



(RESEARCH ARTICLE)



THE PROPORTION EFFECT OF CHICKEN MEAT AND CHICKEN FEET SKIN ON THE CHEMICAL CHARACTERISTICS OF KEKIAN

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ABSTRACT

One of the major problems faced by the poultry industry is the high volume of by-products, particularly chicken feet (shank), therefore innovation is needed to utilize these by-products into food products, one of which is *kekian*. This study aimed to determine the effect of the proportion of chicken meat and chicken feet skin on the chemical characteristics of *kekian*. The study was designed using a Completely Randomized Design (CRD) consisting of four treatments and four replications. The treatments applied were A1: 450 g chicken meat and 50 g chicken feet skin (9:1); A2: 400 g chicken meat and 100 g chicken feet skin (8:2); A3: 350 g chicken meat and 150 g chicken feet skin (7:3); and A4: 300 g chicken meat and 200 g chicken feet skin (6:4). The observed variables were chemical characteristics including protein, fat, moisture content, ash content, and carbohydrate content. The results showed that the proportion of chicken meat and chicken feet skin had no significant effect on protein, fat, moisture content, ash content, or carbohydrate content. Based on the results of the study, it can be concluded that the proportion of chicken meat and chicken feet skin did not significantly affect the chemical characteristics (protein, fat, moisture content, ash content, and carbohydrate content) of *kekian*. Ratios of chicken meat to chicken feet skin ranging from 9:1 to 6:4 in *kekian* yield favorable chemical characteristics (protein, fat, ash, moisture, and carbohydrate content) that comply with SNI standards.

Keywords: Kekian, Chicken meat, Chicken feet skin, Chemical characteristics.

1 INTRODUCTION

Processed meat products continue to undergo innovation in response to evolving consumer needs. Consumers today seek food that is not only delicious but also nutritious and cost-effective. Diversifying meat-based food products is crucial and can be achieved by utilizing various raw material sources including underutilized animal parts such as chicken feet, which currently lack significant consumer appeal.

One processed food product that is quite popular and holds potential for further development is *kekian*. *Kekian* is a processed meat product originating from China, typically made from minced meat mixed with seasonings and wrapped in bean curd sheets [12]; [22]. It is a side dish that can be served either steamed or fried [4]. *Kekian* can also be made using fish, shrimp, or chicken [9].

A challenge facing the poultry industry is the high volume of slaughter by-products, specifically chicken feet (shanks). If left unprocessed, these by-products can cause environmental pollution. In 2023, the average Indonesian consumed 7.46 kilograms of commercial chicken meat per capita annually a 4.3% year-on-year (yoy) increase compared to 2022 [2]. This data indicates an abundance of chicken foot waste that is not fully utilized by food businesses, resulting in the remainder becoming waste that pollutes the environment [24]. Therefore, innovation is needed to utilize chicken foot skin in the creation of value-added food products [13].

Chicken meat is widely used as a primary ingredient in the production of processed meat products due to its relatively low cost, tender texture, pleasant aroma and flavor, and high nutritional value particularly its protein content [20]. The high protein content in chicken meat plays a role in enhancing and stabilizing the emulsion of animal-based product batters [15]. Sari reported that a proportion of 450 g of chicken meat to 50 g of catfish (a 9:1 ratio) in the production of moringa-infused catfish nuggets yielded a product with the best chemical quality characteristics (regarding moisture, ash, protein, fat, and carbohydrate content) [16].

The use of chicken foot skin (corium) in the production of chicken-based *kekian* is thought to enhance its chemical composition, particularly regarding protein content. The 12.08% collagen content found in chicken feet can serve as a binding agent that improves texture, thereby influencing physical, chemical, and sensory qualities [17]. Ivan found that the addition of 8% chicken foot skin gelatin improved the chemical quality of dadih spread slices [6].

However, to date, no scientific study has specifically examined the proportions of chicken meat and chicken foot skin used in the production of *kekian*, particularly regarding chemical characteristics. Yet, the potential use of chicken foot skin as a protein source could enhance the product's nutritional value and texture, while also contributing to the utilization of chicken slaughter by-products. Therefore, a study was conducted on the proportions of chicken meat and chicken foot skin to determine their effect on the chemical characteristics of *kekian*.

