Efforts to improve the chemical quality of processed chicken meatball products by adding potato skin flour (*Solanum tuberosum*) as a substitute for tapioca flour

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Abstract. The objective of this research is to investigate the effects of incorporating potato skin flour as a substitute for tapioca flour on the moisture content, protein content, fat content, ash content, carbohydrate content, and crude fiber content of broiler chicken meatballs. The method employed in this research was a Completely Randomized Design (CRD), incorporating potato skin flour as a substitute for tapioca flour at different proportions: P0 (0% potato skin flour); P1 (25% potato skin flour); P2 (50% potato skin flour); P3 (75% potato skin flour); and P4 (100% potato skin flour). This research was replicated four times, yielding a total of 20 experimental units ensure robustness and reliability of the findings. The findings of the research demonstrate that the inclusion of potato skin flour as a substitute for tapioca flour has a significant effect ($P<0.05$) on the moisture content, protein content, fat content, ash content, carbohydrate content, and crude fiber content of broiler chicken meatballs. The best treatment in this research was P4, with a moisture content of 53.20%, protein content of 15.32%, fat content of 8.17%, ash content of 1.92%, carbohydrate content of 21.39%, and crude fiber content of 4.05%.

1 Introduction

Broiler chicken meat is one of the livestock products that has high nutritional content and is relatively inexpensive. However, due to its high nutritional content, broiler chicken meat is prone to spoilage. Several preservation methods were employed to maintain the quality of broiler chicken meat for a longer period. One processing technique used to preserve the meat effectively and held potential for product diversification was the production of

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chicken meatballs. Meatballs were a processed meat product that utilized the restructured meat technique, which involved grinding and mashing the meat with various seasonings, shaping it into round balls, and then cooking it by boiling it in hot water [1].

In the making of meatballs, a filler material is typically added in the form of flour to act as a binder. The flour commonly used in chicken meatball production is tapioca flour, known for its high elasticity and carbohydrate content. However, tapioca flour has a drawback, which is its low nutritional content, and the addition of tapioca flour to meatballs generally results in a soft or less chewy texture, making it less appealing to the public. In addition to tapioca flour, other types of flour, such as potato skin flour, can also be utilized. Potato skin has nutritional content that is nearly equivalent to its flesh. It contains high levels of carbohydrates, vitamins, minerals, fiber, potassium, antioxidants, iron, zinc, calories, and various other nutrients [2].

Considering the potential of potato skin, it can be processed into flour and utilized as an alternative food ingredient, which can be applied as a filler in the production of chicken meatballs. Processing potato skin into flour holds great potential as a food diversification strategy, which not only helps in reducing household waste but also contributes to the creation of innovative food ingredients that are beneficial for the community.

In this research, potato skin flour was used as a filling material to substitute tapioca flour in the production of chicken meatballs, with the aim of improving texture, reducing cooking shrinkage, enhancing water-binding capacity, and extending the shelf life of chicken meatballs. This was consistent with the research by [3], which stated that potato skin flour could be used as an alternative food ingredient that improved the texture of food due to its high carbohydrate content. The carbohydrate content of potato skin flour was 75.26%, protein content was 11.37%, moisture content was 7.84%, ash content was 4.67%, and the potassium content of potato skin flour was 1671.86 mg/100 g. Potato skin flour has the ability to control lipid oxidation, which is the cause of rancid odor [4]. Thus, it is crucial to conduct research on the diversification of chicken meatball processing by incorporating potato skin flour to improve product quality while also producing a healthy, safe, and economically valuable food with high nutritional value.

2 Materials and methods

2.1 Material

The materials used in this research were broiler chicken meatballs made from chicken meat, with the addition of potato skin flour as a substitute for tapioca flour. The materials used included broiler chicken, potato skin flour, tapioca flour, ice cubes, egg whites, salt, garlic, sugar, fried shallots, and powdered pepper. The dough formulation in the production of broiler chicken meatballs for each treatment could be seen in Table 1.

Table 1. Formulation of broiler chicken meatball production.

