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The Effect of Cooking Methods on the Characteristics of Various Types of Processed Meat: A review

Solahudin[1], Ainun Nafisah[2]*, Tubagus Bahtiar Rusbana[1], Nurul Annazhifah[1]

[1] Food Technology Study Program, Faculty of Agriculture, University of Sultan Ageng Tirtayasa
[2]Animal Science Study Program, Faculty of Agriculture, University of Sultan Ageng Tirtayasa
Jalan Raya Palka No.Km.3, Sindangsari, Kec. Pabuaran, Kota Serang, Banten 42163
* Email Correspondence: ainunnfsh@untirta.ac.id

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ABSTRACT. *Meat cooking affects the physicochemical and nutritional quality of the final product, which includes various methods such as wet, dry cooking, and a combination of both. This review article discusses the effect of cooking methods on meat characteristics, including the processing of lamb, chicken, beef, and beef se'i sausages. Research shows that cooking methods such as oven, air fryer, steam, and pressure cooker affect the water content, protein, fat, and tenderness of meat. Processing using moist cooking methods such as steaming and sous vide can maintain texture quality and moisture, while dry cooking enhances flavor and strengthens the Maillard reaction. In addition, smoking methods have been shown to affect the chemical, microbiological and organoleptic qualities of products such as beef se'i. Appropriate processing methods can result in products that are optimal in flavor, texture, and nutritional value.*

Keywords: cooking method, food process, meat, lamb sausage

INTRODUCTION

The choice of cooking method has an important influence on determining the final characteristics of processed meat, both in terms of texture, color, aroma, taste, and nutritional value. The cooking process triggers physical, chemical, and biochemical changes in meat tissue, which ultimately affect the sensory quality and acceptability of the product by consumers. Commonly used cooking techniques, such as boiling, steaming, grilling, frying, and high-pressure cooking, each have a unique impact on processed meat. For example, dry heat cooking, such as grilling or frying, encourages the Maillard reaction which produces a brown color and a distinctive, appetizing aroma (Sun *et al*., 2020). Meanwhile, moist heat methods such as boiling and steaming tend to maintain the tenderness and moisture of the meat due to the low evaporation rate (Domínguez *et al*., 2019).

However, cooking methods also have disadvantages. Excessive heating can cause protein denaturation leading to the loss of the desired texture, as well as the degradation of essential vitamins and minerals such as vitamin B complex and iron (Roldán *et al*., 2021). On the other hand, the reduction of fat during dry cooking processes such as roasting provides health benefits, but can reduce the juiciness of the meat, which is an important aspect for consumer satisfaction (Pereira and Vicente, 2018).

Modern technology has brought new innovations in cooking methods to overcome these challenges. For example, the sous-vide technique, which uses low temperatures for a long time, has been shown to maintain nutritional value and provide a soft and uniform texture (Baldwin, 2012). In addition, the air fryer method, which uses hot air flow as a frying medium, offers a healthier low-fat cooking alternative without sacrificing taste (Zhang *et al*., 2021). The application of

technologies such as microwave and high-pressure cooking is also starting to gain attention in meat processing research because of its ability to shorten cooking time while maintaining nutritional quality (Sikes *et al*., 2017).

In addition to modern processed meat products, cooking methods are also an important element in maintaining the uniqueness of traditional products, such as rendang, dendeng, or shredded meat. These products are highly dependent on specific cooking processes to produce distinctive textures and flavors. For example, rendang requires a slow cooking method that not only enhances the flavor but also acts as a natural preservative through repeated heating (Nurdiani *et al*., 2020). In the context of the food industry, choosing the right cooking method is one of the keys to success in increasing the added value of meat products. Research by Domínguez *et al*. (2019) shows that appropriate cooking methods can increase shelf life, reduce production costs, and meet consumer preferences that are increasingly concerned about health and sustainability aspects. Therefore, understanding the effect of cooking methods on meat characteristics is important, not only for large-scale producers but also for small and medium enterprises (SMEs) who want to compete in an increasingly competitive market. Through this study, it is hoped that comprehensive insight can be obtained regarding the role of cooking methods in processing various types of meat products, as well as their development potential to produce high-quality products that meet the needs of modern consumers.