2 MATERIAL

The ingredients needed in making *kekian* are chicken meat and chicken feet skin obtained from the Denpasar City Chicken Slaughterhouse (RPA), eggs, tapioca flour, rice flour, cooking oil, sesame oil, ice cubes, as well as tofu shells and spices consisting of green onions, garlic, salt, sugar, pepper powder, flavoring, oyster sauce.

The materials needed in the analysis of moisture content, ash content and carbohydrate content are *kekian* samples. Potassium content testing requires ingredients, namely *kekian* samples, concentrated sulfuric acid (H₂SO₄), aquadest, sodium hydroxide (NaOH), copper sulfate (CuSO₄), potassium sulfate (K₂SO₄), hydrochloric acid (HCl 0.1 N), phenolphthalein (PP) indicators, zinc (Zn). The analysis of the fat content of the material is only up to *kekian* and hexane 70%.

The tools used in making *kekian* are analytical scale, knives, cutting boards, *chopper*, steamer pot, pan, stove, spoons, spatulas, containers (plates, basins). The tools used in finding moisture content are scales and petri dishes.

The tools needed for the protein level test are a Kjeldahl flask, a set of distillation tools, Erlenmeyer 250 ml burette 50 ml, a set of destruction tools, a 5 ml drop pipette; 10 ml; 25 ml mouthpiece and filter paper, measuring cups (10 ml and 100 ml), beakers (100 ml and 250 ml), measuring flasks 100 ml, clamps, ring stands, petri dishes, analytical balances, desiccators, bunsen, matches and boiling stones.

Tools for fat content analysis are filter paper, fat gourd, soxhlet, oven, analytical balance, fat-free cotton desiccant/executor. Tools for ash content analysis are porcelain cups, ovens, desifiers, buns, matches and scales. Tools for carbohydrate content analysis are stationery and calculators.

3 METHODS

This research used a completely randomized design (CRD) experiment with four treatments and four replications, so there were 16 experimental units. The treatment applied is as follows:

- A1: 450 g chicken meat and 50 g chicken foot skin (9:1)
- A2: 400 g chicken meat and 100 g chicken foot skin (8:2)
- A3: 350 g chicken meat and 150 g chicken foot skin (7:3)
- A4: 300 g chicken meat and 200 g chicken foot skin (6:4)

3.1 Making *Kekian*

The chicken meat is cleaned under running water, and the chicken meat is separated. The prepared meat is then weighed according to requirements. The chicken meat and chicken feet skin are processed with ice cubes in a food chopper, following the specific treatment parameters. Afterward, the chicken meat is mixed with the necessary seasonings. The *kekian* mixture is then shaped [21]. This shaping process is performed on square-cut bean curd sheets to ensure the mixture does not spill out during wrapping [9]. The wrapped *kekian* is then steamed for 20 minutes at 100°C. Subsequently, the *kekian* is removed and allowed to cool, after which it is sliced to a thickness of approximately 2 cm.

3.2 Observed Variables

The observed variables were chemical characteristics of *kekian*.

3.2.1 Protein content

Protein content analysis was performed using the AOAC method [1]: grind the sample, weigh out 1 gram, and transfer it into a Kjeldahl flask along with boiling chips. Add 7.5 g of potassium sulfate (K_2SO_4), 0.35 g of copper sulfate ($CuSO_4$), and 15 mL of concentrated sulfuric acid (H_2SO_4), then mix until uniform and homogeneous. Heat the contents of the Kjeldahl flask inside a fume hood until fuming ceases, then continue heating until the mixture boils and the liquid becomes clear. Heat for approximately 30 minutes, then turn off the heat and allow the flask to cool. Proceed to the distillation stage by transferring the digested sample into a distillation flask and rinsing the Kjeldahl flask with distilled water. Add 50 mL of 50% NaOH, 200 mg of Zn, and 100 mL of distilled water. Gently reheat the flask until the liquid is well-mixed, then heat rapidly until the boiling point is reached. Collect the distillate in an Erlenmeyer flask containing 50 mL of hydrochloric acid (0.1 N HCl) and 3-5 drops of 1% phenolphthalein indicator; ensure the tip of the distillation condenser is submerged in the 0.1 N HCl solution. Distillation concludes when the final drops of distillate are no longer alkaline. Finally, in the titration stage, the distillate is titrated with 0.1 N sodium hydroxide (NaOH). The titration endpoint is reached when a persistent pink color appears. Subsequently, duplicate analyses and a blank determination are performed.