Ingredient	Treatment				
	P0	**P1**	**P2**	**P3**	**P4**
Broiler chicken meat (g)	500	500	500	500	500
Potato skin flour (g)	0	25	50	75	100
Tapioca flour (g)	100	75	50	25	0
Ice cubes (g)	100	100	100	100	100
Egg white (g)	15	15	15	15	15

Salt (g)	12.5	12.5	12.5	12.5	12.5
Garlic (g)	12.5	12.5	12.5	12.5	12.5
Sugar (g)	10	10	10	10	10
Fried shallots (g)	12.5	12.5	12.5	12.5	12.5
Ground pepper (g)	1.25	1.25	1.25	1.25	1.25

2.2 Method

The research method used in this study is the experimental method with a Completely Randomized Design (CRD) consisting of 5 treatments and 4 replications, resulting in 20 experimental units. The research treatments consist of P0 (100% tapioca flour, 0% potato skin flour); P1 (75% tapioca flour, 25% potato skin flour); P2 (50% tapioca flour, 50% potato skin flour); P3 (25% tapioca flour, 75% potato skin flour); and P4 (0% tapioca flour, 100% potato skin flour).

2.3 Research variables

The chemical quality test of broiler chicken meatballs includes the determination of moisture content, protein content, fat content, ash content, carbohydrate content, and crude fiber content.

2.3.1 Measurement of moisture content in broiler chicken meatballs

The measurement of moisture content using the gravimetric method [5]. Prepared the equipment and materials for measuring moisture content and oven-dried the crucible for 24 hours at 105°C. The crucible was then removed from the oven and placed in a desiccator for approximately 15 minutes. Subsequently, the crucible was weighed using an analytical balance to determine its weight (M1). Next, 3-5 grams of broiler chicken meatball samples were added to the crucible and weighed to obtain the initial weight (M2). The broiler chicken meatball sample and crucible were then oven-dried for an additional 24 hours, followed by placing them in a desiccator for 15–30 minutes. Afterward, the sample and crucible were weighed after oven drying to determine the final weight (M3). The moisture content was calculated using the following formula:

$$\text{Moisture Content (\%)} = \frac{(M1 + M2) - M3}{M2} x\ 100\% \quad (1)$$

2.3.2 Measurement of protein content in broiler chicken meatballs

The measurement of protein content using the Kjeldahl method [5]. A total of 0.1 grams of broiler chicken meatball sample was placed in a 100ml Kjeldahl flask and mixed with an equal amount of selenium and 3 ml of concentrated H2SO4. The broiler chicken meatball sample was digested until the solution became clear, which took about an hour. The digestion flask was then cooled, and 50 ml of distilled water and 20 ml of 40% NaOH were added, followed by distillation. The distillation result was collected in a flask containing a mixture of 10ml 2% H3BO3 solution and 2 drops of Brom Cresol Green Methyl Red indicator, which appeared pink. After the distillate volume reached 10ml and turned bluish-green, the distillation was stopped, and the distillate was titrated with 0.1 N HCl until it turned pink. The same procedure was also conducted for the blank. The protein content can

be calculated using the following formula:

$$\text{Protein Content (\%)} = 6.25 \times \%N \quad (2)$$

2.3.3 Measurement of fat content in broiler chicken meatball

The measurement of fat content using the soxhlet extraction method [5]. The sample was weighed 1 gram and wrapped in filter paper. The sample was then placed into a constant-weight Soxhlet extraction tube. The reaction tube was assembled in the Soxhlet distillation apparatus, and it was extracted with Petroleum Ether solvent for approximately 4 hours. The obtained fat extract was then oven-dried until a constant weight was achieved. The weight of the residue in the extraction tube was considered as the fat content. The fat content can be calculated using the following formula:

$$\text{Fat Content (\%)} = \frac{Weight\ of\ tube\ after\ extraction\ (grams) - Weight\ of\ tube\ before\ extraction\ (grams)}{Sample\ weight\ (grams)} \times 100\% \quad (3)$$

2.3.4 Measurement of ash content in broiler chicken meatball

The determination of ash content was conducted using the gravimetric method following the [5] procedure. Porcelain crucibles were prepared and dried in an oven (at a temperature of 100-105°C) and cooled in a desiccator for approximately 15 minutes. The empty crucible was weighed on an analytical balance and recorded as the initial crucible mass (M1). A sample of 3-5 grams, which had been finely ground, was weighed and placed in the porcelain crucible, recorded as the sample mass (M2). The sample was then heated on a stove until it turned into charcoal without emitting smoke. It was subsequently placed in a furnace at 600°C until the sample appeared grayish or until a constant mass was achieved. After cooling in a desiccator for approximately 15 minutes, the crucible and sample were weighed (M3). The ash content was calculated using the following formula:

$$\text{Ash Content (\%)} = \frac{M3-M1}{M2} x\ 100\% \quad (4)$$

2.3.5 Measurement of carbohydrate content in broiler chicken meatballs

The determination of carbohydrate content is carried out using the by-difference method following the [5] procedure, which involves subtracting the percentages of moisture, protein, fat, and ash content from 100% to obtain the carbohydrate content, as it is dependent on the subtraction factor. Carbohydrate content has an impact on other nutrients. The carbohydrate content can be calculated using the following formula:

$$\text{Carbohydrate Content (\%)} = 100\% - (\%\text{moisture content} + \%\text{protein content} + \%\text{fat content} + \%\text{ash content}) \quad (5)$$

2.3.6 Measurement of crude fiber content in broiler chicken meatballs

The determination of carbohydrate content is conducted using the gravimetric method with the fibretherm apparatus [5]. Several fiber bags (including a blank fiber bag) are weighed (B1), then dried in an oven at 105°C for one hour. Afterward, they are cooled in a desiccator and weighed (M1). The spacer glass is placed into the fiber bag and then placed into the carousel (M3). The weight of the chicken broiler meatball sample is measured to be approximately 10 grams (M2). After the fibertherm process is completed, the chicken broiler meatball sample, which has reduced its fat content, is taken out from the fiber bag

and transferred into a platinum crucible, then weighed (M4).

The platinum crucible containing the sample is placed in an oven for 24 hours at a temperature of 105°C. After that, the sample, along with the platinum crucible, is placed in a furnace at a temperature of 650°C for 2 hours (B3). The platinum crucible containing the sample is burned, resulting in the sample turning into ash. The furnace with the ash is weighed (B4). The calculation of the fiber content uses the following formula:

$$\text{Dietary Fiber Content (\%)} = \frac{(M3-M1-M4)-(B3-B1-B4)}{M2} x\ 100\% \quad (6)$$

2.4 Procedure for making potato skin flour

The required ingredient is potato. The potatoes are cleaned from attached soil and peeled. Then, the potato skins are soaked in a 0.3% sodium bisulfite solution for 120 minutes. The soaking of potato skins is done with a water to sodium bisulfite ratio of 1:2. After soaking, the skins are dried at approximately 55°C in an oven for 7 hours, then ground and sieved using an 80 mesh sieve [3].

2.5 Procedure for making broiler chicken meatballs

Modification of the procedure for making meatballs, based on [41] research, involved using broiler chicken meat that was cleaned from surface fat. The meat that has been cleaned is then cut into small pieces. These pieces of meat are then put into a meat grinder with ice cubes and ground finely for one minute. Next, add pepper, garlic, fried shallots, granulated sugar, egg whites, tapioca flour, and potato skin flour according to P0 treatment (100% tapioca flour, 0% potato skin flour); P1 (75% tapioca flour, 25% potato skin flour); P2 (50% tapioca flour, 50% potato skin flour); P3 (25% tapioca flour, 75% potato skin flour); and P4 (0% tapioca flour, 100% potato skin flour), then blend again for one minute. After the dough is formed, let it rest for 10 minutes. The dough is then formed into balls and placed in hot water at 80°C for 15 minutes. The meatballs are then removed and cooked again in boiling water at a temperature of approximately 100°C for approximately 10 minutes.

2.6 Data analysis

The data analysis used in the study was the Analysis of Variance (ANOVA) based on the Completely Randomized Design (CRD) experiment with 5 treatments and 4 replications. The obtained data were analyzed using ANOVA, and if the treatments showed a significant effect ($P<0.05$), the analysis was followed by Duncan Multiple Range Test (DMRT). The purpose of this analysis was to determine the effect of adding potato skin flour as a substitution for tapioca flour in the production of broiler chicken meatballs to improve and enhance the quality.

3 Results and discussion

3.1 Characteristics of raw material: potato skin flour

The main ingredient in meatball production was chicken meat with the addition of potato skin flour as a substitution for tapioca flour. The raw material of potato skin was analyzed in the form of dried flour and was then subjected to proximate analysis. The potato skin flour used in this research was in the form of fine brownish powder, with a taste and aroma

similar to potatoes. The proximate analysis results of potato skin flour could be seen in Table 2.

Table 2. Proximate analysis of potato skin flour.

