Functional Characteristics of Trash Fish in Lamongan Regency, East Java, Indonesia

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Abstract. Trash fish has several weaknesses, such as having tight spines, having little meat, and being highly perishable. The purpose of this study was to determine the functional characteristics of trash fish through fillet preparation techniques and types of fish. This study used a completely randomized design method. The first factor is the type of fish consisting of Orangefin ponyfish (*Leiognathus bindus* Valenciennes, 1835), Chacunda gizzard-shad (*Anodontostoma chacunda* Hamilton, 1822) and Sardine (*Sardinella Fimbriata* Valenciennes, 1847). The second factor was the type of preparation technique which consisted of mechanical, blanching, 1 % acid immersion and 1 % papain enzyme immersion. The data obtained were then analyzed descriptively from the preparation technique for each observation parameter and presented in tabular form and plotted in graphical form. The results of this study indicate that Orangefin ponyfish, Chacunda gizzard-shad and Sardine fish have a range of functional properties of the three types of fish, namely: foaming power (17.68 % to 61.87 %), foam stability (50 % to 57.14 %), emulsifying power (3.31 % to 4.29 %), emulsion stability (1.91 % to 3.37 %), WHC (33.9 % to 46.64 %), and OHC (24.75 % to 29.57 %).

Keywords: Fish fillet, functional properties, preparation technique, trash fish, waste utilization.

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1 Introduction

Lamongan regency is known as one of the fisheries areas or minapolitan in East Java, Indonesia [1, 2]. Fish that are not included in the main purpose of fishing are called trash fish and are commonly used as a mixed ingredient in the production of animal feed [3] or processed into salted fish and sometimes just thrown away resulting in a rotten smell during the main harvest season. Several researchers have recommended trash fish to be a product diversification as an effort to recycle or waste utilization [4–8]

Trash fish in Lamongan has the potential to be made into high-value economic products, namely Orangefin ponyfish (*Leiognathus bindus* Valenciennes, 1835), Chacunda gizzard-shad (*Anodontostoma chacunda* Hamilton, 1822) and Sardine (*Sardinella Fimbriata* Valenciennes, 1847) [9]. Trash fish has a small and varied morphology, is easily damaged, has tight spines, and has little flesh, making it difficult to separate the fish flesh from the bones and skin. Trash fish is considered a marine fisheries waste [10].

Animal food products from fish meat make a very important contribution as a source of protein. Protein with its functional properties can make food ingredients very attractive and encourage the emergence of flavors, textures and other qualities desired by consumers [11]. Fresh fish can be converted into semi-finished raw materials, namely in the form of fillets, surimi and so on.

To obtain fillets with good physical, chemical and functional characteristics, various preparation techniques are necessary. Kuniran fish (*Upeneus sulphureus* Cuvier, 1829) preparation technique by slashing has a high yield value (67.50 %), and a faster separation process time (11.35 kg h^{-1}) [12]. The preparation technique for trash fish fillets with 1 % enzyme dissolution has better physical and chemical characteristics than the mechanical preparation techniques, blanching, or with 1 % acid dissolution [13]. While functional properties: Suglir fish protein concentrate (*Elagatis bipinnulatus* Quoy & Gaimard, 1825) has oil absorption (2.48 g g^{-1}) and water absorption (2.02 mL g^{-1}) [14], in Wader fish fillets (*Rasbora jacobsoni* Weber & de Beaufort, 1916) has foaming power (211.03 %), foam stability (19.17 %), emulsifying power (2.42 %), emulsion stability (0.55 %) [15], in cowpea protein isolate (*Vigna unguiculata* (L.) Walp.) has foaming power (68 mL g^{-1}), foam stability (8 %), OHC (84.89 %), WHC (136.61 %) [16]. This study aims to obtain the functional properties of Indonesian Lamongan trash fish fillets.

