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The Effect of Tapioca Flour and Bogor Taro Flour (*Colocasia esculenta* L. Schott) Formulations on the Chemical, Physical, and Sensory Characteristics of Catfish Sausage (*Pangasius hypophtalmus*)

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Abstract

This study was aimed to determine the effect of tapioca flour and Bogor taro flour formulation on the chemical, physical, and sensory characteristics of catfish sausage and to determine the best formulation. This study was arranged in a Randomized Complete Group Design (RCGD) with a single factor of tapioca flour and Bogor taro flour formulation with 6 treatments P1 (100%:0%), P2 (80%:20%), P3 (60%:40%), P4 (40%:60%), P5 (20%:80%), and P6 (0%:100%) with 4 replications. Data were tested for equality of variance with Barlett's test and data saturation with Tuckey's test. The data were analyzed for variance to determine the effect between treatments, then further analyzed using the HSD test at the 5% level. The results showed that the formulation of tapioca flour and Bogor taro flour had a very significant on water content, ash content, hardness, springiness, cohesiveness, appearance, and overall acceptance but no effect on the taste and aroma of catfish sausage. P5 was the best treatment with a water content of 52.08%, ash content of 1.55%, hardness of 270.75 gf, springiness of 10.03 mm, cohesiveness of 0.83, appearance of 2.93 (slightly dull), taste of 3.87 (typical of fish), aroma of 3.87 (typical of fish), overall acceptance of 3.88 (like), protein content of 15.61%, and fat content of 4.29%.

Keywords: Bogor taro flour; catfish sausage; tapioca flour.

INTRODUCTION

As a maritime country, Indonesia possesses significant economic potential in the fisheries sector, including capture fisheries and aquaculture. Lampung Province excels in freshwater fisheries, with one of its potentials being catfish cultivation. According to the Ministry of Marine Affairs and Fisheries (2020), the total catfish production in Lampung Province reached 19,080.98 tons in 2019 and increased to 21,713.87 tons in 2020. Based on this data, the freshwater fisheries sector, especially catfish in Lampung Province, has the potential for further development and utilization. Catfish contains approximately 75.75-79.42% water, 12.94-17.59% protein, 1.81-6.57% fat, and 0.16-0.23% ash (Wahyuningtyas et al., 2020). The yield of catfish meat is 61.7% of the initial weight of the fish, which is significantly higher than several other fish species (Harmain & Dali, 2017). Catfish protein content is relatively high and contains all essential amino acids, especially lysine and arginine (Wahyuningtyas et al., 2020). However, catfish are prone to quality deterioration and perishability as a fishery product. Therefore, food processing, such as diversification into sausage products, is necessary to address this issue.

The consumption of processed fast food, such as meat sausages, in Indonesia, continues to rise at an average rate of 4.46% per year (Wulansari, 2013). Sausage is a diversified food product produced by mixing ground meat with fillers and other permitted additives, which are then filled into sausage casings (BSN, 2013). The fillers must contain high starch content to produce a compact texture and structure (Ernawati et al., 2012). Catfish have meat characteristics with a smooth and somewhat tender texture (Setiawati et al., 2015). Therefore, appropriate fillers are needed in the production of catfish sausages. Tapioca flour can be used as a filler to improve emulsion stability and bind other ingredients in product processing. Tapioca contains starch ranging from 73.3−84.9%, consisting of 17% amylose and 83% amylopectin (Herawati, 2012). Tapioca has high amylopectin content, is not prone to clotting, has high adhesive strength, is not easily broken or damaged, and has a relatively low gelatinization temperature (Aristawati et al., 2013). However, tapioca flour is insoluble in cold water and requires long cooking times (Purwantika, 2016), hence

the need to formulate it with other fillers to produce catfish sausages.

