Aplication of Natural Preservative "Atung" (*Parinarium Glaberimum*, Hassk) on Enzymatic Fish Sauce Nutrition Produced of Tuna Loin Waste in Parigi Wahai Village North Seram Sub-district Central Maluku District

Trijunianto Moniharapon, Fredy Pattipeilohy and R. B. D. Sormin
Department of Fish Product Technology, Pattimura University, Ambon, Indonesia

Keywords: Natural Preservatives, *Parinarium Glaberimum, Hassk*, Nutrition, Tuna Loin Waste, Parigi Village, North Seram, Central Maluku.

Abstract: The aim of this study is to find out the effect of "atung" (*Parinarium glaberimum*, Hassk) applications as natural preservative for washing of red tuna flesh, salt concentration and long fermentation with pineapple extract (3 times) on the nutrition and calorie value of fish sauce. The nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing without atung solution, added 15% salt, at fermentation range 3 days, (K1) were 61.42%, 5.68%, 0.32%, 5.86%, and 10.19%; respectively with a calorie value 66.4 kcal. Fish sauce with the same as previous treatment but 4 days of fermentation (K2) were: 63.26%, 5.36%, 0.72%, 5.53%, and 8.55% respectively with a calorie value 62.1 kcal. The nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing without atung solution, added 20% salt, at fermentation range 3 days, (K3) were 63.34%, 5.62%, 1.08%, 5.87%, and 9.31% respectively with a calorie value 69.4 kcal. Fish sauce with the same as previous treatment but 4 days of fermentation (K4) were: 60.42%, 5.53%, 0.71%, 5.94% and 12.22% respectively with a calorie value 77.4 kcal. The nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing without atung solution, added 20% salt, at fermentation range 2 days, (K5) were 62.32%, 3.51%, 0.61%, 4.92%, and 9.39% respectively with a calorie value 57.1 kcal, and the nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing atung solution, added 20% salt, at fermentation range 2 days (K6) were: 57.66%, 3.62%, 0.30%, 5.91% and 10.07% with a calorie value 57.5 kcal.

1 INTRODUCTION

The fish sauce industry, a part of fish processing industry, has a great opportunity of being developed to provide added value of fish as perishable food. By that processing diversification, the fish processor community will ultimately increase their income, absorb labor, and increase foreign exchange through exploiting export opportunities. In the future fish sauce industry will be the replacement to the soy sauce industry.

Soy sauce is one of fermented products used as flavor ingredient, especially in Asian countries, which is the oldest condiment in China for more than 3000 years (Muangthai et al, 2009). Meanwhile, Chinese soy sauce is usually produced by put a very small amount or even no wheat flour. Sausage is a product in which flesh is mixed with additives, stuffed into suitable casings and heat processed (Raju et al, 2003). The word *sausage* comes from the Middle English *sausige*, which came from sal, Latin for salt. In France they are called *sausissons* and in Germany, *wurst*. There are several basic categories of sausages, namely, fresh sausage, cooked sausage, cooked and smoked sausage, uncooked and smoked sausage, dry sausage and specialty meats (Fillppone, 2009). Many research based on non-soy sauce has been carried out in Indonesia including "koro pedang" sauce (Astuti, 2012), "kacang gude" sauce (Andriana, 2014) and

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"lamtoro gung" sauce as well as "moromi" (Rahayu *et al*, 1992).