2 Methods

2.1 Materials

The main ingredients of fresh trash fish are Orangefin ponyfish, Chacunda gizzard-shad and Sardine with an average weight of 50 g $tail^{-1}$ to 100 g $tail^{-1}$ purchased from the fish mother market in Lamongan Regency, East Java, Indonesia. The fish was immediately stored in the refrigerator and transported to the Department of Agroindustry Technology, the University of Jember for 5 h. Once you arrive, the fish is stored in the freezer. Before analysis, the fish is immediately thawed at room temperature, washed, filled, and chopped to a uniform using a chopper. The ingredients used are young papaya fruit, lime juice, cooking oil, CH_3COOH and other chemicals (analytical class) are TCA 5 %, sodium hydroxide, H_2SO_4, selenium, boric acid 3 %, SDS 0.1 %, and petrolium benzene [15].

2.2 Preparation of trash fish fillets

Preparation fish samples to eliminate fishy odor by giving lime as much as 15 % (b/v) of the weight of the fish for 10 min. Removing fishy odor in the trash done after washing the fish with clean water. The three types of marine fish have carried out preparation techniques in four ways, namely mechanical preparation techniques with the Palmeira method in fish [17], blanching with the Nguyen method on asparagus [18] and chemically with the Moniharapon method in fish [19], and enzymatic with the Ma method on softening meat [20]. The preparation technique performed on fish are given the same time limit of 5 min for blanching treatment and 30 min for chemical and enzyme treatments. Preparation fish mechanically is done by way of fillets directly on fresh fish. In this process, the three types of fish are carried out early washing using running water, while the other fish are temporarily accommodated in a freezer. Fish have been washed discarded scales and stomach contents, then the fish is carried out the filleted process from the tip of the tail, splitting the back to the direction of the head. Fish that have been cleaned and detached from thorns are weighed and recorded in weight stored in a freezer.

