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BY-PRODUCT UTILIZATION OF JAMBAL ROTI SALTED FISH AS THE RAW MATERIALS FOR MAKING FISH SAUCE

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ABSTRACT
Pangandaran is the *"jambal roti"* processing center. The by-product of the *"jambal roti"* processing (salting residual liquid) can cause environmental problems. This study aimed at utilizing the by-product of the *"jambal roti"* processing as the raw material for making fish sauce. The method used was experimental involving three treatments and using the dose of salting residual liquid of 100%, 75% and 50% of the total production of fish sauce as much as 1 L. Every treatment was added with 10% salt and 25% starter *(Aspergillus oryzae)* and fermented for 30 days. The observed variables follow the standard of fish sauce quality requirements according to SNI for fish sauce No.01-4271-1996, including pH, salinity (NaCl), total-N, heavy metal contamination, and microbial contamination. The pH and heavy metal contamination in the fermented liquids (fish sauce) are in accordance with the SNI for fish sauce No. 01-4271-1996. Also, microbial contamination does not have a potential to cause disease and is safe for consumption. After being fermented for 30 days, the total-N increased. The highest total-N was obtained at treatment III (50% of salting residual liquid) or equal to 8465.19 mg/L. Therefore, it can be concluded that the by-product of the *"jambal roti"* processing has the potential to become the raw material for making fish sauce.

KEY WORDS
Fish sauce, jambal roti, salting residual liquid.

Salted fish is one of the traditional archipelagic culinary made of fish meat preserved with the addition of salt. In Indonesia, salted fish are often found in the north and south of Java island. Pangandaran is one of the cities in the southern part of Java island which is famous for its specialty products, that is *jambal roti* salted fish. The *jambal roti* salted fish is popular because of its large size and delicious taste.

The processing of *jambal roti* salted fish produces a by-product in the form of salting residual liquid and fish entrails. Those by-products have not been utilized by the Pangandaran community. According to the *jambal roti* processors, the salting residual liquid will cause unpleasant odors.

Fish sauce is liquid obtained from the fermentation of the fish juice both specially-made or a by-product (Afrianto and Liviawati, 1989). To process fish sauce traditionally, it mixes salt with two or three parts of fish and then fermented at room temperature (± 30oC) for 6-12 months (Lopetcharat et al., 2001). According to Timoryana (2007), traditional processing of fish sauce has several advantages: cheap processing, simple technique, a little waste, longer expiration date, and distinctive taste and aroma.

Restu's (2017) study revealed that the salting residual process could be used as the raw material for making fish sauce. Therefore, the author tries to utilize the by-products of the *jambal roti* salted fish processing as the raw material for making fish sauce.

MATERIALS AND METHODS OF RESEARCH

The materials used to conduct this study were the *s*alting residual liquid and the fish stomach contents, salt, and starter *(Aspergillus oryzae).* The equipment needed was: jerry can, knives, cutting boards, basins, measuring cups, funnels, pans, filters, and jars.

The main raw materials were the salting residual liquid fermented for 3-6 days and fish stomach contents. Before being used, they were boiled first to kill the pathogenic bacteria. In addition, the salting residual liquid must be characterized first. Later on, the salting residual liquid was given an acidity (pH), salinity (NaCl), protein content (total-N), and heavy metal contamination test to ensure that the raw materials were suitable for making fish sauce.

This research was conducted using the experimental method involving three treatments: Treatment I (100% SRL); treatment II (75% SRL); treatment III (50% SRL) of the total production of fish sauce as much as 1 Liter. Every treatment was added with 10% salt and 25% starter *(Aspergillus oryzae)*

The stages of fermentation are as follows: First, the salting residual liquid was boiled to kill pathogenic microbes. Second, the stomach contents were washed, boiled, and cut into 1-2 cm size.

Third, it was added with 10% salt and 25% starter *(Aspergillus flavus)* then put in a jar and fermented for 30 days at room temperature. The fermented liquid was then filtered and tested according to the SNI for fish sauce No.01-4271-1996 (BSN, 1996).

