The effect of gradual salt soaking and atung (Parinarium glaberimum, Hassk) on the yield and quality of dry salted bony flying fish (Cypselurus oxycephalus)

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Abstract. The study on the effect of soaking salt and atung (Parinarium glaberimum, Hassk) has been conducted to investigate the production and quality of dried salted Bony flying fish (Cypselurus oxycephalus). There are two types of soaking salt used in this study i.e. gradual soaking (5 and 10% salt concentration) and single soaking (25% salt concentration). Three types of quality parameter used in this experiment i.e. organoleptic (appearance, smell, taste and texture), chemical (water content, salt content, protein content, peroxide number) and microbial (Total Plate Count). The yield of dried salted bony flying fish (C. oxycephalus) obtained through gradual soaking of salt and atung was 21.85 and 23.00% respectively which is less than the yield obtained through single soaking salt treatment (32.57%). For chemical parameters, the quality of dried salted of bony flying fish obtained through gradual soaking salt and atung were 16.12 – 16.96%, 76.37 – 79.15%, 0.23 – 0.34 mg ek./g, and 4.03 – 4.56 (Log X) (1.07×10^3 – 3.63×10^3 colony) respectively which is better than that of single soaking which have chemical parameters of 22.66%, 53.26%, 18.68%, 0.43 mg ek./g and 5.26 (Log X) (1.82 x 10^5 colonies) respectively. For organoleptic analysis, the quality of dry salted flying fish attained from gradual soaking salt and atung were 7.4 – 8.0; 7.3 – 7.6; 6.9 – 7.4; 7.4 – 7.6 respectively whilst from single soaking salt were 7.2; 7.2; 7.2 and 6.5 respectively. Organoleptic results achieved from gradual soaking salt and atung seems to have slightly higher quality compare to single soaking salt.

1. Introduction

Traditional fish processing still has prospects to be developed because of the high need of fish nutritional on the community. Salted fish is the largest traditional fishery product in Indonesia, because this processing method is easy to apply, cheap and fast (fish is called perishable food). In some place is difficult to get ice because of no ice factory so the low temperature to be the expensive matter. There is only a minimum inovation on the salted fish processor, bacause of the hereditary processing method. As a result, the salted fish produced are characterized by high saltiness, moldiness, rancidity and get the formaldehide.

Salted fish is the largest processed fishery product in Indonesia. Recently the big problem faced by this product is formaldehid applied by the fishermen or the trader. Others negative image of people to this product are very salty, rancid, mildew, smells bad, hard and unattractive appearance. Actually, it can not be denied that the research on salted fish in Indonesia has been carried out in large number even the handling of irradiation techniques conducted [1].

The escalation of dangerous synthetic chemical preservatives used by salted fish processors, such as formalin, borax, bleach and kututox, were to be the concern of many researcher in 2009 -
2016; the widespread spread of salted fish contaminated by formalin and the use of borax in several markets in Indonesia have been reported [2, 3, 4, 5, 6, 7, 8]. On the other hand the study of Atung seeds as a food preservative has been proven as a food anti-bacterial food and anti-oxidant, as a broad-spectrum anti-bacterial includes pathogenic and destructive bacteria [9, 10]). Atung is evidently to be 9 times more effective than BHT synthetic antioxidants (11). Application of atung for fresh fish handling has been carried out for shrimp, small fresh pelagic fish and loin tuna export quality.

Recently, the salted fish research in Indonesia has not been bringing up yet, the research still around the length of drying and salt concentration [12, 13, 14, 15]. This indicated no increase of innovation and science and technology capabilities on the salted fish products. This is confirmed by the continuous uses of formaldehyde and other chemical preservatives in the processing of salted fish.

Generally, the method of drying salted fish is differs from one country to another even on the same country, depending on the type of fish used and the product desired. The drying process may not use salt or with the addition of salt. In Indonesia the method of fish drying is by salting and dried under the sunshine. In tropical regions such as Indonesia drying of fish is often disturbed by insects (flies), bacteria during and after drying process, and it causes a large loss of fish protein. One effort to solve this problem is preservatives. The addition of preservatives can be applied in several ways including: mixing, dyeing, and fumigation.