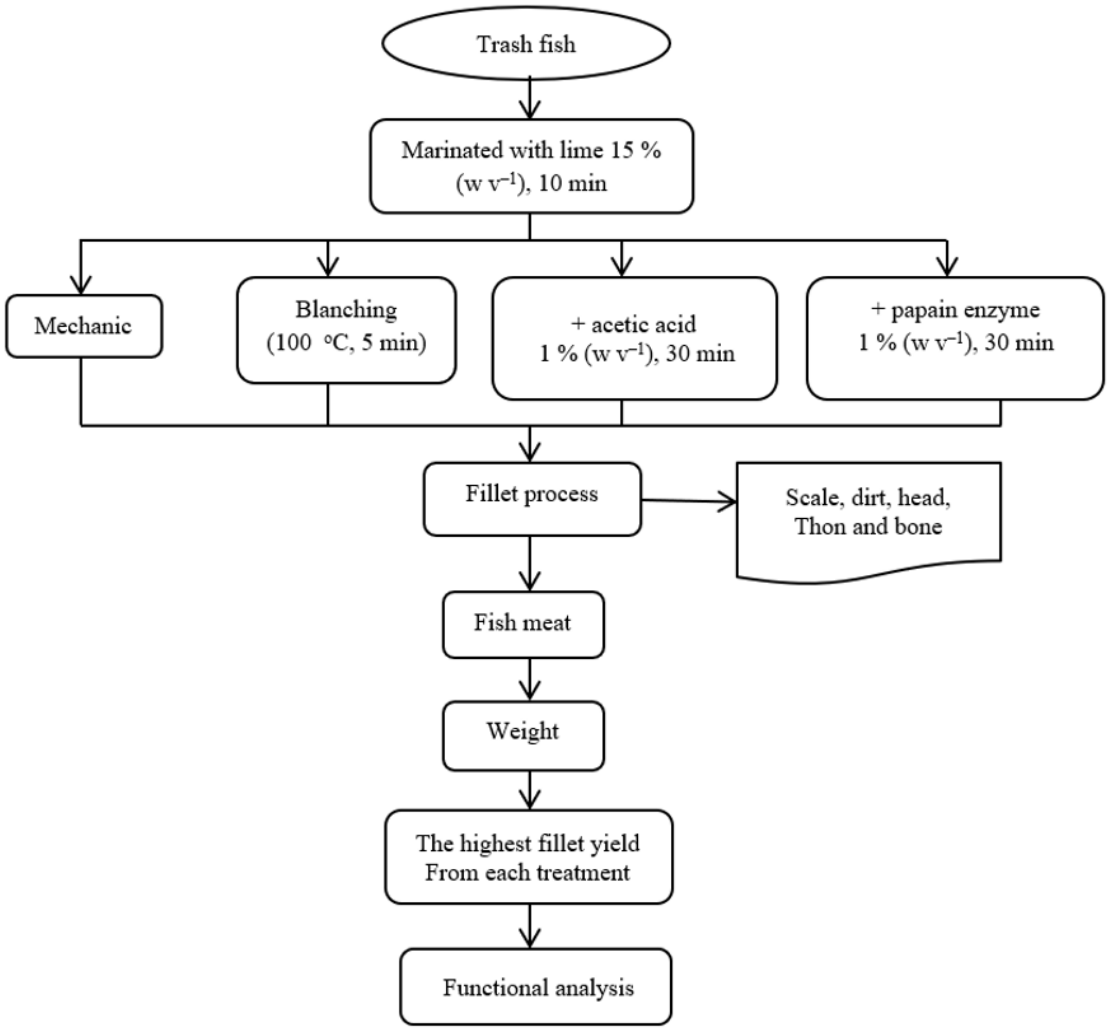

Fig. 1. Flowchart of trash fish preparation technique [21].

In the technique of fish blanching, all three types of fish are done by way of fish cleaned alternately using running water. After washing, the fish is boiled at a temperature of 100 ºC for 5 min. The fish is lifted and cooled in the open air. After chold, the three types of fish have carried out the removal of thorns, and the fillet process is carried out. Fish that are clean and detached from thorns are weighed and recorded in weight the stored in the freezer. Chemical and enzymatic preparation techniques are carried out by soaking fish. Chemically, fish is soaked with acetic acid solution at a concentration of 1 %. Enzymatically, fish are soaked with a solution of papain enzymes at concentration of 1 %. This immersion is done for 30 min, after which the fillet process is then weighed and recorded the results. The process of filleting trash fish can be seen in Figure 1.

Papain enzymes are made by tapping the fruit skin of papaya plants that have been aged 2 mo to 3 mo. Tapping is done by sticking a sad tool (knife) on the fruit's skin from the base to the end of the fruit. The depth of the nick is between one mm to mm. Papaya sap that comes out is accommodated in a container. Papaya sap mixed with buffer phosphate 0.2 M pH 7 (ratio 1:1). The mixture is centrifuged at 8 000 rad s^{-1} at 4 ºC for 10 min (1 rad s^{-1} = 1/60 Hz). Filtrate is a papain enzyme. The manufacture of papain enzyme follows the method of Urgessa [22] with a little modification.

The yield of the preparation technique on each treatment will be analyzed for physical characteristics and chemical. Chemical and enzymatic treatment will be taken at the concentration with the highest yield and the fastest time based on the fillet type of trash fish.

2.3 Functional properties

Analysis for foaming capacity and foam stability [16], emulsion capacity and emulsion stability [23], water holding capacity [24], and oil holding capacity [16].

2.4 Data analysis

The research design used was experimental laboratory. First, the test data is calculated using Microsoft Excel and presented in table form. Next, it is explored graph form, then analyzed with the ANOVA - One Way (minitab 17) test. After that, Tukey test ($P \leq 0.05$) if there is a significant difference [25, 26]

3 Results and discussion

3.1 Foam strength and stability

The results of variance showed that variations in preparation techniques and fish species had a significant effect on foaming capacity and there was an interaction between the two factors. The foaming ability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets can be seen in Figure 2. Meanwhile, the results of the foam stability analysis showed that variations in preparation techniques and types of fish had a significant effect and there were interactions between the two factors. The foam stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets is shown in Figure 3.

