

Evaluation of Nutritional Quality of Processed Livestock Products of Micro, Small and Medium Enterprises in North Bengkulu Regency

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Abstract: The purpose of this study was to evaluate the quality of processed livestock products from Micro, Small and Medium Enterprises (MSMEs) in North Bengkulu Regency. The research location was MSME located in Kota Argamakmur. A total of 6 samples of processed livestock products were selected with 3 replications for each sample. All samples were measured nutritional composition and microbial counts. All data were processed using descriptive statistical methods. Furthermore, a comparative analysis was conducted to compare the nutritional composition profiles between types of processed products. For meatball and nugget products, a direct comparative analysis was conducted by comparing the average test results with the quality requirements listed in SNI 3818:2014 and the reference SNI 6683:2014. The results showed that the protein content of liver-gizzard, meatball, nugget, otak-otak, sempol (1) and sempol (2) were 28.50%, 7.20%, 11.93%, 14.83, 9.43 and 9.10, respectively. The fat content of liver and gizzard were 3.50%, 8.87%, 18.50%, 4.50%, 12.13%, and 12.50%, respectively, the Nitrogen Free Extract content was 0.37%, 10.60%, 10.23%, 10.03%, 14.20%, and 13.07%, respectively, and the crude fiber content was 0.53%, 1.33%, 1.76%, 0.90%, 1.43%, and 1.53%, respectively. The meatball did not meet the Indonesian National Standards (SNI), whereas the nuggets met SNI. It could be concluded that the liver and gizzard product contains the highest protein content, while the nuggets contain the highest fat content. The quality of meatballs needs to be improved to meet the minimum SNI, whereas nuggets have met SNI standard.

Keywords: Nutritional Composition, Meatball, Nugget, Otak Otak, Sempol, Liver-Gizzard, Micro, Small and Medium Enterprises

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1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) are the backbone of the national and regional economy, including in North Bengkulu Regency. Efilia et al. (2024) reported that MSMEs employ 97% of the national workforce, and MSMEs contribute over 60% of the National Gross Domestic Product. The food MSME sector, particularly those processing livestock products, not only absorbs labor and creates business opportunities, but also supports food security, particularly by meeting the community's nutritional needs (Widianingrum and Septio, 2023). Products such as meatballs, nuggets, sepol, and other processed foods have become an inseparable part of the culinary landscape and people's consumption habits due to their practicality and affordable prices. With increasing urbanization and changing lifestyles, consumer demand for convenient, ready-to-eat foods continues to rise (Jahan et al., 2020). This phenomenon is a major driver of the rapid growth of MSMEs in the livestock processing sector. However, this quantitative growth is often not balanced by consistent product quality assurance and standardization (Listyaningrum et al., 2024). The quality of food products is not only determined by taste, but also by nutritional content and safety for consumption. Therefore, objective quality assessment through chemical analysis is important to ensure that products circulating in the community meet appropriate nutritional and safety standards.

The North Bengkulu Regency Government has demonstrated a strong commitment to elevating the MSME sector to become a more standardized and competitive pillar of the economy. As a first step, evaluation of processed livestock products in North Bengkulu Regency is very important. This evaluation is crucial for mapping the actual quality of MSME products. This allows the government to accurately guide MSMEs to produce high-quality, safe, and processed livestock products that meet national standards. Legal aspects such as Good Manufacturing Practices (GMP) and halal certification (Listyaningrum et al., 2024), product quality and safety (Sugijanto et al., 2022), and consumer trust (Wu et al., 2021) are crucial considerations in MSME development programs.

The awareness at the policy level that the quality of MSME products is a strategic issue (Piliang, 2024) that affects the local economy, public health, and regional competitiveness, makes this research a fundamental initial step. Thus, this research is positioned not merely as an academic activity, but as a scientific foundation for the formulation of more targeted and effective MSME development policies.

Although MSMEs in the livestock processing industry have significant economic potential, there is a significant gap between this potential and the quality of products in the field. A lack of understanding of proper formulation, limited access to quality raw materials, and limited knowledge of national quality standards are the main challenges faced by business actors. This has the potential to lead to a lack of quality assurance and food safety (Dewi et al., 2019), which ultimately reduces consumer trust and product competitiveness.

Based on this description, this study aims to evaluate the quality and safety of processed livestock products in MSMEs in Argamakmur City.