Parameter	Potato Skin Flour	Tapioca Flour Literature*	Potato Skin Flour Literature**
Moisture Content (%)	11.77	15.20	7.84
Ash Content (%)	5.25	2.50	4.67
Fat Content (%)	0.81	0.60	0.87
Protein Content (%)	12.23	1.20	11.37
Carbohydrate Content (%)	69.94	-	75.26

Description: *[6], **[3]

Based on the proximate analysis results of the raw material, the potato skin flour used in the production of broiler chicken meatballs had a moisture content of 11.77%, ash content of 5.25%, fat content of 0.81%, protein content of 12.23%, and carbohydrate content of 69.94%. The results of the analysis of water content obtained, namely 11.77%, met the SNI for flour with a maximum of 14.5%. Research by [3] stated that potato skin flour had a moisture content of 7.48%; this was influenced by soaking in a sodium bisulfite solution, which increased the process of removing water from the material, resulting in a decrease in water content during the drying process. The drying process at the same temperature and time could still lead to differences in results because the raw materials used were also different, which affected variations in moisture content and nutrient content [7]. The water content affected the duration of storage and resistance to attack by microorganisms. [8] explained that the purpose of testing the water content was to increase the thickness of the water-absorbing layer to enhance the strength of the liquid bridges formed between the powder particles. Increasing water content reduced the ability of the powder to flow [9].

The results of the research showed that the ash content of potato skin flour was 5.25%. The results obtained were in accordance with the research of [3], which showed that the ash content of the potato skin flour produced ranged from 4.15–4.67%. The longer soaking of sodium bisulfite during the process of making potato skin flour caused an increase in the resulting ash content [10]. [11] explained that the ash content was closely related to the mineral content of a material. The determination of ash content was carried out to determine whether a processing process was good or not and to determine the type of material used. It could also be used as a parameter of the nutritional value of a food ingredient.

The results of the research on the protein content of the potato skin flour produced were 12.23%. The resulting protein levels were higher than those reported in the literature. The protein content of the potato skin flour produced ranged from 11.37–11.60% [3]. Soaking using sodium bisulfite resulted in changes in cell membranes, such as the loss of soluble substances and a decrease in nutrient composition due to dissolution in immersion water [12].

The results of the research showed that the fat content of potato skin flour was 0.81%. The resulting fat content was not significantly different from that in the literature. Research by [3] showed that the fat content of the potato skin flour produced ranged from 0.74 to 0.87%. The higher fat content was affected by the longer soaking time of sodium bisulfite. A soaking time of 120 minutes resulted in a fat content of around 0.87%.

The results of the research on the carbohydrate content of the potato skin flour produced were 69.94%. Carbohydrate content was calculated using the by-difference method, namely the result of 100% minus the moisture content, ash content, fat content, and protein content.

The resulting carbohydrate content was lower than in the literature. Research by [3] showed that the carbohydrate content of potato skin flour with various soaks ranged from 74.49 to 75.25%. There was a tendency that the longer the soaking, the more the resulting carbohydrate content tended to increase; this was suspected because the longer the soaking time, the more carbohydrates would precipitate. Carbohydrates are macronutrients needed by the body in large quantities. There are carbohydrates that can be digested by the body to produce glucose and energy [13]. Additionally, the carbohydrate content that cannot be digested by the body is useful as dietary fiber [14].

3.2 Chemical characteristics of broiler chicken meatballs

The chemical characteristics observed in the research on the production of broiler chicken meatballs with the addition of potato skin flour included tests for moisture content, protein content, fat content, ash content, carbohydrate content, and crude fiber content. The results of the chemical tests of broiler chicken meatballs could be seen in Table 3.

Table 3. Mean value of chemical properties of chicken meatballs.