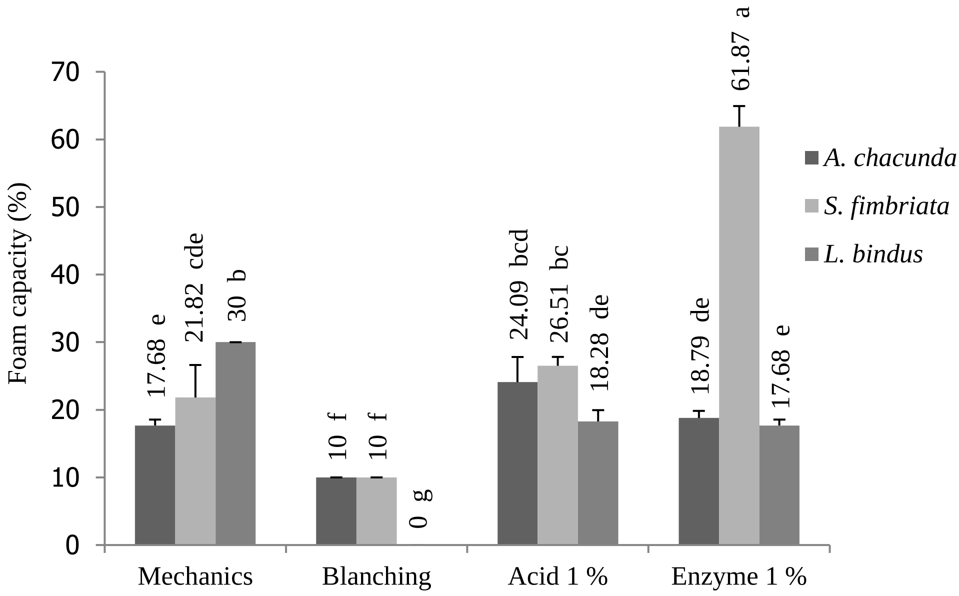

Fig. 2. Fish fillet foaming capacity.

Figure 2 shows the foaming power contained in Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets with mechanical treatment (17.68 %, 21.82 %, and 30 %). The foaming capacity of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in the blanching treatment (10 %, 10 %, and 0 %). The foaming ability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in 1 % acetic acid solution immersion (24.09 %, 26.51 %, and 18.28 %). Sardine, Chacunda gizzard-shad and Orangefin ponyfish fulllet foaming ability in 1 % papain enzyme solution immersion treatment (18.79 %, 61.87 %, and 17.68 %). The highest foaming power was found in Chacunda gizzard-shad fish treated with 1 % enzyme, which was 61.87 %. This value was significantly different compared to Chacunda gizzard-shade fish with 1 % acid treatment, which was 26.51 %.

The results of the analysis above show that the foaming power of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish in the mechanical treatment, blanching, soaking in acid solution and immersion in papain enzyme solution is lower when compared to the foaming capacity of Wader fish fillets, which is equal to 211.03 % [15]. The foaming power value will be lower after the processing treatment. This is because the treatment during processing can dissolve water-soluble sarcoplasmic proteins, causing changes that lead to a decrease in foaming power. Sarcoplasmic protein is a reflection of the relationship between protein solubility and foam formation [27]. This is in accordance with the statement of Afrianto et al. [28], blanching by boiling has weaknesses, including being able to remove nutrients in water-soluble fish, in this case the foaming ability of the three types of blanching treated fish has a low value.