MATERIALS AND METHODS

Literature review with journal review approach is a method used. This method can be done by analyzing the data and results obtained in the article about various cooking method in variour types of processed meat. Physicochemical Characteristics of Various Processed Meats with Different Cooking Methods, The Effect of Steaming, Pressure Cooker, and Roasting Methods on the Characteristics of Minced Beef

RESULT AND DISCUSSION

Meat cooking methods are techniques applied to process meat into safe, delicious, and optimally nutritious food. This method includes various techniques, such as wet cooking, dry cooking, and a combination of both. Wet cooking, such as boiling, steaming, or using slow cooking, uses liquid as a medium for conducting heat. This method is effective for softening meat fibers, especially in parts of the meat that have a lot of connective tissue (Lawrie, 2017). Dry cooking, such as grilling, roasting, or sautéing, uses direct heat without liquid. This technique produces a drier texture on the surface of the meat and enhances the flavor through the Maillard reaction, which is the interaction between amino acids and sugars at high temperatures (McGee, 2004). The combination of wet and dry methods, such as braising (boiling after sautéing), produces tender meat with a rich flavor.

Cooking also affects the nutritional quality of meat. Heating can reduce the content of some water-soluble vitamins, such as vitamin B complex, but increases the bioavailability of protein and fat. Therefore, the choice of cooking method must take into account the type of meat, culinary purpose, and health aspects (Toldrá, 2017). Knowledge of these methods is important in the culinary industry and households to create meat dishes that are optimal in taste, texture, and nutritional value.

Physicochemical Characteristics of Various Processed Meats with Different Cooking Methods

The physicochemical characteristics of processed meat are greatly influenced by the cooking method used, including changes in water content, protein, fat, color, and texture. Cooking methods such as grilling, frying, boiling, or steaming have different impacts on meat due to the influence of heat, pressure, and cooking medium. For example, boiling tends to maintain meat moisture but can cause loss of water-soluble nutrients, such as vitamin B complex and minerals. In contrast, grilling produces Maillard reactions that enhance flavor and aroma, but can cause a reduction in water content and an increase in texture hardness (Park *et al*., 2016).

The frying method usually gives meat a crispy texture on the outside, but has the potential to increase fat content due to oil absorption (Bakar *et al*., 2008). Meanwhile, steaming is considered a healthier method because it can retain more nutrients without adding fat, but produces a softer and less flavorful texture than other methods (Pathare and Roskilly, 2016). Therefore, the selection of cooking methods must take into account the specific objectives of meat processing, both in terms of nutritional value, sensory, and food safety.

The Effect of Steaming, Pressure Cooker, and Roasting Methods on the Characteristics of Minced Beef

Various cooking methods such as steaming, pressure cooking, and roasting have a significant effect on the characteristics of ground beef. Research by Ratnawati (2022) shows that grinding meat for 5 minutes with a steam cooking technique accelerates the drying process of ground beef. The mathematical model that represents the kinetics of meat drying is the Page model with a k value of 0.529–1.178 and n = 1.332–2.088, and an R^2 of 0.974–0.992 and an RMSE of 0.021–0.053. This drying process reduces water activity (Aw) from 0.94–0.97 to 0.11–0.29 in dry conditions. In addition, the cooking method also affects the texture and nutritional value of the meat.

Cooking with the pressure cooker method, which uses high temperatures (up to 120°C) and high pressure (1–2 atm), can make the meat texture softer. This high temperature and pressure are achieved using a pressure cooker. In addition to affecting the texture, the pressure cooker method can also increase the protein content of the meat due to the processing process with salt and high temperatures (Indrajoni, 2023). The roasting method, which involves heating without water, can affect the physicochemical characteristics of the meat. Although specific research on the effect of the roasting method on ground beef is still limited, studies on other food ingredients show that this method can affect the water content, water absorption, and emulsion capacity of the product.