This study presents findings related to the evaluation of livestock products produced by MSMEs in Argamakmur City, focusing on nutritional content and product safety aspects. The findings include an in-depth analysis of the protein, fat, and moisture content in various products such as meatballs, nuggets, liver, and sempol. In addition, this study will also discuss the number of microbes contained and the level of compliance with Indonesian National Standards (SNI). The results of the study show significant variations in quality between MSME products, indicating the need for improved standardization and quality control to ensure product safety and increase consumer confidence. These findings are in line with the research objective to evaluate the current quality of SME products and provide recommendations for policy improvements and industry development.

2. Method

This research was conducted for four months, namely from June 2025 to September 2025.

Materials and Tools

The main material of this study was 6 samples of processed livestock products obtained from MSMEs in Kota Argamakmur. The samples were grouped into six different product types, with each product type represented by three samples from different manufacturers to assess variability. Details of the types of processed livestock products in MSMEs in Kota Argamakmur are liver and gizzard, meatballs, nuggets, otak-otak, sempol 1 and sempol 2. Each sample was repeated 3 times.

Product sampling was carried out strategically in several snack sales centers and community activity centers in Kota Arga Makmur, North Bengkulu Regency. These locations were chosen to represent processed livestock products that are popular and widely consumed by the public. Sampling was carried out using the purposive random sampling method, where samples were purchased randomly from different traders at predetermined locations. Each sample was placed in a plastic package and coded to maintain the anonymity of the manufacturer and ensure traceability during analysis.

The equipment used in this study was standard laboratory instruments for proximate analysis and microbial analysis.

Sample Preparation and Laboratory Analysis

Prior to analysis, each product sample was homogenized using a food processor. This process ensures that each subsample taken for each test type is truly representative of the entire sample, thereby reducing analytical error. Analysis of moisture, ash, protein, fat, and crude fiber content followed the AOAC (2016) method. The total bacterial and coliform counts in selected samples were measured using the Total Plate Count test (Safrida et al., 2021).

Data Analysis

All data were processed using descriptive statistical methods. For each variable from each sample, the mean value and standard deviation were calculated using standard statistical formulas. The mean value was used to represent the best estimate of the nutritional composition of the product, while the standard deviation was presented to indicate the precision of the measurement and the level of variability of the data.

Next, a comparative analysis was conducted to compare the nutritional composition profiles between the six types of processed products. Data is presented in tabular form to facilitate visualization and interpretation. For meatball and nugget products, a direct comparative analysis was conducted by comparing the average test results with the quality requirements listed in the Indonesian National Standard (SNI) 3818:2014 and SNI 6683:2014. The results of this comparison were used to draw conclusions regarding the level of conformity of MSME products to the applicable SNI.

3. Result and Discussion

Comparative Analysis of Nutritional Content Between Product Types

Table 1 presents the nutritional composition of processed livestock products from MSMEs in Kota Argamakmur. The results showed that liver-gizzard contained the highest protein content at 28.5 %, followed by otak-otak (14.83%), nuggets (11.93%), sempol 1 (9.43%), sempol 2 (9.10%), and meatballs (7.20%). Otak-otak was in second place (14.83 %), indicating the use of chicken as the dominant raw material in its formulation. Chicken contains 23.2 % protein (Gultom et al., 2023). Nuggets contained the highest fat content at 18.50 %, followed by sempol 2 (12.50%), sempol 1 (12.13%), meatballs (8.87%), otak-otak (4.50%), and liver-gizzard (3.50%). Ishak et al. (2014) reported that chicken nuggets contain fat ranging from 29.7 % - 41.18%.

Table 1. Nutritional Composition of Processed Livestock Products (%) of MSMEs in Kota Argamakmur