A testing process of the fermentation result adjusts the SNI for fish sauce no.01-4271-1996 which includes the pH, N-total, salt content (NaCl), microbiological test (total plate number, mold, *Coliform*, *Salmonella,* and *Staphylococcus aureus*) and heavy metals (Pb, Zn, Cu, As, Hg) tets. The test was carried out in the integrated laboratory of Bogor Agricultural Institute.

RESULTS AND DISCUSSION

The acidity degree (pH) of the SRL before being fermented was 7.1 while the pH of the fermented liquid at treatments I, II and III ranged from 5.7-5.9. Data obtained showed a decrease in pH after the fermentation process for 30 days. Ardiansyah (2015) revealed that the pH value of fish sauce decreased because of the length of the fermentation process. The pH value for 30 days fermentation was lower than the pH value for 10 and 20 days fermentation because the glycolysis process converts carbohydrates to lactic acid. The production of lactic acid during the fermentation will decrease the pH value of the final product. Apart from the glycolysis process, a decrease in pH is due to the addition of the salt during the fermentation process. According to Timoryana (2007), a decrease in pH value is due to the ionic bonds between H+ ions from water and Cl- ions from salts which produce acidic HCl compounds.

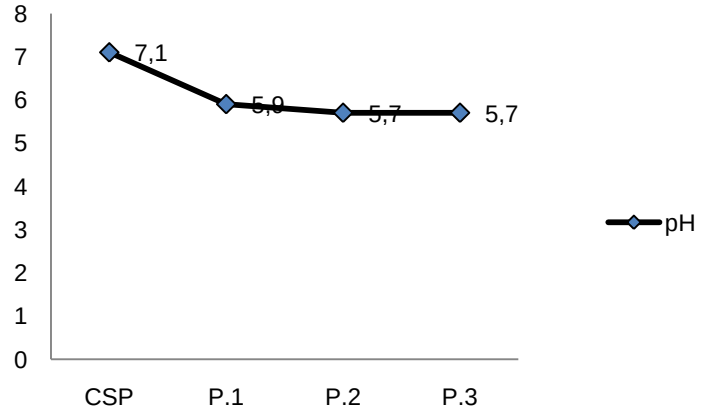

Figure 1 – The Acidity Degree (pH) of the Salting Residual Liquid (SRL) and the Fermented Liquid at Several Treatments (Description: SRL = Salting Residual Liquid; T.1 = Treatment I; T.2 = Treatment II; T.3 = Treatment III)

Data showed that the pH value at treatment II (75% SRL) and treatment III (50% SRL) is lower than the pH value in treatment I (100% SRL). This is assumed because of a mixture

of fish contents with higher carbohydrates at treatment II and III but not with the treatment I. Carbohydrates derived from the fish stomach will be broken down into lactic acid through the glycolysis process. High carbohydrate will produce a final fermentation product with high lactic acid so the pH value will be lower.

Based on the data above, the pH value obtained from those three treatments ranged from 5.7-5.9. According to the National Standardization Body (Badan Standardisasi Nasional or BSN, 1996), the pH for fish sauce referring to SNI 01-4271-1996 range from 5-6. While the pH value of commercially produced fish sauce from several countries in East Asia and Southeast Asia ranges from 4.9-6.23 (Park et al., 2000). Therefore, it can be concluded that the pH value of the fermented liquid is in accordance with the SNI for fish sauce and commercial soy sauce in East and Southeast Asia.

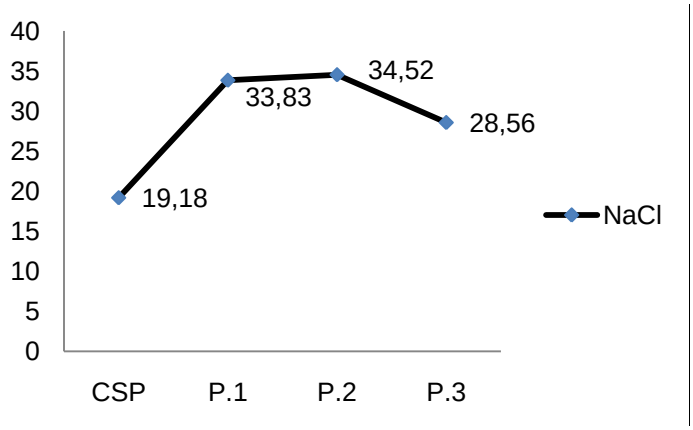

Figure 2 – Salt Content (NaCl, %) of Salting Residual Liquid (SRL) and Fermented Liquid in Several Treatments (Description: SRL= Salting Residual Liquid; T.1 = Treatment I; T.2 = Treatment II; T.3 = Treatment III)