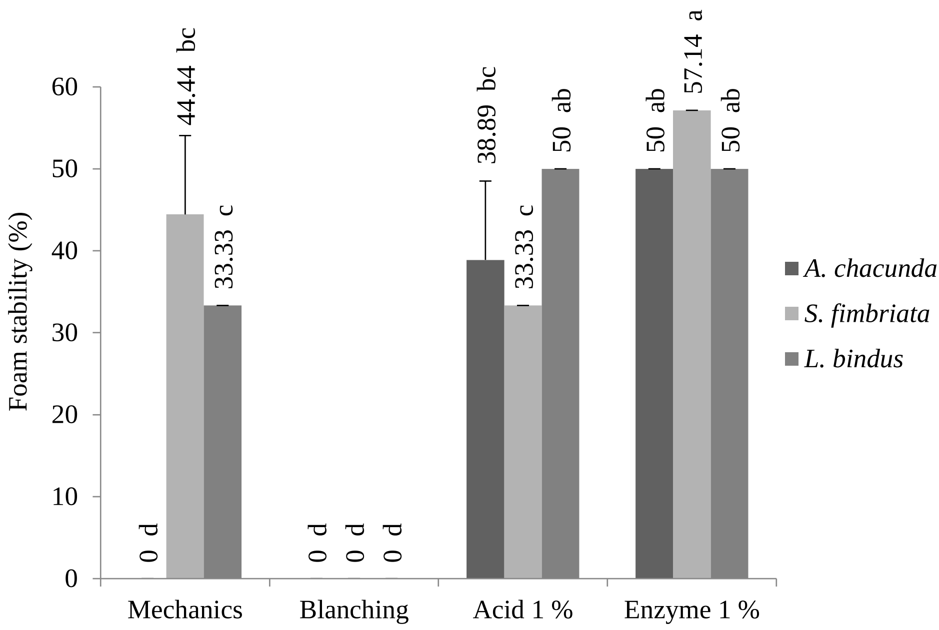

Fig. 3. Foam stability of fish fillet.

Figure 3 shows the stability of the foam contained in Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets with mechanical treatment (0 %, 44.44 %, and 33.33 %). The foam stability of the blanching treatment of all types of fish was 0 %. The foam stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in the 1 % acetic acid solution immersion treatment (38.89 %, 33.33 %, and 50 %). Foam stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in 1 % papain enzyme solution immersion (50 %, 57.14 %, and 50 %). The highest foam stability was found in Chacunda gizzard-shad fish treated with 1 % enzyme, which was 57.14 %. This value was significantly different from the stability of the foam of Chacunda gizzard-shad fish with mechanical treatment, which was 44.44 %.

The results of the analysis above show that the foam stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish in mechanical treatment, soaking in acid solution and soaking in papain enzyme solution is higher when compared to the foam stability of Wader fish which is 19.17 %, and Bader fish (*Puintius javanicus* Bleeker, 1855) namely 18.38 % [15]. While fish with mechanical treatment and all types of fish with blanching treatment have a lower value.

The low value of foam stability is due to the foam that is formed large and breaks easily. Foam strength and stability increase with increasing protein concentration, where increasing protein concentration can increase viscosity and form many layers of protein cohesion on the surface. Foaming capacity is influenced by intramolecular and flexibility of protein molecules [29].

3.2 Emulsion capacity and stability

The emulsion capacity of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets ranged from 2.64 % to 5.94 %. The results of the analysis of variance showed that there was an interaction between the preparation technique and the type of fish on the emulsifying power of the fish fillets. The emulsion power of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets can be seen in Figure 4, while the emulsion stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets ranges from 1.56 % to 3.37 %. The results of the emulsion stability analysis of variance showed that there was no interaction between the various preparation techniques and the types of fish. The emulsion stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets can be seen in Figure 5.

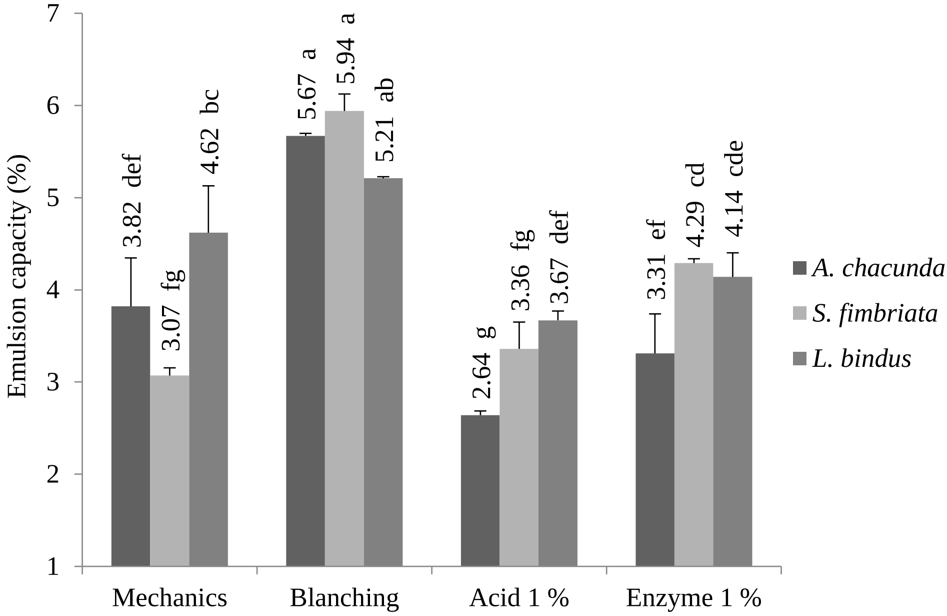

Fig. 4. Emulsion capacity of fish fillets.