Product	Water	Protein	Fat	Crude Fiber	Ash	BETN
Liver-Gizzard	65.50 ± 0.89	28.50 ± 0.60	3.50 ± 0.30	0.53 ± 0.06	1.60 ± 0.10	0.37 ± 0.12
Meatball	69.27 ± 0.80	7.20 ± 0.30	8.87 ± 0.65	1.33 ± 0.15	2.73 ± 0.21	10.60 ± 0.95
Nuggets	55.43 ± 0.65	11.93 ± 0.51	18.50 ± 0.60	1.76 ± 0.15	2.13 ± 0.15	10.23 ± 0.76
Otak-otak	67.23 ± 0.75	14.83 ± 0.65	4.50 ± 0.40	0.90 ± 0.10	2.50 ± 0.10	10.03 ± 0.57
Sempol (1)	60.50 ± 0.70	9.43 ± 0.50	12.13 ± 0.65	1.43 ± 0.15	2.30 ± 0.10	14.20 ± 1.05
Sempol (2)	61.50 ± 0.60	9.10 ± 0.56	12.50 ± 0.70	1.53 ± 0.15	2.30 ± 0.20	13.07 ± 0.40

Mean ± SD.

Meatballs showed the lowest average protein content (7.2%), while their water content was the highest (69.27 %). Sempol also had a relatively low protein content. This composition pattern—low protein, high carbohydrate, and high water content—reflects the business model and processing of MSMEs. The use of tapioca flour or other starches in significant proportions serves as a binder, volume enhancer, and chewy texture. This is a common economic strategy to reduce production costs

and keep the selling price of the product affordable for the snack market segment. However, the consequence is a decrease in nutritional value, especially protein content.

One clear finding from Table 1 is the difference in moisture content between products. The product with the highest moisture content is meatballs (69.27 %), followed by otak-otak and sempol with moisture contents of approximately 67.23% and 61%, respectively. The high moisture content of meatballs, sempol, and otak-otak indicates that these products tend to be more perishable and have a shorter shelf life compared to products with lower moisture content, such as nuggets (55.43 %) and liver-gizzard (65.5%). Products with lower moisture content are more durable in storage because microorganisms that cause spoilage require water to reproduce. Therefore, MSMEs need to pay attention to packaging techniques (Ropikoh et al., 2024) and storage that can extend shelf life without compromising quality.

Crude protein is a crucial nutritional component for the body. The product with the highest protein content is liver-gizzard (28.5 %), indicating that it is excellent in providing protein intake for consumers. This is understandable because chicken liver undergoes minimal processing (generally only boiled or fried), making its composition closest to the original protein-rich raw material. Ramadhani (2024) reported that chicken liver contains 27.4 % protein. In comparison, products such as nuggets and sempol 1 and 2 show much lower protein levels, indicating the use of more binders and fillers, which tend to reduce the protein content of these products. Otak-otak, although containing more binders than liver-gizzard, still has a relatively high protein content. This indicates that meat-based products have greater potential to provide a higher protein source for consumers. MSMEs should maintain a balanced raw material composition to optimize protein content.

Fried foods like nuggets and sempol contain significantly higher levels of fat than other foods like liver-gizzards or otak-otak. The high fat content of nuggets and sempol could be explained by the deep-frying method. During this process, the cooking oil is absorbed by the product, increasing the fat content. Furthermore, flour and other binding agents absorb oil during the frying process. The more binding agents and flour used, the more fat will be absorbed during the frying process. While frying imparts a savory flavor and chewy texture to products, high-fat products also contain higher calories, which might not suit the preferences of health-conscious consumers. High fat consumption increases the risk of obesity, diabetes, cardiovascular disease, and cancer (Ma et al., 2025).

The high water content in meatballs indicates the presence of filler ingredients that contain a lot of water, such as flour or starch. The use of fillers aims to lower production costs and increase product volume. This results in lower protein content. Therefore, MSMEs must consider ways to balance the use of binders without compromising nutritional quality.

The high fat content in nuggets and sempol provides a chewier texture and a more savory taste, which is one of the main attractions for consumers. This crispy, savory product is very popular among consumers seeking convenient and delicious meals. However, it's important for MSMEs to consider processing options that

reduce fat content without sacrificing flavor and texture. Using healthier binders or frying techniques with less oil can be a solution to reduce fat content in products.