Bogor taro flour is a carbohydrate source with a starch content of 75.18%, consisting of 5.59% amylose and 94.41% amylopectin (Sembong et al., 2019). Bogor taro flour has high swelling power and peak viscosity, thus having a higher ability to form a gel and can be used as a substitute for tapioca flour in sausage making. Bogor taro flour has granules with a small size of about 8.3 μm, which can form a fine gel structure (Aryanti et al., 2017). Bogor taro flour contains a relatively high fibre content of 6.67% (Hartati & Prana, 2003). The small granule size and fibre content in Bogor taro flour make it highly digestible, thus beneficial for digestion (Sembong et al., 2019). Bogor taro has a higher starch content and lower oxalate content (the cause of itching) compared to beneng and kimpul taro. The starch content of Bogor taro is 18.03%, while beneng taro is 6.97% and kimpul taro is 13.20%. The oxalate content of Bogor taro is 8,578.28 ppm, while beneng taro is 61,783.75 ppm and kimpul taro is 17,400 ppm (Lestari & Susilawati, 2015).

The use of tapioca flour and Bogor taro flour as fillers in catfish sausage production is expected to improve the physical and sensory characteristics of the sausages. Research on the production of catfish sausages using tapioca flour and Bogor taro flour as fillers has yet to be conducted thus far. Therefore, this study aims to determine the effect of the ratio of tapioca flour to Bogor taro flour as fillers on the chemical, physical, and sensory properties of catfish sausages, as well as the chemical properties of the best treatment according to Indonesian National Standard (SNI) 7755:2013 concerning fish sausages.

MATERIALS AND METHODS

Materials and equipment

The main ingredients used in sausage making were living *Siamese* catfish (*Pangasius hypophtalmus*) with a size of 2 fish/kg obtained from the Gedongtataan Pesawaran Market, Bogor taro flour (Naya Jagapati), and tapioca flour (Pak Tani Cap Gunung). Additional ingredients included Soy Protein Isolate (Para Agribusiness), salt, ice water, ginger, powdered pepper, sugar, garlic, oregano, Sania Royale soybean oil, and polyamide casings (food-grade and non-edible). The materials used for chemical analysis are concentrated H_2SO_4 solution, 0.02N HCl, distilled water, 50% NaOH, alcohol, NaOH-$Na_2S_2O_3$, K_2SO_4, HgO, PP indicator, and H_3BO_3.

The equipment used in sausage making includes a grinder (food processor), cooking utensils, scales, stove, casing filler, tying string, basin, knife, spoon, spatula, cutting board, and other cooking utensils. The equipment used for chemical analysis includes a boiling stone, crucible clamp, porcelain crucible, metal crucible, Erlenmeyer flask, oven, desiccator, phenolphthalein indicator, distillation apparatus, burette, pipette, test tube, vortex mixer, analytical balance, filter paper, electric furnace, Kjeldahl flask, and Brookfield CT-3 Texture Analyzer for physical analysis, as well as a set of sensory testing equipment.

Data analysis

The study used a Randomized Complete Group Design consisting of one factor and four replications. The treatment of the comparison between tapioca flour and Bogor taro flour consisted of 6 levels, namely P1 (100%:0%), P2 (80%:20%), P3 (60%:40%), P4 (40%:60%), P5 (20%:80%), P6 (0%:100%). The amount of filler used is calculated from 30% of the weight of ground catfish meat (w/w). The data obtained were analyzed for variance (Anova) to obtain error variance estimates and significant tests to determine the effects between treatments. Data were further analyzed using the Honestly Significant Difference (HSD) test at the 5% level to determine differences between treatments. The best treatment for catfish sausages was determined using the star test method.