Effect of Oven, Air Fryer, and Steam Methods on Lamb Sausage Characteristics

Lamb meat can be processed into various processed products, one of which is sausage. Processing lamb meat into sausage can extend the shelf life of meat, and can offer interesting product innovations for consumers. In addition, lamb sausage also contains a fairly high source of protein. According to Sivaprasad *et al*. (2023), the level of acceptance of processed meat is influenced by several aspects, including product quality (71.8%), product safety (56%) and trusted sellers (21.7%). In this case, the quality of processed meat products is highly dependent on the processing method used.

Table 1. The results of several studies on the physicochemical properties of processed meat

Product	Methods	Result	Reference
Lamb sausage	P1= oven method P2= air fryer method P3= steamed method	• Water content 62.16% • Fat content 13.11% • Protein content 14.34% • Cooking loss 2.67%	Wibowo *et al.,* 2024
Chicken meat	P1= boiling (temperature 100℃; 30 minutes) P2= steaming (temperature 90℃; 30 minutes) P3= pressure cooking (temperature 110℃; 30 minutes)	• Fat content 1.82% • Protein content 28.51%	Sari, 2023
Ground beef	P1= steam (1, 2, 5 minutes) P2= pressure cooker (1, 2, 5 minutes) P3= roast (1, 2, 5 minutes)	• Aw 0.94-0.97 (cooked ground beef 0.11-0.29 (dry ground beef)	Ratnawati *et al.,* 2022
Beef sausage	Steaming (30 minutes; temperature 70-80℃)	• Cooking loss 2.6% • Binding power 52.15% • Softness 4.15 mm/sec • pH value 6.21	Lenzun *et al.,* 2021
Beef	Frying (100℃; 10, 15, 20 minutes) Boiling (100℃; 10, 15, 20 minutes)	• Protein 4.25% (frying) • Protein 5% (steaming)	Nidianti *et al.,* 2023
Smoked beef	P1= open smoking P2= closed smoking (drum placed on the ground) P3= closed smoking (drum buried)	• Water content 50.21% • Protein 33.46% • Fat 8.34%	Aoetpah *et al.,* 2023
Beef sirloin	Roasting temperature 65-80℃; 10 minutes	• pH 6.27 • Cooking loss 19.56%	Apriantini *et al.,* 2024
Beef	Smoking with various concentrations of liquid smoke from porch wood (*Schleichera oleosa*)	• Water content 10.27% • pH 6.10 • Total phenol 1.20	Meha *et al.,* 2022
Goat satay	Oven roasting	• Water content 64.56% • Tenderness 28.35	Pratama, 2020
Chicken nuggets	P1= frying (T: 160℃, t: 3 minutes) P2= roasting (T: 190℃, t: 5 minutes) P3= boiling (T: 100℃, t: 5 minutes) P4= steaming (T: 90℃, t: 10 minutes)	• Water content 38.29% • Fat content 19.34% • Protein content 6.07%	Azzahra, 2024

The method of processing lamb sausages is carried out using 3 methods, namely, the oven method, the air fryer method, and the steaming method. Based on the results of the study, the cooking method has a significant effect on the water, fat, and protein content in lamb sausages, but does not affect the cooking loss of lamb sausages. The oven cooking method (P3) showed the best results with the highest protein content of 15.22% and the lowest fat content of 12.61%. Meanwhile, cooking with the steaming method can maintain the protein content in sausages where the presence of protein is able to bind water (Anggraini *et al*., 2024). The results of the water content cooked with the oven and air fryer methods were not significantly different because both methods use dry heating which produces a similar water evaporation rate.