Figure 4 shows the emulsifying power contained in Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets with mechanical treatment (3.82 %, 3.07 %, and 4.62 %). Emulsion power of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in the blanching treatment (5.67 %, 5.94 %, and 5.21 %). Emulsion power of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in 1 % vinegar solution (2.64 %, 3.36 %, and 3.67 %) immersion treatment. Meanwhile, the emulsion power of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets was treated with 1 % papain enzyme solution immersion (3.31 %, 4.29 %, and 4.14 %). The highest emulsion power was found in the blanching treatment of Chacunda gizzard-shad fish, which was 5.94 %. This value was significantly different compared to the emulsion power of Chacunda gizzard-shad fish with 1 % enzyme treatment, which was 4.29 %. The three types of fish had the ability to form good emulsions in the blanching treatment, while the other types of fish had almost the same emulsion power (2.64 % to 4.29 %). The emulsion power of all three types of fish treatment was still higher when compared to Wader fish which had an emulsion power of 2.42 % [15]. Emulsion depends on the high absorption capacity of oil-water (w o^{-1}), and proteins with a high amount of hydrophobicity will be adsorbed on the interfacial oil-water (w o^{-1}) interface. Protein will lower the surface tension between the phases and form an emulsion [30]. This can determine the formation of oil and water emulsions as well as in the stabilization process.

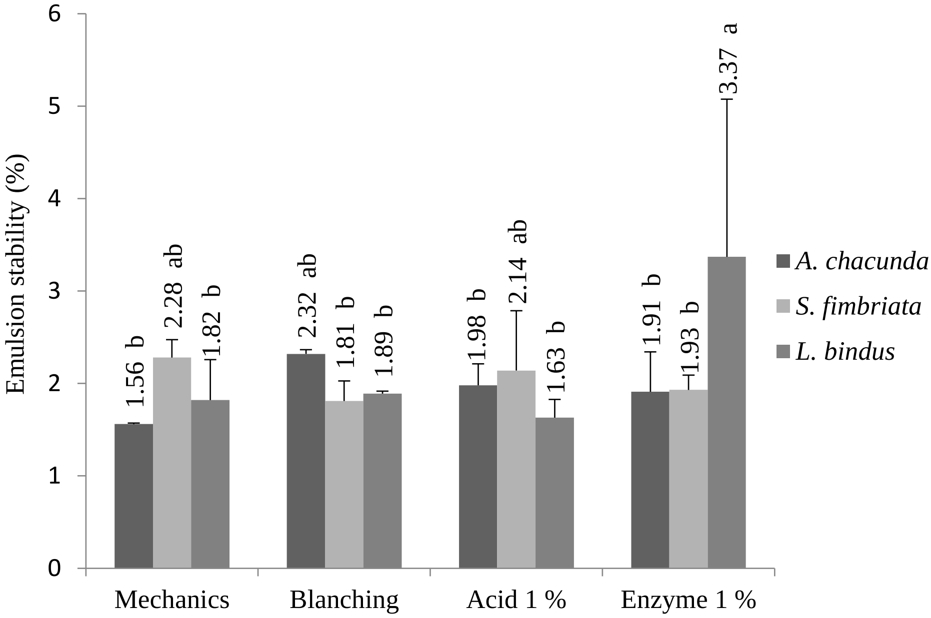

Fig. 5. Fish fillet emulsion stability.

Figure 5 shows the stability of the emulsion found in Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets with mechanical treatment (1.56 %, 2.28 %, and 1.82 %). Emulsion stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in the blanching treatment (2.32 %, 1.81 %, and 1.89 %). Emulsion stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in 1 % vinegar solution immersion (1.98 %, 2.14 %, and 1.63 %). Stability of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillet emulsion in 1 % papain enzyme solution immersion treatment (1.91 %, 1.93 %, and 3.37 %). The highest emulsion stability was found in Orangefin ponyfish fish fillet with 1 % enzyme treatment, namely 3.37 %. This value was significantly different from the stability of the blanching treatment of Orangefin ponyfish fish emulsion, which was 1.89 %. The three types of fish have higher emulsion stability when compared to Wader fish which has an emulsion stability of 0.55 % [15]. The stability of the emulsion depends on the thickness and thickness of the membrane or protein film absorbed by the interface between the oil and water phases. Emulsification properties are determined by the quality of the protein, not the quantity or amount of protein [31]. Emulsion stability depends on the interpartial strength of the ingredients in maintaining the hydrophobic interaction between oil and protein [32]. Emulsion stability is affected by emulsification conditions in proteins, protein sources and concentrations, pH, ionic strength (salt type and concentration) and viscosity in the food system [33].

