Effect of salt pretreatment, chitosan, and storage period on the sensory acceptability of peda, fermented sardine (Sardinella sp.)

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Abstract. Peda is one of Indonesian traditional salt fermented whole fish products. Diverse method of making peda resulted in varying quality of the fermented peda during storage as affected by various ways of adding salt in the fermentation of peda, and chitosan addition. Factorial Randomized Block Design (RBD) with 3 factors and 2 replications was used. The first factor was the pretreatment, i.e. time of salt addition (P) which consists of P⁰ = salt was added directly to the fish, P¹ = salt was added after soaking fish in water for 6 hours, and P² = salt was added after leaving fish at room temperature for 6 hours. The second factor was addition of chitosan (K), consists of K¹ = no chitosan added, and K² = 2% chitosan. The third factor was peda storage period at room temperature (S), consists of S¹ = 0 months, S² = 2 months, and S³ = 4 months. The sensory attributes i.e. color, aroma, and taste of the resulted peda was monitored by trained panelist using descriptive sensory test with 5 scale. The results show that P¹ treatment with a storage period of up to 2 months (S²) produced the best aroma and taste with the highest descriptive value of 4.3 (= strong) and a relatively high color value of 3.7 (= neutral to bright). The next best treatment was P⁰ and finally P². The addition of chitosan did not notably affect the color value, but caused a lower taste value, and a higher aroma value. All peda treatments generally still have neutral color, aroma, and taste (= 3) up to a storage time of 4 months.

1. Introduction
Fisheries products, both fresh and processed, are increasingly in demand due to high amounts of beneficial nutritional components like high-quality protein, essential vitamins, minerals and healthy polyunsaturated fatty acids. Fish processing and preservation can maintain fish quality which is known as very perishable, economically increase value added of the products, and provide product variations and alternatives. Preserving fish quality include simple chilling, salting, smoking, fermenting, drying, using synthetic and natural additives, canning, and electromagnetic field application [1][2]. Indonesian well known traditional salt fermented fish products include fish sauce, shrimp paste, and peda.

Peda is one of Indonesian traditional fermented whole fish products. Salt concentration of peda usually very high, up to 30% (w/w) [3]. Generally, peda fermentation is spontaneous, without the

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addition of microbial starter. High salt concentrations select the desired fermentative microorganism and inhibit spoilage and pathogen microorganism growth [4]. Fermented peda usually left moist, not dried, so that the fermentation process remains. Peda has distinctive aroma and texture which well accepted and preferred by consumers. However, the growth of microorganism in spontaneous fermentation is usually diverse so the final quality of peda is varied. The shelf life of peda can be up to 3 months in the refrigerator and two months at room temperature [5]. During storage, peda will experience a quality change that is clearly noticeable in peda texture and aroma. Later, peda stored more than three months will produce white spots which is caused by the growth of bacteria that are resistant to salt. The growth of during storage will negatively impact fish color and causes unpleasant odors [6].

Chitosan is a natural biopolymer derived from chitin that commercially produced from exoskeletons of crustaceans such as shrimp, crab, and crawfish. Chitosan has a lot of functional properties in food such as binder, emulsifier, texturizer, source of antioxidant, and antimicrobial compound. As biopreservatives substance chitosan significantly and positively influence processing and storage quality of foods. It can inhibit pathogenic bacteria and decomposing microorganisms, including fungi, gram-positive bacteria and gram-negative bacteria [7]. Chitosan also functions as a coating that prevents external influences and preserves sensory characteristics of food such as color, aroma, and flavor.

The quality of fermented fish product influenced mostly by its sensory characteristics that associated with fish muscles, viscera, microorganisms and enzymes which are intrinsic to certain fish species [8]. The level of acceptance or preference of consumers for peda fish needs to be considered. This information is required since consumer acceptance is one of the factors that influence the consumption of a food. The objective of this study was to evaluate the descriptive sensory acceptability of sardine peda during storage as affected by various ways of adding salt in the fermentation of peda, and the effects of chitosan addition.

2. Materials and Method

2.1. Material and Preparation of Peda
Sardines (Sardinella sp.) which were immediately kept in ice after caught collected from fishermen in Banda Aceh, Indonesia. Salt, chitosan, and acetic acid obtained from laboratory chemical stores in Banda Aceh city. The salt used is regular salt and the acetic acid used is pure acetic acid.

Sardines were eviscerated, washed, drained and divided into 3 groups (P) and prepared for the 20% salt addition pretreatment, namely P0 = salt was added directly to the fish, P1 = salt was added after soaking fish in water for 6 hours, and P2 = salt was added after leaving fish at room temperature for 6 hours. First, some of fish has been treated were arranged in two layers in a container, The first layer is sprinkled with some salt, then some other fish is coated on top and sprinkled with other parts of salt. Each layer consists of 4 fish and salt sprinkled on each layer will melt during fermentation so that all fish will be submerged can be interpreted every fish receives the same amount of salt. The containers were covered with cheesecloth to avoid dirt and flies. Then the fish was fermented for two days. After the fermentation the fish was drained from the water, which was formed during fermentation. The peda obtained after the fermented fish was sundried for 4 hours to evaporate the excess water. The addition of chitosan was done by dipping peda for 3 minutes in chitosan solution which was prepared by dissolving 2% of chitosan in 1% acetic acid. Then it was sun dried again for another 1 hour. The storage treatment was carried out by wrapping peda with opaque paper, then placed at room temperature for 0, 2, and 4 months.