Catfish sausage making procedure

The sausage-making procedure refers to the method by Apriyani (2019) with modifications. Fresh catfish is filleted by removing and cleaning the gut contents thoroughly. The cleaned catfish is filleted, separating the meat from the skin and bones. The catfish meat is ground into 200 g using a food processor until smooth. Ice water is added to the catfish meat in 40 g during grinding. Other required ingredients, including tapioca flour and Bogor taro flour according to the calculated formulation of 30%, are weighed based on the weight of ground catfish meat (w/w). The weighed catfish meat is then placed in a container and mixed with other ingredients and fillers according to the treatment formulation. Next, all ingredients were stirred until well mixed. The evenly mixed dough is then filled into the sausage filler and filled into sausage casings. The sausages are then tied with string at both ends and in the middle at intervals of 10 cm, with each sausage dough weighing around 31-33 g. After that, the sausages were immersed in boiling water and boiled for 30 minutes. The cooked sausages are then removed and drained.

Observation

Observations of the chemical properties of catfish sausages were based on parameters such as water content and ash content (AOAC, 2015). Observations of the physical properties of catfish sausages were based on texture parameters, including hardness, cohesiveness, and springiness (Wulansari, 2013). Sensory observations of catfish sausages include scoring tests for appearance, taste, and aroma and hedonic tests for overall acceptance (Apriyani, 2019). Observations of the chemical properties of the best-treated catfish sausages include

protein and fat content (AOAC, 2015). The determination of the best treatment is done using the star test method.

RESULTS AND DISCUSSION

Chemical properties

The chemical analysis carried out on catfish sausage included water and ash content parameters. The results of the water and ash content can be seen in Table 1. Based on Table 1, it can be seen that the water content and ash content of catfish sausage were significantly different between treatments. The water content results ranged from 50.34%-52.68%, while the ash content ranged from 0.90%-1.67%.

Table 1. Results of chemical analys of catfish sausage.

Treatments (tapioca flour: Bogor taro flour)	Water content (%)	Ash content (%)
P6 (0%:100%)	52.68±0.31^{a}	1.67±0.16^{a}
P5 (20%:80%)	52.08±0.65^{ab}	1.55±0.09^{ab}
P4 (40%:60%)	51.22±0.58^{b}	1.44±0.08^{b}
P3 (60%:40%)	50.81±0.13^{bc}	1.33±0.02^{bc}
P2 (80%:20%)	50.57±0.24^{c}	1.20±0.10^{c}
P1 (100%:0%)	50.34±0,16^{c}	0.90±0.10^{d}
HSD 5%	0.845	0.219

Note: The numbers followed by different letters on the same row indicate significant differences based on the HSD test 5%

Water content

The water content of catfish sausages increases with the increase in the amount of Bogor taro flour and the decrease in the amount of tapioca flour added. This is because the amylopectin content in Bogor taro flour is higher, thus absorbing more water. This result is in line with the research by Sembong et al. (2019), where the increased use of Bogor taro flour in pork sausage production increased the water content of sausages, with the highest value observed when using 75% taro flour. Amylose and amylopectin can absorb water and have good gelatinization properties. The end of the amylopectin and amylose molecule chains has hydroxyl groups that can interact with hydrogen from water (Kusnandar, 2019).

Kusnandar (2019) states that amylopectin has bonds with α-1,6-glycosidic branch structures, thus able to maintain water content compared to amylose, which has linear bonds with α-1,4-glycosidic structures. Amylose absorbs water more easily and releases its bonds more easily, while amylopectin takes longer to absorb water and also takes longer to release its bonds during cooking. This causes the higher the amylopectin content in the raw material, the higher the water content in the resulting food product (Pratama, 2018). The amylopectin content of Bogor taro flour at 94.41% is higher than the amylopectin content of tapioca flour at 79.59-79.99% (Sembong et al., 2019), thus resulting in higher water content in catfish sausages when Bogor taro flour is added.

According to Kusnandar (2019), starch has hydrophilic properties to absorb the water. Starch granules' ability to absorb and bind water influences water absorption capacity. Granule size plays an important role in the water absorption process of filler materials. Smaller granule sizes can increase the hydration rate and facilitate water entry into starch granules, increasing water absorption capacity (Ulyarti et al., 2022). The granule size of tapioca flour, reaching 35 μm (Herawati, 2012), is larger than that of Bogor taro flour, which is 8.3 μm (Aryanti et al., 2017).