The salt content (NaCl) of the SRL was 19.18% and the fermented liquid of the three treatments ranged from 28.56-34.52%. Data obtained showed an increase in the salt content (NaCl) after being added with 10% salt during the fermentation process. The increase in salt content is due to the salt dissolved in the liquid so that the filtrate salt content is higher than the added salt. In accordance with the research conducted by Subasinghe et al. (1990), the salt content of fish was 1.65% and increased up to 22.85% after being fermented for 30 days. According to Suardani (2012), fish sauce processing contains a proteolytic enzyme to penetrate fish tissue increase the salt content of fish sauce.

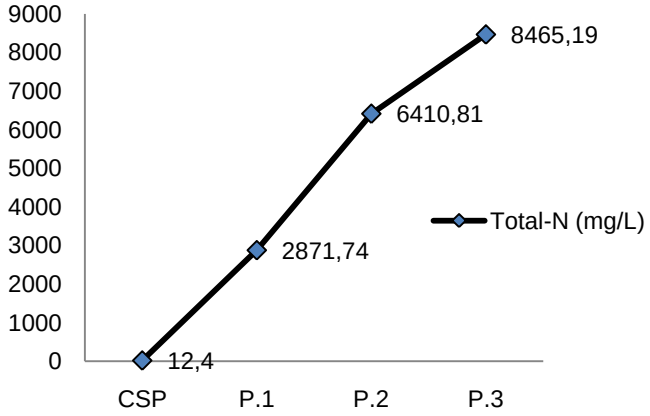

Figure 3 – Total Nitrogen (Total-N) of the Salting Residual Liquid (SRL) and the Fermented Liquids at Several Treatments (Description: SRL = Salting Remaining Liquid; T.1 = Treatment I; T.2 = Treatment II; T.3 = Treatment III)

The results showed that the salt content (NaCl) at treatment I (100% SRL) andtreatment II (75% SRL) are higher than the salinity (NaCl) at treatment III (50% SRL) because treatments I and treatment II contain more saline residue than that of treatment III. The salt content of the salting residual liquid was 19.18%. The dissolved salts during the salting process will increase the salt content. According to SNI No 01-4271-1996, the salt content for the fish sauce is 19-25%. The results showed that the salt content (NaCl) of the raw material was too high compared to the salt content (NaCl) of fish sauce according to SNI. In addition to providing saltiness in soy sauce, salt also plays a role in preventing undesirable microbial growth, except halophilic lactic acid bacteria to add specific taste and aroma and to eliminate the bitter taste caused by the breakdown of fish protein protease enzyme (Ebine, 1979).

The total N-value of the SRL of the *jambal roti* salted fish was 12.40 mg/L, while the total-N value of the fermented liquid at the three treatments ranged from 2871.74–8465.19 mg/L. This shows an increase in the total N-value after the fermentation process. The increase in total N was due to the hydrolysis of proteins. A protein hydrolysis reaction during the fermentation process breaks the peptide bond which converts proteins into amino acids and peptides containing N elements. This is in accordance with what Indrawati (1983 and Santy 1992, as quoted in Kurniawan, 2008) proposed that the longer the fermentation, the more the protein molecules solved, so the dissolved N tends to increase.

The highest total-N value was at treatment III (50% CSP) of 8.465.19 mg/L. While the lowest total N-value was at treatment I (100% CSP) of 2,871.74 mg/L. The high total N-value at treatment III was alleged because treatment III used more fish contents than treatments I and II. The protein content in the fish entrails is more than in the salting residual liquid. The protein was then hydrolyzed into amino acids and peptides containing N elements.