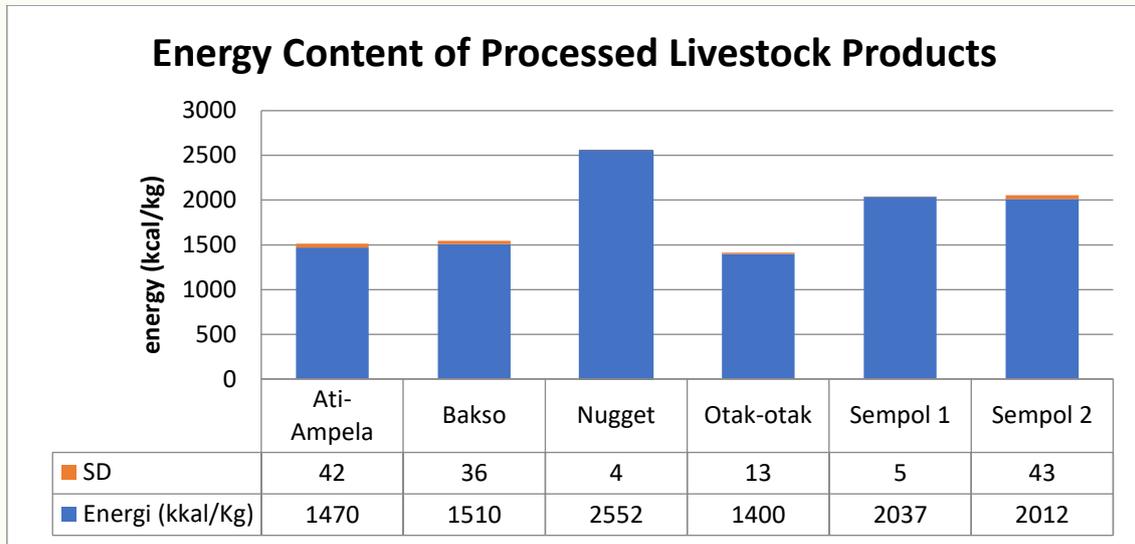


Figure 1. Energy content of processed livestock products

The energy content of processed livestock products is presented in Figure 1. Nuggets contain the highest energy, namely 2,552 kcal/kg, followed by Sempol 1, Sempol 2, meatballs, liver-gizzard and otak-otak respectively at 2,037 kcal, 2,012 kcal, 1,510 kcal, 1,470 kcal and 1,400 kcal/kg. The high energy content of nuggets is due to their high fat content. One gram of fat contains 9 kcal, while one gram of protein or carbohydrate contains 4 kcal of energy (Santoso, 2015).

In general, the comparison between these processed products shows that no single product is perfect in terms of nutritional content balance. Products such as liver-gizzard is very good in terms of protein content, but low in fat and dietary fiber, while products such as nuggets and sempol have a high fat content, but lower in protein and dietary fiber. This shows the importance for MSMEs to develop products that are more balanced in terms of nutritional content, taking into account the increasingly diverse market demand for products that are not only delicious but also nutritious, safe and halal (Syafriada, 2016).

Based on the findings of this comparative analysis, it is recommended that MSMEs in Kota Argamakmur consider several strategies to improve the quality of their products. MSMEs should explore ways to reduce the fat content in products such as nuggets and sempol without compromising taste or texture, and increase the protein content in products such as meatballs. Furthermore, increasing the dietary fiber content in processed products could also provide added value for consumers increasingly concerned about healthy eating (He et al., 2022). By innovating products with more balanced nutritional content, MSMEs could increase their competitiveness in a market increasingly aware of the importance of healthy eating.

The quality variability of processed MSME products reflects process inconsistencies. The standard deviation for each parameter (Table 1) indicates that even for similar products, the quality produced by different MSMEs is not uniform.

This inconsistency is a fundamental problem in the MSME sector, rooted in the lack of standard recipes, standard operating procedures (SOPs) in production, and raw material quality control. Thus, it is difficult for MSME products to build a long-term brand reputation and consumer trust. One of the main causes of this inconsistency is the lack of a standard recipe consistently applied by MSMEs. Many MSMEs still rely on subjective experience in measuring ingredients or adjusting proportions based on intuition. This uncertainty causes each batch of product to vary in texture, taste, nutritional content, and even shelf life. Irregularities in dough mixing, cooking duration, or frying can also exacerbate this variability.

The main root cause of product quality inconsistency in the food MSME sector lies in the lack of implementation of quality management systems and standard operating procedures for production. Previous studies have shown that many MSMEs in the food sector have not implemented comprehensive quality management systems, so that production processes rely on the subjective experience and intuition of workers rather than standardized procedures (Dora et al., 2013). This irregularity results in significant variations in product attributes such as texture, taste, nutritional content, and shelf life, which directly impact consumer perceptions of product reliability. International studies also indicate that the adoption of quality management systems tailored to the context of MSMEs can reduce process variability and increase consumer satisfaction, but barriers such as lack of knowledge and limited resources often hinder their implementation (Dora et al., 2013). Therefore, the absence of standardized recipes and strict SOPs makes it difficult for MSMEs to build a strong brand reputation and long-term consumer trust.