The Effect of Different Moist Cooking Methods on the Properties of Chicken Meat

Moist cooking methods such as boiling, steaming, and sous vide can affect the physicochemical properties of chicken meat, including texture, juiciness, color, and nutritional value. Boiling at high temperatures tends to cause greater fluid loss due to water migration from the meat tissue to the cooking medium. As a result, the meat texture becomes tougher and less juicy (Roldan *et al*., 2013). In contrast, steaming, which uses hot steam, tends to retain more fluid and nutritional compounds in the meat because the cooking temperature is more controlled and there is no direct contact with water (Zhang *et al*., 2017). The sous vide method, which involves cooking at low temperatures for a long time under vacuum, is known to be able to maintain the quality of meat texture and moisture better than other methods. This is because low cooking temperatures reduce excessive protein denaturation and fluid loss from the tissue (Baldwin, 2012). In addition, this method also maintains a more natural meat color and maintains nutrients such as protein and vitamins (Keller *et al*., 2018).

This chicken meat processing method is carried out using 3 methods, namely, P1 = boiling (temperature 100 ℃; 30 minutes), P2 = steaming (temperature 90 ℃; 30 minutes), and P3 = pressure cooking (temperature 110 ℃; 30 minutes). The sample is then ground and tested as needed. The variables observed are chemical quality including water content, protein, fat, ash, carbohydrates and meat cholesterol. Physical quality includes pH, binding power, cooking loss and tenderness. Sensory values include color, aroma, texture, tenderness, taste and acceptability. The results of the analysis showed that the cooking method had a significant effect (P<0>2, the taste preferred by the panelists with a score of 3,580.89 and low-fat content with a value of 1,820.75%. The type of crossbred chicken has a fairly high protein content of 28,510.86% and low tenderness of 2,160.89 kg/cm2. Based on the research above, crossbred chicken that is pressure-cooked has a high protein content, low fat content and tenderness and taste preferred by the panelists.

Effect of Steaming Method on Beef Sausage Characteristics

The steaming method has a significant effect on the physicochemical characteristics of beef sausage. Research by Wibowo *et al*. (2023) showed that variations in cooking methods, including steaming, had a significant impact on the water, fat, and protein content of sausages. Sausages cooked using the steaming method had the highest water content of 63.63% and the highest protein content of 15.22%, while the fat

content was lower compared to the oven method.

This shows that steaming can increase the water and protein content and reduce the fat content in beef sausages. In addition, the steaming method is also effective in maintaining the nutrition and taste of meat, and reducing the risk of carcinogenic compounds that can occur in high-temperature cooking methods. Thus, choosing the steaming method as a cooking technique for beef sausages can produce products with better physicochemical quality and are healthier for consumers. The results of the study by Lenzun *et al*. (2021), showed the results of cooking loss of 2.6%, binding power of 52.15%, tenderness of 4.15 mm/sec, and pH value of 6.21.

Effect of Frying and Boiling Methods on Beef Characteristics

Beef processing methods, such as frying and boiling, have a significant impact on the physical and chemical characteristics of meat, including protein, fat, and organoleptic quality. Research by Nidianti *et al*. (2023) showed that variations in frying and boiling time at 100°C for 10, 15, and 20 minutes did not significantly affect the protein content of beef. However, the frying method tends to increase fat content due to oil absorption during the cooking process, while boiling can reduce fat content due to fat dissolution into the cooking water.

In addition, research by Suprapto (2018) compared various frying methods on the physical, chemical, and organoleptic qualities of processed chicken meat products. The results showed that the deep fat frying method produced products with better quality than the pan-frying method, especially in terms of texture and taste. Thus, choosing the right cooking method and duration is very important to maintain the nutritional and sensory quality of beef. Frying can increase fat content due to oil absorption, while boiling can reduce fat content by dissolving it into the cooking water. Therefore, consumers and the food industry need to consider cooking methods that are in accordance with nutritional goals and desired taste preferences.

Effect of Smoking Method on Characteristics of Smoked Beef

The smoking method has an influence significant to the chemical characteristics and organoleptics of cows. Research by Aoetpah *et al*. (2023), comparing three methods fumigation: open fumigation, fumigation covered with the drum on the ground, and closed smoker with embedded drum in the ground. The research results show that the smoking method has a big influence real impact on water, protein, and fat; real effect on color; but did not have a significant effect on aroma, taste and tenderness. Fumigation with a closed system and embedded drum produces smoked beef with a dark red color, while open smoking produces brown.

