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Research paper

Comparison of Parameters Physical and Chemical Surimi from Three Species of Fish Cultivation and Washing Frequency

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Abstract

The availability of marine fish as surimi raw material will experience obstacles because there is no effective cultivation effort. In other conditions currently the cultivation and production of catfish (Clariasbatracus), catfish (Pangasiuspangasius) and tilapia (Oreochromis-mossambicus) have been quite successful and increasing, but there has been no processing effort to become surimi. This study aims to determine the physical and chemical characteristics of surimi from cultured fish species. The results showed that the three fish species could produce surimi with good physical and chemical properties of surimi. Tilapia species with washing frequency 3 times produce the best surimi compared to catfish (Clariasbatracus), catfish (Pangasiuspangasius).

***Keywords**: Surimi; Fish Cultivated; Washing Frequency.*

1. Introduction

Fish are easily damaged during cold storage due to enzymatic and microbiological activities, and therefore innovative preservation techniques and prompt handling must be carried out to maintain quality and supply for human consumption (Feng et al., 2015 [1] and Kumar et al., 2017) [2]. The availability of fish as traditional raw materials to meet protein sources has a major threat in their fulfillment. The application of surimi technology can provide solutions to these problems.

Surimi is a fish myofibril protein that has been stabilized and produced through continuous process stages which include removal of head and bone, meat dozing, washing, removal of water, addition of cryoprotectant and freezing (Benjankulet al, 2003, [3]. Surimi contains 15-16% insoluble proteins, 7?% water and 8-9% freezing stabilizers (Ismail et al, 2011) [4]. Cryoprotectants are compounds that protect or stabilize the product during freezing and frozen storage, also function to extend shelf life and quality of frozen food (Mathew and Prakash, 2007) [5].

Surimi raw materials generally come from marine fish such as pollock Alaska, big snapper, white pacific, mackerel, bigeye snapper, lizardfish, croaker, and silver carp (Benjankulet al, 2003, Park, 2005 and Zhanget al, 2017) . (Zuraida et al 2017) [6] reported that marine fish species used for surimi production in Indonesia include threadfin bream (Nemipterusjaponicus), snapper (Priacanthustayenus), goatfish (Upeneussulphureus), Lizardfish (Sauridatumbil), white croaker (Genyonemuslineatus) and biddy silver (Gerresoyena). The types of freshwater fish used are limited to tilapia (Tina et al, 2010 and Yoediet al, 2015) [7].

The rarity of Alaskan pollock and other marine species as surimi raw materials has brought a new trend in making surimi. New sources for surimi are obtained from new species besides marine fish species. Because of the marine species, no cultivation effort has been carried out. Dayseet al (2016) states, in making surimi can use species that are underutilized with little or no commercial value. Arafat and Benjakul (2012) stated, in general, lean fish have been used for the production of surimi.

The Indonesian government through the Ministry of Maritime Affairs and Fisheries has launched 2014 Indonesia to become the largest aquaculture producer in the world. This policy is reinforced by restrictions on the use of fishing gear for Indonesian waters through the regulation of the Minister of Maritime Affairs and Fisheries no. 72 / MEN-KP / II / 2016, in order to avoid overexploitation of fisheries in waters, can encourage the use of new species to meet the adequacy of fish consumption needs (Wijayantiet al, 2014 and Zuraidaet al, 2017) [8].

Zhang et al, (2014) stated, the decrease in the proportion of the sea due to the deterioration of the marine environment, rationalization, and processing technology of effective freshwater fish resources is very important. Another factor is the cheap price of freshwater fish that strongly supports the development of surimi.

This research tries new sources that are catfish (Clariasbatracus), catfish (Pangasiuspangasius) and tilapia (Oreochromismossambicus) which are currently quite successfully cultivated in Indonesia and the production is only used as consumption, as a side dish.