In addition, the challenge of MSME product quality is exacerbated by weak control over raw materials and inadequate quality assurance systems. A global study of food quality management systems shows that the adoption of elements such as HACCP prerequisites and process control procedures is essential to ensure food quality and safety stability, but their implementation in MSMEs is still low due to the complexity and cost of certification (Charalambous et al., 2015; Lee et al., 2023). This inconsistency in raw material control can cause fluctuations in nutritional composition—e.g., protein, fat, and moisture content—and increase the risk of microbial contamination if sanitation and hygiene procedures are not followed consistently. The implementation of systems such as ISO 22000, which emphasizes a risk management approach across the entire production chain, has been shown to assist in standardizing processes, although MSMEs often struggle to meet full certification requirements (Psomas et al., 2018; Lee et al., 2023). Overall, the adoption of strong quality management practices and structured raw material control are key elements in minimizing product variation and building the consistency needed for market competitiveness.

Furthermore, the lack of a SOP increases the likelihood of production errors. SOPs are crucial for ensuring consistency in every stage of production, from raw material selection and processing to final processing techniques. Without clear SOPs, product quality control becomes difficult, making variations in production results commonplace. The existence of SOPs that are implemented with discipline could be

a foundation for MSMEs to produce consistent products that meet the quality standards.

Another factor contributing to inconsistency is limited raw material quality control. Raw materials, such as meat, liver, or binder flour, could vary in quality depending on the supplier or batch received. These differences directly impact the protein, moisture, and fat content of the final product. Therefore, quality inconsistency is not only a technical issue on the production line but also related to raw material management. Proper handling, such as more consistent raw material selection and batch quality records, is crucial to improving product quality uniformity.

These selected snacks are foods that are popular among children and teenagers. Therefore, this can impact the health of children and adolescents. The low protein content of meatballs and sempol, coupled with high levels of fat and carbohydrates, makes these products more of a calorie-dense energy source than a source of protein for growth. While liver-gizzard is rich in protein and iron, its cholesterol content should also be considered. Nuggets, with their high fat content, contribute to the daily fat intake, which requires careful attention. This data is important for nutritional education to the public so they can choose snacks more wisely.

The nutritional implications of the results of this analysis are very important, especially because these snack products are widely consumed by children and adolescents. The low protein content in meatballs and sempol indicates that although these products appear to be a source of meat, their protein content is not sufficient to support muscle growth, body tissue development, and children's metabolic needs. Regular consumption of low-protein snacks has the potential to reduce the daily protein intake required, especially for children.

In addition, the high fat and carbohydrate content of meatballs, sempol, and nuggets makes these products a dense source of calories. High calorie consumption without sufficient physical activity can increase the risk of obesity and metabolic disorders in children. This is an important concern for parents and educators, as street food is often part of children's daily diet, especially in school or playground environments.

Liver-gizzard products, while rich in protein and iron, are also high in cholesterol because they come from the liver and gizzard. High cholesterol levels should be monitored, especially if consumed excessively, as they can increase the risk of cardiovascular disease in the long term (Idoko et al., 2020). Therefore, consumption of liver and gizzard should be limited or balanced with the intake of vegetables and low-fat foods to maintain nutritional balance.

Nuggets, which are high in fat, also contribute significantly to daily fat intake. Excessive fat in the diets of children and adolescents can increase the risk of metabolic diseases such as obesity, hypercholesterolemia, and other metabolic disorders (Ofori et al., 2024). The frying process used in nugget production plays a significant role in the final fat content of the product, so controlling processing methods and selecting healthy oils is crucial for manufacturers to minimize negative health impacts.

These findings emphasize the importance of nutrition education for the public, especially parents, teachers, and children. Accurate nutritional data could be a guide in choosing snacks that are healthier, more balanced, and meet daily nutritional needs. Furthermore, this education could encourage consumers to demand products with better nutritional quality, which in turn could motivate MSMEs to improve the nutritional composition of their products. In this way, children and adolescents' snack consumption patterns could be wiser and support long-term health.

