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Development Of Pempek Made From Surimi Fish From Farmed Fish

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ABSTRACT
Currently, catfish (Clariasbatracus), catfish (Pangasius pangasius), and mujair fish (Oreochromis mossambicus) have been quite successfully cultivated, and their production is increasing. Still, there have been no efforts to process them into processed food products with high economic value. This study aims to determine the chemical, physical and organoleptic characteristics of pempek from cultivated fish surimi ingredients from catfish, catfish, and mujair fish with a comparison of tapioca flour. The results showed that surimi from catfish, catfish and mujair fish with a ratio of tapioca flour could produce pempek with specific chemical, physical, and organoleptic characteristics. The best pempek is made from a combination of mujair fish surimi and flour at a ratio of 1: 1 (S3T1), as determined by protein content, fat content, and most significant water content analyses, as well as organoleptic tests favored by panelists with physical tests against folding tests and biting tests.

Keywords: *pempek, surimi, fish, cultivated products*

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I. Introduction

Fish is a food ingredient easily damaged during cold storage due to enzymatic and microbiological activities(Gao et al. 2018). Innovative preservation techniques must be carried out to maintain quality and availability for consumption fulfillment(Yi et al. 2020). The availability of fish as a traditional food raw material to meet protein sources threatens its completion(Kobayashi and Park 2018).

Pempek is a traditional food from South Sumatra, especially the city of Palembang, using raw ground fish or delicate fish and tapioca flour with a specific ratio as well as additional ingredients of table salt(Tawali et al. 2019). Making pempek begins with dressing the mixed dough between tapioca flour, ground fish, and water using other ingredients of table salt pempek formation and cooking(Kartika and Harahap 2019). The ratio of tapioca flour and ground varies greatly between 1:1 to 1:2 and the cooking method is done by boiling for 20 minutes or until it floats and steaming(Supriadi et al. 2018).

Based on the type of raw materials used and the manufacturing process carried out, there are 16 types of pempek marketed, namely pempeklenjerbesar, pempeklenjerkecil, pempek submarine, pempektelur (small submarine), pempekadaan, pempekkulit, pempekpanggang, pempektahu, pempekpistel, pempek curly, pempeklenggang, pempekgodo-godo, pempek crispy, pempek sausage, pempek dos, and pempek cheese(Atmaja 2021).

The process of making pempek is generally similar to kamaboko bolting(Wei et al. 2018). The most crucial difference between pempek and kamaboko is the use of surimi(Nakamizo et al. 2019). Pempek is consumed using cuko (spicy, sour, and sweet combination soup)(Isnawijayani and Rozalena 2021).

Groundfish results from grinding fish filets removed from thorns and skins and carried out the grinding process without washing(Dodo Murtado 2020). The form, physical, chemical and organoleptic properties of ground fish with fish surimi is similar(Arone et al. 2019). The main difference is the leaching process in ground fish meat.

The types of fish used in making pempek are belida fish (Chitalalopis) and snakehead fish (Channa striata), which are freshwater fish. Both types of fish have thick meat and white color. Snakehead fish has thick and white meat and does not have slip spines, making it easier to process. Belida and snakehead fish are increasingly experiencing scarcity due to overfishing and destructive fishing gear destabilizing fish populations. The famine is also not optimal for cultivation eff, causing the fish price to be higher. Even based on the Law (UU) of the

Republic of Indonesia Number 45 of 2009 Article 70 junto Article 7 paragraph 2 letter c concerning amendments to the RI Law Number 31 of 2004 concerning fisheries, belida fish is one of the protected types of fish so that it is prohibited to catch(Herman, Haris, and Syahbudin 2021).

Using the Ministry of Marine Affairs and Fisheries, the Indonesian government announced in 2014 that Indonesia was the world's most significant producer of farmed fish. That's why we stopped the overfishing that was about to decimate marine fish stocks. This strategy can potentially encourage the adoption of new species to meet the adequacy of fish consumption, primarily if it is supported by restrictions that restrict the use of fishing gear in Indonesian waters. Reducing marine proportions due to the deteriorating marine environment, rationalization, and effective technology for Handling Freshwater Fish Resources are very important.

Currently, catfish (*Clariasbatracus*), catfish (Pangasius pangasius), and mujair fish (Oreochromis mossambicus) are three types of freshwater fish that have been quite successfully cultivated in Indonesia. Fish breeders widely produce high adaptability to the cultivation process of these three types.