Catfish is a freshwater fish found in almost all of the world. This is a low-fat and highly nutritious fish rich in vitamins, proteins, minerals, little- saturated fat and is low in carbohydrates (Razaket al., 2014) [9]. Zuraidaet al, (2017) reported, that African catfish have high protein content (16.57% although lower than Alaska pollock 17.18%), low fat with high glutamine and lysine content can be used as an alternative to making surimi.Catfish (Pangasiuspangasius) is the best species for fermented fish processed products (Mahyudinet al., 2015) [10]. Tilapia is a type of consumption of fish from freshwater fish species. This species originates from African waters which were first discovered by Mr. Mujair in 1939 (Istiantoet al, 2014) [11].

All three species, there are currently no attempts to make products of high economic value such as surimi. Another challenge is catfish (Clariasbatracus), catfish (Pangasiuspangasius) and tilapia (Oreochromismossambicus), which has a color of meat that is not good and smells of mud. Research on physical and chemical properties of surimi is also very limited.

Surimi is an intermediate product that can be further processed into kamaboko, chikuwa, meatballs and pempek (Santana et al, 2012 and Yoedyet al, 2015) [12].Pempek is aIndonesian food, especially in the city of Palembang in South Sumatra province, which is made from tapioca flour with minced fish meat. Initially, the fish used were belida fish and cork fish, but the availability of these fish began to scarce, so marine fish was used. But the aroma of pempek produced is fishy (Murtado et al., 2014 and Murtado et al., 2015) [13]. Using surimi as a substitute for chopped fish is a solution to these weaknesses.Although in Japan surimi is marketed in a variety of different varieties, formulas, and manufacturing, the process is very similar (Duceptet al, 2012) [14]. (Hosseiniet al, 2015) [15] explained in principle that making surimi begins with weeding, separating fish meat and washing with cold water.

The stages of the process in making surimi refer to the (Suzuki method, 1981) [16] with a slight modification, which starts with removing the skin, bones and stomach contents, then grinding is done by using a fish mill. The crushed meat is washed with cold water (temperature ± 10 ° C) with the addition of salt at the end of 19 washing by 0.1%.

This research aims to determine the physical and chemical characteristics of surimi from cultured fish species and washing frequency.

2. Materials and methods

The research material was sangkuriang catfish (Clrariasbatracus), catfish (Pangasiuspangasius), tilapia fish (Oreochromismossambicus), kitchen salt and sodium tripolyphosphate. The tools used include scales, knives, plastic tubs, fish grinders, freezers, stirrers and several tools and materials for chemical analysis and sensory testing.

2.1. Research procedure

Catfish (Clariasbatracus) is the local name lelesangkuriang, catfish (Pangasiuspangasius) is the local name patinand tilapia (Oreochromismossambicus) is the local name mujairare carried out by removing the head and stomach contents, washing with cold water to remove blood and dirt. Then the separation of meat and bones is done manually so that the fillet is obtained. To get minced fish, fillets are put into a fish grinder. Then cold and 0.2% salt was washed 1 to 4 times, with a comparison of water and meat (4: 1). Washing is carried out for 10 minutes with agitation in cold temperatures (<10 ºC). The composition of surimi is done by using a food processor to produce homogeneous surimi paste. Surimi is put into polyethylene plastic and stored the freezer (temperature -20 oC) for 9 days. Analysis of water content, protein content, pH, EMC (expressible moisture content) and organoleptic test on color, aroma, and ranking of elasticity were carried out.

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2.2. Data analysis

Data were analyzed by analysis of Variance (ANOVA) using factorial complete randomized design with two factors, namely: fish species, consisting of catfish (I1), catfish (I2) and tilapia (I3) and the washing frequency was 1 time (F1), 2 times (F2), 3 times (T3), and 4 times (F4) with three replications. Further tests are carried out with honestly significant different tests (Steel and Torrie, 1980) [17].

2.3. Composition analysis

Analysis moisture using drying method at 105 oC. Protein content was carried out using the AOAC (2005) method to obtain total nitrogen and then converted by a factor of 6.25. The measurement of acidity (pH) was carried out using pH meters and EMC (expressible moisture content) using the Benjankul (2001) method. To determine the level of panelists' preference for color, aroma, andelasticity, and organoleptic test was conducted (Pratama, 2013) [18].