According to Lopetcharat and Park (2002), the quality and the price of fish sauce is generally based on the total N-levels, while amino nitrogen contents are usually used as an indicator of the degree of fermentation. According to the Thai Industrial Standard (1983), total-N more than 20,000 mg/L is classified as quality I and 15,000-20,000 mg/L as quality II. Whereas according to Codex Allimentarius, the minimum content of N-total is 10,000 mg/L (Codex, 2011). Dissaraphong et al. (2006) reported that the N-total of Tuna Viscera was higher than 20,000 mg/L after being fermented for four months. It indicates that the fermentation of fish sauce from viscera Tuna can be obtained after being fermented for four months. The results showed that after 30 days, the fermentation of the raw materials with 10% salt addition still did not meet the Codex Alimentarius standard in terms of N-total. This was alleged to have short fermentation time and high salt content. Ardiansyah's (2015) research showed that fish sauce with trash fish as the raw material fermented for 30 days with the addition of 9% papain enzyme produced a total N-value of 8.320 mg/L. Rianigsih (2016) also explained that the N-total for a fish sauce made from viscera fish *(Arius sp.)* with the addition of 25% salt is lower than the addition of salt 15% and 20%. This indicates that the high salt content during the fermentation process slows down the hydrolysis of protein. According to Chapters et al. (2010), salt will slow down the activity of protease enzymes and inhibit bacterial growth, including proteolytic bacteria.

Chemical testing is one of the important things in the agri-food, it is not only obliged by the government to include in a food product but also provides a function to guarantee food quality and safety. One of the chemical testings that has to be conducted is a heavy metal contamination testing.

Heavy metal contamination in the fish habitat can accumulate in the fish body. Based on Darmono (2008), heavy metals can accumulate in the fish body through several paths, among others, breathing (respiration), food channels, and the skin (diffusion). The metal is absorbed in fish meat by the blood which binds to blood proteins and is then distributed throughout the body's tissues. The average heavy metals found in fish meat sequentially from the largest to the smallest is Pb>Cu>Cd>Hg. According to the BSN (1996), the quality requirements of fish sauce referring to SNI for Fish Sauce No.01-4271-1996, a heavy metal contaminants testing that must be done is Lead (Pb), copper (Cu), Zinc (Zn), mercury (Hg), and Arsenic (As) testing.

Table 1 – Heavy Metal Contamination of the Salting Residual Liquid and the Fermented Liquid at Various Treatments

Type of test	SRL	Fermented Liquid (mg/L)			INS
		I	II	III	
	<0.04	<0.04	<0.04	<0.04	Max.2,0
Cu	<0.006	0.03	0.05	0.12	Max.20.0
Zn	0.26	0.68	5.24	9.26	Max.100.0
	0.001	<0.0002	<0.0002	<0.0002	Max.0.05
As	<0.0004	<0.0004	<0.0004	<0.0004	Max.1.0

Description: Pb = Lead; Cu = Copper; Zn = Zinc; Hg = Mercury; As = Arsenic; SRL = Salting Residual Liquid.

It is known that the contents of heavy metals (Pb, Cu, Zn, Hg, and As) in the SRL and the fermented liquids for all treatments are below the threshold level of heavy metals according to SNI for Fish Soy Sauce No.01-4271 -1996. It can be concluded that the fermented liquid from the *jambal roti* salted fish by-products is safe from heavy metal contamination.

In terms of microbiological quality control, laboratory testing is needed to isolate and identify microbial contaminants in food. Microbes found in foods are bacteria and mold/fungus which lead to undesirable changes such as appearance, texture, taste, and smell. According to SNI for Fish Sauce No.01-4271-1996, microbiological contaminants testing to consider is the Total Plate Number (TPN), Coliform, Salmonella, Staphylococcus aureus, and mold.