3.3 Water Holding Capacity (WHC)

The calculation results obtained WHC values for Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in the mechanical treatment (42.72 %, 34.697 %, and 27.64 %). WHC values in the blanching treatment of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets (78.9 %, 112.39 %, and 43.24 %). WHC values of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in 1 % acid solution immersion treatment (35.96 %, 17.98 %, and 44.44 %). WHC values in 1 % enzyme solution immersion treatment of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets (33.9 %, 43.11 %, and 46.64 %). The results of variance showed that variations in preparation techniques and fish species had a significant effect and there was an interaction between the two parameters (Figure 6).

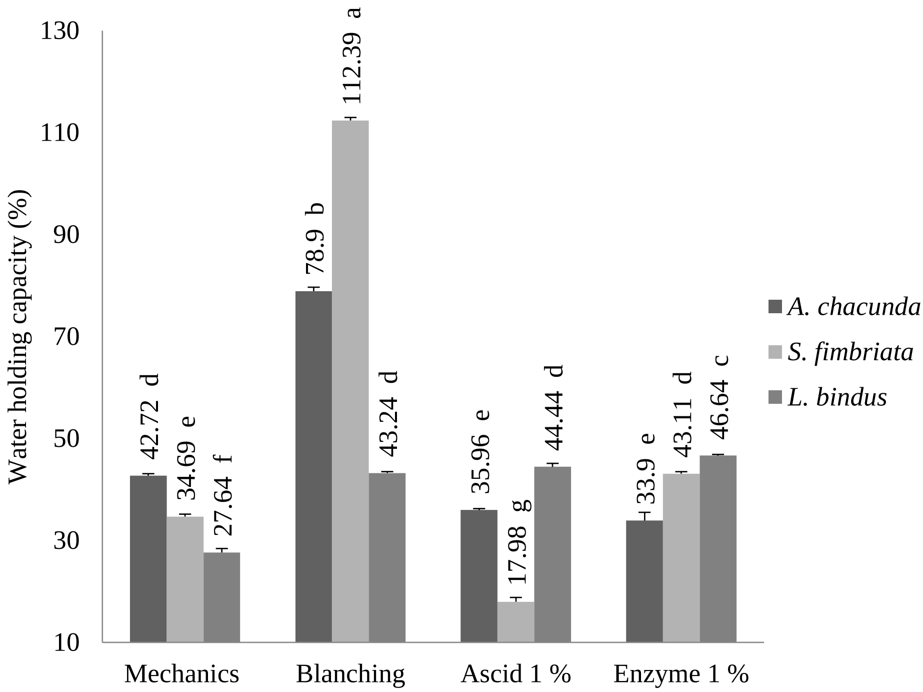

Fig. 6. WHC value of fish fillets.

Figure 6 shows the largest WHC value is in Chacunda gizzard-shad fish fillets with blanching treatment (112.39 %). This value was significantly different when compared to Chacunda gizzard-shad fish fillets treated with 1 % enzyme (43.11 %). This could be due to the bond in the fish fillet tissue which has changed due to the influence of high temperatures, making it easy to absorb water. In addition, the WHC value is influenced by the protein content of the meat. Chacunda gizzard-shad fish has a good protein content (8.89 % to 10.59 %) [13] so it can hold water in the fish meat. Water absorption is strongly influenced by protein concentration, ionic strength, temperature and other components such as hydrophilic polysaccharides, fats, salts, and is also influenced by the duration of heating and storage conditions. The higher the protein concentration, the better the water absorption. As the protein content of the meat increases, the WHC of the meat will increase due to the protein's ability to chemically bind water [34]. The ability to absorb or bind water is needed, especially in one of the most important food applications, for example in the manufacture of sausages.