Fish sauce, a liquid clear brown color, is a product based on a fish hydrolysis whether by salt, enzymatic or chemical fermented (Astawan and Astawan, 1988). Fish sauce is made of fish and fish waste through fermentation, it has a distinctive taste and smell and a long shelf life (Purwaningsih and Nurhayati, 1995). Besides fermented process can preserve food this process also provide a certain properties that attract the consumers, unique and increase an economic value (Hutkins, 2006). The problem sometimes faced by the soy sauce industry were the increase of soybean price and the long duration of soy sauce procesed which can take months. This has led some entrepreneurs to replace soybean with other cheaper ingredients, such as mixing water with sauce flavoring and coloring. As a result, the quality of sauce tends to decline or the sauce become liquor therefore the quantity is increasing. Meanwhile, the soy sauce industry development in Indonesia has grown in line with the increasing of soy sauce consumption in society (Maryani, 2007). The qualified sauce is produced from high protein raw materials such as soybean. For that reason, it's a good thing to make sauce based on fish. The raw material was a kind of dark tuna flesh. Dark tuna flesh was the waste of tuna loin produced is 18% of the whole tuna (logs). In order to get the qualified fish sauce the raw material should be as fresh as possible. To attain that, it should be considered the cold chain process start from fish handling on the ship and when tuna loin processed. Sometimes, it is difficult to get an ice, as an alternative it has been found "atung" (Parinarium glaberimum Hassk) a natural preservative. "Atung" has been shown to maintain the freshness of small pelagic fish (Moniharapon and Pattipeilohy, 2018) then handling of Tuna (Moniharapon *et al*, 2019). Diversification of tuna loin waste-based processing has been made since 2012, but it has been not for fish sauce (Pattipeilohy *et al*, 2012). The aim of this study was to determine the effect of natural preservative "atung" (*Parinarium glaberimum*, Hassk) solution applied in washing tuna red flesh, salt concentration and fermentation time on the quality and nutritional value of fish sauce.

2 MATERIALS AND METHOD

2.1 Sample Collection and Preparation

Tuna were gotten from fishermen in Parigi Hamlet, Wahai Seram Village, Central Maluku, while the "atung" fruit was gotten from Hutumuri village, Ambon Island, Maluku Province. The materials used are: red meat tuna (tuna loin waste), ice, "atung" solution (4% W/V), salt, bay leaves, turmeric, lemongrass, and brown sugar.

2.2 Proximate Composition

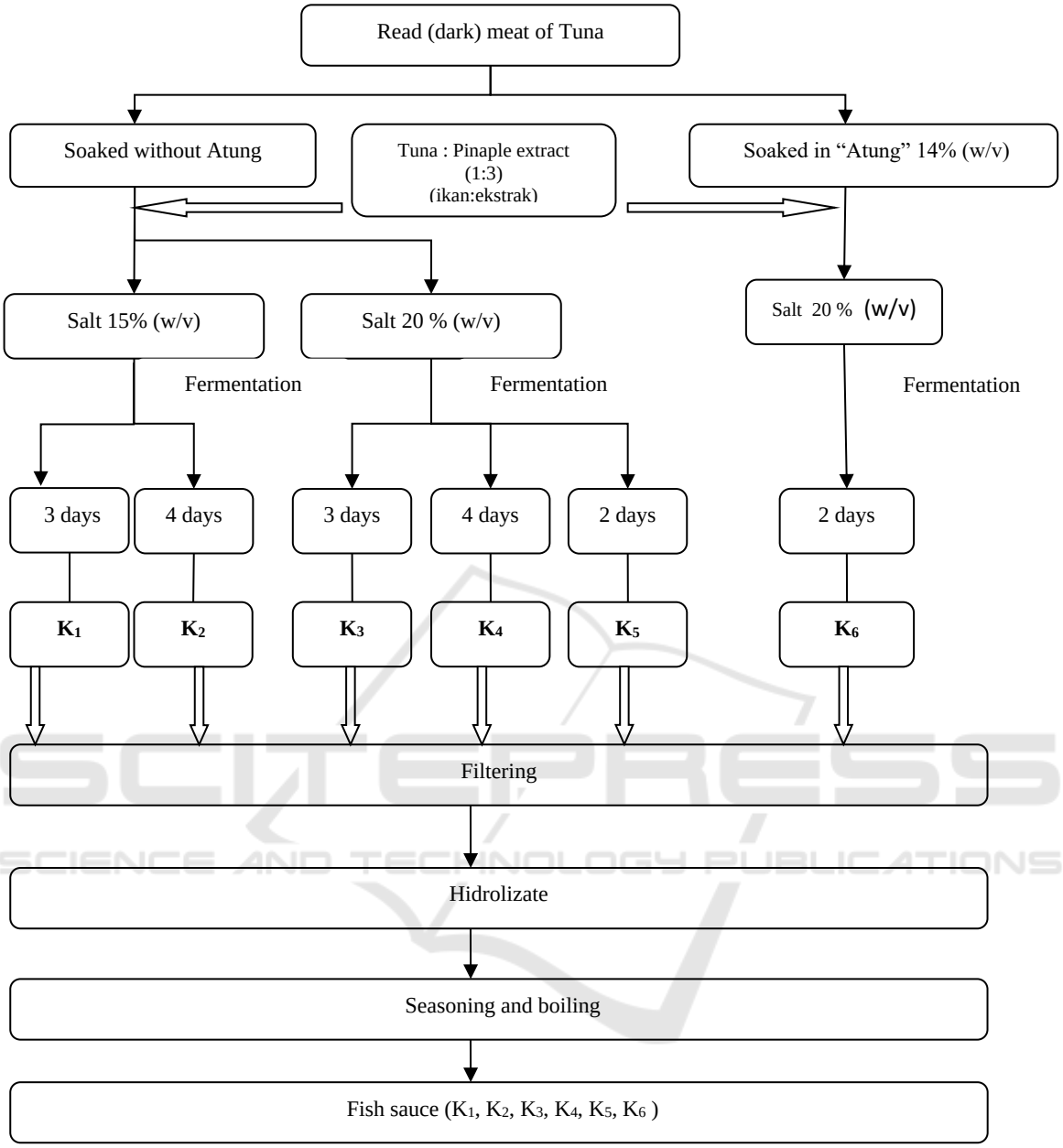
The proximate composition of the fish sausages was determined according to the (AOAC, 2020). The crude protein and crude lipid contents were measured by Kjeldahl and Soxhlet methods respectively. The ash content was determined by ashing the samples at 550ºC. The moisture content was determined by drying the samples overnight at 105°C and the carbohydrate content was calculated by difference.

