Original Research Article

THE NUTRITIONAL QUALITY OF SEMPOL WITH DIFFERENT MEAT VARIANTS

ABSTRACT

Aims: This study aims to examine the effect behind the use of different types of meat on the chemical and organoleptic properties of sempol.
Study design and Methodology: It employed an experimental method with Fully Randomized Design (FRD) in three treatments, each of which was applied to DA (chicken), DS (beef), and DK (lamb), and repeated four times each. The observed variables were chemical composition (moisture, protein, fat, ash, and carbohydrate content), organoleptic quality (taste, aroma, texture, and color), microstructure, and element composition of sempol.
Place and Duration of Study: It was conducted in March - April 2022 at West Waru, Pamekasan for sempol production, Nutrition Laboratory of UMM for testing the chemical content,BioScience Laboratory of Universitas Brawijaya for SEM testing.
Results: The study provided a significant effect (P<0.05) on the physicochemical composition except fat and protein(P>0.05), due to the physicochemical content of the meat used. The average physicochemical value of moisture is 58.22%, ash 3.06%, fat 23.76%, protein 10,81%, and carbohydrate 35,38%. The physicochemical content of sempol meets SNI 2014 standards except for fat and carbohydrate. Based on sensory properties, panelists prefer sempol using chicken. The use of different meatto sempol did not provide a significant effect (P>0.05) on organoleptic taste, aroma, and texture, except color. Meanwhile, the microstructure of sempol beef has a better shape. The cavity surface tissue forms more uniformly and creates a fibrous three-dimensional metric compared to that of chicken and lamb. Some of the elements detected in sempol beef are carbon (C), oxygen (O), sodium (Na), silicon (Si), sulfur (S), chlorine (Cl), potassium (K), and zirconium (Zr). The most complete elementis detected only in sempol lamb.
Conclusion: The use of different types of meat for sempol products has met the SNI quality standards in terms of physicochemistry and organoleptic.

Keywords: Beef, chicken, chemical quality, lamb, organoleptic

1. INTRODUCTION

Meat is a food product with high protein value, containing complete and balanced essential amino acids[1]. It is, therefore, the ideal medium for the growth of microorganism, thus categorized as perishable food[2]. To prevent the perish, we can make sempol product from it. Sempol is a finely ground meat processed product, mixed with spices, tapioca flour and wheat flour, then wrapped around a 30 cm long bamboo skewer, boiled, fried half cooked,

Comment [EO1]: Delete

Comment [EO2]: aimed

Comment [EO3]: delete

Comment [EO4]: Bioscience

Comment [EO5]: This should be small letter "p". Apply this in all the articles where necessary.

Comment [EO6]: This should be small letter "p".

Comment [EO7]: "was". Please, note that your report should be in past tense because you already did the research.

Comment [EO8]: This should not be a comma, but a "period".

Comment [EO9]: This should not be a comma, but a "period".

Comment [EO10]: What is the full meaning of this, please always mention a word before using the abbreviation in a statement. Again, is that supposed to be a citation?

Comment [EO11]: preferred

Comment [EO12]: with

Comment [EO13]: types

Comment [EO14]: in

Comment [EO15]: were

Comment [EO16]: What do you mean by "complete element"?

Comment [EO17]: was

Comment [EO18]: delete

Comment [EO19]: I suggest you re-visit your conclusion. Your conclusion should be from the research you did. The product meeting any standard should be an additional statement.

Comment [EO20]: To reduce meat spoilage or prolong the shelf life, meat products such as sempol can be produced from meat.

dipped in egg solution, then fried again with hot oil. Sempol is a meat restructured product modified with the presentation of fried foods that use cooking oil as an introduction to heat. Sempol frying process with high temperatures can cause damage to amino acids that affect changes in the chemical composition and sensory of sempol[3].

It can be made from chicken, beef, lamb, and other meat. Among the widely used meat in the production of sempol is chicken because it is easy to find and the price is affordable. Based on information from Directorate General of Animal Husbandry and Animal Health, chicken production in Indonesia in 2021 amounted to 3,426,042 tons, greater than beef by 437,783 tons, and lamb by 61,724 tons[4]. The use of chicken, beef, and lamb exerts different consequences to the resulting product, which can be influenced by the characteristics of each meat.

Chicken (DA) has a good source of animal protein, contains complete essential amino acids in a balanced ratio, and has fat of 12.12%[5]. It might provide a distinctive taste and aroma, as well as a soft texture. Beef (DS) has connective tissue and protein of 18.26%[6].Beef protein plays a major role as a binder and emulsifie, so it can bind moisture and fat, by which the aroma, texture, and distinctive taste imroves. Lamb (DK) has a darker color and smooth fiber, and contains a low fat (8.35%)[7]. It can affect the hard and chewy texture of sempol products. Each type of meat provides a source of diversity, so different meat may produce varied quality of sempol.

Producing sempol with different types of meat (chicken, beef, and lamb) is expected to contribute to its diversity of chemical and organoleptic properties.

2. METHODOLOGY

2.1. Research methods

Sempol was produced in West Waru, Pamekasan, East Java. The research was conducted at the Livestock Product Technology Laboratory, Faculty of Animal Husbandry, Universitas Brawijaya from March-April 2022.

It used an experimental method with fully random design in three treatments, and 4 replications to obtain 12 experimental units from P1 (sempol chicken), P2 (sempol beef), and P3 (sempol lamb). The formulation of producing sempol with different types of meat still refers to the manufacture of chicken nuggets combination with 23% minimum percentage of meat[8]. The following is the formulation of sempol after Trial and Error Test presented in Table 1. The process of producing sempol Figure 1.