3.2.2 Fat content

Fat content analysis was performed using the AOAC method [1]. The fat flask was dried in an oven for 30 minutes at 100-105°C, cooled in a desiccator to remove moisture, and then weighed. A 2-gram sample was placed into folded filter paper and covered with fat-free cotton wool. The sample was loaded into a Soxhlet apparatus connected to a pre-weighed and dried fat flask containing boiling chips. Hexane solvent was added until the sample was submerged, and extraction was carried out for 6 hours. The solvent was distilled and collected. The fat extract in the flask was dried in an oven at 100-105°C for one hour, cooled in a desiccator, and weighed. The drying process for the fat flask was repeated until a constant weight was obtained.

3.2.3 Water content

Moisture content analysis was performed using the AOAC method [1]. An empty porcelain crucible was heated at 105°C for 30 minutes, cooled in a desiccator for 15-30 minutes, and then weighed to determine its initial weight. Subsequently, approximately 10 grams of the sample was added to the crucible, and the combined weight of the crucible and sample was recorded prior to oven drying. A constant weight for the crucible and sample was achieved by drying in an oven at 105°C for 4-6 hours. The sample was then cooled in a desiccator for 15-30 minutes.

3.2.4 Ash content

Ash content determination was performed using the AOAC method [1]. A porcelain crucible was prepared for ashing by drying it in an oven for 15 minutes. Subsequently, the crucible was cooled in a desiccator for approximately 10 minutes until a constant weight (A) was reached. A sample weighing approximately 3 g was placed into the dried crucible (B). The sample in the porcelain crucible was ignited using a Bunsen burner until smoke was no longer emitted. The crucible containing the sample was then placed in a furnace at 400–600°C for 4-6 hours until the sample turned into white ash or reached a constant weight. The resulting ash in the crucible was cooled in a desiccator and then weighed.

3.2.5 Carbohydrate content

Carbohydrate content determination was performed using the AOAC method [1] specifically the by difference method by subtracting the total of the four components (moisture, ash, protein, and fat) from 100%.

4 RESULTS AND DISCUSSION

The results of the chemical analysis (protein, fat, water content, ash content, and carbohydrates) of *kekian* are shown in Table 1.

Table 1: Chemical Characteristic Test Values of *Kekian* with Different Proportions of Chicken Meat Dan Chicken Feet Skin

Variables	Treatment ¹⁾				SEM ²⁾
	A ₁	A ₂	A ₃	A ₄	
Protein (%)	13.13 ^a	13.81 ^a	13.63 ^a	11.22 ^{a2)}	1.24
Fat (%)	7.39 ^a	8.00 ^a	7.95 ^a	7.93 ^a	0.30
Water content (%)	57.91 ^a	56.55 ^a	56.89 ^a	57.48 ^a	0.52
Ash content (%)	1.74 ^a	1.83 ^a	1.78 ^a	2.00 ^a	0.11
Carbohydrates (%)	19.84 ^a	19.81 ^a	19.75 ^a	21.36 ^a	1.18

Note: 1) A₁:450g chicken meat and 50g chicken foot skin (9:1); A₂:400g chicken meat and 100g chicken foot skin (8:2); A₃: 350g chicken meat and 150g chicken foot skin (7:3) A₄: 300g chicken meat and 200g chicken foot skin (6:4); 2) SEM: Standard Error of the Treatment Mean; 3) (a,b) : Values with the same letters on the same line show no significant difference (P>0.05).

