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Chemical and Organoleptic Characteristics of Pempek Using Different Ratios of Lampam Fish Surimi and Tapioca Flour

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ABSTRACT

The use of lampam fish as a raw material for pempek is a new effort to overcome the high cost of snakehead fish. The study aims to determine the chemical and organoleptic characteristics of pempek using a comparison of lampam fish surimi with tapioca flour. The study was conducted in the laboratory of the Muhammadiyah University of Palembang and the Agricultural Product Technology laboratory, Faculty of Agriculture, Sriwijaya University from December 2023 to February 2024. The study used a non-factorial randomized block design with five treatment levels, namely P1 (surimi 250 g:tapioca flour 350 g), P2 (surimi 300 g:tapioca flour 350 g), P3 (surimi 350:tapioca flour 350 g), P4 (surimi 400 g:tapioca flour 350 g), P5 (surimi 450 g:tapioca flour 350 g) with three replications. The research parameters include analysis of protein content and water content, organoleptic tests of color, aroma, taste, and elasticity. The results showed the highest protein content in P5 at 23.37% ± 0.10, and the highest water content in P5 at 59.11% ± 0.35. The highest level of preference for color was 4.28 ± 1.06 (like), aroma was 3.76±1.54 (rather like), taste was 3.84 ± 0.72 (rather like) and elasticity was 3.92± 1.00 (rather like) in P5.

1. INTRODUCTION

Pempek is a traditional food from the city of Palembang, South Sumatra province, with the raw ingredients being crushed or ground fish, tapioca flour, clean water and table salt in certain proportions (Aminullah *et al*., 2020; Dasir *et al*., 2021; Muchsiri *et al*., 2023). The stages of making pempek begin with mixing ground fish or crushed fish, water, table salt and tapioca flour into a homogeneous or smooth dough, forming pempek and boiling until cooked (Murtado *et al*., 2014). In the process of making pempek, only fish flesh is used while the other parts consisting of scales, skin, bones and head are discarded, so the fish must have a certain large size to be able to be milled to separate the flesh and bones (Aminullah *et al*., 2021; Muchsiri *et al*., 2023).

Aminullah *et al*. (2020) explained that initially pempek entrepreneurs used types of freshwater fish, namely belida fish (*Chitala lopis*) and snakehead fish (*Channa striata*). The advantages of these two types of fish compared to other types of fish are that they have white and thick flesh and do not have thorns in the flesh or thorns tucked into the flesh so they can speed up the processing process (Ayu *et al*., 2022). Belida fish and snakehead fish are increasingly experiencing scarcity and prices are increasingly expensive because fishing is carried out excessively and is destructive and uses fishing gear that endangers the population (Kartamihardja, 2014). Another reason for the scarcity of belida fish and snakehead fish is that there have been no successful cultivation efforts. According to applicable regulations concerning fisheries (UU No. 45/2009), belida fish is a type of fish that is protected and prohibited from being caught (Presiden R.I. & DPR, 2009). This has caused pempek entrepreneurs to switch to marine fish such as mackerel and parang-parang fish even though the resulting pempek has a slightly fishy aroma (Murtado *et al*., 2015).

In the Musi River, there are 233 species of fish from the black fish group, including betok fish, snakehead fish, Siamese sepat fish, tepig fish (sapil fish) and the white fish group, including lais fish, baung fish, catfish, jelawat fish, lampam fish, and other types of fish (Ridho *et al*., 2017). The catching of these fish is quite high, especially in the dry season peoples harvest swamps which are drought. These small fish are known as local fish which are an endemic and is only found in one body of water and not in other waters. This endemic type of fish of various sizes is only used as a side dish and has not been used as raw material for pempek or other processed foods, so its economic value is low and even lower than the price of introduced fish such as goldfish, tilapia and pomfret (Iskandar *et al*., 2021).