Bony Flying fish is small pelagic fish inhabit the surface layers of tropical and subtropics waters at a depth of 0-20m. These fish are spread out around the Pacific, Indian, Atlantic and surrounding seas. The highest number of species is spreading along the equator, the number will decreases to the north and south. Pacific ocean is an inhabitat area of flying fish with population about 40 species, especially in the waters of Indonesia, the Philippines, Japan, and the Southern part of Oceania. In other words, these waters are the center of the spread of flying fish [16]. Flying fish are often found in eastern Indonesia such as: Makassar Strait, Flores Sea, Natuna Sea, Aru Sea, Arafura Sea, Northern Papua, North Sulawesi, Bali Strait and East Java Waters, West Sumatra Coast, Halmahera Sea, Banda Sea, the waters of Sabang (Banda Aceh) and the North Sea of Papua.

In association with the problem above, It need optimal innovation breakthrough in solving national problems. These problems can be overcome with the use of natural insect repellent from the Atung skin. Atung serve not only as flies handling, but atung sprayed to the dried fish during fish drying also function as anti-bacterial (pathogenic and destructive), antioxidant and antifungal. As preservative, atung can replace the position of formalin. Preliminary research by immersing fish in atung solution, can replace the function of the salt, so that, the salt concentration for fish soaking can be lower. The advantage of low salt concentrations avoids 5% protein loss. Thus low salt content technology in salted fish can be applied. Atung is very strategic to overcome the big issue that causes the decline in quality of salted fish, namely, high saltiness, moldiness, and rancid smell.

The combination between atung and salt is a new innovation breakthrough in applying the low salt technology. This technology is more advantageous than single treatment because the fish dried resulted is more qualified. The days before, technology of single treatment of salted has been practiced by using salt only. This technology needed 20 – 30 % of salt concentration.

The objective of this study was to determine the effect of salt and atung level immersion (Parinarium glaberimum, Hassk) on the quantity and quality of dried salty bony flying fish (Cypselurus oxycephalus).
2. Material and Method

2.1. Material
The material used in this study was fresh bony flying fish (*C. oxycephalus*), originated from Ambon Island waters, NaCl solution, and Atung fruit (*P. glaberimum*, Hassk). The equipment used in this research are: Cool box, baking pan, scales, sticky stickers, plastic, sample clamp, blender, petri dish, autoclave, pipette, test tube, flask, blender jars, filter paper, cup glass.

2.2. Research method
The method used in this study is the experimental method.

2.3. Research procedure
The seeds of atung (*P. glaberimum*, Hassk) are removed from the fruit, grated and dried in the sun, blended and put into plastic container. A total weight about 750 g of flying fish (10 specimens) was cleaned, weighted and then soaked in 5 and 10% salt solution for 30 minutes and continued with a 5 and 10% solution. For control soaked for 30 minutes with a concentration of 25%. Then it is dried for 8-9 hours, which starts from 09:00 to 17:00 for 2 (two) days. Furthermore, determining the yield of salted fish and analysis of water content, protein content, salt content, peroxide number, Total Plate Count (TPC) and organoleptic. The preparation procedure for atung solution can be seen in Figure 1 and the research procedure in Figure 2.

2.4. Treatment
Treatment applied in this study was immersion differences by 5 levels of concentration i.e.

1. 5% salt following by 5% atung (C1)
2. 5% salt following by 10% atung (C2)
3. 10% salt following by 5% atung (C3)
4. 10% salt following by 10% atung (C4)
5. 25% salt (control) (C5)

2.5. Observation
Objectively parameter observed includes: yield, moisture content, protein content (SNI 01-2897 - 1992), salt content (SNI 01-2721 - 2009), peroxide number (SNI 01-3555-1998) and TPC ( SNI 01-2891 - 1992), while subjective analysis is organoleptic which includes appearance, smell, taste and texture (SNI 01-2343-1991 / O1).