4.1 Protein content

The results of statistical analysis in Table 4.1 show that the different proportion of chicken meat and chicken feet skins did not have a significant effect (P>0.05) on protein levels. This is suspected because chicken meat and chicken feet skins both have a fairly high protein content. Based on Indonesian Food Composition Data, chicken meat contains around 18.2 g of protein per 100 g of ingredients [8]. Meanwhile, chicken feet skins also contain relatively high amounts of protein, which is 19.4 g per 100 g of ingredients, especially collagen protein, which is the main structural protein that makes up connective tissue [4]. Therefore, increasing the proportion of chicken skins in *kekian* formulations is still able to maintain the overall protein content of the product. In addition, other potentials with the addition of chicken feet skin are able to increase the antioxidant capacity of the product, such as in the case of research on the fortification of chicken feet skin for sausage functionality [10] and also in the application of sausage stirring [11] so that this is also suspected to have an important influence on the functional properties of *kekian*. During the steaming process, the protein is denatured so that the protein structure opens and forms a gel tissue that is able to bind water and trap fat globules [23]. Myofibril protein from chicken meat interacts with collagen derived from chicken feet skin so that a more stable gel matrix is formed. During heating, some collagen is hydrolyzed into gelatin which is able to increase water binding, maintain emulsion stability, and improve product texture [7]. As a result, the loss of water and fat during the steaming process is relatively the same throughout the treatment so that the moisture content and fat content do not show a noticeable difference. Thus, the stability of the protein content in each treatment contributes to maintaining water binding, emulsion stability, and product structure so that the chemical characteristics of the product remain uniform.

When compared to SNI similar processed meat products, namely meatballs [5], the protein content obtained in all treatments has met the quality requirements, namely the minimum protein content of 11%. The protein content in this study ranges from 11.22-13.81%, so that all treatments are above the minimum required limit. These results show that the use of chicken feet skin up to a proportion of 40% is still able to maintain the protein content of the product so as to meet the quality standards of processed meat products in terms of protein content.

4.2 Fat content

The results of statistical analysis in Table 4.1 show that the different proportions of chicken meat and chicken skin did not have a significant effect (P>0.05) on the fat content. This is because the two ingredients contain fat so that changes in the proportion of meat and skin do not cause a large change in the amount of total fat. Chicken meat contains fat stored in muscle tissue and tissue under the skin, while chicken skin also contains a certain amount of fat that is bound to connective tissue and subcutaneous layer [8]. Therefore, the increase in the proportion of chicken skin in the *kekian* formulation has not been able to produce a change in fat content large enough to show a statistically significant difference. In addition to being influenced by the composition of raw materials, fat content is also closely related to the protein content in the product. Myofibril protein in chicken meat has natural emulsifying properties that are able to absorb the surface of fat globule, while collagen from chicken feet skin will be denatured during the steaming process and partially hydrolyzed into gelatin. The interaction between myofibril and gelatin proteins forms a gel matrix that is able to trap fat globules so that the emulsion becomes more stable and fat loss during the heating process can be

minimized [7]. This mechanism causes the fat distribution in the product to remain homogeneous so that the fat content between treatments does not show a noticeable difference even though the proportion of chicken feet skin is increased.

When compared to SNI similar processed meat products, namely meatballs [5], the fat content in this study has met the quality requirements. SNI sets a maximum fat content of 10%, while the content of fat obtained ranges from 7.39% to 8.00%. This value shows that all treatments are still below the maximum required limit, so that the use of chicken feet skins up to a proportion of 40% still produces products that meet meat quality standards in terms of fat content.