3. Results and discussion

Results of analysis of variance (ANOVA), fish species factors, washing frequency, and interaction of both factors have a very significant effect on moisture content, protein content, pH and EMC surimi. The results of the test of significant differences between 23 parameters of moisture, protein, pH, and EMC are presented in Table 1, Table 2 and Table 3.

Table 1: Test of Real Differences Honest Treatment of Fish Species to Observed Parameters

Treatment of Fish Species	Parameters Observed			
	Water content (%)	Protein content (%)	pH	EMC
I_3tilapia	76.72^a	11.90^a	6.30^a	18.02^a
I_2catfish(Patin)	81.23^b	8.18^b	6.59^b	24.00^b
I_1catfish(lele)	78.26^c	7.40^c	6.73^c	25.74^c

Remarks: Numbers followed by the same letters showed that they are notsignificantly different

Table 2: Test of Real Differences Honest Treatment of Frequency of Washing (F) to Observed Parameters

Treatment Frequency of Washing	Parameters Observed			
	Water content (%)	Protein content (%)	pH	EMC
F_1 (1)	75.96^a	12,29^a	6.42^a	18.81a
F_2(2)	78.68^b	10,29^b	6.48^a	20.59b
F_3(3)	80.01^c	7,96^c	6.57^a	24.23c
F_4 (4)	80.29^c	6,09^d	6.68^a	26.72d

Remarks: Numbers followed by the same letters showed that they are not significantlydifferent

Table 3: Test of Real Differences Honest Treatment Inter Action of Fish Species (I) and Frequency of Washing (IF) to Observed Parameters

Interaction (IF)	Parameters Observed			
	Water content (%)	Protein content (%)	pH	EMC
I_1F_1	74.66 a	9.52 a	6.60 a	29.88 a
I_3F_1	75.34 a	16.79 b	6.20 bc	20.24 b
I_3F_2	76.25 a	13.64 bc	6.25 bc	18.50 bc
I_3F_3	77.57 bc	9.94 bc	6.35 bc	17.94 bc
I_3F_4	77.70 cd	7.24 bc	6.40 bc	15.43 d
I_2F_1	77.89 fg	10.58 d	6.45 bc	28.94 e
I_1F_2	78.73 de	8.12 de	6.65 bc	29.88 ef
I_1F_3	79.73 e	6.68 de	6.75 bc	22.23 g
I_1F_4	79.93 e	5.27 de	6.90 bc	19.87 h
I_2F_2	81.05 gh	9.10 f	6.55 d	24.31 hi
I_2F_3	82.73 h	7.27 f	6.60 d	21.61 i
I_2F_4	83.24 h	5.78 f	6.75 d	21.14 i

Remarks: Numbers followed by the same letters showed that they are not significantly different

3.1. Moisture content

Figure 1 shows the water content of catfish (I_2) surimi species is higher than catfish (I1) and tilapia fish (I_3). This difference is due to the higher initial water content of catfish compared to catfish and tilapia fish. Data from the Ministry of Health of the Republic of Indonesia (2004) states that the water content of catfish is 78.5%, catfish 82.20%, and tilapia 80.20%. The difference in the initial water content causes the difference in the final water content of the surimi produced. Figure 2 shows the more washing frequency, the higher the water content of surimi. The lowest water content at a washing frequency of 1 time is 75.961% and the highest in F_4 is 80.29%. (Uju et al. 2004) [19], stated that the entry of water into the tissue is caused by the inflating of myofibril proteins due to the influence of Cl-ions from NaCl salts. The Cl-ion will bind with a positively charged filament so that the space between the filaments will become wide and the water will enter and get trapped inside. Myofibril protein has a high water binding capacity of around 97% (Pomeranz, 1991) [20].