According to Sembong et al. (2019), the dietary fibre content in the ingredients also causes the water content of the product to increase because dietary fibre easily absorbs water due to its large surface area. The dietary fibre content of Bogor taro flour sausages is 9.66%, which is greater than tapioca flour sausages at 5.01%. This result is directly proportional to the water content testing results, meaning the higher the Bogor taro flour content, the higher the dietary fibre content, and consequently, the higher the water content of the sausages (Sembong et al., 2019). The water content of catfish sausages using tapioca flour and Bogor taro flour in various formulations complies with the Indonesian National Standard (SNI) 7755:2013 for the quality requirements of fish sausages, which is a maximum of 68%.

Ash content

The ash content increases with the increase in the amount of Bogor taro flour and the decrease in the amount of tapioca flour added. Bogor taro flour has a higher ash content than tapioca flour, resulting in increased ash content of catfish sausages with the increasing use of Bogor taro flour. The ash content of Bogor taro flour ranges from 3.11% to 3.84% (Hawa et al., 2020), while the ash content of tapioca flour is 1.1% (Wely, 2021). This is consistent with Susanti's research (2016), where meat sausages with the addition of Bogor taro flour and tapioca flour resulted in the highest ash content with 100% Bogor taro flour addition at 5.38% and the lowest with 100% tapioca flour addition at 4.39%.

Ash content is related to minerals in the form of organic and inorganic salts in a food ingredient (Nisa & Wardani, 2016). Bogor taro flour contains several mineral components, such as 67 mg phosphorus and 31 mg calcium. Tapioca flour has a lower mineral content, with 7 mg of phosphorus and 20 mg of calcium (Susanti, 2016). Furthermore, the ash content of Bogor taro flour is higher than tapioca flour because Bogor taro flour is soaked in a sodium metabisulfite solution in its production process. Sodium metabisulfite is an inorganic salt containing Na and S minerals, thus increasing the ash content of Bogor taro flour (Yuliyanti, 2023). The ash content of catfish sausages using tapioca flour and Bogor

taro flour in various formulations meets the Indonesian National Standard (SNI) 7755:2013 for the quality requirements of fish sausages, which is a maximum of 2.5%.

Physical properties

The physical analysis carried out on catfish sausage included the parameters of hardness, springiness and cohesiveness. The hardness, springiness and cohesiveness test results can be seen in Table 2. Based on Table 2, it can be seen that the hardness, springiness and cohesiveness of the catfish sausage were significantly different between treatments. The hardness results ranged from 257.06-369.88 gf, springiness ranged from 9.13-10.13 mm, and cohesiveness ranged from 0.73-1.09.

Table 2. Results of physical analys of catfish sausage.

Treatments (tapioca:Bogor taro flour)	Hardness (gf)	Springiness (mm)	Cohesiveness
P6 (0%:100%)	257.06±4.64^{d}	10.13±0.09^{a}	0.73±0.06^{d}
P5 (20%:80%)	270.75±6.94^{cd}	10.03±0.09^{ab}	0.83±0.03^{c}
P4 (40%:60%)	290.44±9.92^{c}	9.78±0.22^{b}	0.87±0.03^{c}
P3 (60%:40%)	327.56±13.25^{b}	9.70±0.14^{b}	0.93±0.02^{bc}
P2 (80%:20%)	351.63±8.01^{ab}	9.40±0.14^{c}	0.97±0.04^{b}
P1 (100%:0%)	369.88±15.14^{a}	9.13±0.09^{c}	1.09±0.06^{a}
HSD 5%	24.746	0.280	0.083

Note: The numbers followed by different letters on the same row indicate significant differences based on the HSD test 5%.