4.3 Water content

The results of statistical analysis in Table 4.1 show that the different portion of chicken meat and chicken feet skin did not have a significant effect ($P > 0.05$) on the moisture content of *kekian*. This is suspected because the water content of chicken meat and chicken skins are relatively not much different. Chicken meat is a food ingredient that has a fairly high water content, which is around 65-75% of the weight of 65%-75% of fresh ingredients [14], while chicken skins also have a fairly high amount of water content, which is around 65%-70% because it is composed of connective tissue, collagen, and other structural components [13]. The similarity of these characteristics causes an increase in the proportion of chicken skins in the *kekian* formulation does not provide a noticeable change in the moisture content of the product. The moisture content in the product is also influenced by the ability of proteins to bind to water. Myofibril proteins in chicken meat and collagen found in chicken skin have hydrophilic groups that are able to bind to water molecules. During the heating process, proteins undergo denaturation and form gel tissue, while collagen changes to gelatin. The gel structure is able to retain water in the product matrix so that water loss during the steaming process is relatively equal throughout treatments. Sun and Holley explain that myofibril proteins that are denatured during heating will form gel tissue that plays a role in increasing water holding capacity [18], while Tornberg stated that gelatin from collagen denaturation also contributes to retaining water in the tissue of meat products [19].

When compared to the Indonesian National Standard (SNI) 3818:2014 concerning Meatballs [5], the moisture content obtained in this study has met the quality requirements. SNI 3818:2014 [5] stipulates that the maximum moisture content of meatballs is 70.0%. Meanwhile, the moisture content of meatballs in all treatments only ranges from 56.55% to 57.91%, so it is still below the maximum required limit. These results show that the use of chicken feet skins up to a proportion of 40% does not cause an excessive increase in moisture content and still produces products with good chemical quality.

4.4 Ash Content

The results of statistical analysis in Table 4.1 show that the different proportions of chicken meat and chicken skins did not have a significant effect ($P > 0.05$) on the ash content. The ash content values obtained ranged from 1.74% to 2.00%, although numerically there is a tendency to increase ash content as the proportion of chicken skins increases. This is suspected because chicken skins contain various minerals, such as calcium, phosphorus, magnesium, sodium, and potassium [4]. However, the difference in mineral content between chicken meat and chicken skins is not large enough to produce a significant increase in ash content, so the substitution of some chicken meat with chicken skins still produces relatively uniform ash levels. In addition, chicken skins are also rich in collagen which is associated with connective tissues and tissue-forming minerals, so that it has the potential to increase the mineral content of the product [9].

Based on SNI 3818:2014 concerning Meatballs [5], the maximum permissible ash content is 3.0%, while the ash content in this study only ranges from 1.74% to 2.00%, so that all treatments have met the quality requirements. The value of ash content that is still below the maximum SNI limit shows that the use of chicken feet skins up to a proportion of 40% is able to maintain the mineral content without reducing the chemical quality of the product. Thus, chicken feet skin has the potential to be used as a substitute material for some chicken meat in the manufacture of *kekian*, as well as increasing the use of livestock by-products without reducing the quality of the products produced.

4.5 Carbohydrates content

The results of statistical analysis in Table 4.1 show that the different proportion of chicken meat and chicken feet skin did not have a significant effect ($P > 0.05$) on the carbohydrate content of the skin. The absence of a significant difference among treatments may be attributed to the fact that chicken meat and chicken feet skin are not major sources of carbohydrates. Based on Indonesian Food Composition Data, the carbohydrate content in chicken meat and chicken skins is very low compared to carbohydrate source foods such as flour or cereals [8]. Chicken meat has a carbohydrate content of 0.0 grams per 100 grams of ingredients [8], while chicken skin has a carbohydrate content of 0.2 grams per 100 grams of ingredients [4].

In table 4.1, it can be seen that the A4 treatment has a higher carbohydrate content than other treatments. This condition is thought to be related to the relatively lower protein value in the treatment. In the by difference method, a decrease in one of the proximate components such as protein can cause the calculated carbohydrate value to be higher.

5 CONCLUSION

The proportion of chicken meat and chicken feet skin from 9:1 to 6:4 did not significantly affect the chemical characteristics (protein, fat, water content, ash content, and carbohydrates) of kekian. All treatments showed acceptable chemical characteristics when compared with the requirements of SNI 3818 for meatballs as a reference for a comparable processed meat product.

COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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