Treatment	Parameter					
	Moisture Content (%)	**Protein Content (%)**	**Fat Content (%)**	**Ash Content (%)**	**Carbohydrate Content (%)**	**Crude Fiber Content (%)**
P0	55.37 ± 0.10^{a}	15.88 ± 0.07^{a}	8.75 ± 0.05^{a}	0.82 ± 0.06^{e}	19.18 ± 0.09^{a}	0.35 ± 0.03^{e}
P1	55.34 ± 0.47^{a}	15.62 ± 0.07^{b}	8.58 ± 0.03^{b}	1.21 ± 0.03^{d}	19.40 ± 0.21^{b}	1.37 ± 0.03^{d}
P2	54.49 ± 0.08^{b}	15.55 ± 0.08^{bc}	8.52 ± 0.05^{bc}	1.39 ± 0.01^{c}	20.05 ± 0.11^{c}	2.54 ± 0.04^{c}
P3	53.91 ± 0.06^{c}	15.48 ± 0.04^{c}	8.46 ± 0.06^{c}	1.53 ± 0.03^{b}	20.63 ± 0.08^{d}	3.81 ± 0.05^{b}
P4	53.20 ± 0.08^{d}	15.32 ± 0.04^{d}	8.17 ± 0.06^{d}	1.92 ± 0.04^{a}	21.39 ± 0.13^{d}	4.05 ± 0.07^{a}

Description: P0 (0% potato skin flour, 100% tapioca flour); P1 (25% potato skin flour,75% tapioca flour); P2 (50% potato skin flour, 50% tapioca flour); P3 (75% potato skin flour, 25% tapioca flour); and P4 (100% potato skin flour, 0% tapioca flour) and Notations ^{a} and ^{b} in the same column indicate significant influence ($P<0.05$).

3.2.1 Moisture content

The moisture content was an important component in a food material to determine how quickly the food material might undergo spoilage due to microorganisms. Moisture content could influence the physical, enzymatic, physicochemical, and microbiological conditions, leading to changes in the food [15]. The analysis of variance results showed that the treatment with the addition of potato skin flour as a substitution for tapioca flour significantly influenced ($P<0.05$) the moisture content of broiler chicken meatballs. The average moisture content values in this research ranged from 53.20% to 55.37%. The highest average moisture content was found in the treatment (without the addition of potato skin flour), which was 55.37%, while the lowest average moisture content was found in (100% potato skin flour), which was 53.20%. The increase in the substitution of potato skin flour in the production of broiler chicken meatballs resulted in a reduction in the moisture content of the meatballs. This was because potato skin flour acted as a binder that could

bind water. Potato skin flour bound the water present in the meat matrix, resulting in a decrease in the moisture content of the broiler chicken meatballs. In this research, the raw material, potato skin flour, had a moisture content of 11.77%, which was lower than the moisture content of tapioca flour. This was consistent with the outcomes of [6], who reported that the moisture content of tapioca flour was 15.20%. The research outcomes of [16] indicated that the decrease in moisture content in meatballs was caused by the addition of filling materials, such as flour, which led to an increase in the binding of starch granules with proteins. The increased binding of starch granules and proteins resulted in water not being able to be absorbed maximally, as the hydrogen bonds that should have been used to bind water were used for the mechanism of starch-protein binding in the meat. This decrease was also attributed to the starch contained in the flour, which added to the total weight and had water-absorbing properties, while the water content in the meat remained constant, resulting in a decrease in moisture content [17].

Based on the Indonesian National Standard (SNI), the maximum allowable moisture content in meatballs was 70% [18]. In this research, the moisture content of broiler chicken meatballs already complied with the Indonesian National Standard (SNI), which was less than 70%. The purpose of this research was to substitute tapioca flour with potato skin flour in the production of chicken meatballs. Potato skin flour could be used as a substitute for tapioca flour as a binder. According to [19], the use of flour as a binder was based on the ability of amylopectin to enhance elasticity, which could affect the springiness of chicken meatballs. Tapioca flour had amylase and amylopectin content of 17.41% and 82.13%, respectively, while the amylase and amylopectin content in potato starch were 21.04% and 78.96%, respectively [20]. The formation of elasticity properties led to the potential for strong adhesive properties due to the high amylopectin content, which could influence the moisture content in meatballs [21]. The lower the water content, the denser and more compact the resulting texture, whereas the higher the water content, the softer the resulting texture. The research conducted by [22] explained that low water content in meatballs resulted in a dense and compact texture.

3.2.2 Protein content

Protein content was one of the essential components in a food material that functioned as a builder in tissues, replaced damaged tissues or cells, and served as an energy source [23]. The analysis of variance results showed that the treatment with the addition of potato skin flour as a substitution for tapioca flour significantly influenced ($P<0.05$) the protein content of broiler chicken meatballs. The average protein content values in this research ranged from 15.32% to 15.88%. The highest average protein content was found in (without the addition of potato skin flour) at 15.88%, while the lowest average protein content was in (100% potato skin flour) at 15.32%. Based on the Indonesian National Standard (SNI) 3818-2014, the protein content of meatballs should be a minimum of 11% [18]. In this research, the protein content of broiler chicken meatballs met the quality requirements of the Indonesian National Standard (SNI), which was greater than 11%.