Evaluation of Quality Conformity with the Indonesian National Standards (SNI)

Meatball quality analysis (SNI 3818:2014)

The meatball samples were evaluated based on the quality requirements for the combination meat meatball category (Badan Standarisasi Nasional, 2014^a), which was considered most relevant for MSME level products. Comparison of test results with standards is presented in Table 2.

Table 2. Comparison of Nutritional Composition of Meatballs with SNI 3818:2014

Test Parameters	SNI Quality Requirements (Combination Meatballs)	Average Test Results	Information
Water content (%)	max . 70.0	69.27	FULFIL
Ash Content (%)	max . 3.0	2.73	FULFIL
Crude Protein (%)	min. 8.0	7.20	DOES NOT MEET
Fat Content (%)	Max. 10	8.87	FULFIL

The evaluation results revealed crucial findings. Although the meatball samples successfully met the quality requirements for moisture, ash, and fat content, they failed to meet the minimum protein requirements. The average protein content of meatballs was 7.20 %, which did not meet the minimum threshold of 8.0% set by the SNI. Previous research found that chicken meatballs contained 9.65% protein, 0.64% fat, 0.08% crude fiber, 0.07% ash, and 73.91% water (Kartika and Alimuddin, 2020).

This failure indicates that the proportion of meat used in the meatball formulation by the surveyed MSMEs is likely lower than 20% or the use of starch-based fillers is very dominant. This is a serious concern from two sides. From the consumer's perspective, they do not get the protein intake they should from products labeled meatballs. From the producer's perspective, this demonstrates the challenge of balancing production costs with nutritional quality. This non-conformity can hinder MSME products from moving up a class and penetrating wider markets, such as modern retail, which requires compliance with SNI.

Table 1 shows that the water content in the meatballs was 69.27%, which is within the limits set by SNI 3818:2014. The water content that meets this standard indicates that the meatball has an appropriate moisture balance. Therefore, in terms of water content, the meatballs have met the expected standards..

The ash content of the meatball samples was 2.73 %, which is also below the maximum limit set by the SNI 3818:2014 standard, which is 3.0%. Ash content indicates the amount of minerals contained in the product, and a lower value indicates a product that is cleaner from unwanted additives. A higher ash content could indicate the presence of uncontrolled fillers or preservatives. Therefore, the meatballs met the ash content requirements.

The crude protein content of meatballs was 7.20 %, which was lower than the minimum limit set by SNI 3818:2014. This failure to meet the protein requirement is a significant problem, considering that meatballs are classified as a processed meat product that should contain a fairly high amount of protein. Crude protein is the main nutritional component in meatballs, derived from meat or other protein sources. Failure to meet protein standards indicates that the meatballs likely contain starch-based fillers or other non-protein ingredients, such as tapioca flour.

From the consumer perspective, these results indicate that the meatball products produced by this MSME do not provide sufficient protein intake.. Consumers who purchase this product may expect to get protein from the meatballs, but in reality, the protein content is lower than expected. This could certainly impact customer satisfaction and brand reputation, especially as consumers become more aware of the importance of a balanced diet. A well-balanced diet is critical to maintaining optimal health and well-being (Khokhar, 2023). From a manufacturer's perspective, failure to meet protein content requirements indicates challenges in managing raw material composition and production costs. The use of starch-based fillers, while lowering production costs, leads to a decrease in the nutritional quality of the product.

To address this issue, MSMEs can consider increasing the proportion of meat in their meatball formulations or using other protein-rich ingredients instead of starch-based fillers. Using ingredients such as chicken, fish, or other protein sources could increase the protein content of meatballs. Furthermore, using higher-quality ingredients will add value to the product and enhance the MSME's brand image in the eyes of consumers. MSMEs could create meatballs with greater variety, such as meatballs enriched with plant-based protein such as soybeans or tempeh, or meatballs with added vegetables rich in fiber and nutrients. By developing more nutritious product variants, MSMEs could expand their market share, meet the demands of health-conscious consumers, and adapt to evolving market trends. Based on these findings, it is clear that production standardization is very important to ensure the quality of products produced by MSMEs. Although MSMEs have the capacity to produce delicious and affordable meatballs, product quality that does not meet SNI standards could limit their expansion potential. Implementing stricter standards in the production process, such as the use of higher-quality raw materials and more regular quality testing, will help MSMEs produce better and more competitive products.