Catfish is a freshwater fish that is found almost all over the world. It is a fish that is low in fat and nutrients, rich in vitamins, proteins, and minerals, have little saturated fat and is common in carbohydrates(Nazeer et al. 2022). Dumbo catfish has a high protein content (16.57%, although lower than Alaskan pollock 17.18%) and low fat with high glutamine and lysine content and can be used as an alternative to making surimi(Syevidiana, Arief, and Hamid 2019).

Patin (Pangasius pangasius) is the best species for fermented fish processed products(Asmaida et al. 2019). Mujair fish is a type of consumable fish of the freshwater fish species(Faried and Trianto 2020). This species came from African waters and was first discovered by Mr.Mujair in 1939.

The three species are currently used only as a side dish, and there is no actual use in processed food products with high economic value. Another challenge is that catfish and mujair have poor meat color and scent with mud. Fish surimi processing technology can provide a solution to this problem.

Surimi is a fish myofibril protein that has been stabilized and produced through successive stages of head and bone removal, meat crushing, washing, water removal, cryoprotectant addition, and freezing.Surimi contains 15-16% insoluble protein, 75% water, and 8-9% clotting stabilizers. Surimi is an intermediate product that can be further processed into kamaboko, chikuwa, meatballs, and pempek.

II. Research and Methods

A. Tools and Materials

The research materials are surimi sangkuriang catfish (*Clrariasbatracus*), catfish surimi (*Pangasius pangasius*), mujair fish surimi (*Oreochromis mossambicus*), tapioca flour, table salt, and clean water. The tools include scales, trays, stoves, pots, and winnowing trays.

B. Research Procedure

Making pempek begins with a homogeneous or rinsed dough between tapioca flour, surimi, and clean water. In addition, a pempek, shaped like a miniature lenjer, is utilized to accomplish a fine or homogenous dough. Lenjeran is cooked for 15 minutes or until it floats. Pempek was removed, drained, and cooled. An analysis of protein content, fat content, carbohydrate content and water content, and ash content was carried out. Physical examination of the bite test. Organoleptic test of color, scent, and ranking test for suppleness.

C. Data Analysis

The data were analyzed with an analysis of Variance (ANOVA) using a factorial complete randomized design model with two factors, namely: fish surimi factor, consisting of catfish surimi (S 1) catfish surimi (S 2) and mujair fish surimi (S 3) and the ratio of tapioca flour to surimi consisting of T 1 (1:1 2), T 2, (1:1,5), and T_3 (1:2), with three replays. Further tests are carried out with honest fundamental differences.

D. Composition Analysis

Protein levels are carried out by testing total nitrogen with titrimetric tests on fishery products following SNI 01-0554.2-2006), water content is carried out by drying method at a temperature of 105 °C, and fat content by the Soxhlet method. An organoleptic test was carried out to determine the level of liking of the panelists for color, scent, and texture.

Results and Discussion

The analysis of variance (ANOVA), surimi factors of fish type, comparison of tapioca flour, and the interaction of the two elements have a noticeable effect on protein content, water content, and fat content 'pempek. The test results of the real difference in the parameters of protein, water, and fat content of surimi are presented in Table 1, Table 2, and Table 3.

Table 1
Test of Real Differences Honest Treatment of Surimi (S) to Observed Parameters

Treatment of Surimi	Parameters Observed		
	Protein content (%)	Water content (%)	Fat content (%)
S_1	9,86a	55,18a	1,15a
S_2	7,41b	54,10b	1,39b
S_3	6,10c	51,78c	1,18c
Remarks: Numbers followed by the same letters showed that they are not significantly different			

Tabel2
Test of Real Differences Honest Treatment of PerbandinganTepungTapioka(T) to ObservedParameters

Treatment PerbandinganTepungTapioka	Parameters Observed		
	Protein content (%)	Water content (%)	Fat content (%)
T_1	7,99a	53,86a	1,36a
T_2	7,99a	53,81a	1,19b
T_3	7,39b	53,38b	1,15c
Remarks: Numbers followed by the same letters showed that they are not significantly different			

Table 3
Test of Real Differences in Honest Treatment of Inter Action Surimi (S) and Comparison of Tapioca Flour (T) to Observed Parameters