Table 1. Sempol formulations with different types of meat

Material	Composition		
	P1	P2	P3
Chicken (gr)	46	-	-
Beef (gr)	-	46	-
Lamb (gr)	-	-	46
Tapioca flour (gr)	100	100	100
Wheat flour (gr)	5	5	5
Egg (gr)	45	45	45
Garlic (gr)	15	15	15
Red onion (gr)	15	15	15
Onion (gr)	15	16	15
Salt (gr)	5	5	5
Pepper (gr)	0.6	0.6	0.6

Comment [EO21]: other types of meat.

Comment [EO22]: ,

Comment [EO23]: delete

Comment [EO24]: I suggest you introduce your sample codes (for example: Lamb - DK), under **2.1. Research methods,** and not under the Introduction section of the article.

Comment [EO25]: For instance, you can write it this way, "In this study, the samples are coded as chicken (DA), Lamb (DK) codes , and so on.

Comment [EO26]: So please, delete all the samples codes you added in the last part of the Introduction section.

Comment [EO27]: emulsifier

Comment [EO28]: improves.

Comment [EO29]: Delete comma

Comment [EO30]: Trial-and-Error

Comment [EO31]: The process of producing sempol is shown in Figure 1.

Sugar (gr)	2.5	2.5	2.5
Total	**250**	**250**	**250**

Description: The percentage of meat refers to the douch weight

2.2. The process of making sempol

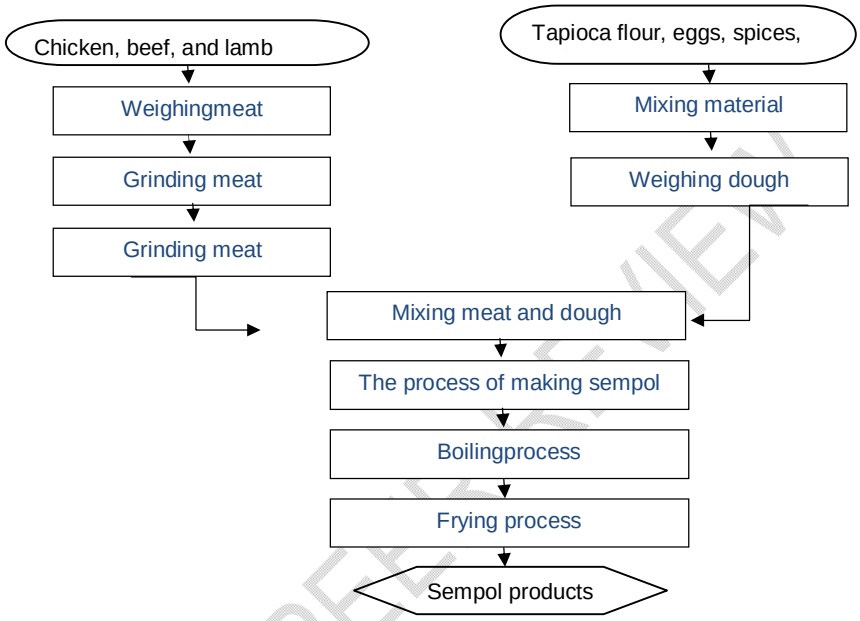

Figure 1. The process of making sempol with different types of meat

2.3. Research Variable

The moisture content was calculated on the basis of the weight lost during heating in the oven at a temperature of (125 ± 1) °C. The ash content was calculated based on its weight formed during combustion in the furnace at 550 ± 5°C until white ash was formulated. The fat was hydrolyzed in the sample using HCl and then extracted with petroleum ether. The petroleum ether extract obtained was evaporated to dry, and the fat was calculated in gravimetric. Samples were destroyed to release nitrogen from proteins as ammonium salts. The ammonium salt was decomposed into NH3 at the time of distillation using NaOH. NH3 released and bound with boric acid produced ammonium borate, which was quantitatively titrated with acid raw solution to obtain total nitrogen. The protein was obtained from the product of total nitrogen with 6.25. Carbohydrates were made by difference, the reduction result of 100% with moisture, ash, protein, and fat so that the carbohydrate depends on the reduction factor [8].

Comment [EO32]: What do you mean by "destroyed"? Is this the right word to use in this statement. OR do you mean to write "the samples were **digested**?

Organoleptic test was conducted by hedonic test method as a scientific measure with human senses, the sense of taste to know the taste, the sense of smell to know the aroma, the sense of touch to know the texture, and the sense of sight to see the color. The test adopted hedonic method with a scale of 1-5 from extremely like to extremely dislike. The sample was randomly presented to 30 untrained panelists to give assessment[9].

It used SEM (Scanning Electron Microscopy) to determine the pore size and morphology of the composite and used EDX (Energy Dispersive X-Ray) to analyze the chemical elements or characteristics of a material. The pore morphology of sempol composites with different types of meat was also compared with the morphology of the fibers that had been activated. The characterization was completed with the SEM-EDX instrument. The working principle of Scanning Electron Microscopy (SEM) is utilizing an electron beam to interact with the sample and scan the entire surface of the sample. As a result, the sample will emit new detectable electrons. The results captured by detector are then sent to the monitor so that the monitor translates the information in the form of sample surface topography[10].

Comment [EO33]: Delete

Comment [EO34]: was used to determine the pore size and ...

2.4. Statistical Analysis

The Data obtained from the study results were analyzed using Analysis of Variance (ANOVA). If the result of data analysis indicated that the value of Fcount < F table 0.05, the treatment of the use of different types of meat is not significantly different (P>0.05), so the data analysis is not performed with Duncan's Multiple Range Test (MRT). If it showed the value of Fcount > F table 0.05, the use of different types of meat proved significant differences (P<0.05). Furthermore, to determine the differences among treatment levels, it is necessary to further examine with Duncan's Multiple Range Test (MRT).