In addition, research by Tandri *et al*. (2023) examined the microbiological quality, fat oxidation, antioxidant activity, and cholesterol of smoked beef using different methods. The results showed that the smoking method had a significant effect on total plate count (TPC), antioxidant activity, and fat oxidation, but did not significantly affect cholesterol levels. The closed smoking method with a drum planted effectively reduced microbial contamination levels and increased antioxidant activity. Another study by Sabtu and Suryatni (2023) evaluated the effects of smoking duration on pH, cholesterol levels, and Staphylococcus aureus and Bacillus cereus bacterial contamination in smoker beef products added with red yeast rice and stored cold. The results of the study showed that the longer the

smoking process, the pH value and cholesterol content of the product decreased, but the number of S. aureus and B. cereus bacteria remained the same. The smoking time of 55 minutes was considered optimal with a pH of 4.54 and a cholesterol content of 55.4 mg/dl, and total bacteria within safe limits for consumption.

Overall, the smoking method and duration affect the chemical, microbiological, and organoleptic quality of smoked beef. The closed smoking method with a planted drum tends to give better results in terms of color, reduced microbial contamination, and increased antioxidant activity. The optimal smoking duration, such as 55 minutes, can reduce pH and cholesterol levels without increasing bacterial contamination. Choosing the right smoking method and duration is very important to produce smoked beef with the desired quality. The results showed that the smoking method had a significant effect on the water, protein, and fat content of smoked beef. In general, the closed smoking method (P2 and P3) tends to produce smoked beef with lower water content, and higher protein and fat content compared to the open smoking method (P1). This is due to the more controlled closed smoking environment, so that the dehydration process and smoke penetration are more effective. This study emphasizes the importance of choosing the right smoking method to achieve the desired chemical characteristics of smoked beef.

Effect of Roasting Method on Sirloin Beef Characteristics

The roasting method has a significant effect on the characteristics of sirloin beef, especially in terms of pH, texture, and organoleptic quality. Research by Purwasih (2019) showed that variations in roasting time did not significantly change the pH of beef. However, in terms of organoleptics, panelists preferred meat that was roasted longer, with the highest ratings for taste, aroma, texture, appearance, and preference at a roasting time of 10 minutes at 200°C. In addition, research by Alghifary *et al*. (2023) found that the addition of marinade spices, such as torch ginger, can increase antioxidant activity and affect the pH of roasted meat, water, although it does not have a significant impact on malonaldehyde levels. Thus, the method and duration of roasting, as well as the use of marinades, play an important role in determining the physical and sensory quality of roasted sirloin beef.

The results of the study by Apriantini *et al*. (2024), grilled meat at a temperature of 65-80°C for 10 minutes produced a pH of 6.27 and a cooking loss of 19.56%. Related research shows that the temperature and duration of grilled meat affect the pH and cooking loss of meat. According to Soeparno (2015), a higher cooking temperature can increase cooking loss because more meat fluid is lost until it reaches a constant level. In addition, research by Rakhmat (2012) found that the use of higher frying temperatures and longer times can improve the texture and reduce the pH of fried chicken meat. Thus, roasting at 65-80°C for 10 minutes produced pH and cooking loss that were in accordance with the findings of previous studies, where increasing temperature and cooking time affected the pH and cooking loss of meat.

Effect of Smoking with Various Concentrations of Liquid Smoke from Serambi Wood (*Scleichera oleosa*) on Beef Characteristics

Smoking beef using liquid smoke from Kusambi wood (*Schleichera oleosa*) has been studied to understand its effects on meat characteristics. This liquid smoke contains phenolic compounds that function as natural antioxidants and preservatives, which can affect the organoleptic quality and chemical composition of beef. In a study conducted by Sarifudin (2023), the use of grade 2 liquid

smoke from Kusambi wood at concentrations of 0.5%, 2.5%, and 7.5% showed an increase in the organoleptic quality of beef se'i meat, including color, aroma, taste, and texture. In addition, there was a decrease in the number of Salmonella bacterial colonies, indicating the antimicrobial effect of the liquid smoke. Lopi *et al*. (2014) also reported that the use of liquid smoke kusambi at a concentration of 12% can increase the protein content and taste of beef se'i, and reduce the water, fat, and cholesterol content. This study shows that the right concentration of liquid smoke can increase the nutritional value and taste of meat.