Lampam fish (*Barbodes schwanenfeldii*) with local names *bader*, *lemaduk*, *lempam*, *lempem*, *kepiat*, *sala*, *tengadak*, red *tenadak*, and *kapiek*. Every 100 g of lampam fish has a protein content of 19 g, fat 13 g, calcium 48 mg, potassium 264.90 mg 150 mg and phosphorus 154 mg (Direktorat Jenderal Kesehatan Masyarakat, 2018). The use of lampam fish in making pempek using all parts of the fish (flesh, skin and bones) is expected to overcome the difficulties and scarcity of fish raw materials, increase the economic value of local natural resources and produce a new type of product in the form of pempek using all parts of the fish as raw materials with a fairly high protein content and mineral content of calcium, phosphorus and potassium.

One of the weaknesses of local ground fish meat is that the color of the fish meat is not good so it needs to be processed into fish surimi. Processing it into fish surimi can improve the poor color of ground fish meat. Surimi is ground fish meat that has undergone stages of weeding to remove entrails, milling, grinding, washing with clean water, draining the water, mixing cryoprotectant and freezing or not freezing (Park, 2013; Ramadhan *et al*., 2014).

Making pempek uses ground fish meat or crushed fish and tapioca flour as raw materials. The stages of making tapioca flour start from the process of breaking down the cells by grinding or crushing and separating the starch grains by filtering, extracting the starch by settling, removing water and carrying out the process, drying and flouring by milling (Dwijaya *et al*., 2015; Edam, 2017). The ratio of ground fish to tapioca flour varies from one entrepreneur to another; namely between 1:1 to 1:2 (Aminullah *et al*., 2021; Dwijaya *et al*., 2015). According to Yasin, (2005), tapioca flour has several weak natural properties, namely the gel formed is less cohesive, the gelatinization temperature is high, the formation capacity of starch dispersions is high, the ability to bind water is low, the dispersion has low resistance to acids, has agitation properties, and in pasta products the formation of retrogradation.

The aim of this research was to determine the comparison of lampam fish surimi and tapioca flour on the chemical and organoleptic characteristics of pempek. The novelty in this research is the pempek product which is made from tapioca flour and fish surimi which is produced from all parts of the fish (flesh, skin and bones) so that the fish does not have to be a certain large size to be able to be milled to separate the flesh and bones.

2. MATERIALS AND METHODS

2.1. Material

The ingredients used in making pempek consist of lampam fish (*Barbodes schwanenfeldii*) obtained from the Plaju market fishmonger, Palembang City, tapioca flour, granulated sugar and salt obtained from the Plaju market grocery store, Palembang City, ice water, sodium tripolyphosphate (STTP) obtained from the Kimia Hadi Palembang shop. Meanwhile, the tools used include fish/meat grinders, scales, basins, stoves, pans, stirrers, cutting boards, laboratory analysis equipment and organoleptic test equipment. Pempek making and organoleptic tests were carried out in the laboratory of the Faculty of Agriculture, Muhammadiyah University, Palembang; and chemical analysis was carried out in the Sriwijaya University Palembang laboratory.

2.2. Method

2.2.1. Pempek Preparation

The manufacturing process consists of 2 stages, namely, preparation of fish surimi (Putranti *et al*., 2020) and pempek production (Aminullah *et al*., 2020; Dasir *et al*., 2021; Muchsiri *et al*., 2023). The first stage of the process of making fish surimi begins with weeding the fish which includes removing the scales, removing the entrails and removing part of the head. Then wash it to remove dirt and blood. Next, grind the fish using a fish grinder. The ground fish is washed

(1st washing) using a mixture of ice water and 0.3% table salt (NaCl), then pressed using a filter cloth. The ground fish is washed again (2nd washing) with a mixture of ice water and 0.3% table salt (NaCl), then pressed using a filter cloth. The results of pressing the ground fish were added with 3% granulated sugar and 0.2% (STTP) and mixed until homogeneous. The result of this homogeneous mixture is lampam fish surimi.