Comment [EO35]: Small letter "d"

Comment [EO36]: small letter

3. RESULTS AND DISCUSSION

3.1. Chemical Composition of Sempol

The results of printing average moisture, ash, fat, protein, and carbohydrate of sempol with different types of meat are available in Table 2.

Table 2. The average moisture, ash, fat, protein, and carbohydrate of sempol with different types of meat.

Treatment	Parameters				
	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrates (%)
DA	59.27 ± 6.58^{a}	3.69 ± 0.23^{a}	24.39 ± 1.14^{a}	11.00± 0.37^{a}	36.86 ± 0.98^{a}
DS	58.95 ± 0.50^{b}	2.38 ± 0.23^{b}	23.73 ± 1.08^{a}	10.80 ± 0.53^{a}	37.11 ± 0.57^{b}
DK	56.44 ± 0.87^{b}	3.10 ± 0.36^{c}	23.15 ± 2.20^{a}	10.63 ± 0.56^{a}	35.38 ± 0.56^{b}

a,b,c different superscripts on the same line show a noticeable difference (P<0.05).

Comment [EO37]: Endeavor to decode the sample codes under the Table 1 with their full meaning. For instance, DA (chicken), and so on.

3.2. Moisture of Sempol

Comment [EO38]: Change to small letter "p"

Comment [EO39]: Moisture content of Sempol

The variety analysis demonstrated that different types of meat in sempol products have a significant effect (P<0.05) on the moisture content of sempol products. The treatment of DA is significantly different from that of DS and DK; the treatment of DS is significantly different from that of DA and is not significantly different from that of DK; the treatment of DK is significantly different from that of DA and is not significantly different from that of DS. It is contrary to the research result by Ahmadi et al that the use of this type of meat in the raw material for meatballs does not affect the meatball moisture content[11]. The study found

that moisture of sempol with different types of meat goes into an average value of 56.44% – 59.27%. The high moisture in DA treatment might be caused by the higher moisture in chicken than than that in beef and mutton. The high moisture of meat will remove a lot of water bound in the meat[12]. Therefore, the high moisture within food can decompose the food substances into water and increase moisture in the product produced. The low moisture in the sample code DK is influenced by the low moisture and protein level bound in the lamb. The protein within the lamb is 18.72% [13]. The protein plays as an emulsifer and has a compact structure in binding water, so the lower the ability of the proteins to bind water, the lower the percentage of water bound in sempol. It affirms the finding of Khasrad et al those high levels of meat protein lead to increased ability to bind water so as to lower the free moisture, and vice versa[14].
The moisture of sempol with different types of meat ranges from 56.44% - 59.27% w/w. It can meet the quality standards of SNI 2014 about chicken nugget combination with a maximum limit of moisture in 60% w/w.

Comment [EO40]: Add the year of publication too

Comment [EO41]: led

3.3. Ash Content of Sempol

The variety analysis demonstrated that different types of meat in sempol have a significant effect (P<0.05) on the ash content of sempol products. All the treatments of DA, DS and DK provided a noticeable difference. The results of the analysis on the ash content of sempol with different types of meat showed an average value between 2.38% – 3.69% w/w. The highest ash content was obtained in the DA sample code, and the lowest was found in the DS sample code. The ash content of sempol was perceived to be caused by the organic matter and minerals bound inside the meat. Qurniawan et al argued that the meat poses minerals that can increase the ash content in the resulting product[15]. The ash in the lamb is 1.11% [16]. The mixture of foodstuffs in the production of sempol also affects the ash content of sempol because they contain minerals and inorganic. Inorganic or mineral components inside the foodstuffs can increase the production of ash content [17]. The process of boiling and frying sempol products affects the content of ash content of sempol because during the cooking process they will release organic matter and minerals out dissolved in water. It goes in line with the idea of Andika et al that the lower the concentration and cooking temperature, the lower the value of the ash content produced. This occurs due to the release of minerals dissolved in water[18].
The lowest ash content inside sempol is found in DK (2.38%), and the highest ash content is found in DA 3 (69%) (Table 2). The ash content in SNI 2014 on the combination nugget is not listed, so comparison is not required.

Comment [EO42]: The results showed

Comment [EO43]: delete

Comment [EO44]: Inorganic components.

3.4. Fat of Sempol

The fat of sempol with different meat from each treatment varies: that of DA is 24.39%; DS is 23.73%, and DK is 23.15%. THe variety analysis proved that different types of meat exert no significant effect (P>0.5) on sempol fat content. It does not agree with the finding of Rahim Taha et al that the use of different types of meat as fillers affect the fat of ilabolu[3]. The results of the variety analysis of sempol with different types of meat demonstrated that the average value of the lowest fat content lies in the treatment of lamb (DK), which is 23.15%, while the highest fat content lies in the treatment of chicken (DA), 24.39%. The fat level of sempol is influenced by the type of meat used because the fat of chicken is higher than that of lamb. Therefore, the higher the fat of the meat, the higher the fat of sempol. According to Rahmadaeni et al, the fat of broiler chicken is 12.12%[5], while that of lamb is 8.56% [12]. In addition, a long processing with high temperature can cause damage to fat bound within food because fat functions as a heat conducting medium that causes the product emulsion to break and absorb more during the frying process. It agrees with the idea of Basuny et al

and Dhanapal et al that the shrinkage of the fat is affected by the rupture of the emulsion which causes the tissue fluid to be lost during the cooking process[19][20].
Sempol fat with different types of meat ranged from 23.15% - 25.39% (Table 2). Referring to the SNI 2014 on meat nugget combination, the maximum limit of fat is 20% w/w. Therefore, the fat of sempol with different types of meat approaches the quality requirements of SNI on all treatments.