Figure 3 shows the interaction of fish species and washing frequency showed the highest water content of surimi ininteraction catfish with a washing frequency of 4 times (I_2F_4) of 83,240% and the lowest 83,240% in catfish with a washing frequency of 1 time (I_1F_1). This shows that there is a correlation between the initial moisture content of each fish species which is different from the washing frequency.

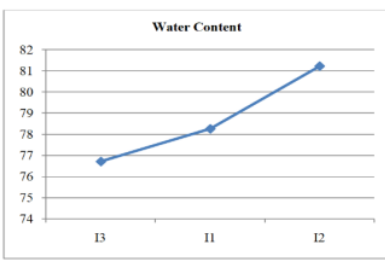

Fig. 1: Water Content of Surimi From Three.

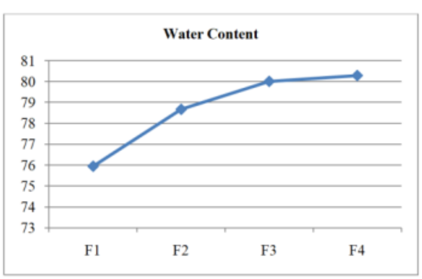

Fig. 2: Water Content of Surimi from 4 Species of Fish Washing Frequencies.

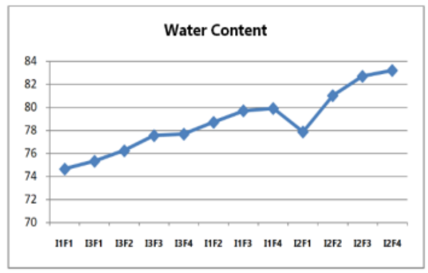

Fig. 3: Water Content of Surimi from Interaction between Fish Types and Washing Frequencies.

3.2. Protein content

Figure 4 shows that protein surimi levels from tilapia (I_3) are 11.90% higher than catfish (I_2) and catfish (I_1). This difference is due to the higher initial protein content of tilapia compared to catfish and catfish. Data from the Ministry of Health of the Republic of Indonesia (2004) mentions catfish protein levels of 18.7%, catfish 14.54%, and tilapia 18.7%. Figure 5 shows, the more washing frequency, the lower the protein content of surimi. Sarcoplasmic protein is present in muscle cells and is water soluble (Suzuki, 1981; Watabe, 1990 in Ujuet al., 2004) [21]. The washing process can reduce water-soluble protein to 30% (Lee, 1984 in Ujuet al., 2004) [22].

Figure 6 shows, the highest protein surimi levels in the interaction of tilapia fish with a washing frequency of 1 time (I_3F_1) of 16.79% and the lowest of 5.27% in catfish with a washing frequency of 4 times (I_1F_4). This shows the correlation of the initial protein levels of each type of fish which is different from the frequency of washing on surimi protein levels.

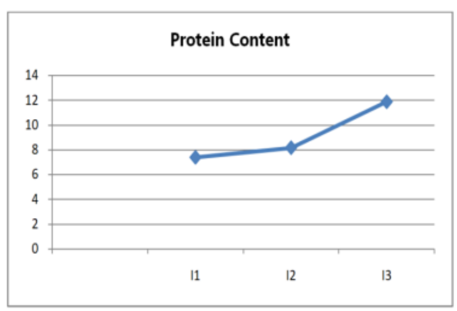

Fig. 4: Protein Content of Surimi from Three.

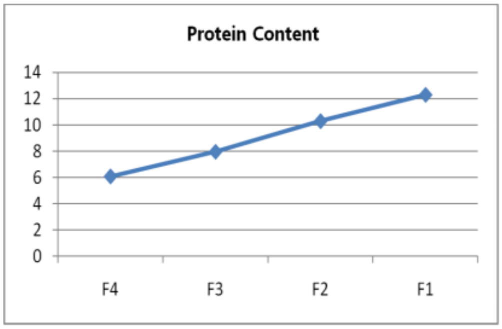

Fig. 5: Protein Content of Surimi from 4 Fish Species Washing Frequencies.

