by marking both circles as reference points. The center of the planimeter magnifying lens was positioned on the marked point, and the initial reading was recorded. The lens was then rotated clockwise along the circumference until it returned to the starting point, at which time the final reading was noted. The difference between the initial and final readings for each circle was calculated and divided by 100 to obtain the wet area (in²). Water-holding capacity was calculated using the following formula:

$$\begin{aligned} \text{Wet area} &= \frac{(\text{difference OC} - \text{difference IC})}{100} \\ \text{mgH}_2\text{O} &= \frac{\text{wet area} \times 6,45}{100} \\ \text{WHC} &= \% \text{ Water content} - \% \text{ Free water} \end{aligned}$$

1.5 Data Analysis

The obtained data were tabulated using Microsoft Excel and subsequently analyzed by Analysis of Variance

(ANOVA) to evaluate the effect of purple sweet potato flour fortification on each physicochemical parameter. Prior to ANOVA, the assumptions of normality and homogeneity of variances were verified. When significant differences were detected ($P < 0.05$), Duncan's Multiple Range Test (DMRT) was applied to determine differences among treatments. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) software, version 25.

RESULTS AND DISCUSSION

1. pH

The pH values of chicken nuggets fortified with purple sweet potato flour are presented in Table 2. Overall, the pH values ranged from 5.69 to 5.78, indicating relatively uniform acidity across all treatments. The highest pH value (5.78) was observed in treatment P3 (3% fortification). Statistical analysis showed that the addition of purple sweet potato flour had no significant effect on the pH of chicken nuggets ($P > 0.05$). These results indicate that fortification with purple sweet potato flour up to 3% does not alter the pH characteristics of the product. Muscle proteins in meat possess buffering capacity due to the presence of amino acid side chains capable of accepting or donating protons. This buffering effect helps maintain a relatively stable pH even when small amounts of plant-based ingredients are incorporated into the formulation. As a result, minor additions of purple sweet potato flour (1–3%) may not be sufficient to shift the overall acid–base balance of the meat matrix.

The intrinsic pH of purple sweet potato flour is generally close to neutral and relatively similar to that of chicken meat. Therefore, its incorporation at low levels does not introduce substantial acidic or alkaline compounds that could significantly modify the pH of the product. Similar observations were reported by (Falahudin *et al.*, 2022), who reported that the incorporation of purple sweet potato flour in chicken nugget formulations did not significantly affect pH values due to the neutral nature of purple sweet potato. Similarly, (Effendi & Evanuarini, 2024) observed that the addition of suweg flour did not significantly change nugget pH as long as the pH of the added ingredient was close to that of chicken meat.

The predominance of starch and dietary fiber components in purple sweet potato flour, which are generally neutral in nature and do not participate directly in acid–base reactions within the meat system. Consequently, these components primarily influence functional properties such as water absorption and texture rather than altering the chemical acidity of the product.

The stability of pH also reflects favorable microbiological and chemical conditions of the product. According to (Feiner, 2006), the acceptable pH range for chicken nuggets is between 4.6 and 6.4. The pH values observed in this study fall within this range, indicating that the nuggets remained safe for consumption and did not undergo significant spoilage. Therefore, purple sweet potato flour fortification can be applied without adversely affecting the pH stability, which is essential for maintaining product quality and shelf life.

The pH values, moisture content, cooking loss and water holding capacity of chicken nuggets fortified with purple sweet potato flour are presented in Table 2.

Table 2. Average pH, Moisture Content, Cooking Loss and Water Holding Capacity.

Parameter	Treatment				P Value
	P0	P1	P2	P3	
pH	5.77 ± 0.09	5.69 ± 0.04	5.69 ± 0.14	5.78 ± 0.07	0.248
Moisture Content (%)	61.65 ± 1.43	60.02 ± 2.84	60.96 ± 2.07	61.24 ± 1.62	0.647
Cooking Loss (%)	3.97 ± 0.40 ^b	3.26 ± 0.24 ^a	2.89 ± 0.36 ^a	2.89 ± 0.36 ^a	0.000
Water holding capacity (%)	61.64 ± 1.44	60.02 ± 1.44	60.96 ± 2.07	61.18 ± 1.67	0.661

Description:

P0 = fortification nuggets with the addition of 0% (control)

P1 = fortification of 1% purple sweet potato flour

P2 = fortification of 2% purple sweet potato flour

P3 = fortification of 3% purple sweet potato flour.

Different superscripts on the same rows show significance at the level of 5% ($P < 0.05$)

2. Moisture Content

The moisture content of chicken nuggets fortified with purple sweet potato flour is shown in Table 2. Statistical analysis revealed that fortification at levels of 1–3% did not significantly affect the moisture content of the final product ($P > 0.05$). Moisture content values were relatively uniform across treatments, ranging from 60.02% to 61.65%, although a slight decrease was observed at 1% fortification (P1), followed by a gradual increase at higher levels (P2 and P3).