3.5. Protein of Sempol

The results of statistical analysis of sempol with different types of meat proved no significant difference (P>0.05) to the protein content of each treatment, DA 11.00%, DS 10.80% and DK 10.63%. It does not agree with the finding of Rahim Taha et al that the use of different types of meat as fillers affect the fat of ilabolu[3]. The test result of sempol protein levels is available in table 2. The highest protein content in sempol products with different types of meat is found in the treatment of chicken (DA) 11.00%, and the lowest is in the treatment of lamb (DK) 10,63%. It is influenced by the protein bound inside the meat used. The protein inside the meat as the raw materials affects the protein of the resulting product[11]. The protein content of chicken is higher compared to that of the lamb. The protein of chicken is 33.03% while the protein of lamb is 29.59%[21]. Protein in meat plays as a binder for the damage of meat that can form a compact structure. Therefore, the higher the protein content of meat, the higher the levels of protein produced in sempol products, and vice versa. The cooking process can also affect the low protein content in sempol products due to protein denaturation during the boiling and frying process. Inarest stated that protein denaturation can performed in various ways, such as by heat, pH, chemicals, mechanics, and so on[22]. Water-soluble protein will break down due to boiling, thereby reducing protein levels [3].
The protein of sempol with different types of meat ranged from 11.00%. - 10.63% (Table 2). Meanwhile, the minimum limit of quality standard protein of meat nuggets combination according to SNI 2014 is 9%. Therefore, the use of different types of meat in sempol have met the quality standards of SNI 2014 based on protein content.

3.6. Carbohydrate Levels of Sempol

The results of the variety analysis demonstrated that the use of different types of meat in sempol has a significant effect on its carbohydrate content (P<0.05) in each treatment, D-A is 36.86%, D-S is 37.11%, and DK is 35.38%. The treatment of DA is significantly different from that of DS and DK; the treatment of DS is significantly different from that of DA and is not significantly different from that of DK; the treatment of DK is significantly different from that of DA and is not significantly different from that of DS. The result showed that the average value of carbohydrate content ranged from 35.38% to37.11%. The highest carbohydrate is obtained from beef treatment (DS) while the lowest one is found in lamb (DK). It happens because the carbohydrate content of each meat is relatively different. The carbohydrate of beef is much higher than that of lamb, and it causes the levels of carbohydrate in sempol products. The carbohydrate of beef reaches 3.78%[23]. while that of lamb is 0.5%[24]. Tapioca flour filler material affects the carbohydrate content of sempol because it has amylose and amylopectin properties. When it is poured into water, the starch granules will absorb and swell to make it hard and sticky. Lekahena stated that tapioca flour helps the gel formation process by binding water during the blending and cooking process[25].
Sempol carbohydrate content with different types of meat has the lowest value of 35.38% in DK samples and the highest of 37.11% in DS (Table 2). According to SNI 2014, the maximum carbohydrate of meat nugget combination is 25% w/w. Therefore, sempol

Comment [EO45]: showed

products with different types of meat do not meet the quality standards of SNI 2014 in all treatments based on the carbohydrate levels.

3.7. Sempol Organoleptic Test with Different Types of Meat

The analysis results of the effect of the use of different types of meat on organoleptic characteristics of sempol, which includes taste, aroma, texture and color, can be seen in Table 3.

Table 3. The average organoleptic value of taste, aroma, texture and color of sempol products with different types of meat.

Treatment	Parameters			
	Taste (%)	Aroma (%)	Texture (%)	Color (%)
DA	4.50[a]	4.30[a]	4.50[a]	4.37[b]
DS	4.50[a]	4.50[a]	4.50[a]	4.50[a]
DK	4.50[a]	4.50[a]	4.50[a]	4.37[b]

a,b,c Different superscripts on the same line show a noticeable difference (P<0.05).

3.8. Taste of Sempol

The highest taste indicators (4.50%) in sempol with different types of meat is found in the use of chicken (DA), and the lowest (4.13%) lies in the use of beef (DS). The result of statistical analysis on the hedonic taste of sempol shows no significant difference (P>0.05) between the treatment of DA (4.50%), DS (4.13%), and DK (4.37%) (Table 3).
The most preferred taste of sempol by the panelists is sempol which uses chicken because chicken has the highest source of protein compared to beef and lamb. The protein of fresh broiler chicken is 33.03% [21]. The use of chicken mixed with fillers can lead to interaction of food constituent components, such as protein, fat and other components that may cause chemical reactions to create a distinctive and good taste of sempol. The taste is influenced by the use of chicken and seasonings [26]. Ismanto et al content that the combination of food ingredients can cause chemical reactions that can create a distinctive taste to the resulting product[27].

3.9. Aroma of Sempol

The highest aroma average of sempol (4.50%) is found in the use of chicken (DA), and the lowest (4.13%) lies in the use of beef (DS). The result of hedonic statistical test of the aroma of sempol showed no significant effect (P>0.05) on the sempol aroma of chicken (4.30%), beef (4.03%), and lamb (4.07%) (Table 3).
Panelists prefer the aroma of sempol with chicken because the fat of chicken is higher than that of beef and lamb. The fat of chicken is 12.12%[5]. The meat that contains a lot of fat will cause flavor aroma of sempol at the time of the cooking process because the evaporation raises the volatile compounds of sempol. The process of releasing fat bonds is caused by the influence of spices, temperature, and cooking process that causes aroma[28]. The aroma of sempol can also be influenced by additional ingredients used during the production process, such as seasonings and fillers, because the bound fat and protein do not completely come out during cooking. Ismanto et al.,states that proteins and fats are bound by transglutaminase because the precursor aroma of meat does not come out much during cooking[27].

Comment [EO46]: The highest mean value for aroma of sempol (4.50%) was found in sample DA, while sample DS had the lowest (4.13%) mean value for aroma.