The second process of making pempek begins with mixing tapioca flour and lampam fish surimi according to the ratio, and adding table salt. Next, mix until the material is homogeneous, then add water and make a smooth dough that is no longer sticky to your hands. The smooth dough is then shaped into an elongated cylinder (lenjeran) with a diameter of 2 cm and a length of 6 cm, then boiled for 15 minutes (until the pempek floats). Next, the cooked pempek is removed and drained. The comparative treatment of fish surimi and tapioca flour is as in Table 1.

Table 1. Comparative treatment of fish surimi and tapioca flour

Treatment	Fish Surimi	Tapioca Flour
P1	250	350
P2	300	350
P3	350	350
P4	400	350
P5	450	350

2.2.2. Protein Content

Protein content in pempek were analyzed using the Kjeldahl method (Sudarmaji *et al*., 1997) as specified in the procedure according to SNI 01-2891-1992 (BSN, 1992). After the sample was made homogeneous, it was weighed at 2 grams and wrapped in folded weighing paper. Next, it is destroyed in a digestion flask at a temperature of 410º C for ± 2 hours until the solution is clear, plus 2 catalyst tablets, several boiling stones, 15 ml of concentrated H_2SO_4 and 3 ml of H_2O_2. Next, leave it for 10 minutes in the acid chamber. The solution formed was left at room temperature and then 50 ml of distilled water was added. An Erlenmeyer container containing 25 ml of 4% H_3BO_3 solution and PP indicator was then distilled. In a series of steam distillation equipment, the digestion results are installed in a digestion flask. To the distillate was added 50 ml of sodium hydroxide-thiosulfate solution. The distillate is distilled until the volume in the Erlenmeyer flask reaches 150 ml and the color changes to yellow in the distillate. The distillation result in the form of distillate is titrated with 0.2 N HCl until the color changes from green to neutral gray (natural gray). After the sample analysis stage is complete, blank treatment (without sample) is carried out. Protein content is determined using the following formula:

$$Protein\ Content(\%) = \frac{(V_{sample} - V_{blanko}\ x\ N_{HCl}\ x\ 14.007\ x\ 6.25}{Sample\ Weight\ (mg)}\ x\ 100\% \quad (1)$$

2.2.3. Water Content

Water content was analyzed using the AOAC method (Sudarmaji *et al*., 1997). 2 grams of sample was put into an empty porcelain cup which had first been heated in the oven for 3 hours at 105o C. The cup containing the hot sample was put in a desiccator for 30 minutes and after it had cooled, it was weighed. The sample and porcelain cup were reheated for 3 hours in an oven at 105º C, cooled in a desiccator for thirty minutes, then weighed. This treatment is repeated until a relatively constant weight is achieved. Determination of water content is calculated using the formula:

$$Water\ content = \frac{B-C}{B-A} \times 100\% \quad (2)$$

where *A* is weight of empty cup (g), *B* is weight of cup + initial sample (g), and *C* is weight of cup + dry sample (g).

2.2.4. Color, Aroma, and Taste

The color, aroma and taste of pempek were tested using a sensory test by 20 panelists who were somewhat trained in sensory testing, who were panelists who had often taken part in sensory tests (Pratama, 2013). The panelists are assessed by filling in the assessment form with an assessment score from 1 (very dislike criteria) to 5 (very like criteria). The higher the score given, the higher the degree of liking for pempek.

2.2.5. Firmness Testing

The level of firmness of pempek lenjer was tested using the ranking method or grading test (Pratama, 2013). This is done by sorting the sensory properties of pempek from the best sensory properties to the worst, namely the most chewy pempek to the least chewy. Test score 1 (chewy) to 5 (not at all chewy). The worst elasticity is given the largest serial number (5) and the best characteristic is given the smallest serial number (1) according to the number of treatments studied.

2.3. Data Analysis

Data for pempek characteristic was analyzed using ANOVA (analysis of variance). If the treatment significant, then continued by LSD (Least Significant Difference) at 5% significance level. Organoleptic data for pempek was analyzed using Conover test to compare scores or preferences and determine whether there are significant differences in panelist preference scores for certain attributes such as taste, aroma, or color of food products.