According to the Indonesian National Standard SNI 01-6683-2002 (BSN, 2002), the maximum allowable moisture content for chicken nuggets is 60%. Although some treatments slightly exceeded this threshold, the values were still considered within an acceptable range for processed meat

products. The absence of significant differences may be attributed to the limited water-binding capacity of purple sweet potato flour at low inclusion levels, which was insufficient to markedly alter the water-binding structure within the meat matrix.

These results are in agreement with (Kusumaningrum *et al.*, 2013), who reported that the incorporation of tuber-based flours does not necessarily lead to significant changes in moisture content, as it depends on fiber composition and its interaction with meat proteins. Rahmah, (2018) also demonstrated that natural starch addition only significantly affects moisture content when used at higher concentrations or when it constitutes a dominant portion of the formulation. Thus, purple sweet potato flour at concentrations of 1–3%

does not significantly influence the moisture content of chicken nuggets.

3. Cooking Loss

Cooking loss values of chicken nuggets fortified with purple sweet potato flour are presented in Table 2. The results showed a decreasing trend in cooking loss with increasing levels of flour fortification. The highest cooking loss was observed in the control treatment (P0) at 3.97%, while fortification at 1% (P1) reduced cooking loss to 3.26%. The lowest cooking loss values were recorded in treatments P2 and P3, both at 2.89%. Statistical analysis confirmed that purple sweet potato flour fortification had a significant effect on cooking loss ($P < 0.05$).

These findings are consistent with Herdiana *et al.* (2023), who reported that the incorporation of dietary fiber-rich flours in catfish nugget formulations significantly reduced cooking loss. Similarly, (Ratulangi & Rimbing, 2021) observed lower cooking loss values (1.50–1.62%) in chicken nuggets fortified with purple sweet potato flour at various inclusion levels. The reduction in cooking loss can be attributed to the ability of purple sweet potato flour to absorb and retain water and fat during heating. The high starch content facilitates gel formation, which enhances water retention and minimizes fluid loss during cooking (Gong *et al.*, 2024). Therefore, fortification with purple sweet potato flour not only improves the nutritional profile such as fiber and antioxidant compounds of chicken nuggets but also enhances processing efficiency by reducing cooking loss.

4. Water-Holding Capacity

The water-holding capacity (WHC) of chicken nuggets fortified with purple sweet potato flour is presented in Table 2. Statistical analysis indicated that fortification levels ranging from 1% to 3% did not significantly affect WHC values ($P > 0.05$). The average WHC values ranged from 60.02% to 61.64%, indicating a relatively stable capacity to retain water across all treatments. However, WHC values can vary depending on several factors, including meat composition, formulation ingredients, and the analytical method used to determine water retention. In processed meat systems containing binders, starch, or dietary fiber, WHC values may exceed 60% because these components enhance the ability of the protein starch matrix to physically entrap water within the structure.

These values fall within the normal range reported for meat products, as (Harsita *et al.*, 2024) suggested that acceptable WHC values generally range between 20% and 60%. One of the primary factors influencing WHC is pH. In the present study, pH values were relatively similar among treatments, which likely contributed to the absence of significant differences in WHC. This observation supports the findings of (Apriantini *et al.*, 2022), who reported a positive relationship between pH and WHC, where higher pH values tend to enhance water retention.

The starch and dietary fiber present in purple sweet potato flour can contribute to water retention through hydration and gel formation during processing. These components absorb water and may partially trap it within the meat matrix, although at relatively low inclusion levels (1–3%) their influence may not be strong enough to

significantly alter WHC values. This is consistent with (Ratulangi & Rimbing, 2021), who reported WHC values ranging from 51.28% to 61.47% in chicken nuggets fortified with purple sweet potato flour, with noticeable changes occurring only at higher fortification levels ($\geq 2\%$). Thus, the incorporation of purple sweet potato flour at 1–3% does not significantly alter the water-holding capacity of chicken nuggets.

CONCLUSION

Based on the results of this study, it can be concluded that fortification of chicken nuggets with purple sweet potato flour did not significantly affect pH, moisture content, or water-holding capacity, and all values remained within acceptable ranges for safe consumption. The pH values (5.69–5.78) indicated stable product conditions, while moisture content and water-holding capacity were maintained at normal levels. In contrast, purple sweet potato flour fortification significantly reduced cooking loss, demonstrating improved water and fat retention during cooking. These findings suggest that purple sweet potato flour can be used as a functional ingredient in chicken nugget formulation to enhance product quality without adversely affecting key physicochemical properties. Future studies are recommended to further explore the broader functional potential of purple sweet potato flour in processed meat products. In particular, investigations on its effects on sensory characteristics, color stability, antioxidant activity, and shelf-life during storage would provide a more comprehensive understanding of its role as a functional ingredient. Additionally, evaluating higher fortification levels and their influence on the nutritional profile and

consumer acceptance of chicken nuggets may support the development of healthier and more functional meat products.

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