In addition, Mekarsari *et al*. (2017), found that the combination of liquid smoke from wood and kusambi leaves at certain concentrations can reduce fat content, increase aroma, and maintain protein content of smoked beef. The best combination was found in treatment with 50% liquid smoke from wood and 50% from kusambi leaves. Research by Meha *et al*. (2022) shows that increasing the concentration of liquid smoke from kusambi wood can reduce the water content and pH of beef, and increase total phenol activity. However, higher concentrations can increase panelists' acceptance of color, taste, texture, and level of preference for meat. Overall, the use of liquid smoke from kusambi wood at the right concentration can improve the organoleptic quality and chemical composition of beef, and has beneficial antimicrobial effects. However, concentrations that are too high can negatively affect the characteristics of the meat. Therefore, further research is needed to determine the optimal concentration that can be applied in the beef processing industry.

The results of the study by Meha *et al*. (2022), liquid smoke from kesambi wood (Schleichera oleosa) is a condensation product from burning wood that is rich in phenolic compounds, acids, and other bioactive components. The phenol content in liquid smoke plays an important role in providing a distinctive taste and antimicrobial properties to smoked food products. The phenol content in liquid smoke from kesambi wood can vary depending on the manufacturing method and combustion conditions. In a study conducted by Meha *et al*. (2022), different concentrations of liquid smoke from kesambi wood affected the physicochemical and organoleptic properties of beef jerky. The results of the study showed that increasing the concentration of liquid smoke could reduce the water content and pH of the jerky, and increase the total phenol activity. In addition, higher concentrations of liquid smoke could also increase panelists' acceptance of the color, taste, texture, and preference of beef jerky.

In addition, research by Utama *et al*. (2022) showed that variations in temperature and duration of combustion in the manufacture of liquid smoke affected the yield, pH, acetic acid content, and phenol content. Liquid smoke produced at a temperature of 400°C with combustion for 3 hours had an average pH of 2.65 and a phenol content of 3.76 ppm. In general, smoking with a higher concentration of kesambi wood liquid smoke can increase the phenol content in food products, which contributes to improved flavor and antimicrobial properties. However, it should be noted that increasing the concentration of liquid smoke can also affect the physicochemical and organoleptic properties of the product, so adjustments need to be made to achieve the desired quality.

The Effect of Oven Roasting Method on the Characteristics of Goat Satay

Grilling goat satay using an oven can affect various product characteristics, including tenderness, water content, and doneness. A study by Jannah (2020) revealed that grilling temperature and time have a significant effect on the tenderness of goat satay. However, the study did not specifically discuss the use of an oven in the grilling process. In addition,

research by Adiyastiti *et al*. (2014) showed that the duration of grilling and the type of fuel affected the sensory quality and levels of benzo(a)pyrene in goat satay. However, this study also did not specifically discuss the use of an oven in the grilling process. In the context of oven use, research by Triyannanto and Mahardika (2011) discusses the optimization of satay grilling equipment by adjusting the airflow speed. Although not directly using an oven, this study provides insight into how airflow regulation can affect the physical characteristics of goat satay.

Grilling goat satay using an oven can affect the water content and tenderness of the meat. In a study conducted by Jannah (2020), grilling goat satay at a temperature of 200°C for 3 minutes produced an average water content of 65.59% and a tenderness value of 20.45 N. This study shows that temperature and grilling time have a significant effect on tenderness, but do not have a significant effect on water content and meat maturity. In addition, a study by Khoirunisa Zahrawani (2023) examined the effect of marinating with ginger juice on the physical and sensory quality of goat satay. The results showed that marinating with ginger juice had a significant effect on the water binding capacity of goat satay, but did not have a significant effect on pH, tenderness, color, texture, and acceptability of goat satay.