Interaction (ST)	Parameters Observed		
	Protein content (%)	Water content (%)	Fat content (%)
S_3T_1	10,22a	50,98a	1,27a
S_3T_2	10,15a	52,81b	1,17a
S_3T_3	9,21ab	51,40c	1,12ab
S_2T_2	7,62b	52,96d	1,65bc
S_2T_3	7,59b	54,80e	1,18cd
S_2T_1	7,01b	54,69ef	1,33de
S_1T_1	6,75b	55,92g	1,15e
S_1T_2	6,20b	55,66g	1,23ef
S_1T_3	5,36c	54,80g	1,07f
Remarks: Numbers followed by the same letters showed that they are not significantly different			

III. CHEMICAL ANALYSIS

a. Protein Levels

Figure 1 shows the highest protein content of pempek surimi mujair fish (S_3) at 9.86%, followed by pempek with catfish (S_2) at 7.41% and catfish (S 1) at 6.10%.Differences in the types of fish, in general, will cause differences in the composition of the nutrients contained in surimi, including protein. Mujair fish has a protein content of 18.7% and 14.54%, and catfish 11.2%. In the process of making surimi, there is a process of losing some water-soluble fish proteins, such as sarcoplasm, causing a decrease in protein levels. The study showed the surimi protein content of mujair fish was 11.90%, catfish 8.18%, and catfish 7.40%. The protein levels in surimi correlate with the protein levels in the pempek.

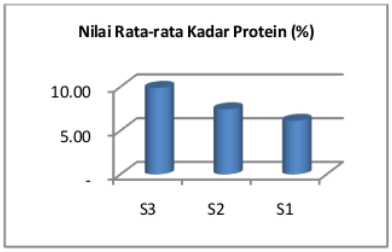


Fig. 1
Graph of Pempek Protein Levels in Surimi Treatment of Farmed Fish Species

Figure 2 shows that the protein content in the ratio of tapioca flour and surimi T 1 (1:1) and T 2 (1:1.5) is the same at 7.99%, followed by T_3 (1:2) at 7.39%. The comparison of tapioca flour shows that the more the ratio of tapioca flour, the lower the pempek protein content. Tapioca flour has a protein content of 0.19%. The low protein content

of tapioca flour is shallow, causing the dominance of protein levels in the resulting pempek to be more influenced by surimi.

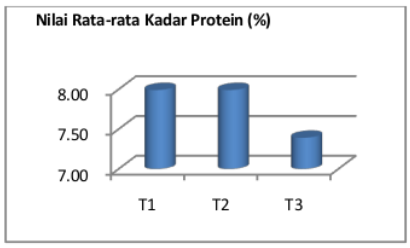


Fig. 2
Graph of Pempek Protein Content in Tapioca Flour Comparison Treatment

The interaction in Figure 3, the surimi interaction of mujair fish and the tapioca flour 1:1 (S 3 T 2) ratio of 10.15%, approached the protein content (S 3 T 1) of 10.22%. The lowest protein content was 5.36% in the surimi interaction of mujair fish with a ratio of tapioca flour 1:2.

The results showed that the initial difference in protein levels in each surimi still affects the final protein content in the pempek produced; the surimi of mujair fish is higher than that of catfish and catfish surimi.

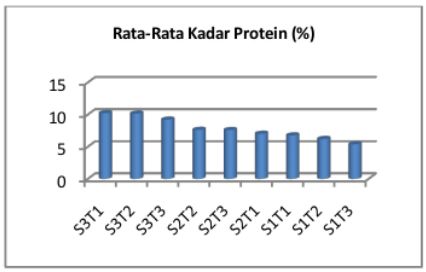


Fig. 3
Graph of Pempek Protein Content interaction Surimi Treatment of Farmed Fish Type Comparison of Tapioca Flour

b. Moisture Content

Figure 3 shows that the highest water content was obtained in pempek with mujair fish surimi (S_3) of 55.18%, followed by catfish (S_2) at 54.10% and catfish (S_1) at 53.78%. Different types of fish will cause differences in the composition of nutrients in processed products produced. Mujair fish has a moisture content of 80.72%, 82.12%, and catfish 78.15%. In the process of making surimi, there is a process of losing moisture content—ratio water surimi fish mujair 76.72%, catfish 81.23%, and catfish 76.72%. The difference in water content in surimi from the three types of fish correlates with the water content of the pempek produced.