Comment [EO47]: preferred

3.10. The Texture of Sempol

The texture of sempol has an average value of 4.03% - 4.17%. The highest value was found in the treatment of sempol with chicken (DA) and the lowest was in beef. The results of statistical tests of hedonic texture of sempol with different types of meat showed no significant difference (P>0.05) on all treatments DA 4.17%, DS 4.03%, and DK 4.13% (Table 3). This does not agree with the research result of kho et al, that the use of different types of meat affects the texture of meatballs[11].
Panelists prefer the texture of sempol chicken because the texture is softer and smoother than that of sempol with beef and lamb which is chewy. It is influenced by the bonding mechanism of starch with chicken protein when mixing the filler material, resulting in the extraction process of chicken meat protein that might be fused during the cooking process. This finding agrees with the argument of Putri that chicken proteins can coalesce during cooking[26]. Rosita et al, also argue that the coagulation of proteins, the release of water and starch gelatinase can affect the texture of meat processed products. The chewy texture of sempol is influenced by the use of beef because beef has a high fiber content that can cause high emulsion[29]. Beef has myosin protein that can form gel formation, resulting in a chewy texture. Myosin protein is contained in beef [30].

Comment [EO48]: values that ranged from 4.03% - 4.17%.

Comment [EO49]: This is a probability symbol and should be written in small letter. Effect this in all the pages of this article where necessary.

3.11. The Color of Sempol

The average level of panelists' preference for the color of sempol products with different types of meat obtained the results ranged from 3.73% – 4.37% (dislike - extremely like). The highest value was obtained in the treatment of sempol with chicken (4.37%) and the lowest was in the treatment of sempol with beef (3.73%) (Table 3). The variety analysis showed that sempol with different types of meat has a very significant effect on the color of sempol (P<0.05). The treatment of DA is significantly different from that of DS but not significantly different from that of DK. DS treatment is significantly different from that of DA and DK. The treatment of DK is not significantly different from that of DA but significantly different from that of DS.
The sempol color preferred the most by the panelists is the color of sempol chicken because it has a golden yellow color while sempol beef and lamb have a blackish brown color, which is influenced by the ioglobin inside the meat. The color of chicken is yellowish white, and the color of beef is dark red [31][32]. Sempol color is also influenced by the duration of the frying process because it experiences the interaction of polysaccharides and proteins that can prevent the components in the product along with the duration of the cooking process. The interaction of polysaccharides and proteins can prevent the components in the product, especially those that are sensitive to heat, one of which is fat [33]. The cooking process can cause discoloration to brown [26].

Comment [EO50]: Please, these codes should be written as for instance "sample DA" or "sample DS", and so on. You don't just have to write it as DA or DS. Please, take note of this, and kindly effect the correction in all the pages of this article where needed.

3.12. The Test Results of Scanning Electron Microscopy (SEM)

SEM is a tool that can be adopted to see the surface morphology of the material of sempol with different types of meat. It works by using electrons for the imaging source as well as electromagnetic fields for the lens. SEM can be equipped with EDX (Energy Dispersive X-ray) to determine the composition of the constituent elements of the material. SEM-EDX results in the form of graphs whose characterization is analyzed based on the peak intensity or element quantity. Then, the value ratio or the element ratio within is calculated (34).
The results of SEM demonstrated that sempol chicken has many cavities with a large size formed from a three-dimensional metric. It is perceived that the interaction of chicken meat protein gelatinization with tapioca starch during the cooking process to form a less homogeneous metric (Picture 1). Less homogeneous and less compact three-dimensional metric cannot hold other components due to gelatinization of food protein[35][36].

Rahardiyan argued that the cavities are assumed to be shrinkage of tissue proteins as a result of cooking loss[37].

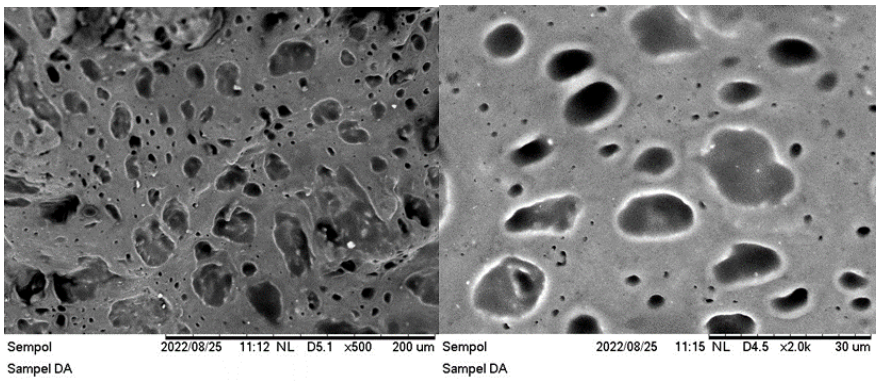

Figure 2. Sempol chicken meat in 500x and 2000x zoom

The microstructure of sempol beef has fewer rough and more open cavities and the formed metric is thicker and fibrous compared to that of sempol chicken and lamb (Figure 2). The less cavity formed the more the resulting product[38]. Because beef has sarcomeres of long muscle fibers interconnected with proteins, resulting in a fibrous three-dimensional metric with few rough cavities. Changes in the structure of fibrous cavities and metrics are caused by changes in proteins due to maillard reactions during frying [36]. Rahardiyan also argued that fibrous three-dimensional tissue can lead to a coarser and more open structure of space due to cooking loss[37].

Comment [EO51]: Maillard

Comment [EO52]: Note: This is a person's name and thus, it should begin with a capital letter "M".