Nugget quality analysis (Reference SNI 6683:2014)

Evaluation for nuggets uses the quality requirements reference from SNI 2014 (Badan Standarisasi Nasional, 2014^b). In relation to SNI, the appropriate standard for

MSME products is combination chicken nuggets. The comparison is presented in Table 3.

Table 3. Comparison of Nutritional Composition of Nugget with SNI Reference Quality Requirements

Test Parameters	SNI Reference Quality Requirements	Average Test Results	Information
Water content (%)	max . 60.0	55.43	FULFIL
Crude Protein (%)	min. 9.0	11.93	FULFIL
Crude Fat (%)	max . 20.0	18.50	FULFIL
Carbohydrates (%)	Max. 25	10.23	FULFIL

The analysis shows that the nuggets meet the Indonesian National Standard (SNI), with their water, crude protein, crude fat, and carbohydrate contents all falling within the required limits. However, the fat content of the nuggets, while still below the maximum allowable limit of 20.0%, is approaching the upper threshold. This suggests that the frying process plays a significant role in the fat content of the nuggets. Research indicates that improper frying conditions, including inadequate temperature control and timing, can lead to excessive oil absorption, which not only alters the nutritional profile but also accelerates the process of rancidity in fried products (Ma et al., 2025; Charalambous et al., 2015). When frying oil is absorbed excessively, the product becomes less healthy, contributing to higher calorie counts and increasing the risk of adverse health effects, such as obesity and cardiovascular diseases (Dora et al., 2013; Lee et al., 2023). Therefore, MSMEs must consider optimizing their frying methods to avoid excess oil absorption and ensure the nutritional integrity of their products.

Proper management of frying conditions, including precise temperature control and adherence to time standards, can significantly improve the quality of fried foods like nuggets by minimizing unnecessary oil absorption. Studies show that adjusting frying temperature and time can help preserve the product's texture, maintain its crispiness, and retain internal moisture without compromising nutritional value (Psomas et al., 2018; Zhu et al., 2024). MSMEs aiming to enhance product quality should not only focus on improving frying techniques but also monitor the quality of frying oil regularly. The oil should be changed or filtered to avoid the buildup of unhealthy compounds and ensure food safety (Wu et al., 2021). By incorporating consistent frying practices, MSMEs can produce healthier products with a longer shelf life, improving both consumer satisfaction and market competitiveness.

Although the average protein content meets the standard, variations between samples may occur. Some batches of nuggets may have lower protein content due to differences in meat proportions, the use of binding agents, or irregularities in the dough mixing process, as inconsistent formulation practices directly affect nutrient composition (Back et al., 2025; Tormási et al., 2025). Furthermore, variability in ingredient measurement and production procedures has been associated with fluctuations in macronutrient profiles across food products,

underscoring the need for systematic control in small-scale production (Perrin, 2018; Eitzbach et al., 2024). Recipe standardization and quality control during production are therefore crucial to ensure that each batch of nuggets has a uniform protein content and consistently meets SNI standards. Standardized recipes help define precise ingredient ratios and procedural steps, reducing reliance on subjective judgement and minimizing batch-to-batch variability in nutrient content (Naumov, 2023).

In addition to standardized formulations, adopting structured quality management practices and monitoring key production parameters can reinforce consistency in protein content. For example, aligning production processes with recognized quality systems such as ISO 22000 helps ensure rigorous control of raw materials, process conditions, and finished product attributes, which is particularly important for maintaining nutritional standards in processed foods (ISO 22000 principles; Raita et al., 2025). By combining standardized recipes with robust quality control and training for production staff, MSMEs can reduce inconsistencies in protein content, improve compliance with regulatory standards, and enhance consumer confidence in product quality.

From the consumer's perspective, nuggets that meet protein standards are nutritious products. High fat content is also a consideration for health-conscious consumers. Therefore, accurate and transparent nutritional information is essential for consumers to make informed choices. With a nutritional composition that meets quality requirements, MSME nuggets might have the opportunity to enter modern and retail markets. High-quality and consistent products will increase consumer confidence and expand market share, including for wider distribution beyond the local environment. Moisture, fat, and protein content affect the shelf life and sensory quality of nuggets. Low moisture content can extend shelf life, controlled fat content maintains a savory flavor, and sufficient protein content maintains a chewy and dense texture. By consistently controlling these parameters, MSMEs can produce nuggets that are not only safe and nutritious, but also attractive in terms of taste and texture.