The decrease in protein content was presumed to be due to the increasing percentage of potato skin flour substitution, which led to a reduction in the resulting protein content. In this research, the raw material of potato skin flour had a protein content of 12.23%. This was consistent with the research by [24], which stated that the concentration ratio of tapioca flour to potato flour (10%:0%) had a protein content of 11.67%, while the concentration ratio of tapioca flour to potato flour (0%:10%) had a protein content of 9.67%. [25] explained that as the carbohydrate content in flour increased, the protein content decreased. This was in line with the results of proximate analysis, which showed that the carbohydrate content of potato skin flour was 69.94%, while the carbohydrate content of tapioca flour

was 89.04% [26].

3.2.3 Fat content

Fat was an essential component in maintaining human body health, especially as an energy reserve. However, excessive fat consumption was not beneficial for health, as it could lead to conditions such as cholesterol-related diseases [23]. The analysis of variance results showed that the treatment with the addition of potato skin flour as a substitution for tapioca flour significantly influenced ($P<0.05$) the fat content of broiler chicken meatballs. The average fat content values in this research ranged from 8.17% to 8.75%. The highest average fat content was found in (without the addition of potato skin flour) at 8.75%, while the lowest average fat content was in (100% potato skin flour) at 8.17%. The decrease in fat content occurred in tandem with an increase in the percentage of potato skin flour substitution, and this was due to the fact that the fat content of potato skin flour was lower than that of tapioca flour. The fat content in potato skin flour was 0.81%, which was lower than the fat content in tapioca flour. This aligned with the research conducted by [3], which indicated that the fat content in potato skin flour ranged from 0.74% to 0.87%, while the fat content in tapioca flour was 3.39% [27].

The maximum fat content value allowed for meatballs according to the Indonesian National Standard (SNI) 3817-2014 was 10% [18]. This indicated that the fat content in all treatments complied with the SNI limit for meatball fat content. An excessively high fat content would affect the surface of meatball products, resulting in an uneven or porous surface that might influence consumer acceptance. Fat was also known to be a cause of food product spoilage due to odor absorption, hydrolysis, rancidity, enzymatic and chemical changes, as well as microbial activity [28].

3.2.4 Ash content

Ash was an inorganic residue resulting from the combustion of organic matter. The ash content was closely related to the mineral content of a substance. Determination of the ash content was performed to assess the quality of a processing method and to identify the type of material used, and it could serve as a parameter for the nutritional value of a food material. The analysis of variance results showed that the treatment with the addition of potato skin flour as a substitution for tapioca flour significantly influenced ($P<0.05$) the ash content of broiler chicken meatballs. The average ash content values in this research ranged from 0.82% to 1.92%. The highest average ash content was found in (100% potato skin flour) at 1.92%, while the lowest average ash content was in (without the addition of potato skin flour) at 0.82%. According to the Indonesian National Standard (SNI) 01-3818:2014, the maximum ash content allowed for meatballs was 3% [18]. This indicated that all treatments met the quality requirements of SNI for meatballs. The higher the percentage of potato skin flour substitution, the higher the ash content in broiler chicken meatballs, attributed to the fact that the raw material used for potato skin flour had an ash content of 5.25%, which was higher compared to the ash content of tapioca flour. The research outcomes of [3] showed that the resulting ash content in potato skin flour ranged from 4.15% to 4.67%. Meanwhile, the average ash content in tapioca flour was in the range of 0.25% to 1.19% [29].

The research results of [1] indicated that the lowest ash content in chicken meatballs was found in treatment a (100% tapioca flour), with an ash content of approximately 1.06%, while the highest ash content was observed in treatment c (100% jackfruit seed flour), with an ash content ranging around 1.29%. The increase in the percentage of jackfruit seed flour substitution led to an elevation in the ash content of the resulting

meatballs. The ash content in jackfruit seed flour was higher compared to the ash content in tapioca flour. [30] stated that the substitution of rice bran flour significantly affected the ash content in meatballs. The highest ash content was obtained in treatment 4 (35% rice bran flour), which was 4.12%, while the lowest ash content was in treatment 1 (0% rice bran flour), which was 0.61%.