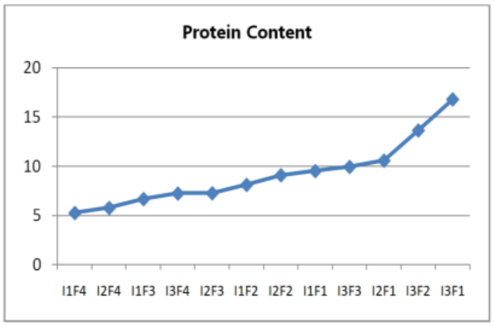

Fig. 6: Protein Content of Surimi from Interaction between Fish Species and Washing Frequencies Ph.

Figure 7 shows that the pH of each fish species is very real. The highest pH in catfish (I1) is 6.73 and the lowest in tilapia (I3) is 6.30. Figure 8 shows, the highest pH is 6.68 at a washing frequency of 4 times (F4) and the lowest is 6.42 at a washing frequency of 1 time (F1). This data shows that the higher the washing frequency, the higher the pH. The increase in pH surimi is caused by the loss of acid residues in muscle protein due to the influence of leaching (Babji and Lee, 1994 in Uju et al., 2004) [23]. Changes in pH values in surimi will affect the ability of myofibril in binding water. The ability of myofibril protein to bind to water will lead to an increase in the pH value of surimi (Goll et al., 1977 in Uju et al., 2004) [24]. Each fish species produces different amino acid residues in different leaching. The degree of acidity of a product is indicated by the pH value. The pH value of fish and meat is usually close to neutral (Berkel et al. 2004) [25]. The washing process dissolves some amino acids and other substances that are acidic, this affects the degree of acidity of surimi (Wijayanti et al., 2014) [26]. The increase in pH is in line with the increase in the washing cycle due to the removal of free nitrogen, free fatty acids, free amino acids or other water-soluble acid compounds during the washing process (Karthikeyan et al., 2004) [27].

Figure 9 shows, catfish species with frequency 4 times washing (I_1F_4) 6.90 near neutral pH. (Asgharzadeh et al. 2010) [28] stated that the value of silver carp surimi pH (H. molitrix) also increased from 7.0 before being washed to 7.8 after washing. (Wijayanti et al. 2012) [29] added that the pH value of catfish surimi increased from 6.69 before being washed to 7.05 after washing 3 times.

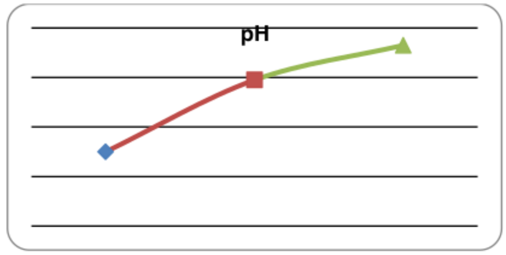

Fig. 7: pH of Surimi from Three Fish Species.

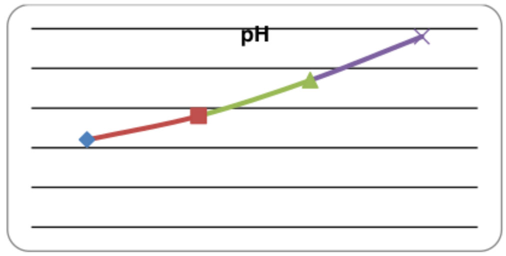

Fig. 8: pH of Surimi from Four Washing Frequencies.

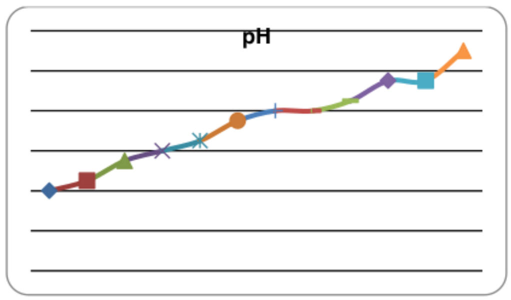

Fig. 9: pH of Surimi from Interaction between Fish Species and Washing Frequencies.