3. RESULTS AND DISCUSSION

Based on the analysis of variance (ANOVA), the comparison treatment of lampam fish surimi with tapioca flour had a very significant effect on the protein content and water content of pempek. Further test results with an honest real difference test are as shown in Table 2.

Table 2. Effect of treatment (lampam fish surimi and tapioca flour) on protein content and water content of pempek

Treatment	Average protein content (%)	Average water content (%)
P5	23.37±0.10 a	59.11a ± 0.35
P4	21.59±0.44 b	58.29b ± 0.32
P3	19.38±0.14 c	57.24c ± 0.32
P2	17.13±0.56 d	55.98d ± 0.32
P1	15.20±0.10 e	54.91e ± 0.44

Note: Numbers followed by different letters have significantly different meanings or very real at the 1% honest significant difference test level.

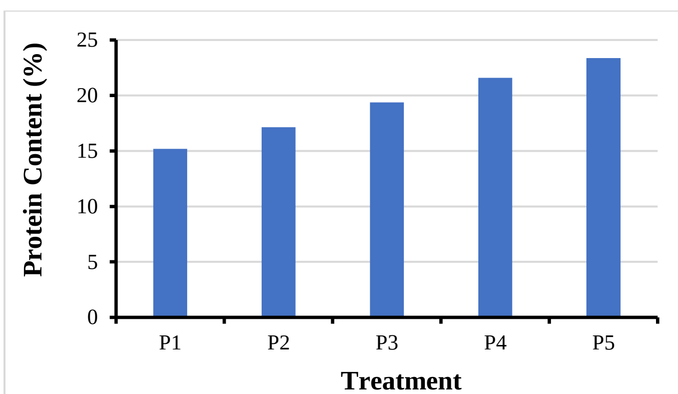

Figure 1. Average protein content of pempek with different recipes

3.1. Protein Content

The results of the Honestly Significant Difference (BNJ) test in Table 2 show that the protein content of each treatment is very significantly different from the other treatments. Figure 1 shows that the higher the ratio of fish surimi to tapioca flour in treatments P1 to P5, the higher the pempek protein content, namely 15.20% ± 0.10, 17.13% ± 0.56, 19.38% ± 0.14, 21.59% ± 0.44 and 23.37% ± 0.10, respectively. Treatment P1 with the lowest ratio of surimi and tapioca flour (250:350), the pempek protein content produced was the lowest, namely 15.20% ± 0.10. Meanwhile, treatment P5 with the highest ratio of surimi and tapioca flour (450:350) resulted in the highest pempek protein content of 23.37% ± 0.10. The high or low protein content of the pempek produced is due to the high or low level of surimi in the tapioca flour used. The results of research (Muchsiri *et al*., 2023), the average protein content of surimi catfish, catfish and tilapia fish with various washings was between 5.36%-10.22%.

Surimi is a fish myofibril protein that has undergone a stabilization process in the production process through several process stages such as removing the head, bones, grinding the meat, washing several times, filtering and adding cryoprotectant and a freezing or non-freezing process (Yasin, 2005; Agustini *et al*., 2008). The addition of catfish surimi can increase the protein content by 10% in jelly candy by 30% (Wicaksana *et al*., 2014). The protein composition in the fish's body influences surimi and the characteristics of the resulting gel (Zuraida *et al*., 2017).

3.2. Water Content

Based on the results of analysis of diversity (ANOVA), the comparative treatment of lampam fish surimi and tapioca flour had a very significant effect on water content. The results of the Honestly Significant Difference (BNJ) test at the 1% test level (Table 2) show that treatment P5 is not significantly different from treatment P4 but is very significantly different from treatments P3, P2 and P1. Treatment P4 was significantly different from treatment P3 but very significantly different from treatments P2 and P1. Treatment P3 was significantly different from treatment P2 but very significantly different from treatment P1. Treatment P2 was significantly different from treatment P1.