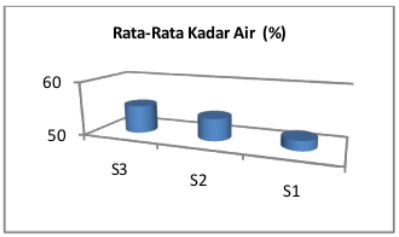


Fig 4
Graph of Pempek Water Content on The Treatment of Surimi Type of Farmed Fish

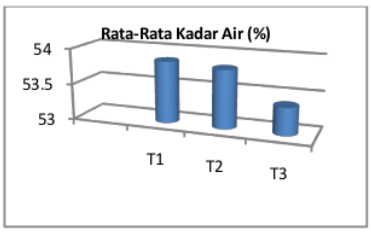


Fig. 5
Graph of Pempek Water Content on Tapioca Flour Comparison Treatment

Figure 5 shows the more the ratio of tapioca flour to surimi, the lower the moisture content of pempek. The moisture content in the percentage of T 1 (1:1) is 53.86%, T 2 (1:1.5) is 53.81%, and T_3 (1:2) is 53.36%. Tapioca flour has a water content of 9%.

Figure 6 shows that the highest water content found in the S 1 T 1 treatment (mujair fish surimi with a ratio of tapioca flour 1: 1) with an average value of 54.92% and the lowest in the S 3 T 1 treatment (Surimi mujair fish with a ratio of tapioca flour 1: 1) with an average value of 50.98%.

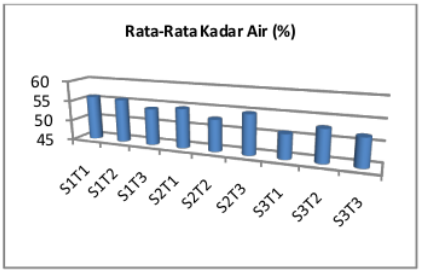


Fig. 6
Graph of Pempek Water Content Interaction of Surimi Treatment of Farmed Fish Type and Comparison of Tapioca Flour

The results showed that the initial difference in water content in each surimi still affects the final water content in the pempek produced inversely, where in catfish surimi, it is higher than that of mujair fish and catfish surimi. But at pempek levels, catfish have the highest water content compared to pempek with surimi patin and mujair.

c. Fat Content

Figure 7 shows that the highest fat content was obtained in the catfish (S 2) pempek surimi at1.39%, followed by catfish (S 1) at 1.18% and mujair fish (S 3) at 1.15%. Different types of fish will cause differences in the composition of nutrients in the processed products. Catfish have a fat content of 1.09%, mujair 1.07%, and catfish 0.7%. The difference in water content in the three types of fish correlates with the water content in the pempek produced.

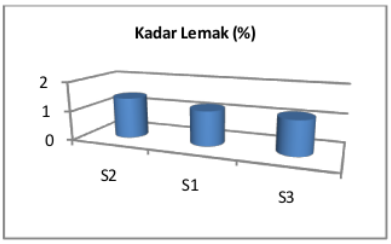


Fig. 7
Graph of Pempek Fat Content Treatment of Surimi Type of Farmed Fish

Figure 8 shows that the highest fat content of 1.36% is found in the ratio of tapioca flour 1:1 (T 1),followed by T 2 (ratio 1:1.5) of 1.19%, and in the percentage of 1:2 (T_3) shows a minor result of 1.17%. Surimi fish concluded that the fat content in tapioca flour of 0.02% does not significantly influence the pempek fat content produced.

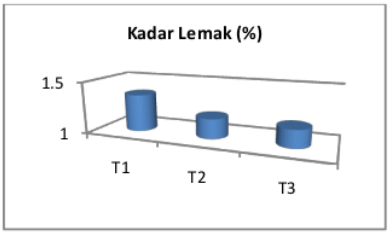


Fig. 8
Pempek Fat Content Chart of Tapioca Flour Comparison Treatment

Figure 9 shows that the highest fat contentfound in the interaction of S 2 T 3 treatment (surimi catfish with a ratio of tapioca flour 1:2) with an average value of 1.33% and the lowest in the S 3 T 3 treatment (Surimi mujair fish with a balance of tapioca flour 1:2) with an average value of 1.07%. The results showed that the initial difference in fat content in each surimi from the type of farmed fish still affects the final fat content in pempek produced inverse, namely in catfish surimi is higher than mujair and catfish surimi. But in pempek, catfish fat content is the highest fat content compared to surimi patin and mujair.