Hardness

The hardness value of catfish sausages decreases with the increasing amount of Bogor taro flour and the decreasing amount of tapioca flour added. This is because Bogor taro flour's amylose content is lower than tapioca flour's. This result is consistent with Aminullah et al. (2020), who found that the increasing addition of Bogor taro flour in making lele fish pempek tends to decrease the hardness level of the resulting pempek. The higher the amylose content, the higher the hardness value of the resulting product. Bogor taro flour contains 5.59% amylose, while tapioca flour contains 20.01%-20.47% amylose (Sembong et al., 2019).

Amylose can reassociate with its sesame molecules to form a rigid structure. This causes gelatinized starch to undergo retrogradation crystallization (Luna et al., 2015). The retrogradation process causes binding matrices in amylose to bind to each other, thus increasing the product's hardness (Fitriyani et al., 2017). Therefore, the addition of Bogor taro flour with higher concentrations can result in a decrease in the hardness value of the product. Amylose can bind water molecules better than amylopectin. Water absorption during heating disrupts the crystal structure, and water molecules bond with hydroxyl groups to form hydrogen bonds (Luna et al., 2015). The greater the bound water content, the narrower the space between molecules, resulting in a denser and more compact product texture (Nurdjanah & Yuliana, 2016). The hardness value of a product is also influenced by its water content. The higher the water content in the product, the lower the hardness value, resulting in a softer and less compact product (Setyowati & Nisa, 2014).

Springiness

The springiness value of catfish sausages increases with the increasing amount of Bogor taro flour and the decreasing amount of tapioca flour added. This is because Bogor taro flour's amylopectin content is higher than tapioca flour's. This result is consistent with Lasi et al. (2019), where the higher concentration of added taro flour produces more resilient bakso. The amylopectin content influences the springiness value of the filling material used. Amylopectin can form a gel and is less soluble in water, resulting in a more resilient and sticky product texture. Amylopectin has longer branch chains, making it strong in forming a gel because it binds water molecules, and their bonds are not easily released (Debora et al., 2023). The high amylopectin content in Bogor taro flour forms the elasticity level of catfish sausages (Sembong et al., 2019).

High amylopectin in the filling material affects gel formation, one of which is in the swelling or starch expansion properties. Starch containing high amylopectin can interact with myofibril protein to form a gel. The interaction between myofibril protein and starch occurs when myofibril matrix spaces are filled with starch molecules, thus forming an elastic product structure (Herdiana et al., 2023). This indicates that the addition of Bogor taro flour in making catfish sausages produces a more resilient product texture.

Cohesiveness

The cohesiveness value of catfish sausages decreases with the increasing amount of Bogor taro flour and the decreasing amount of tapioca flour added. This is because Bogor taro flour's amylose content is lower than tapioca flour. The amylose content of the filling material

used influences the cohesiveness value of the product. Higher amylose content causes the product texture to be more compact. This is because in forming the product texture, amylose plays a role in forming the firmness of the gel during the water absorption stage during gelatinization, resulting in a more compact texture than filling material with lower amylose content (Liur et al., 2013).

Amylose strongly bonds hydrogen due to its straight chains with α-1,4-glycosidic structures in starch granules. The greater hydrogen bonding strength affects the water absorption capacity, thus affecting the formation of product texture (Indrianti et al., 2013). Bogor taro flour has a lower amylose content of 5.59%, while tapioca flour has an amylose content of 20.01%-20.47% (Sembong et al., 2019). The high amylose content in tapioca flour results in catfish sausages with a higher level of compactness compared to the use of Bogor taro flour.

Sensory observations

Sensory analysis on catfish sausage included appearance, taste, aroma and overall acceptance. The results of the appearance, taste, aroma and overall acceptability test can be seen in Table 3. Based on Table 3, the appearance and overall acceptability of catfish sausages were significantly different between treatments, while the taste and aroma of catfish sausages were not significantly different between treatments. Appearance scores ranged from 2.55-4.42; taste scores ranged from 3.63-3.98; aroma scores ranged from 3.58-3.87; and overall acceptance scores ranged from 3.36-3.92.