Figure 2 shows that the higher the ratio of fish surimi to tapioca flour, the higher the water content of pempek shows that the higher the ratio of fish surimi to tapioca flour in treatments P1 to P5, the higher the water content of pempek, namely 54.91% ± 0.44, 55.98% ± 0.32, 57.24% ± 0.32, 58.29% ± 0.32 and 59.11%. ± 0.35. Treatment P1 with the lowest ratio of surimi to tapioca flour (250:350), resulted in the water content of pempek being the lowest at 54.91% ± 0.44. Meanwhile, treatment P5 with the highest ratio of surimi and tapioca flour (450:350) produced the highest water content of pempek at 59.11% ± 0.35. The high or low water content of the pempek produced is due to the high or low level of surimi in the tapioca flour used. The results of research (Muchsiri *et al*., 2023), the average water content of surimi for catfish, catfish and tilapia fish with various washings was between 50.98%-55.92%.

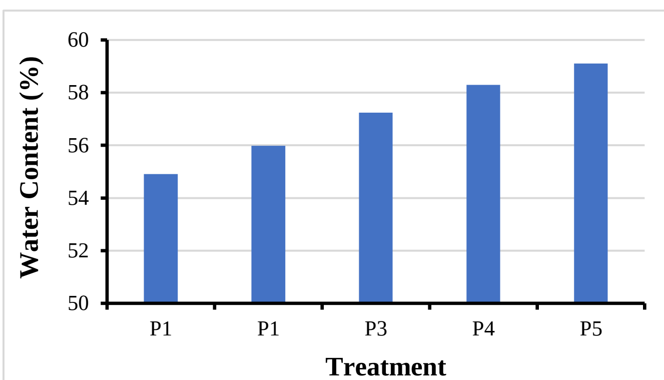

Figure 2. Water content of pempek with different recipes

Surimi in the process of making the washing treatment in the process of making surimi causes the water content of the surimi to be high which will affect the resulting processed product. The water content in treatment P5 was the highest water content. The increase in water content in the pempek produced is influenced by the comparison of lampam fish surimi. The results of research (Wijayanti *et al*., 2012), the more washing done in the process of making surimi, the water content will increase. Making meatballs using tuna surimi has a water content of 64.95% to 66.12% (Moniharapon, 2014). The results of research (As *et al*., 2015) show that the addition of tapioca flour in various ratios produces pempek water content between 44.98% - 61.03%. Increasing the amount of flour will increase the water content, water holding capacity (WHC – water holding capacity) of flour-based processed food ingredients (Ansharullah *et al*., 2017).

3.3. Organoleptic Test

The results of the organoleptic test on the level of panelists' liking for the color, aroma, taste and elasticity of pempek on a scale of 1 to 5 (very dislike to very like) are as shown in Table 3. The results of further test analysis with Conover test (Table 4) show that lampam fish surimi treatment has a significant effect on the color, aroma, taste and elasticity of pempek with a t-critical value of (35.27) greater (>) than the F-table value of 0.05, namely (2.47).

Table 3. Panelists' preference on color, aroma, taste, and elasticity of pempek with different recipe treatments

Treatment	Assess the favorability level			
	Color	Aroma	Taste	Elasticity
P5	4.28±1.06	3.76±1.54	3.84±0.72	3.92±1.00
P4	4.08±1.00	3.60±0.96	3.56±0.10	3.24±1.46
P3	3.96±1.38	3.24±1.71	3.96±0.14	2.72±1.65
P2	3.76±0.74	3.20±1.00	3.20±0.98	2.68±1.06
P1	3.52±1.17	3.12±1.00	2.76±0.53	2.55±1.41

Table 4. Conover test of the treatment of lampam fish surimi and tapioca flour on the color, aroma and taste of pempek

Treatment	Number of Ranks		
	Color	Aroma	Taste
P5	105.91±4.17 a	98.00±4.10 a	106.67±2.16 a
P4	90.84±4.95 b	88.83±2.07 b	93.00±0.42 a
P3	70.92±3.64 bc	72.58±3.78 bc	71.05±1.14 b
P2	59.58±3.35 cd	61.66±5.09 cd	58.05±2.11 c
P1	48.92±1.17 d	50.00±1.92 d	44.00±4.52 d

Note: Numbers followed by different letters have significantly different meanings.