3.2.5 Carbohydrate content

Carbohydrates were one of the macronutrients required by the body in significant amounts. Carbohydrates could be digested by the body, producing glucose and energy. The analysis of variance results showed that the treatment with the addition of potato skin flour as a substitution for tapioca flour significantly influenced ($P<0.05$) the carbohydrate content of broiler chicken meatballs. The average carbohydrate content values in this research ranged from 19.18% to 21.39%. The highest average value of carbohydrate content was found in (100% potato skin flour) at 21.39%, whereas the lowest average value of carbohydrate content was in (without the addition of potato skin flour) at 19.18%. The increase in the percentage of potato skin flour substitution led to an elevation in the carbohydrate content of broiler chicken meatballs. The carbohydrate content in broiler chicken meatballs came from tapioca flour and potato skin flour, which were used as binders in the meatball-making process. One of their functional properties was to assist in the gel formation process by binding water during cooking. The research results of [3] showed that the analysis of carbohydrate content in potato skin flour ranged from 74.49% to 75.26%. The longer the immersion of the sodium bisulfite solution in the process of making potato skin flour, the higher the resulting carbohydrate content, likely due to the precipitation of many carbohydrates. According to [31], an increase in protein content led to a decrease in carbohydrate content. The outcomes of this research supported this, as the protein content of broiler chicken meatballs in P0 was higher compared to P4, while the carbohydrate content in P0 was lower than in P4. The reduction in carbohydrates was closely related to the content of amylose and amylopectin, as they were the main components of starch [32]. The research outcomes of [33] indicated that the use of wild yam flour could increase the carbohydrate content in chicken meatballs. The highest carbohydrate content in chicken meatballs was found in T4 (20%), which was 34.09%, while the lowest carbohydrate content was in T1 (5%), which was 4.83%. The research results by [34] indicated that the substitution of different types of white ear mushrooms and starch had carbohydrate content ranging from 14.65% to 15.56%.

3.2.6 Crude fiber content

The fiber content was an essential component in the digestion process. Although the body could not digest fiber, its presence was necessary to maintain digestive system health. Fiber functioned to facilitate the digestive system, aided in preventing obesity, colorectal cancer, diabetes mellitus, and coronary heart disease. The analysis of variance results showed that the treatment with the addition of potato skin flour as a substitution for tapioca flour significantly influenced ($P<0.05$) the crude fiber content of broiler chicken meatballs. The average crude fiber content values in this research ranged from 0.35% to 4.05%. The highest average value of crude fiber content was found in (100% potato skin flour) at 4.05%, whereas the lowest average value of fiber content was in (without the addition of potato skin flour) at 0.35%. The increase in the percentage of potato skin flour substitution

led to an elevation in the crude fiber content of broiler chicken meatballs, likely because potato skin had a higher crude fiber content compared to tapioca. [13] stated that the crude fiber content of potato skins ranges from 52.58% to 54.82%, while tapioca flour has a fiber content of 21% [35].

The research outcomes of [36] indicated that the addition of red bean sprout flour to chicken meatballs resulted in a range of crude fiber content from 1.91% to 8.49%. The more addition of red bean sprout flour, the higher the content of crude fiber increased. The high crude fiber content in red bean sprout flour could undoubtedly add value to the resulting meatballs. [37] explained that there are two types of fiber, namely soluble and insoluble fiber. Soluble fibers include pectin, gum, mucilage, glycans, and algae, while insoluble fibers consist of cellulose, hemicellulose, and lignin. The fiber in potato skin flour had the ability to form a gel, thus influencing water-binding capacity and yield. This was consistent with the viewpoint of [38], who stated that water-soluble fibers could mix with water to form a gel or a dense network. The research by [39] demonstrated that increasing the concentration of added carrageenan flour could enhance the crude fiber content, ranging from 0.26% to 2.54%. High dietary fiber content could also increase the hardness and decrease the elasticity of meatballs [40].

4 Conclusion

The research results indicated that the higher the percentage of substitution of potato skin flour in broiler chicken meatballs, the lower the moisture content, protein content, and fat content, while the ash content, crude fiber content, and carbohydrate content increased accordingly. The addition of 100% potato skin flour and 0% tapioca flour had the most significant impact on the quality of broiler chicken meatballs.

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