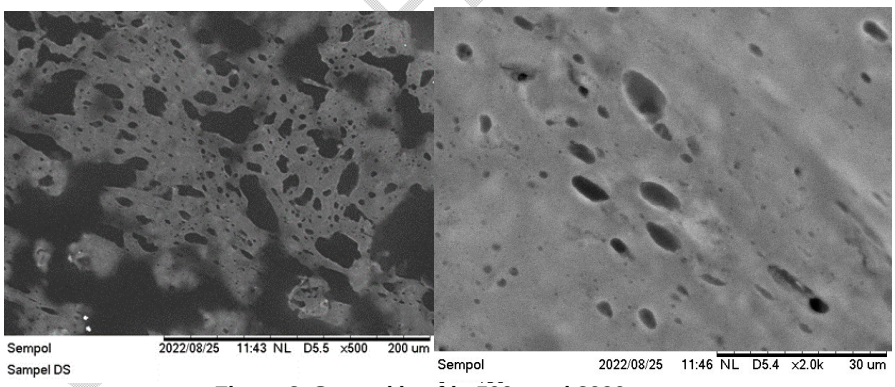

Figure 3. Sempol beef in 500x and 2000x zoom

Sempol lamb contains fat globules trapped on the protein metric (Figure 3). It is affected by the low content of protein levels of sempol lamb (Table 2), which cannot absorb glubola fat formed by the nature of the oil during the frying process. Glubola fat is trapped in the protein metrics damaged by the frying process for the evaporation of water [36]. Fellows argued that the increased fat content is caused by the presence of absorption during the frying process[39]. Alugwu et al,. also argued that the process of frying with a high temperature can lead to high fat content[40].

Comment [EO53]: globule fat

Comment [EO54]: Please, be mindful of your spelling

Comment [EO55]: Globule fat

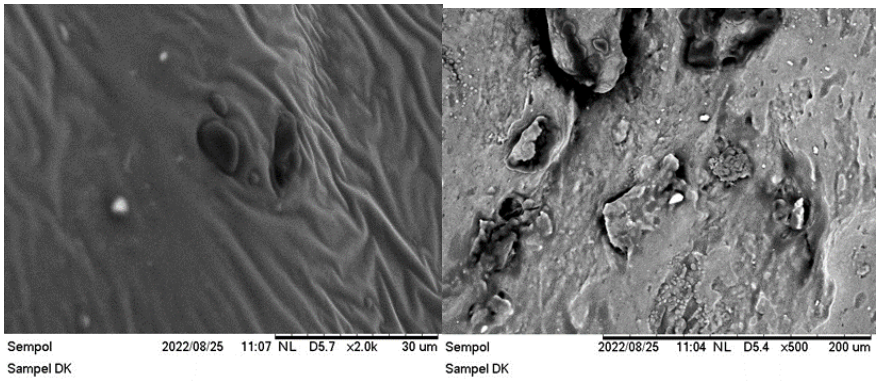

Figure 4. Sempol lamb in 500x and 2000x zoom

The analysis results of element composition of sempol with different types of meat showed the a number of elements contained in sempol chicken, beef, and lamb which lies in the unity of weight (Weight; Wt) and unity of atom (Atomic; At). The elements detected in sempol chicken, sempol beef, and sempol lamb can be seen in table 4.

Comment [EO56]: Delete

Comment [EO57]: delete

Table 4. The process of making sempol with different types of meat

No	Element	*Weight* (Wt %)			*Atomic* (At %)		
		DA	DS	DK	DA	DS	DK
1.	Carbon (C)	0.000	49.805	64.127	0.000	57.335	72.513
2.	Oxygen (C)	81.731	48.255	30.386	88.534	41.704	25.795
3.	Natrium (Na)	6.597	0.983	0.953	4.973	0.591	0.563
4.	Silicon (Si)	6.138	-	0.098	3.787	-	0.048
5.	Sulphur (S)	-	-	0.179	-	-	0.076
6.	Chlorine (Cl)	5.535	0.856	1.441	2.706	0.334	0.552
7.	Potassium (K)	-	0.101	0.171	-	0.036	0.059
8.	Zirconium (Zr)	-	-	2.645	-	-	0.394

There are five elements detected in sempol chicken, one of which is carbon (C) with the lowest percentage compared to sempol beef and sempol lamb (Table 4). This is thought to be due to protein shrinkage due to the cooking process with high temperatures that cause damage to the carbon structure (C), so a lot of large cavities are formulated (Figure 1). Protein shrinkage is caused by increasing the concentration of oil adsorbed in the frying process, so a low protein layer is formed, and the protein charge decreases [41]. Shofa also argued that the damage to the structure of carbon (C) is caused by the high temperature during the frying process, resulting in the formation of many cavities[42].

The amount of carbon (C) and oxygen (O) in sempol beef has the highest percentage compared to other elements that are the main constituents of high protein in sempol beef

(Table 4). Proteins are composed of carbon (C) and nitrogen (N) [43]. Proteins which are interconnected with beef muscle fibers can raise fibrous three-dimensional metrics and rough cavity structures (Figure 2). The formed protein metric seems fibrous as influenced by protein strands that are interconnected to form a three-dimensional structure [44]. Rahardiyan also argued that the structure of the cavity space is rough due to cooking loss[37].

Sempol lamb has a lot of elements compared with sempol chicken and sempol beef (Table 4). However, the highest element is carbon (C) and oxygen (O) as the main constituents of fat because fatty acids forming glubola fat are based on the number of elements of carbon atoms (C) [45][46]. Fats are composed of fatty acids and glycerol obtained from the hydrolysis of fats, oils, and other lipid compounds, resulting in a large fat glubola (Figure 4). Glubola fat replaces water that evaporates during the frying process [36].

Comment [EO58]: globule fat

Comment [EO59]: globules

Comment [EO60]: Globule fat

4. CONCLUSION

The use of different types of meat affects the physicochemical moisture, ash, and carbohydrate content and does not affect fat and protein content. The physicochemical content of sempol has met SNI 2014 standards referring to combination meat nuggets, except the fat and carbohydrate content.