Another study by Bayu Etti Tri Adiyastiti (2014) examined the effect of burning time and type of fuel on the chemical, physical, sensory quality, and benzo(a)pyrene levels of goat meat satay. The results showed that the burning time had a significant effect on the water, protein, and ash content of goat meat satay, and had a significant effect on the tenderness value. However, the type of fuel did not have a significant effect on the water, protein, and ash content of goat meat satay. The results of a study conducted by Pratama (2020) showed that grilling goat satay using an oven produced a water content of 64.56% and a tenderness of 28.35 N. This high-water content indicates that goat meat grilled in an oven tends to be more-moist compared to other grilling methods. The tenderness of the meat recorded at 28.35 N indicates the level good tenderness, although this value is small higher than the tenderness value found in other studies.

Effect of Frying, Roasting, Boiling, and Steaming Methods on Chicken Nugget Characteristics

Processing methods such as frying, baking, boiling, and steaming have a significant influence on the characteristics of chicken nuggets, both in terms of texture, taste, nutritional content, and other sensory qualities. Frying, for example, tends to produce nuggets with a crispier texture on the outside and softer on the inside, because the oil used can affect the process of forming the crispy outer layer. However, frying can also cause a decrease in nutritional content, especially fat content and oil-soluble vitamins (Ockerman & Basu, 2004). Conversely, roasting using high temperatures but without additional oil produces nuggets with a denser texture and a more distinctive taste, but tends to have a lower fat content than frying (Paniagua *et al*., 2017). Boiling and steaming can maintain the softness of chicken nuggets and maintain higher nutritional content such as protein and vitamins because the processing process is softer and does not involve oil. However, this process can cause the texture of the nuggets to become wetter or chewier (Mohan *et al*., 2013). In addition, this processing method can maintain the softness and moisture of the product because of the presence of water vapor that maintains the structure of chicken meat, although it can reduce the presence of a stronger roasted flavor that usually results from grilling or frying (Sárraga *et al*., 2015).

The results of Azzahra's (2024) research, showed that processing chicken nuggets using frying, baking, boiling, and steaming methods

produced a water content of 38.29%, a fat content of 19.34%, and a protein content of 6.07%. Frying at a temperature of 160℃ for 3 minutes (P1) tends to produce nuggets with a higher fat content because the oil used can increase the fat content in the product, while the water content can decrease due to the evaporation process during frying (Arias *et al*., 2007). Roasting at a temperature of 190℃ for 5 minutes (P2) produces nuggets with a lower water content because high temperatures cause water evaporation faster. However, the fat content remains relatively low because it does not use oil in this process (Paniagua *et al*., 2017). The boiling method (P3) at a temperature of 100℃ for 5 minutes and steaming (P4) at a temperature of 90℃ for 10 minutes tend to maintain higher water content because it is a gentler process, but the fat and protein content can be better maintained because no oil is used in the process (Mohan *et al*., 2013; Sárraga *et al*., 2015). The measured protein content of 6.07% reflects the nature of chicken as a high protein source (Ockerman and Basu, 2004).

CONCLUSION

Cooking methods have a significant impact on the physicochemical and nutritional quality of meat products. The use of wet cooking methods such as steaming and sous vide can maintain better moisture and texture of meat, while dry cooking methods such as ovens or air fryers enhance flavor through the Maillard reaction, but can reduce the water content in the meat. Smoking, which is used in the manufacture of products such as smoked beef, has been shown to improve flavor as well as microbiological and chemical quality. Choosing the right cooking method is essential to obtain the best quality meat products, both in terms of taste, texture, and nutritional value. Therefore, various cooking techniques must be selected by considering the end goal in the manufacture of processed meat products.

CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material discussed in the manuscript. Conflicts of Interest should be stated in the manuscript.

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