2.6. Data analysis
Completely Randomized Design (CRD) with 5 (five) replications was used to count the objective parameters (water content and TPC) [17], while Friedman test and continued with Multiple Comparison test of Wayne 1989 [18] for subjective parameters.

2.7. Research time and location.
The research took place from March to July 2018 at the Ambon Industrial Research and Standardization Laboratory and the UPTD Laboratory of Ambon Fisheries Processing and Application Testing, Marine and Fisheries Service, Maluku Province, Indonesia.
To split

Taken out the seed

Be shredded

Soft dried for 2-3 days

Grinded and sifted

Put into the plastic bag

Atung powder

Atung solution 10%

Overnight
1 part of atung : 9 part of water

Maceration

Atung solution 5%

Overnight
1 part of atung : 19 part of water

Figure 1. Procedure of atung solution (*P. glaberimum*, Hassk).
3. Result and Discussion

3.1. Yield.
The yield of dried salted Bony flying fish each 10 specimens with total weight about 750 g is shown on Table 1
Table 1. The yield of dried salted Bony Flying fish.

| Treatment | Flying fish (g), yield (%) / replication | Average of weight (g) | Average of yield (%) |
|-----------|------------------------------------------|-----------------------|----------------------|
|           | 1          | 2          | 3          | 4          | 5          |                    |
| C1        | 182.5      | 167.5      | 165       | 172.5      | 175       | 172.5              | 23.00               |
|           | (24.33)    | (22.33)    | (22.00)   | (23.00)    | (23.33)   |                      |
| C2        | 177.5      | 172.5      | 170       | 167.5      | 162.5     | 170.0              | 22.67               |
|           | (23.67)    | (23.00)    | (22.67)   | (22.33)    | (21.67)   |                      |
| C3        | 165        | 160        | 171       | 170        | 165       | 166.2              | 22.16               |
|           | (22.00)    | (21.33)    | (22.80)   | (22.00)    |           |                      |
| C4        | 162.5      | 166.5      | 162       | 165        | 163.5     | 163.9              | 21.85               |
|           | (21.67)    | (22.20)    | (21.60)   | (22.00)    | (21.80)   |                      |
| C5        | 245        | 246.5      | 245.5     | 242        | 242.5     | 244.3              | 32.57               |
|           | (32.67)    | (32.87)    | (32.73)   | (32.27)    | (32.33)   |                      |
| Average   | 183.38     |             |           |             |           | 24.45              |                     |

It can be seen in Table 1 that the lowest average weight of dried salted Bony flying fish was on the treatment C4, followed by treatment C3, C2, C1 and C5. Thus, the yield of dried salted fish will increase due to decrease of the salt concentration.

Confirmation changes of the fish protein occur in high salt concentration (15-24%) because penetration and aggregation of muscle proteins will occur rapidly when the salt concentration is high [19]. Van Nguyen (2010) [20] stated that the higher the salt concentration applied on the fish salting, the lower the yield obtained and vice versa. Boudhriona et al. (2009) [21] stated that the time, concentration and temperature of salt affect the diffusion of water and salt.

3.2. The quality of dried salted bony flying fish

3.2.1. Objective Parameter. Recapitulation of analysis of variance of immersion treatment and the results of the honestly significant differences (HSD) of objective parameter is shown on Table 2.