Based on sensory properties, panelists prefer sempol using chicken. The use of different types of meat does not affect the organoleptic taste, aroma, and texture but affects the organoleptic color, as influenced by the color of the meat.

Comment [EO61]: preferred

The result of SEM-EDX in sempol with different types of meat demonstrated that the surface microstructure of sempol beef is more compact with smaller and uniform cavity. In addition, the presence of carbon (C) and oxygen (O) in sempol beef in high amounts can indicate that the main content of sempol beef is protein.

REFERENCES

1. Boateng EF, Nasiru MM, Agyemang M. Meat: Valuable Animal-Derived Nutritional Food. A Reviews. Asian Food Science Journal. 2020;15(1):9–19. doi: 10.9734/afsj/2020/v15i130140
2. Dewi ES, el Latifa S, Fawwarahly F, Kautsar R. Microbiological quality of poultry meat in RPA and on the market. Journal of Production Science and Technology of Livestock Products. 2016;4(3):379–85.
3. Rahim Taha S, Panamon F, Laya NK. THE USE OF THREE TYPES OF MEAT ON FAT, PROTEIN AND ORGANOLEPTIC VALUES OF ILABULO. 2022. Available from: https://ejurnal.ung.ac.id/index.php/gijea
4. Directorate General of Livestock and Animal Health K. Buku_Statistik_2021. Directorate General of Livestock and Animal Health Ministry of Agriculture of the Republic of Indonesia. 2021;1–240.
5. Rahmadaeni KI, Suter IK, Sugitha IM. Effect of meat ratio of broiler chicken (Gallus domesticus) and straw mushroom (Volvariella volvaceas) on chicken growth characteristics. Journal of Food Science and Technology. 2019;8(3):303–12.
6. Prasetyo H, Padaga MC, Sawitri ME. Study of the physico-chemical quality of beef in the Malang city market. Journal of Animal Products Science and Technology. 2013;8(2):1–8.
7. Hastuti S, Suparman S. Chemical Properties of Shredded Ettawa Goat (PE) Meat with Different Frying Times. Journal of Tropical Animal Husbandry Science and Technology. 2018;5(3):73–8.

Comment [EO62]: Please, revisit your references. They have different font style from the other write up. Also, make sure that it follows the journal's format of referencing. Some were written in capital letters while some are in small letters. Please, take a good look at the reference section again.

8. [SNI] Indonesian National Standard. National Standardization Agency for Indonesian National Standard Chicken nuggets (Chicken nuggets). 2014; Available from: www.bsn.go.id
9. [BPTP] Center for Agricultural Technology Studies. Procedure for Rice Organoleptic Test. 1st ed. Banda Aceh 23125: Aceh Agricultural Technology Study Center; 2015. 4–13 p.m.
10. Zhou W, Apkarian R, Wang ZL, Joy D. Fundamentals of scanning electron microscopy (SEM). In: Scanning microscopy for nanotechnology. Springers; 2006.p. 1–40.
11. Ahmadi K, Afrila A, Ika Adhi W, Agricultural Industrial Technology and P, Livestock Production, Tribhuwana Tunggadewi University P. THE EFFECT OF THE TYPE OF MEAT AND THE LEVEL OF ADDITIONAL TAPIOCA FLOUR ON THE QUALITY OF MEATBALLS. Vol. 7. 2007.
12. Setiawan MCP, ASW. Study of Physical and Chemical Quality of Goat Meat in Malang City Market. 2014;1–8.
13. el Aqsha G, Purbowati E, Al-Baari AN. Chemical composition of meat of kacang goat, etawah breed and male kejobong at the age of one year. In: National Workshop on Small Ruminant Meat Food Diversification http://kalteng agricultural research and development go id/eng/pdf/all-pdf/peternakan/fullteks/lokakarya/prork11-16 pdf. 2011.
14. Khasrad K, Anwar S, Arfai A, Rusdimansyah R. Comparison of Chemical Quality (Moisture Content, Protein Content and Fat Content) of Biceps Femoris Muscles in Several Breeds of Cattle. Proceedings of National Semester Research Results. 2016;
15. Qurniawan A, Arief II, Afnan R. Performance of broiler production in rearing environments with different altitudes in South Sulawesi. Veterinary Journal. 2016;17(4):622–33.
16. Bulkaini B, Kisworo D, Mastur M. Performance, Physical and Chemical Characteristics of Local Male Goat Meat by Feeding Fermented Cocoa Fruit Skins. Indonesian Journal of Animal Science and Technology (JITPI), Indonesian Journal of Animal Science and Technology. 2019;5(2):105–13.
17. Setyaningrum HD, Saparinto C. Ginger. Self-Help Group Spreaders; 2013.
18. Andika I, Kencana PKD, Gunadnya IBP. Effect of Liquid Smoke Concentration of Tabah Bamboo Stems (Gigantochloa nigrociliata Buse-Kurz) on the Characteristics of Smoked Catfish (Clarias Sp). Journal of BETA (Biosystems and Agricultural Engineering). 2020;8(2):346.
19. Basuny AMM, Arafat SM, Ahmed AAA. Vacuum frying: an alternative to obtain high quality potato chips and fried oil. Banats J Biotechnol. 2012;3(5).
20. Dhanapal K, Reddy GVS, Naik BB, Venkateswarlu G, Reddy AD, Basu S. Effect of cooking on physical, biochemical, bacteriological characteristics and fatty acid profile of Tilapia (Oreochromis mossambicus) fish steaks. Arch Appl Sci Res. 2012;4(2):1142–9.
21. Garnida Y, Widiantara T, Saepul Rachmat F. STUDY OF FROZEN TIME AND TYPE OF MEAT ON THE QUALITY OF BEEF (Bos primigenius taurus), broiler chicken (Gallus domesticus), catfish (Pangasius sp) AND GOAT MEAT (Capra aegagrus hircus) WHICH DITHAWING. Vol. 7, Pasundan Food Technology Journal. 2020.
22. Inarest A. The Effect of Using Different Types of Protein Sources and Filler Types in Making Tofu Dregs Nuggets. Food Science and Culinary Education Journal. 2014;3(1).
23. Tristantini D, Susanti A. The effect of adding red beans, soybean dregs, and textured vegetable protein on the nutritional content and texture of synthetic beef. In: National Seminar on Struggle Chemical Engineering. 2016. p.m. 9.