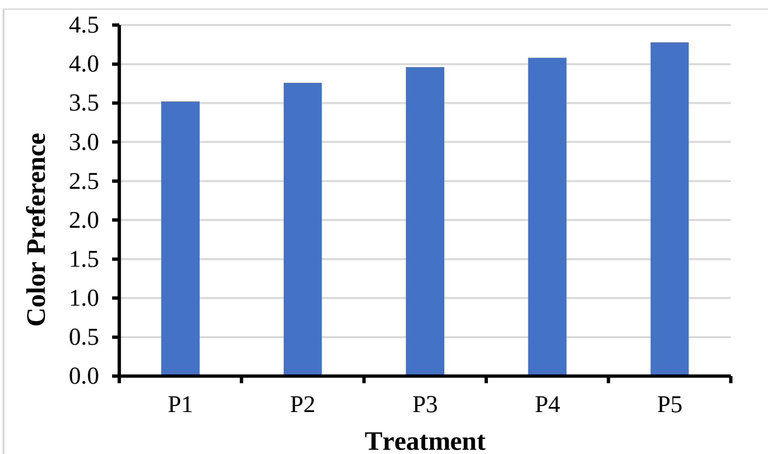

Figure 3. Level of preference for color of pempek treated with fish surimi lampam and tapioca flour

3.3.1. Color

Figure 3 shows that the higher the ratio of lampam fish surimi to tapioca flour, the higher the panelists' liking for the color of pempek, with the lowest liking value of 3.52±1.17 (somewhat like) and the highest liking level for the P5 treatment of 4.28±1.06 (like). Color is one of the factors driving consumers' desire to buy goods or not (Winanti *et al*., 2021). A food product will be attractive if the product color is attractive, so the product quality will also be good. (Wati & Intani, 2021).

The color of the pempek produced is influenced by the color of the surimi produced. The white flesh of lampam fish has a low myoglobin content, causing the color of the surimi produced to be brighter, which has an impact on the color of the pempek produced. Meanwhile, the color of red fish meat is due to the meat containing high myoglobin which will dominate the product color to become darker or not bright (Nofitasari, 2015). The bright color is the cause of the panelists' highest level of preference for the pempek color.

3.3.2. Aroma

Aroma is the response of the sense of smell when volatile compounds enter the nasal cavity from food products and is felt by the olfactory system when humans breathe (Wati & Intani, 2021). The amino acids found in fish meat which is used as one of the main ingredients will influence the distinctive aroma of pempek, especially amino glutamate in fish. Proteins, peptides and amino acids break down into simpler and low molecular weight components which are volatile so that they influence the aroma of pempek which is formed during the cooking process by steaming, boiling, frying and roasting as well as storage. Peptides and free amino acids and free fatty acids are related to the taste and aroma of fish meat.

Figure 4 shows that the higher the ratio of lampam fish surimi to tapioca flour, the higher the panelists' liking for the aroma of pempek, with the lowest liking value in P1 being 3.12 ± 1.00 (somewhat like) and the highest in treatment P5 being 3.76 ± 1.54 (somewhat like). The higher the ratio of surimi used, the higher the protein content of the ingredient. The protein then breaks down into simpler, low molecular weight components which are volatile which influence the aroma of pempek and the panelists' level of preference for the resulting pempek aroma.