Table 2. Recapitulation of analysis of variance of immersion treatment and the results of the honestly significant differences (HSD) of dry salted bony flying fish

| Treatment | Water Content (%) | Protein Content (%) | Salt Content (%) | Peroxida Number (mg.eq./g) | TPC (Log X) |
|-----------|-------------------|--------------------|------------------|-----------------------------|-------------|
| C1        | 16.23 b           | 79.15a             | 4.82 c           | 0.23 b                      | 4.37 b      |
| C2        | 16.12 b           | 79.15a             | 5.27 c           | 0.25 b                      | 4.56ab      |
| C3        | 16.88 b           | 76.37a             | 5.89 c           | 0.34ab                      | 4.13 b      |
| C4        | 16.96 b           | 77.74a             | 8.67 b           | 0.23 b                      | 4.03 b      |
| C5 (Control) | 26.66a b     | 53.26 b            | 18.68a           | 0.43a                       | 5.26 a      |
| F Value   | 66.62***         | 39.43***           | 178.52***        | 3.70*                       | 5.57**      |
| F Table 0.05 | 2.78           | 2.78               | 2.78             | 2.78                        | 2.78        |
| HSD α 0.05 | 2.24            | 7.52               | 1.85             | 0.18                        | 0.85        |

Notes: Number followed by the same letter on same column do not differ at level of p=0.05
Water content

Analysis of variance (Anova) (Table 2) showed that the effect of gradual soaking salt and atung (?gaberimum, Hassk) treatment was very significant (F value 66.62 **; F Table 0.01 4.18) on the water content of dried salted flying fish (? oxycephalus). Based on the Honest Significant Difference (HSD) test, all C1 - C4 treatments were significantly different from the control treatment (C5). The average water content of dried flying fish ranged from 16.12 -26.66%, where the lowest water content was found on treatment (C2) 16.12%, followed by the treatment of C1, C3, C4, and C5. The water content of dried salted Bony flying fish was in the range of water content permitted by SNI -2721-1-2009, where the maximum water content was 40%.

Salt activity in attracting water causes plasmolysis, where water will move from low salt concentrations to high salt concentrations due to differences in osmotic pressure [22]. According to Winarno (2008) [23], free water is the water used by microbes for growth and as a media for chemical reactions. The water content of flying fish (? oxycephalus) decreased due to the influence of the duration of soaking time in the atung solution. The longer the immersion time in the atung extract solution, caused the active material in the seed extract will function as a humectant. Amri (2006) [24] states that one technic to reduce the water activity of some material is adding additives containing humectants. It was suspected that the extract of atung seeds which was used as a solution for immersion leveled for 30 minutes, could draw more water from products. Atung seeds (? glaberimum, Hassk) has been evidently to be a food preservative because it contains a bioactive component fraction that can kill several types of pathogenic and food destructive bacteria.

The part of the atung as a source of antimicrobial activity is the fruit, especially the seeds. Moniharapon and Hashinaga (2004) [25] have investigated the ethyl acetate extract of fruit seeds and it evidently effective in inhibiting microbial growth. Moniharapon et al. (2004) [26] found that antibacterial components of atung seed was azelaic acid. Minimum inhibitory concentration (MIC) test showed the effectiveness of atung as against pathogenic bacteria and spores in food [27]. Usually, the water content of the material is reduced to a certain extent, so that microbes cannot grow on the material [28].

The lower water content of a product is resulting in inhibiting the development of decaying microorganisms and enzyme activities, as result the storage time will be longer [29]. Overall the moisture content of dried Bony flying fish (? oxycephalus) in this study ranged from 30% to 40% [30]. This is because the the process applied caused the water content reduction in the body of the fish. This is due to the penetration of salt into the body of the fish so that the water content in the fishs body becomes small [31]. According to Adawayah [32] basically salt is not killing microorganisms but it absorbs the body fluids range from 10-40%. Drying method can be done using sunlight or artificial drying. To minimize the growth of mold in dried salted fish, the water content in salted fish must be as low as possible [33].

Protein content

Result of Anova in Table 2 showed that the gradual soaking salt and atung (? glaberimum, Hassk) treatment was very significant (F value 39.43 **; F Table 0.01 4.18) on the protein content of dried salted Bony flying fish (? oxycephalus). HSD test showed that all C1 - C4 treatments were significantly different from the control treatment (C5). The average protein content of dried flying fish ranged from 76.37 -79.15%, where the highest protein content was found on treatment C1 while the lowest protein content found on treatmen C5.