24. Rosyidi D, Radiati LE, Uyun N. Chemical quality of meat of male Etawah-breed goat (PE) and castrated Boer-breed goat (PB). Journal of Animal Products Science and Technology. 2009;4(2):9–16.
25. Lekahena VNJ. Effect of adding tapioca flour concentration on nutritional composition and sensory evaluation of red yellowfin meat nuggets. Agrikan: Journal of Fisheries Agribusiness. 2016;9(1):1–8.
26. Daughter of VD. Quality testchemical and organoleptic properties of chicken nuggets from tofu dregs substitution. Catalyst Journal. 2018;3(2):143–52.
27. Ismanto A, Lestyanto DP, Haris MI, Erwanto Y. Chemical composition, physical characteristics, and organoleptic characteristics of chicken sausages with the addition of carrageenan and transglutaminase enzymes. Animal Science: Research Journal of Animal Husbandry. 2020;18(1):73–80.
28. Wahyuni D, Yosi F, Muslim G. SENSORY QUALITY OF GOAT MEAT MARINATED USING CUCUMBER (Cuccumis SativusL.) Solution. Sriwijaya Animal Husbandry Journal. 2019;8(1):14–20.
29. Rosita F, Hafid H, Aka R. Cooking loss and organoleptic quality of beef meatballs with the addition of sago flour at different levels. JITRO. 2015;2(1):14–20.
30. PURWANTO AP, ALI AALI, HERAWATI NH. study of the nutritional quality of meatballs based on beef and mushroom (Volvariella volvaceae). Sago Journal. 2015;14(2):1–8.
31. Yulistiani R. Study of un-slaughtered chicken carcass: organoleptic changes and bacterial growth pattern. Journal of Agricultural Technology. 2012;11(1).
32. Salman Y, Syainah E, Rezkiah R. Analysis of Protein Content, Iron and Acceptability of Snakehead Fish Meatballs and Beef. Journal of Medicine and Health. 2018;14(1):63–73.
33. Hasan A, Nur RM. THE EFFECT OF SUPPLEMENTATION OF MEAT DUDIDIHANG FISH (Thunnus albacares) ON SAGO PLATES ON ORGANOLEPTIK ASSESSMENTS. Marine Science Laot Journal. 2020;2(1):11–22.
34. Rianita Y, Widodo CS. STUDY OF IDENTIFICATION OF DRUG COMPOSITION AND WASTE OF BENZOQUINONE (BQ) RESULTS OF DISPATCHING THERAPY USING SCANNING ELECTRON MICROSCOPY (SEM). 2014.
35. Purnomo H, Rahardiyan D. Indonesian traditional meatballs. Int Food Res J. 2008;15(2):101–8.
36. Yuniarti Utami E, Rosyidi D, Sri Widyastuti E. EFFECT OF BROILER MEAT SUBSTITUTION WITH SNOW MUSHROOM (Tremella fuciformis) ON CHICKEN NUGGET QUALITY The Effect of Substitution Broiler Meat with White Jelly Mushroom (Tremella fuciformis) on Qualities Chicken Nuggets. Vol. 10. 2015.
37. Rahardiyan D. Bakso (traditional Indonesian meatball) properties with postmortem condition and frozen storage. 2004;
38. Ratu N, Dewi K, Widjanarko SB, Technology J, Agriculture H, University F, et al. Physical Characteristics of Porang-Dewi Flour Beef Meatballs, et al. Vol. 3, Journal of Food and Agroindustry. 2015.
39. Fellows PJ. Food processing technology: principles and practices. Elsevier; 2009.
40. Alugwu SU, Okonkwo TM, Ngadi MO. Effect of Different Frying Methods on Cooking Yield, Tenderness and Sensory Properties of Chicken Breast Meat. Asian Food Science Journal. 2022 Aug 11;1–14. doi: 10.9734/afsj/2022/v21i1030469
41. Estiasih T. The Relationship between Sodium Caseinate and Phospholipids in Emulsification and the Implications for Changes in Emulsion Properties. Journal of Agricultural Technology. 2003;4(3):141–54.

42. Shofa. Production of Activated Carbon Made from Sugarcane Bagasse with Potassium Hydroxide Activation. 2012. [accessed 15 Nov 2022] Available from: https://lib.ui.ac.id/file?file=digital/20311088-S43263-Pembuatan%20karbon.pdf
43. Mardiyah U, Nur S, Jamil A, Sandra L. CHARACTERIZATION OF MICROSTRUCTURE AND ELEMENTAL COMPOSITION OF PINK PERCH HEAD GELATIN (Nemipterus Bathybius) USING SCANNING ELECTRON MICROSCOPY-ENERGY DISPERSIVE X-RAY (SEM-EDX). JFMR (Journal of Fisheries and Marine Research). 2022;6(2):19–25. Available from: http://jfmr.ub.ac.id
44. Barbut S. Importance of fat emulsification and protein matrix characteristics in meat batter stability. Journal of Muscle Foods. 1995;6(2):161–77.
45. Sartika RAD. Effect of saturated, unsaturated and trans fatty acids on health. Kesmas: Journal of National Public Health (National Public Health Journal). 2008;2(4):154–60.
46. US Institution. Increase crop yields with organic fertilizers. AgroMedia; 2010.