Table 3. Results of sensory analys of catfish sausage.

Treatments (tapioca:Bogor taro flour)	Appearance	Taste	Aroma	Overall acceptance
P1(100%:0%)	4.42±0.08^{a}	3.98±0.25^{a}	3.70±0.20^{a}	3.92±0.08^{a}
P2(80%:20%)	4.03±0.16^{ab}	3.67±0.12^{a}	3.58±0.07^{a}	3.36±0.18^{c}
P3(60%:40%)	3.65±0.21^{b}	3.64±0.23^{a}	3.62±0.14^{a}	3.67±0.06^{b}
P4(40%:60%)	3.48±0.10^{b}	3.83±0.16^{a}	3.74±0.13^{a}	3.51±0.04^{bc}
P5(20%:80%)	2.93±0.33^{c}	3.87±0.05^{a}	3.87±0.05^{a}	3.88±0.05^{ab}
P6(0%:100%)	2.55±0.41^{c}	3.63±0.09^{a}	3.63±0.11^{a}	3.47±0.04^{bc}
HSD 5%	0.595	0.418	0.310	0.223

Note: The numbers followed by different letters on the same row indicate significant differences based on the HSD test 5%

Score value:
Appearance : (5) ripping, (4) less ripping, (3) slightly dull, (2) dull, (1) very dull
Taste and aroma : (5) very typical of fish, (4) typical of fish, (3) slightly typical of fish, (2) not typical of fish, (1) very not typical of fish
Overall acceptance : (5) really like, (4) like, (3) slightly like, (2) do not like, (1) very dislike.

Appearance

The appearance score of catfish sausages decreases with the increasing amount of Bogor taro flour and the decreasing amount of tapioca flour added. The appearance of catfish sausages is generally influenced by the main ingredients, binders, fillers, and other additives and can be affected by temperature and cooking time (Peka et al., 2021). However, in this study, it is suspected that the filler used affects the appearance of catfish sausages. Bogor taro flour has a darker colour compared to tapioca flour.

Bogor taro flour has a whitish-grey colour, while tapioca flour has a bright white colour. This is because, during the production process of Bogor taro flour, a colour change occurs during the taro drying stage. This colour change occurs because taro sap undergoes enzymatic oxidation, which can convert polyphenol compounds into compounds with a dark brown colour, resulting in Bogor taro flour being darker compared to tapioca flour. The polyphenol compound in taro is quercetin, which provides the colour pigment to the taro tuber (Dana, 2018). Additionally, the gelatinization process during heating can result in the formation of starch paste with a darker colour than before gelatinization (Syafutri et al., 2017). The whiteness degree of Bogor taro flour is 71.6%, which is lower than the whiteness degree of tapioca flour at 97.64% (Ernilawati et al., 2018). Therefore, after the gelatinization process, the resulting sausages become darker with increasing Bogor taro flour. The appearance score of catfish sausages in all treatments meets the requirements of SNI 7755:2013 for fish sausages, with a minimum score of 7 for the slightly dull criterion, equivalent to a score of 3 in this study's sensory questionnaire.

Taste

The taste score of catfish sausages in all treatments meets the requirements of SNI 7755:2013 for fish sausages, with a minimum score of 7 for the slightly typical fish criterion, equivalent to a score of 3 in this study's sensory questionnaire. Based on Table 16, adding Bogor taro flour and tapioca flour with different concentrations in making catfish sausages does not affect the taste

assessment score. This is because Bogor taro flour and tapioca flour do not have dominant flavours, so their use in all treatments does not affect the final product. The main ingredients and other seasonings influence the taste of fish sausages added to the dough (Lasi et al., 2019). The percentage of main ingredients used still meets the requirements of SNI 7755:2013, which is a minimum of 50%. Therefore, the treatments performed do not affect the taste of the sausages. The consistent taste score in all treatments indicates that Bogor taro flour can be an alternative to tapioca flour in making catfish sausages.