Table 2 – Microbial Contamination of Fermented Liquids at Various Treatments

Type of test	Treatment			INS
	I	II	III	
Total Plate Number (cfu/ml)	$2.3x10^4$	$3.5x10^4$	$3.2x10^4$	$Max.10^4$
Coliform (MPN/ml)	<1.8	5.6	5.6	<3
Salmonella sp (/25ml)	Negative	Negative	Negative	Negative
Staphylococcus aureus (cfu/ml)	<1	<1	<1	Negative
Mould (cfu/ml)	<1	<1	<1	Negative

According to SNI No 01-2332.3-2006, the method of determining Total Plate Numbers (TPN) is used to determine the total number of aerobic and anaerobic *(psychrophilic, mesophilic, and thermophilic)* microorganisms found in fishery products (BSN 2006). One parameter of the quality requirements of fish sauce according to SNI for Fish Sauce No.01-4271-1996 states that TPN values are no more than 104 cfu/ml. The results of the TPN test on the fermented liquids from the three treatments ranged from $2.3\text{-}3.5x10^4$ cfu/ml. Based on these data, the fermented liquid of the *jambal roti* salted fish by-products has met the quality requirements considered from the TPN value.

A *coliform* is a group of bacteria used as an indicator of dirt pollution and poor sanitation conditions. The test results showed that treatment II and treatment III using fish stomach as the raw materials contains higher *Coliform* compared to the treatment I which did not use the fish stomach contents. According to Supardi and Sukamto (1996), *Coliform i*s a normal flora in the digestive tract of animals and humans, so that it is suspected in treatments II and III originating from the entrails of fish. According to SNI for Fish Sauce No.01-4271-1996, the quality requirements for Coliform is <3 MPN/ml. Whereas, the result of the Coliform test at treatment II and III was 5.6 MPN/ml. Coliform is a family of Enterobacteriaceae. According to the National Agency of Drug and Food Control (NA-DFC) (2016), the *Enterobacteriaceae* in fish sauce is said safe if not exceeding 104 colonies/g. This bacterium is also sensitive to heat and can be activated at the temperature of food pasteurization or during cooking. Microbiological (Coliform) tests were carried out on fermented liquids without giving sterilization (boiling) treatment first. The next stage was the process of making fish sauce, it boiled the fermented liquid and added with seasoning. Through that stage, the Coliform is expected to be activated.

According to Nugraheni (2010), *Salmonella* is a gram-negative rod-shaped bacteria and does not form spores. It consists of about 2,500 pathogenic serotypes both in humans or animals and aerobic or facultative anaerobes. These bacteria are not indicators of sanitation, but food safety. The presence of these bacteria in water or food is considered dangerous because all *Salmonella* serotypes are pathogenic. Thus, it is very important to know the presence of these bacteria in a food product. These bacteria will cause infection if ingested and enter the body with symptoms of gastroenteritis. The results revealed that the fermented liquid for all treatments was negative. This was in accordance with the SNI No.01-4271-1996 for the fish sauce.

The number of *Staphylococcus aureus* cells in the fermented liquids is <1 cfu/ml. According to Supardi and Sukamto (1996), the number of Staphylococcus aureus bacteria in food can cause intoxication symptoms if reaches 10^6 cells/g of food or more. It can be concluded that the Staphylococcus aureus <1 cfu/ml in the fermented liquids does not have the potential to cause symptoms of intoxication.

The quality requirements of fish sauce for molds according to SNI No. 01-4271-1996 are negative, while the test results of molds on fermented liquids are <1 cfu/ml. However, according to SNI 7388: 2009, the maximum limit of microbial contamination on food for mold contamination in fish sauce is 5 x 101 colonies/g (BSN, 2009). Nugraheni (2010) also stated that the results of mold testing on soy sauce with an average colony <10 cfu/ml proved to be safe.

CONCLUSION

The results reveal that the pH values and heavy metal contamination in the fermented fish sauce are in accordance with SNI for Fish Sauce No. 01-4271-1996. The salt content of the fish sauce is too high and the N-total never met the standard. Microbial contamination does not have the potential to cause disease and is safe for consumption. It can be concluded that the *jambal roti* salted fish processing by-product has the potential to become the raw material for making fish sauce.

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