The ratio of protein content between gradual salting and single treatment ranged from 23.11 to 25.89%. In comparing to the highest protein content of 79.15% as a denatured protein value, then the value becomes 29.24 -32.71%. This result is only half that compared to those reported by
Heredia et al (2007[34], where reported on high salted process 60% protein is denatured. Generally, salting concentration is 21-30%. As the salt content higher, the protein will dissolve more [35,36]. Various salting techniques in overseas research indicate that several types of salted method have been carried out including brine salting, dry salting, kench salting, pickling and pre-salting methods, namely injection, brining and pickling, where all of the method tent to accelerate the diffusion of salt into fish, discharge of water from fish, transfer of fish mass, drying kinetic, changes in muscle psychochemistry of protein and fish fat, protein denaturation and aggregation in parts of myosin and fish collagen [37,38,39,40,41,42,43]. Changes in fish protein confirmation occur in high salt (15-24%) because high salt concentration will accelerate titration and aggregation of muscle proteins (total S-H and SS) 18].

Salt content
The gradual soaking salt and atung (P. glaberimum, Hassk) treatment has very significant effect (F value 178.52 **; F Table 0.01 4.18) (Table2) on the salt content of dried salted Bony flying fish (C. oxycephalus). HSD test showed that all C1 - C4 treatments were significantly different from the control treatment (C5). The average salt content of dried flying fish ranged from 4.82 – 8.67%, where the lowest salt content was found on treatment C1 while the highest salt content found on treatmen C5. The average of salt content of dried salted bony flying fish produced is still on the range determined by directorate o food product standardization i.e. between 4% and 20%.

Peroxide number
Result of Anova presented in Table 2 showed that the gradual soaking salt and atung (P. glaberimum, Hassk) treatment was significant (F value 3.70 **; F Table 0.01 4.18) on the peroxide number of dried salted Bony flying fish (C. oxycephalus). Subsequent HSD test show that except for C3, all the treatments were significantly different from the control treatment (C5). The average peroxide number of dried flying fish ranged from 0.23 to 0.43 mg eq/g, where the lowest peroxide number was found on treatment C1while the highest peroxide number found on treatmen C5 i.e. 0.43 mg eq/g.

TPC (Total Plate Count)
Analysis of variance in Table 2 showed that the gradual soaking salt and atung (P. glaberimum, Hassk) treatment was very significant (F value 5.57 **; F Table 0.01 4.18) on the TPC of dried salted Bony flying fish (C. oxycephalus). Based on HSD test, the highest TPC is on control treatment (C5) were significantly different from all treatment C1 to C4. The average TPC ranged from 4.03 to 4.56 (log x) or range from 1.07 x 10⁴ to 3.63 x 10⁴. TPC of the salted dried flying fish was on the range permitted by SNI-2721-1-2009, where the maximum TPC was 1.0 x 10⁵.

Salting and drying process cannot kill all the bacteria in the fish. Generally, deteriorated bacteria are not tolerate to the salt presence, but halophilic bacteria can still survive well, as well as xerophilic bacteria (tolerated to low A_w). Bacteria that are often found in salted fish are Alcaligenus, Pseudomonas, Flavobacterium and Corynebacterium. The use of atung in processing of dried salted Bony fying fish (C. oxycephalus) is as an antimicrobial material.

Immersion treatment of fish for 30 minutes using atung solution greatly influenced the value of TPC of dried salted Bony flying fish (C. oxycephalus), because of immersing for about 30 minutes caused the active material contained in the Atung extract functioned as humectants. The use of atung fruit seeds (P.glaberimum, Hassk) has been proven as a food preservative because it contains a fraction bioactive component and kills several types of pathogenic and food deteriorated bacteria. The part of the atung crop that has antimicrobial activity, is the fruit, especially the fruit
seeds [24], have examined the ethyl acetate extract of fruit seeds and are effective in inhibiting microbial growth.