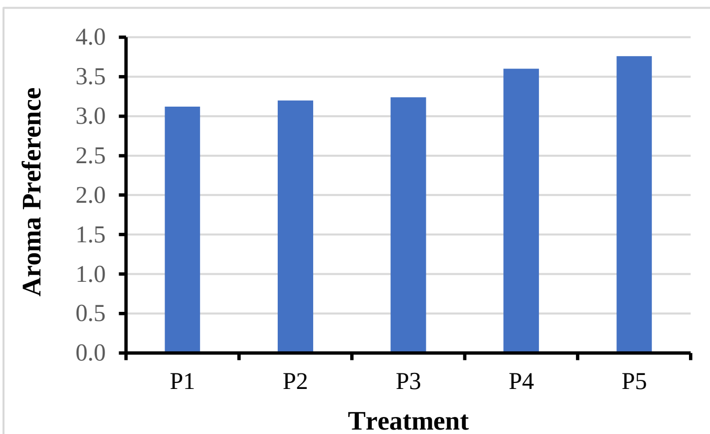

Figure 4. Level of preference for the aroma of pempek treated with fish surimi lampam and tapioca flour

3.3.3. Flavor

Taste, texture and color are greatly influenced by proteins, lipids and carbohydrates, thus determining the properties of food. The savory taste of a product is influenced by the fat, carbohydrate and protein content (Winarno, 2008). The amino acid that plays a role in providing a savory taste to fish meat is glutamic acid. The highest comparison of surimi with P5 treatment produces pempek with a slightly more savory taste so it has the highest value. According to (Ketaren, 2008) minerals in food, salt creates a unique taste in lampam fish surimi pempek apart from the presence of protein, carbohydrates and fat. Glutamic acid can improve the taste of dishes. One of the amino acids that is very abundant in nature is glutamic acid. One natural substance that is easy to find and is found in foods that contain protein such as meat, milk, fish and vegetables is glutamic acid (Handayani *et al*., 2016). Taste is a compound in food or a combination of two or more compounds in food that causes biological perception through the sense of taste (Tarwendah, 2017). Figure 5 shows that the higher the ratio of lampam fish surimi to tapioca flour, the higher the panelists' preference for the aroma of pempek. The lowest liking value for the taste of pempek was 2.76±0.53 (don't like it) and the highest was for treatment P5 at 3.84±0.72 (somewhat like it).

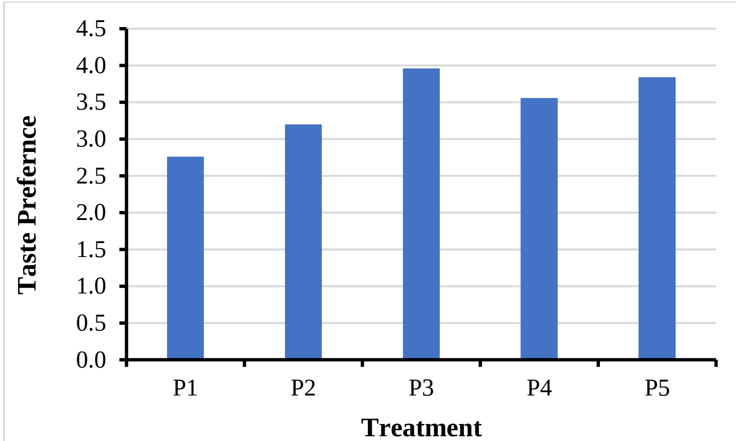

Figure 5. Level of preference for the taste of pempek treated with fish surimi lampam and tapioca flour

Table 5. Ranking test data for lampam fish surimi pempek on the chewiness of pempek.