2.3 Statistics

The data were analized by factorially experimental designed with block randomized design (BRD) with 4 (four) replications followed by the Honestly Significant Difference test (HSD test) (Gaspersz, 1994).

2.4 Treatments

The research method is experimental by the following procedure: The washing treatment of tuna flesh (A) consists of 2 levels, namely: washing used 4% (w / v) "atung" solution (A1) and washing used ice water as a control (A2). Towards A1 was applied 2 treatments of salt concentration namely 15% (B1) and 20% (B2) salt concentrations. Next, towards A2B1 and A2B2 treatments was applied fermentation period for 3 days (C1) and 4 days (C2) and it's obtain 4 samples, namely: A2B1C1 (K1), A2B1C2 (K2), A2B2C1 (K3) and A2B2C2 (K4).Then toward the treatment of A1B2 and A2B2 was applied 2 days of fermentation (C3) and its obtained 2 treatments namely: A2B2C3 (K5) and A1B2C3 (K6). Thus, only 6 (six) samples were treated along with 4 (four) replications. The test parameters were: water, ash, protein, fat and carbohydrate.



* Seasoning for Hydrolyzate 1000 ml:
1 clove garlic, 4 cm ginger, 4 cm galangal, 1/2 tablespoon cumin, 1 roll of bay leaves, 1 stick of lemon grass, 1 hazelnut, 3 tablespoons of granulated sugar, 300 g of brown sugar and 1 gram of jelly.

Figure 1: Flowchart of tuna sauce processing.

Table 1: Recapitulation of the honest real difference test (HRD) of the objective parameters.

Treatments	The average of objective parameters and its difference					
	Water Content (%)	Protein Content (%)	Lipid Content (%)	Ash Content (%)	Carbohydrate content (%)	Calori (kcal)
K1	61,42b	5,68a	0,32 b	5,86a	10,19 b	66,4 b
K2	63,26ab	5,36a	0,72ab	5,53 b	8,55d	62,1 c
K3	63,34a	5,62a	1,08a	5,87a	9,31c	69,4 b
K4	60,42b	5,53a	0,71ab	5,94a	12,22a	77,4a
K5	62,32ab	3,51b	0,61b	4,92c	9,39c	57,1 d
K6	57,66c	3,62b	0,30b	5,91a	10,07b	57,5 d
BNJ 0.05	***2,47***	***0,37***	***0,44***	***0,23***	***0,54***	***3,60***
BNJ 0.01	***3,42***	***0,51***	***0,61***	***0,32***	***0,75***	***4,99***

3 RESULT AND DISCUSSION

K1: washing without atung solution, added 15% salt, at fermentation range 3 days;
K2 washing without atung solution, added 20% salt, at fermentation range 4 days;
K3: washing without atung solution, added 15% salt, at fermentation range 3 days;
K4: washing without atung solution, added 20% salt, at fermentation range for 4 days;
K5: washing without atung solution, added 20% salt, at fermentation range for 2 days;
K6: washing by applied atung solution 4% (w / v), added 20% salt, at fermentation range 2 days.