Sempol quality analysis (Reference SNI 6683:2014)

The quality analysis of chicken sempol can be done using SNI 6683:2014 for chicken nuggets (Badan Standarisasi Nasional, 2014^b). The comparison with SNI shows that the water content of sempol exceeds the maximum water content limit. To improve the quality of sempol, MSMEs need to reduce the water content of sempol from 61.0 % to 60.0%, which is the maximum water content limit. Sempol can be enriched with 5% moringa leaves, which can increase vitamin A content (Ximenes et al., 2021) .

Table 4. Comparison of Proximate Test Results of Sempol Samples with SNI Reference Quality Requirements

Test Parameters	SNI Reference Quality Requirements	Average Test Results	Information
Water content (%)	max . 60.0	61.0	DOES NOT MEET THE

Crude Protein (%)	min. 9.0	9.27	FULFIL
Crude Fat (%)	max . 20.0	12.3	FULFIL
Carbohydrates (%)	Max. 25	13.64	FULFIL

Strategy for Improving the Quality of Processed Livestock Products

The structural and economic challenges faced by MSMEs are key factors in explaining the low product quality, particularly in the protein content of meatballs. This economic pressure arises because the price of key raw materials, such as meat, continues to rise while consumer purchasing power in the street food segment remains relatively stable. This forces MSMEs to adjust production costs to maintain affordable and competitive selling prices in the local market. As a result, the use of fillers such as tapioca flour or starch becomes a rational strategy to maintain profit margins while keeping selling prices from being too high. This economic strategy, although cost-effective, has a direct impact on the nutritional quality of the product. Decreasing protein levels and increasing filler content indicate that MSMEs must make a compromise between profitability and nutritional value. From a manufacturer's perspective, this choice is pragmatic. They must ensure that their products remain marketable despite the limited purchasing power of consumers, who are often price-sensitive. In fact, for MSME products to develop further and enter the modern market, criteria for product nutritional quality, product safety, and consumer satisfaction (Fiorentina and Ariyantoro, 2024) are very important.

Therefore, a solution approach based solely on strict supervision will be ineffective. If it only emphasizes sanctions for failing to meet protein standards, MSMEs may struggle to maintain their business continuity. Such an approach fails to consider existing economic pressures and tends to burden small producers without providing concrete solutions to improve product quality. A more effective approach is supportive and based on empowerment or mentoring (Saddam et al., 2022). For example, the government or supporting institutions can facilitate MSMEs' access to more affordable raw materials, such as quality local meat or protein-rich binders. Furthermore, training on efficient product formulation, processing that reduces excess fat, and adjusting meat proportions can help MSMEs improve the nutritional value of products without significantly increasing production costs. Other supportive measures can include providing modern processing equipment or simple technologies that improve product quality consistency. For example, the use of a uniform mixer for meatball dough or a temperature-controlled fryer for nuggets. With a combination of training, facilities, and better access to raw materials, MSMEs can maintain competitive selling prices while improving the nutritional quality of their products.

This holistic approach not only benefits producers but also positively impacts consumers who obtain healthier and more nutritious products. Rouf (2025) stated that to improve the implementation of SNI certification, several recommended policies include: 1) increasing producer and consumer awareness regarding the implementation of product certification, 2) increasing government assistance in

product certification programs by producers, and 3) harmonizing national standard regulations by improving Mutual Recognition Arrangements.

4. Conclusion

The nutritional composition profiles of processed livestock products produced by MSMEs in Kota Argamakmur showed significant variability. This reflects the diversity in raw material use, recipe formulations, and processing methods among businesses. Liver and gizzard stand out for their highest protein content, while nuggets exhibit the highest fat content due to the frying process.

The nuggets have met the Indonesian National Standard (SNI), whereas meatballs did not meet SNI. Overall, these findings confirm the existence of significant quality challenges for MSME processed livestock products in Kota Argamakmur. There is an urgent need for structured interventions in the form of technical guidance, quality control, and policy support to improve the quality, safety, and competitiveness of local products.

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