3.3. CMC (expressible moisture content)

Figure 10 shows, catfish (I_1) has the largest EMC value of 25.74% and the lowest is tilapia fish (I_3) of 18.02%. This means that the tilapia fish surimi gel has the ability to hold water more than the catfish (I_1) and catfish (I_2). Figure 11 shows, the more washing frequency the greater the ability of the gel surimi to retain water. This is indicated by the increasing number of EMC washing frequencies getting smaller. The results showed that the more washing frequency, the higher the surimipH. This condition causes the higher pH of the material. Ng, X.Y. and Huda (2011) reported, that an increase in pH caused an increase in water retention from materials.

Figure 12, the interaction between the two treatments (I_1F_1) correlated in producing the largest EMC value of 30.99%, and the smallest EMC was found in tilapia fish with a washing frequency of 4 times (I_3F_4) of 15.43%. The ability to bind water or hold water is related to functional proteins (Zayas, 1997 in Santosoet al, (2015). Expressible moisture content (EMC) is one of the quick methods to see the water content coming out of the material after being given a weight of 5 kg. The greater the ability of EMC to retain water, Chaijanet al. (2010) in Wijayantiet al. (2014) stated that the lowest value of expressible moisture content in short bady mackerel indicates a high WHC value. The ability to bind water or hold water is related to functional protein (Zayas, 1997 in Santosoet al (2015). Expressible moisture content (EMC) is one of the quick methods to see the water content coming out of the material after being given a 5 kg load. The smaller the EMC value the greater the ability to hold water.

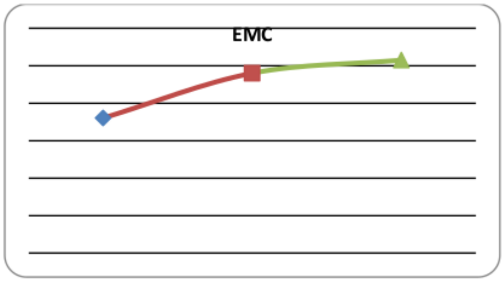

Fig. 10: EMC of Surimi from Three Fish Species.

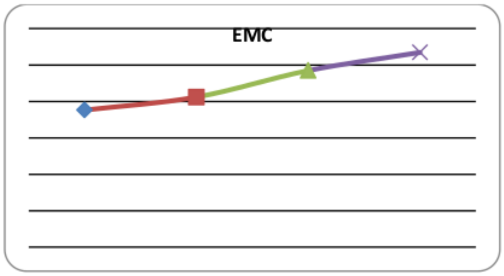

Fig. 11: EMC of Surimifrom Four Washing Frequencies.

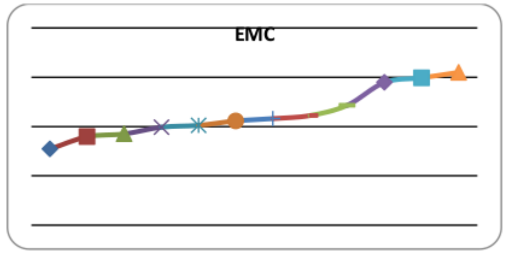

Fig. 12: EMC of Surimifrom Interaction between Fish Species and Washing Frequencies.

3.4. Organoleptic test

The average score of panelists' assessment of surimi color and aroma was 3 (likes) from the score of 1 to 5, with the highest score of surimi color 4.25 (very like) and the highest score of scent 4.38 (very like). (Chaijan et al. 2005) [30] stated that higher myoglobin removal results in a lower reddish index than washed material. Besides, that washing can also cause the loss of flavor and flavor components found in fish meat (Ujuet al, 2004) [31]. Therefore, myoglobin extraction efficiency depends on fish species, muscle type, storage time and washing process (Karthikeyanet al, 2004) [32]. Myosin is a protein that plays a role in protein gel formation in surimi (Kumar et al, 2017) [33]. While the results of the ranking test for elasticity, the highest value is 0.85 (from the transformation value). The highest average score was found in tilapia with a frequency of 3 times (I_3F_3) as shown in Figures 13, 14 and 15.