The proximate compositions, i.e., moisture, protein, fat, ash and carbohydrate and the mineral contents of the sausages are shown in the Table 1. The fish sausages showed significant differences ($p<0.05$) in all the proximate compositions among the samples. The proximate compositions were in the ranges of 57.66-63.34% for moisture, 3.62-6.6% for protein, 0.30-1.08% for fat, 4.92-5.94% for ash and 8.55-12.22% for carbohydrate.

3.1 Water Content

The Honest Significant Difference (HSD) test (Table 1), showed the highest average protein content of fish sauce was the treatment K3 63.34% followed by K2 63.26; K5 62.32; K1 61.42; and the lowest was at treatment K6 57.66%. It showed treatment K3 significantly different from treatment K1, K4 and K6, but not significantly different from K2 and K5.

These results also did not significantly diffrerent (slightly lower and slightly higher ranges) when compared to studies (Moniharapon *et al*, 2014;2016) and (Moniharapon *et al*, 2016). Further report the water content of fish sauce was between 57.15 - 65.94% with an average of 61.06%. As a comparison, the water content of Bango soy sauce was between 74.28 - 77.46% with an average of 75.96%. The range of moisture contents in Malaysian fish sausages was similar to the fish sausage evaluated was (68.64%) (Raju *et al*, 2003). Reported that the moisture content of a meat based product will affect the qualities of the product such as gel strength and whiteness (Park, 2000). Reported that was 67.33-73.36% for moisture (Huda *et al*, 2012).

3.2 Protein Content

The Honest Significant Difference (HSD) test (Table 1), showed the highest protein content of fis sauce was on treatment K1 5.68% followed by K3 5.62; K4 5.53; K2 5.36; K6 3.62 and the lowest was K5 3.51%. Treatment K1 significantly different from treatment K5 and K6, but not significantly different from K2, K3 and K4.

These results also did not significantly diffrerent (slightly lower and slightly higher ranges) when compared to studies where stated that fish sauce protein content ranged between 3.30 – 5.24 % by the average of 4.34% (Moniharapon *et al*, 2014) and (Moniharapon *et al*, 2016).. On the other hand, the protein content of Bango soy sauce less than protein content of fish sauce produced where the protein content was between 1.30 - 2.06% with an average of 1.62% (Moniharapon *et al*, 2014). Sweet soy sauce is a typical Indonesian flavoring ingredient which is generally made through a traditional fermentation process. Protein content indicated the quality of sweet soy sauce, where according to SNI 154 3543: 2013 the protein content of sweet soy sauce is 1% (National Standardization Institution, 2013). The amount of its protein content is due to an ability of sweet soy sauce producers in Indonesia as long with the justification the sweet soy sauce is not used as the main food for daily consumption but it's only a part of the seasoning

or flavoring (Meutia, 2015). Furthermore, based on the protein content of sweet soy sauce tested from 24 small and medium industry in Indonesia, it was found the average 1.30%. The analysis of producer encompass soy sauce companies a large and small scale in Indonesia. The previous SNI of soy sauce (SNI 3543 - 1999) mentioned the protein content of sweet soy sauce at least 2.5% and minimum 4% for salt soy sauce, with consideration that sweet soy sauce has been added sugar and other spices (National Standardization Institution, 1999).