Aroma

The aroma score of catfish sausages in all treatments meets the requirements of SNI 7755:2013 for fish sausages, with a minimum score of 7 for the slightly typical fish criterion, equivalent to a score of 3 in this study's sensory questionnaire. The assessment of the aroma score of catfish sausages in this study is consistent with the study by Aminullah et al. (2020), where the use of Bogor taro flour and tapioca flour in making lele fish pempek does not affect the aroma score. This is because Bogor taro flour and tapioca flour do not have dominant aromas, so their use in all treatments does not affect the final product. The aroma of processed meat products is influenced by the type of raw material used, cooking time, and other additives, such as spices, that have volatile properties due to cooking (Sujianti et al., 2023). The percentage of main raw materials used still meets the requirements of SNI 7755:2013, which is a minimum of 50%. Therefore, the treatments performed do not affect the aroma of the sausages and produce a similar aroma in all treatments. This indicates that Bogor taro flour can be an alternative to tapioca flour in making catfish sausages.

Overall acceptance

The highest overall acceptance score was obtained in treatments P1 with a 3.92 (like) and P5 with a 3.88 (like). The lowest overall acceptance score was obtained in treatments P4 with a score of 3.51 (like), P6 with a score of 3.47 (somewhat like), and P2 with a score of 3.36 (somewhat like). Based on the overall acceptance assessment scores, catfish sausages with treatments P1 and P5 produced the most preferred assessments by the panellists. According to the panellists' assessment in the questionnaire, these treatments had a dense, compact, and slightly resilient texture, a typical fish taste but not too fishy, and a slightly less radiant appearance that was still acceptable and liked by the panellists. Treatment P2 was less preferred by the panellists than other treatments, with the lowest overall acceptance score due to a slightly fishy aroma and taste and the hardest texture.

Best treatment

The best treatment was determined based on chemical tests for water and ash content, physical tests for hardness, springiness, and cohesiveness, sensory tests, including scoring (appearance, taste, and aroma) and hedonic tests (overall acceptance). The method used to determine the best treatment was the star test method. The star test method was conducted by marking stars on the 5% HSD test results with the notation 'a' because data with the notation 'a' are treatments with the highest values. Then, the stars for each treatment were added up, and the best treatment was chosen based on the highest number of stars. The treatment designated as the best was P5, which produced the best hardness, springiness, cohesiveness, water content, ash content, appearance, taste, aroma, and overall acceptance and met the requirements of SNI 7755:2013. The best treatment of catfish sausages, P5, underwent analysis for protein and fat content, and the results were compared with SNI 7755:2013. The chemical analysis results of the best treatment of catfish sausages can be seen in Table 4.

Table 4. Results of best treatment for catfish sausage.

Parameters	P5 (20%:80%)	SNI 7755:2013	Remarks
Protein content (%)	15.61	Min 9.0	Meet the standard
Fat content (%)	4.29	Max 7.0	Meet the standard

CONCLUSIONS

The comparison between tapioca flour and Bogor taro flour in making catfish sausages significantly affects water content, ash content, hardness, springiness, cohesiveness, appearance, and overall acceptance. However, it does not affect the taste and aroma of catfish sausages. The best catfish sausage ratio is tapioca flour and Bogor taro flour 20%:80% (treatment P5), which results in a water content of 52.08%, ash content of 1.55%, hardness of 270.75 gf, springiness of 10.03 mm, cohesiveness of 0.83, appearance score of 2.93 (slightly dull), taste score of 3.87 (typical of fish), aroma score of 3.87 (typical of fish), and overall acceptance score of 3.88 (like). The protein content is 15.61%, and the fat content is 4.29%. The water, ash, protein, and fat content of catfish sausages have met the requirements of SNI 7755:2013 for fish sausages.

***Competing Interest*:** The authors declare that there are no competing interests.

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