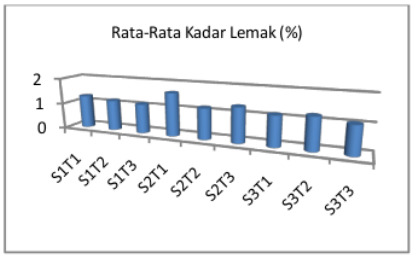


Fig. 9
Graph of Pempek Fat Content Interaction of Surimi Treatment of Aquaculture Fish Type Comparison of Tapioca Flour

IV. Organoleptic Test

a. Color

Values for panelists' preference of pempek color ranged from a high of 3.92 (criteria near to favorable) in the interaction of S 2 T 1 treatment (catfish surimi in a ratio of 1:1) to a low of 2.86 in the S 1 T 3 treatment (Figure 10). (pempek with catfish surimi flour ratio 1:2, criteria close to somewhat preferred).

The washing process in the manufacture of surimi with a large amount of water serves to remove sarcoplasmic proteins, blood, fats, and other nitrogen components from fish meat which produces a whiter color than the color of the raw material; and. In the process of making surimi, catfish have a yellowish-white color. In contrast, catfish produce a dark white paint, and mujair fish produce a pale white color, so making pempek surimi catfish with 1: 1 flour has a very bright yellowish-white color. This condition caused the panelists to give the highest rating on the treatment.

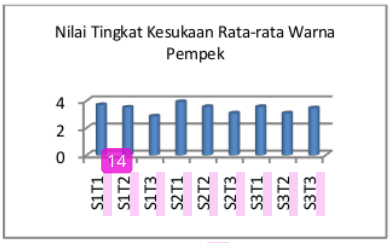


Fig. 10
Graph of panelists' favorability values for pempek colors using fish surimi

b. Scent

With a mean score of 4.58 (criteria near to highly preferred), the panelists chose the S2T2 treatment (catfish surimi at a ratio of 1: 1.5) for the pempek aroma (Figure 11), whereas the S3T3 treatment received afewest votes (pempek using catfish surimi with a flour ratio of 1: 2, with the criteria being somewhat preferred).Scent has more to do with the five senses of the speaker. Odors can only be recognized when they take the form of vapors and odor component molecules touching the olfactory cells' cilia. In general, the smell received by the nose and brain is more of a mixture of the four primary odors: fragrant, sour, and charred. The scent of food is also one of the essential indicators in determining the quality of foodstuffs. Generally, consumers will like foodstuffs if they have a distinctive smell that does not deviate from familiar scents.

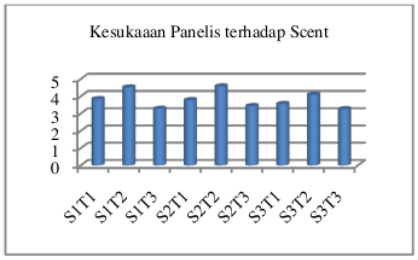


Fig. 11
Graph of panelists' favorability values towards scent pempek

The sense of smell typically perceives the scent depending on the constituent ingredients and the ingredients added to the food. Meanwhile, scent assessment influences psychic and physiological factors that give different opinions.

c. Taste

In Figure 12, we see that the panelists liked pempek the most.In the interaction of the S_3T 1 treatment (using mujair fish surimi in a ratio of 1:1) with an average value of 4.62 (criteria favored or close to very liked). The taste of pempek surimi catfish and catfish with a flour ratio of 1: 1 has almost the same assessment score of 4.50 and 4.16 (criteria for favorability or close to very liked). At the same time, the lowest value was 3.24 in the S 1 T3 treatment (pempek used catfish surimi with a flour ratio of 1:2, with the panelists' assessment criteria close to somewhat preferred).

Protein, carbs, and lipids are a source of building materials and energy and contribute to a food's flavor depending on how well they mix.Taste differs from the smell and involves more of the five senses of the tongue. Taste sensing can be divided into tastes: salty, sour, sweet, and bitter. Food taste can be recognized and distinguished by the buds on the papillae, namely the orange-red stain on the tongue.

Kadar protein surimi catfish is 11.90% higher than catfish surimi 8.18% and mujair fish 7.40%. Meanwhile, the fat content of catfish is 1.1% higher than catfish 1.09 and mujair fish by 1.00%. S3 T1 4.62 (near to extremely favored) was judged to be distinct from S2T1 4.50 based on its higher protein and fat content, as well as the panelists' appreciation for the unique flavor profiles afforded by each species of fish and the tapioca flour from which it was made.Duringthe processing foodstuffs, there will be a decomposition of carbohydrates, proteins, and minerals so that the taste will be better.