The results of the study by Purwoko and Handajani (Purwoko dan Handajani, 2007), on protein content of fermented sauce by *Rhyzopus oryzae* and *R. oligosporus* showed the fermented soy sauce without moromi provided a higher dissolved protein and total protein than fermented sweet soy sauce by moromi. Dissolved protein and total protein of fermented sweet soy sauce by *R. oligosporus* higher than that of fermented sweet soy sauce by *R. oryzae.*

The dissolved protein content of fermented soy sauce by *R. oligosporus* without moromi was 8.2%, while that of *R. oryzae* was 4.1%. The protein content of Malaysian fish sausage (8.18-10.77%) was lower than the protein content of fish sausage reported by (Raju et al, 2003) was (16.76%). The lower protein contents of the samples were related to the lower percentages of fish flesh used in their preparation.

Based on the Malaysian Food Regulation of 1985, article 167 stated that fish balls and fish cakes shall contain not less than 50 percent fish. However, the Malaysian Food Regulation did not state a specific protein content required for fish sausage or fish (huda et al, 2012). The protein content of eel sauce ranges from 7.64% to 10.57% (Widowati, 2018). Protein is important nutritional indicator in food product including fish sauce, and it also important for human body as builder and regulatory substances, it seems that the protein content of soy sauce varies depend on the type and the quality of the raw material, initial handling and processing (Winarno, 1997).

3.3 Lipid Content

Honest Significant Difference (HSD) test (Table 1) showed the fat content of treatment K1 average 1.08% was the highest followed by K2 0.72; K4 0.71; K5 0.61; K1 was 0.32 and the lowest was K6 at 0.30%. There is a significant difference between treatment K3 and K1 also K6, but its not significantly different from K2, K4 and K5. These results turned out to be significantly different (slightly higher and much higher) when compared (Moniharapon *et al*, 2014) and (Moniharapon *et al*, 2016). Furthermore, reported the fat content of fish sauce ranged from 3.16 to 4.26% with an average 3.96%. Meanwhile, the protein content of Bango soy sauce as a comparison of fat content was between 0.21 - 1.16% with average 0.86% (Moniharapon *et al*, 2014). While reported that 0.93-6.53% for fat (Huda *et al*, 2012).

3.4 Ash Content

Honest Significant Difference (HSD) test (Table 1), showed the highest ash content of fish sauce was on treatment K1 average 5.68%, followed by K3 5.62%; K4 5,53%; K2 5.36%; K6 was 3.62% and the lowest was K5 at 3.51%. There is a significant difference between treatment K1 and K5 also K6, but not significantly different from K2, K3 and K4. This result is also not significantly different (still in the range slightly lower and slightly higher) compared to studies which reported that the ash content of fish sauce was between 3.67 - 5.28% with a mean of 4.63% (Moniharapon *et al*, 2014) and (Moniharapon *et al*, 2016). Meanwhile, the ash content of Bango soy sauce as comparison, it was between 1.98 - 2.48% with an average 2.22% (Moniharapon *et al*, 2014). Previously reported that 1.71%-2.61% for ash (Huda *et al*, 2012).

3.5 Carbohydrate Content

The Honest Significant Difference (HSD) test (Table 1), showed the highest carbohydrate content of fish sauce was treatment K4 average 12.22%, followed by K1 10.19%; K6 10.07%; K5 9.39%; K3 9.31 and the lowest was K2 at 8.55%. Based on HSD there was a significant difference between treatment K4 and all other treatments, whereas it was not a significant difference between treatment K1 and K6 also between K3 and K5. These results significantly different (much higher) compared to studies (Moniharapon *et al*, 2014) and (Moniharapon *et al*, 2016). Furthermore, it was reported that the carbohydrate content of fish sauce ranged from 17.95 to 29.31% with an average of 24.25%, while the carbohydrate content of Bango soy sauce as a comparison was between 14.49 - 21.21% with an average of 18.85% ((Moniharapon *et al*, 2014) . The previous, for carbohydrates was 8.55-12.22% (Huda *et al*, 2012).