Treatment	Average Likeability	LSD Tukey = 0.12
P5	3.92	0.62* 1.22* 1.20* 1.48*
P4	3.24	0.56* 0.52* 0.08tn
P3	2.72	0.04tn 0.24*
P2	2.68	0.28*
P1	2.55	

Notes: * = significantly different; tn = not significantly different

3.3.4. Elasticity

The results of the diversity analysis showed that the comparison treatment of fish surimi and tapioca flour had a very significant effect on the elasticity of pempek. Further test results with the Tukey test are in Table 5. The ability of a food product to break due to compressive forces is called elasticity. Toughness is formed during cooking by the process of protein denaturation so that the molecules expand. This process causes the polypeptide chain to open and rebinding to the same reaction group (Asngari & Rahmawati, 2016). The elasticity that forms in the fish pempek produced comes from the protein content of the fish and tapioca starch. The texture is formed due to the three-dimensional structure, which is formed by cross-linking of myofibril proteins in fish meat and starch from tapioca flour to form disulfides. This structure plays a role in gel formation, so that the texture of the material is supple and sturdy. Amylose is a straight chain polymer with many hydroxyl groups (-OH) which makes it easier to form hydrogen bonds with other polyhydroxyl polymers (Zhang *et al*., 2023). The polymers in starch will form a starch gel matrix network structure which plays a role in forming elasticity (Syahbanu *et al*., 2023).

Figure 6 shows that the highest average elasticity value of 3.92 (somewhat liked) was in treatment P5 (Figure 6), the lowest was in P1 with an average value of 2.44 (disliked). The higher the ratio of lampam fish surimi (P5), the panelists preferred, in treatment P1 with the lower ratio of lampam fish surimi, the panelists' liking level decreased further. In treatment P5, the higher the ratio of lampam fish surimi, the higher the protein produced. The actin and myosin content of the protein can play a role in increasing the elasticity of lampam fish surimi pempek (Asngari & Rahmawati, 2016; Parnanto & Atmaka, 2010). The protein composition in the fish's body influences surimi and the characteristics of the gel produced (Zuraida *et al*., 2017). The increasing treatment of P5 with surimi means that the amount of stromal protein in the material also increases, resulting in a reduction in the water binding capacity of the myofibril proteins. In making pempek tapioca flour functions as a water binder, leavening agent and adhesive.

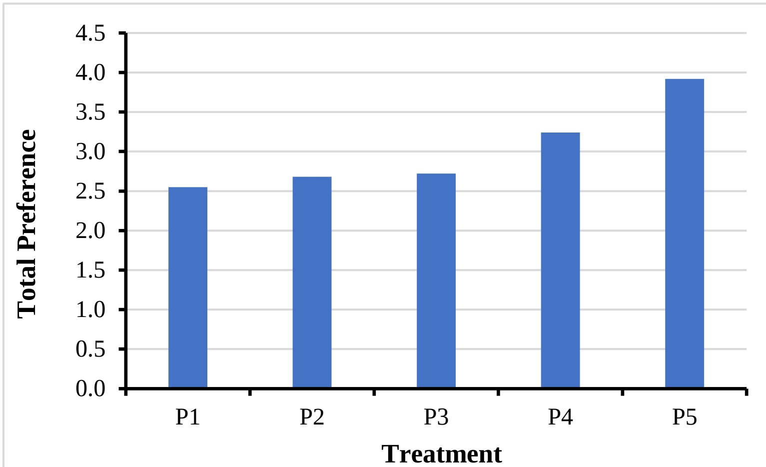

Figure 5. Level of total preference of pempek treated with fish surimi lampam and tapioca flour

The average value of the panelists' liking for the chewiness of pempek was between 3.92±1.00 to 2.44. The highest average value of elasticity was in P5 with a value of 3.92±1.00 (somewhat chewy) while the lowest value was in treatment P1 (2.55±1.41) which is not chewy.

4. CONCLUSION

The comparison of lampam fish surimi with tapioca flour has a very significant effect on the water content and protein content of the pempek produced. The highest average value of water content was 59.11%±0.35 while the protein content was 23.37%±0.10 in the P5 treatment. The highest average value of the organoleptic test for color was 4.28±1.06 (like criteria), aroma 3.76±1.54 (somewhat like criteria), taste 3.84±0.72 (somewhat like criteria), and elasticity test value 3.92±1.00 (slightly chewy criteria) is found in treatment P5.

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