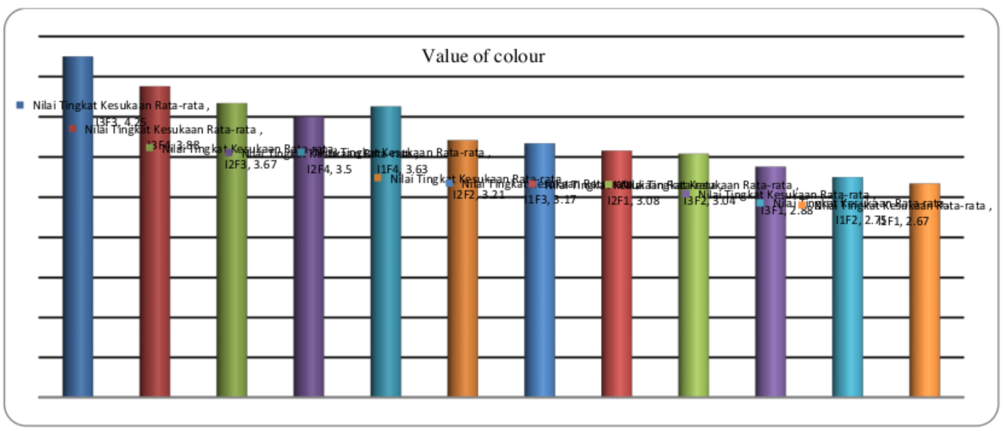

Fig. 13: Diagram Value of Colour.

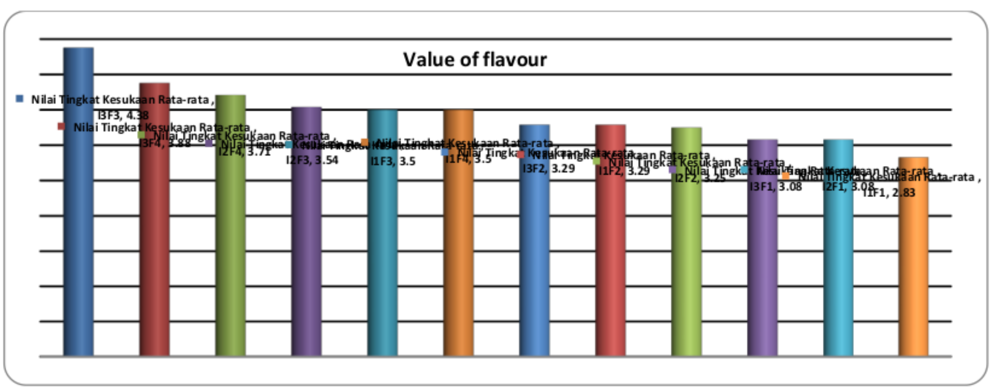

Fig. 14: Diagram Value of Flavor.

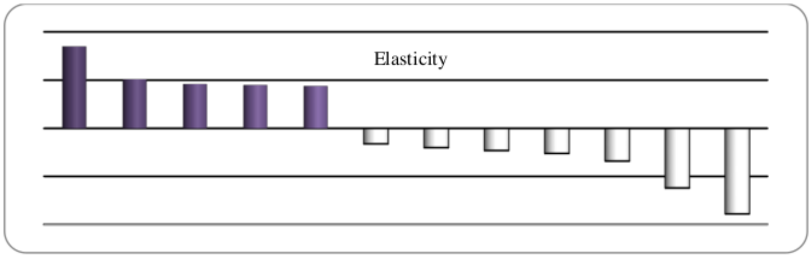

Fig. 15: Diagram Elasticity.

4. Conclusion

Based on the physical and chemical properties of surimi, it can be concluded that tilapia fish species (I_3), and washing frequency 3 times (F_3), as well as their interactions (I_3F_3) are the best treatment for surimi produced.

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