3.6 Calorie Value

The Honest Significant Difference (HSD) test (Table 1), showed the highest calorie value of fish sauce was on treatment K4 average 77.4 kcal,

followed by K3 69.4; K1 66.4; K2 62.1; K6 is 57.5 and the lowest was on treatment K5 average 57.1 kcal. The treatment K4 showed a significant difference with all other treatments, while treatment K1 with K3 and treatment K5 with K6 was not significantly different. (Auliana, 2001), stated the energy value of a food can be determined using the Atwater factor, where each gram of fat, carbohydrates and protein were equivalent to 9, 4, and 4 calorie respectively. The results in Table 1 showed a significant difference compared to studies (Moniharapon *et al*, 2014) and (Moniharapon *et al*, 2016). Furthermore, it was reported that the caloric value of fish sauce ranged from 130.1 to 165.0 kcal with an average 149.3 kcal. While, the calorie value of Bango soy sauce as comparison was ranged 137.3 - 163.1 kcal with an average 148.6 kcal (Moniharapon *et al*, 2014). When compared with Bango soy sauce, the calorie value was 60 kcal.

4 CONCLUSION

The nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing without atung solution, added 15% salt, at fermentation range 3 days, (K1) were 61.42%, 5.68%, 0.32%, 5.86%, and 10.19%; respectively with a calorie value 66.4 kcal. Fish sauce with the same as previous treatment but 4 days of fermentation (K2) were: 63.26%, 5.36%, 0.72%, 5.53%, and 8.55% respectively with a calorie value 62.1 kcal. The nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing without atung solution, added 20% salt, at fermentation range 3 days, (K3) were 63.34%, 5.62%, 1.08%, 5.87%, and 9.31% respectively with a calorie value 69.4 kcal. Fish sauce with the same as previous treatment but 4 days of fermentation (K4) were: 60.42%, 5.53%, 0.71%, 5.94% and 12.22% respectively with a calorie value 77.4 kcal. The nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing without atung solution, added 20% salt, at fermentation range 2 days, (K5) were 62.32%, 3.51%, 0.61%, 4.92%, and 9.39% respectively with a calorie value 57.1 kcal, and the nutrition content of fish sauce i.e. water, protein, fat, ash, and carbohydrate, treated by washing atung solution, added 20% salt, at fermentation range 2 days (K6) were: 57.66%, 3.62%, 0.30%, 5.91% and 10.07% with a calorie value 57.5 kcal.

4.1 Suggestion

For further research, its necessary to exploit the red tuna meat (tuna loin waste) to diversified products such as nuggets and fish burgers. It is also necessary investigate the effectiveness of atung solutions with concentrations lower than 4%.

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REFERENCES

Andriana, D. 2014. Effect of substitution of Gude Beans (Cajanus cajan) on Protein Levels and Acceptability of Soy Sauce.*Unnes Journal of Public Health* 3 (3): 1-8. (In Indonesian)

Astawan, M.W. dan Astawan, M. 1988. Appropriate Animal Food Processing Technology. *The Book*. Akademika Pressindo. Jakarta. (In Indonesian)

Astuti, B.B. 2012. Moromic Characteristics Resulting from Moromi Fermentation of Koro Sword Soy Sauce (*Canavalia ensiformis* L.) in Different Fermentation Conditions. *Thesis*. Universitas of Gajah Mada. Yogyakarta. (In Indonesian)

AOAC, 2000. Association of Official Analytical Chemists, Official Methods of Analysis. *The book*. 17th Edition, Washington, DC.

Auliana, R., 2001. Nutrition and Food Processing. The *Book*. Adicita Karya Nusa. 155 hal. (In Indonesian)

Fillppone, P.T. 2009. Sausage History. http://home cooking.about.com/od/foodhistory/a/sausagehistory.htm (date of accessed 10 July 2009).

Gaspersz, V., 1994. Experimental Design Methods For Agroindustry Sciences, Biology and Technik Sciences. *The Book*. CV Armico. Bandung. 472 page. (In Indonesian)

Huda, N, T.L.J. Alistair, H.W. Lim and R. Nopianti. 2012. Some Quality Characteristics of Malaysian Commercial Fish Sausage. *Pakistan Journal of Nutrition* 11 (8): 700-705, 2012.ISSN 1680-5194.

Hutkins RW. 2006. *Microbiology and Technology of Fermented Foods.* USA: IFT Press. Blackwell Publishing.

Maryani, R. 2007. Analysis of Demand and Supply of Soy Sauce Industry in Indonesia. *Thesis.*Departemen of Economic Science. Economic and Management Faculty. IPB University. Bogor. (In Indonesian).