3.2.2 Subjective Parameter. Recapitulation of Friedmen test and Multiple Comparision of sensory test value can be seen at Table 3.

Table 3. Recapitulation of Friedman test and multiple ocmparsion of sensory test value

| Treatment | Appearance | Smell | Flavor | Texture |
|-----------|------------|-------|--------|---------|
|           | Average    | Total Ranking/ Differ. | Average | Total Ranking/ Differ. | Average | Total Ranking/ Differ. |
| C1        | 7.4        | 10.0 bc 7.5 | 19.5a 7.3 | 19.5ab 7.4 | 14.0ab |
| C2        | 7.6        | 16.5a 7.3 | 9.0 b 6.9 | 6.5 c 7.6 | 22.0a |
| C3        | 7.9        | 21.0ab 7.5 | 17.0ab 7.1 | 12.5 bc 7.6 | 18.5a |
| C4        | 8.0        | 21.5a 7.6 | 22.0a 7.4 | 23.0a 7.5 | 14.0ab |
| C5        | 7.2        | 6.0 c 7.2 | 7.5 b 7.2 | 13.5abc 7.3 | 6.5 b |

\[X^2 = 7.8\]

Notes: Number followed by is same letter on same column do not differ at p= 0.05

Appearance
Friedman test (Table 3) showed that the gradual soaking salt and atung (P. glaberimum, Hassk) treatment was very significant (S / Xi 14.9> Xi2 = 7.8) on the appearance of dried salty Bony flying fish (C. oxycephalus). Multiple comparison tests confidently proved that the treatment of 10% salt concentration and 10% atung (C4) showed the highest appearace value while the control treatment (C5) obtained the lowest ranking value.

Appearance or color is an important factor of product attracted. Visually the color will appear first and often determine the value of the product. Winarno (2008) [23] stated that the color of a food has an important role in determining quality and consumers impression of product.

The influence of atung seed extract as humectant during the immersion resulted in a good appearance of dried salted flying fish products and makes it on the quality permitted by SNI-2721-1-2009, with value of 7.

Smells
Result presented in Table 3 showed there is very significant effect of the gradual soaking salt and atung (P. glaberimum, Hassk) treatment on the smell of dried salty flying fish (C. oxycephalus). Treatment C4 showed the highest smells value and rank while the control treatment (C5) obtained the lowest but still in the quality standard permitted by SNI -2721-1-2009.

The quality decrease of salted fish can be indicated from rancid or foul odors, usually caused by the long term of storage. The addition of preservatives such as formaldehyde leads to the peculiarities reduction of the salty fish [44]. The good value of the smell of dried salted flying fish is influenced by the content of fruit extracts from atung during gradual immersion process with salt and atung.

Taste
The gradual soaking salt and atung (P. glaberimum, Hassk) treatment has very significant effect on the taste of dried salty flying fish (C. oxycephalus). Treatment C4 showed the highest taste value and rank while treatment C2 was the lowest.
The difference in taste preferences of dried salted flying fish (*Cypselurus oxycephalus*) from various combinations of treatments, due to the use of different salt concentration. Thus the organoleptic value of taste increases with the addition of salt, because salt besides helping preserve also gives a distinctive taste of salty and the meat of the fish is more compact due to the withdrawal of water by salt and protein coagulation and causes the taste of the fish to become better [45].

**Texture**
There is very significant effect of the gradual soaking salt and atung (*P. glaberimum*, Hassk) treatment on the texture of dried salty flying fish (*C. oxycephalus*). Multiple comparison test showed that the treatment C2 has the highest texture value and ranks while the control treatment (C5) has the lowest values.

**4. Conclusion**
It can be concluded that the yield of dried salted fish will increase due to the decrease of the salt concentration. Based on the objective parameters, the quality of dried salted flying fish provided by gradual soaking salt and atung is better than that of single soaking. Similarly, based on the subjective parameters, the subjective quality of dried salted fish provided by gradual soaking salt and atung is also better than that of single soaking treatment.

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