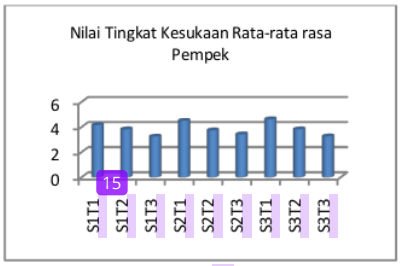


Fig. 12
Graph of panel's liking value towards pempek taste

3. Physical Test

a. Folding Test

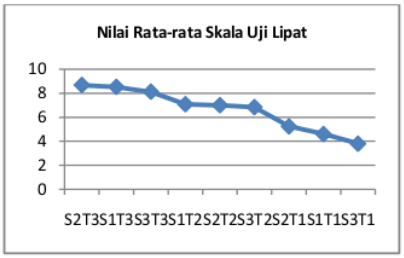
The highest average value of the pempek folding test (Figure 13) of 3 types of farmed fish and the ratio of tapioca flour ranges from 3.80 to 8.68, from slightly cracked to not cracked if folded. A 1:1 ratio of surimi and tapioca flour resulted in a fold test of slight cracks if folded in all types of fish. But for the ratio of 1:1.5 and 1:2, the resulting pempek does not crack in all kinds of fish.

The folding test method separates high-grade and low-grade gels but is insensitive to

distinguishing between good-grade and excellent-grade gels.The fish's protein content, freshness, and pH level affect the gel's creation. It believes that the washing technique used to make surimi involves the texture of the gel in the finished fish. Washing can increase the strength of the gel, remove sarcoplasmic proteins that will inhibit the formation of gels, and dissolve myofibril proteins to form Clarithromycin.

Fish proteins classify into myofibril, sarcoplasmic, and stroma proteins. The composition of a third type of protein in fish meat consists of 65-75% myofibrils, 20-30% sarcoplasm, and 1-3% stroma. Myofibril plays a role in water binding, clumping, and gel formation in processed fish meat.

The increase in water content during the washing process is likely due to the hydration process by myofibril protein. The higher the temperature, the greater the water absorption from the dough.The more compact the texture formed, the better the resulting folding test.



Draw 13
Graph of the value of the folding test against the taste of pempek

b. Teeth Cutting Test

Figure 14 shows the average value in the bite test parameters of all treatments produced, ranging from 5.74 – 8.56. Pempek is on the criterion of being somewhat weak in suppleness to almost close to very chewy. Treatment of S 2 T 3 (catfish surimi) and S 1 T_3 (mujair fish) with a ratio of tapioca flour 1:2. It has a bite test value close to very strong chewy. The proteins contained in the material will form cross bonds and the gel formed will add chewiness to the treatment.

The bite test is carried out to provide a subjective estimate to determine the strength of the gel and the chewiness of the resulting fish sausage. Several factors affect the strength value of the gel so that its value also varies, the formation of gel or gelation is influenced by various factors including concentration, pH, the presence of other components and heat treatment when cooking.

The higher the concentration of protein added, the more elasticity will increase and affect the bite test results. The higher the protein content, the more crosslinks and gels will be formed, as a result of which the texture will bemore chewy and compact. The protein content per 100 grams of mujair fish is 19.70% in every 100g of meat.Mujair fish urimies produce the highest protein content of 11.30%, ikan catfish 8.18% and catfish as much as 7.40%.

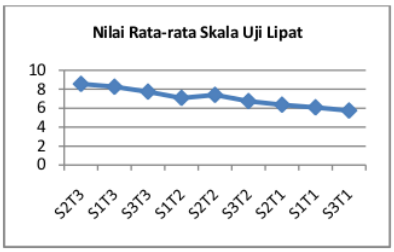


Fig. 14
Graph of bite test values against pempek

Surimi washing with a frequency of three times produces a high gel compared to the value of lumat meat gel. Along with the reduction in the amount of surimi raw materials, the percentage of gel in the nugget dough is getting less and less, resulting in a decrease in the value of the folding test. Kilcast and Subramaniam (2000) stated that the folding test with a value of three (B) showed a fairly good level of elasticity and the value of four (A) the elasticity was good Theincrease in washing frequency increased the bite test value from 5.4 to 6.94.

V. Conclusion

Based on the results of the study, it was concluded that the surimi of mujair fish with a flour ratio of 1: 1 (S3T1) produced the best pempek with the results of the analysis of protein content, fat content and the highest water content favored as well as the organoleptic panelist test with physical tests against folding tests and bite tests were quite good.

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