Meutia Y.R. Standardization of Sweet Soy Sauce Products as a Typical Indonesian Product. *Standardization*

Journal. Volume 17 Number 2: hal 147-156. (In Indonesian)

Moniharapon, T., Pattipeilohy, F., Gaspersz, F.F., dan Latucosina, A. 2014. Study of Processed Products from Tuna Loin Waste *Final Report*. Collaboration of Regional Planing Agency of Mollucas Province with Fishery and Marine Science Faculty. Pattimura University, Ambon. (In Indonesian)

Moniharapon, T., Pattipeilohy, F., dan Moniharapon, A. 2016. Utilization of Tuna Loin Waste Red Meat in Enzymatic Fish Sauce Processing. *Proceeding National Conference* MPHPI 2016 (Indonesia) Meet Sciences 8th. ISBN: 978-602-61551-0-8. Published: Department of Fish Processing Technology. Fishery and Marine Science Faculty. Pattimura University. Ambon. Hal: 297-302. (In Indonesian)

Moniharapon, T dan Pattipeilohy, F., 2018. “Method of Making Fresh Fish Preservative from Atung Powder”. Patent. Number IDP000050840 at 30 A April 2018, Departemen KumHam R.I.(In Indonesian)

Moniharapon, T., Pattipeilohy, F., Mailoa, M.N., dan Soukotta, L.M. 2019. Application of Atung Preservative (Parinarium glaberimum, Hassk) in the Tuna Loin Industry in Parigi Hamlet, Wahai Village *Jurnal of BIAM* e-ISSN: 2548-4842; p-ISSN: 0215-1464. No. 25: 70-76. (In Indonesian)

Muangthai, P, U. P. Suwunna, and W. Patumpai. 2009. *Development Of Healthy Soy Sauce From Pigeon Pea And Soybean*. *Asian Journal of Food and Agro Industry s*Vol.2: 291 – 301

National Standardization Institution. (1999). National Standardization Indonesian *(SNI) 3543:1999. Soy Sauce*. Jakarta. (In Indonesian)

National Standardization Institution. 2013. National Standardization Indonesian *(SNI) 3543: 2013. Sweet Soy Sauce. Part 1:* Jakarta. (In Indonesian)

Park, J.W. 2000. Surimi and Surimi Seafood. Marcel Dekker., New York.

Pattipeilohy, F., Gaspersz, F.F., dan Moniharapon, A. 2012. Surimi Technology Development and Diversification of Processed Products by Utilizing Tuna Loin Production Waste Research Journal of Fishery and Marine Sciences. *Ichthyos.* Vol. 11 No.1. : 57-63.(In Indonesian)

Purwaningsih, S dan Nurhayati.1995. Making Fish Soy Sauce Using Enzymatic and Fermentation Combination from Tuna Fish Offal (Thunnus sp.). *Buletin THP*. Vol-I. No 1-1995. (In Indonesian)

Purwoko, Tj. dan N.S. Handajani. (2007). Protein Content of Sweet Soy Sauce without Moromi Fermentation Result of Fermentation Rhyzopus oryzae and R. oligosporus. *Biodiversity* 8: 223 – 227. (In Indonesian)

Rahayu, W.P., Ma'oen, S., Suliantari dan Fardiaz, S. 1992. Fishery Product Fermentation Technology. PAU Pangan dan Gizi. IPB. Bogor. *The Book*. (In Indonesian)

Raju, C.V., B.A. Shamasundar and K.S. Udupa, 2003. The use of nisin as a preservative in fish sausage stored at ambient (28±2°C) and refrigerated (6±2°C) temperatures. *Int. J. Food Sci. Technol*., 38:171-185

Widowati. 2018. Protein Analysis of Eel Fish Sauce (Monopterus albus) with Volume Variation of Pineapple Extract (Ananas comosus). *Agritepa.* Volume V. Number 1. Juli-Desember 2018. ISSN: 2407-1315. (In Indonesian)

Winarno F.G. 1997. Food Chemistry and Nutrition. PT. Gramedia. 251 hal. *The Book*. (In Indonesian).