Mechanical treatment, immersion in vinegar and enzyme solutions has a relatively low water absorption capacity. This can be caused by the low protein content in fish fillets and due to a decrease in pH. The low WHC value is caused by changes in the ions bound by the meat protein due to the large amount of lactic acid that has accumulated as a result of which many myofibril proteins are damaged. In addition, the hydrolysis of meat protein by enzymes causes the volume of muscle fibers to expand. This damage causes the loss of the protein's ability to bind water [35].

3.4 Oil Holding Capacity (OHC)

The calculation results obtained OHC values for Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in the mechanical treatment (34.55 %, 23.25 %, and 13.33 %). The OHC value of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in the blanching treatment (59.14 %, 71.52 %, and 55.63 %). OHC values of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in 1 % acid solution immersion treatment (8.64 %, 21.94 %, and 12.58 %). OHC values of Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish fillets in 1 % enzyme solution immersion treatment (29.57 %, 24.75 %, and 26.49 %). The results of the variance indicated that there was an interaction between various preparation techniques and fish species (Figure 7).

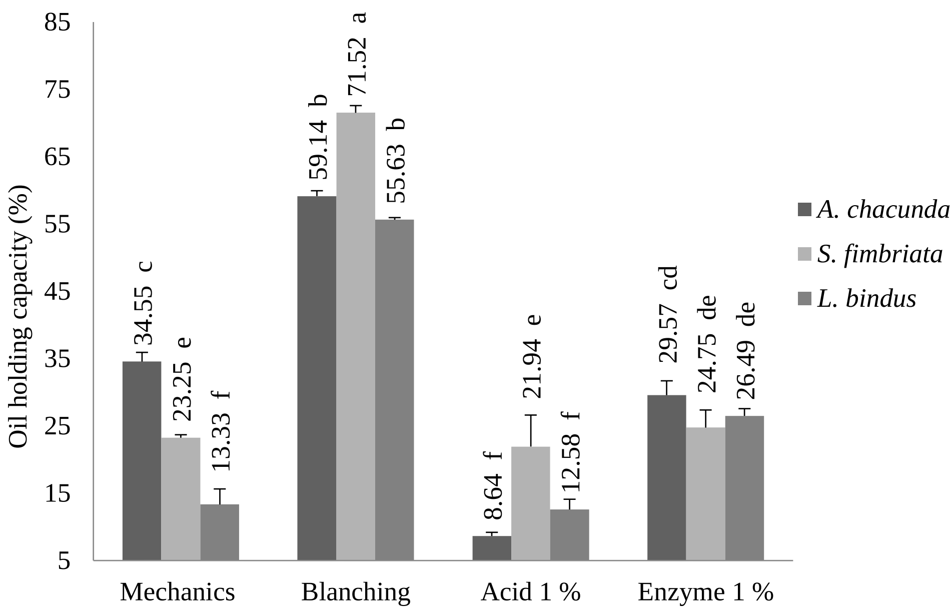

Fig. 7. OHC value of fish fillets.

Figure 7 shows the largest OHC value was found in Chacunda gizzard-shad fish fillets with the blanching treatment (71.52 %). This value was significantly different from the OHC Juwi fish with 1 % enzyme treatment (24.75 %). This could be due to the protein content of Chacunda gizzard-shad fish in the blanching treatment having the highest protein content (10.59 %) [13] compared to other types of fish, so that Chacunda gizzard-shad fish have good oil absorption abilities. Oil absorption occurs because the oil is physically trapped in the protein. Protein structure is a factor that greatly determines the ability to absorb oil. Structures that are more lipophilic contain more non-polar protein branches and will contribute to increased oil absorption [36].

4 Conclusion

Sardine, Chacunda gizzard-shad and Orangefin ponyfish fish have functional properties, namely: foaming power (17.68 % to 61.87 %), foam stability (50 % to 57.14 %), emulsifying power (3.31 % to 4.29 %), emulsion stability (1.91 % to 3.37 %), WHC (33.9 % to 46.64 %), and OHC (24.75 % to 29.57 %).

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