2.2. Statistical Analysis
The study used a Factorial Randomized Block Design (RBD) with 3 factors and 2 replications. Factor 1 was pre-treatment (P) which consists of P0 = salt was added directly to the fish, P1 = salt was added after soaking fish in water for 6 hours, and P2 = salt was added after leaving fish at room temperature
for 6 hours. The second factor was the addition of chitosan (K), consists of K1 = no chitosan added, and K2 = 2% chitosan. The third factor was peda storage period at room temperature (S), consists of S1 = 0 months, S2 = 2 months, and S3 = 4 months. The data obtained were analyzed by va ANOVA (Analysis of Variance) and further test was done using the Smallest Significant Difference (LSD).

2.3. Sensory Analysis

The descriptive analysis was done by 8 trained panelists. The descriptive analysis was conducted at the peda fish market in Lhok Seudu village, Leupung sub-district, Aceh Besar. The trained panelists are peda producers, who interact and have their daily activities in fish and peda industries. The sensory attributes intensities of peda sardines was descriptively measured in color, aroma, and taste using a 5-scale intensity test. Peda color was analyzed with the following criteria, 1= very pale, 2= pale, 3= neutral, 4= bright, and 5= very bright, whereas for the aroma and taste, the scale of 1= very weak, 2= weak, 3= neutral, 4= strong, and 5= very strong.

3. Results and Discussion

3.1. Descriptive Sensory Evaluation of Peda Color

Color descriptive sensory test of peda sardines ranged from 2.19-4.69 (pale to almost very bright) with an average value of 3.75 (neutral approaching bright). Figure 1 shows that the highest value (3.93=neutral to almost bright) of panelist peda color acceptance obtained in K1 treatment that is without the addition of chitosan. The lowest panelist reception value (3.58= neutral) obtained in the K2 treatment which was with 2% chitosan addition.

![Figure 1. Sensory descriptive color of sardine peda as affected by chitosan addition (K). Descriptive sensory value of peda color: 1= very pale, 2= pale, 3= neutral, 4= bright, and 5= very bright.](image)

Fish color with neutral criteria in the color description test is in line with the results of research conducted by [9] who immersed mackerel in 1% chitosan solution and stored the fish for 24 hours. Chitosan solution serves as a coating that capable of minimizing fish discoloration so that fish color was still in the neutral criteria. The color value of peda with chitosan addition was still acceptable because the difference in the values was very small. The low color of the peda with 2% chitosan addition was suspected due to the yellowish color of the peda which has the color of the chitosan solution used. [10].

The interaction effects of the pretreatment of salt addition (P) and storage time (S) on the peda color description test was shown in Figure 2. The highest value of panelist acceptance of the peda color obtained in peda treatment P0S0 which is 4.54 (=bright) and P0S1 which was 4.35 (=bright). The lowest panelist reception was obtained in P2S2 treatment with a value of 2.50 (=pale). There is a tendency that the difference in pre-treatment and the longer storage period can reduce the color quality.
of peda. The peda color at the beginning of storage period (0 month) was bright, then along with the increase of a storage period up to 4 months, the peda became pale to brownish in color. [11] also found that browning reactions occurred in salted fish products with salt levels range from 7.70 - 16.90% which is in accordance with the peda in this study which have an average salt content of 13.86%.

![Interaction between Pre-treatment and Shelf-life(PS)](image)

**Figure 2.** Effect of pretreatment salt addition (P) and storage period (S) interactions on the sensory descriptive color of sardine peda. Descriptive sensory value of peda color: 1= very pale, 2= pale, 3= neutral, 4= bright, and 5= very bright.

### 3.2. Descriptive Sensory Evaluation of Peda Aroma

Figure 3 show the effect of the pretreatment of salt addition (P) on the peda aroma. Based on Figure 3, the highest value of intensities of aroma perceived by panelist of the peda aroma obtained in the pretreatment P1 (salt was added after soaking fish in water for 6 hours) which was 4.35 (=strong) and the lowest value was obtained on the pretreatment P2 which was 3.84 (=neutral approaching strong). There was a tendency that the difference in pretreatment given can determine the scale of the peda aroma.

![Pre-treatment (P)](image)

**Figure 3.** Effect of pretreatment salt addition (P) on the peda aroma. Descriptive sensory value of peda color: 1= very pale, 2= pale, 3= neutral, 4= bright, and 5= very bright.
The pretreatment P1 resulted in a strong aroma to the peda produced. This is in line with the results of [12] who conducted immersion of fish in the production of dried salted yellow stripe trevally and concluded that immersion had an effect on the aroma of dried salted fish produced.

Pre-treatment P2 (salt was added after leaving fish in room temperature for 6 hours) produced the weakest aroma. This was because at room temperature bacteria and enzymes begin to degrade the macro components in fish, especially proteins, into simple compounds that produce ammonia, histamine, indole, and skatol that caused less favored aroma. These results were the research conducted by [13] who carried out different handling techniques on the quality of fresh fish as raw material for making pindang fish (salted and seasoned fish, and then smoked or boiled until dry for preservation). Fish placed at room temperature for 3 hours began to change odors because bacteria and enzymes were very effective at 30°C. However, in this study the panelists gave an assessment of the P2 treatment with a rather neutral criterion. The effect of storage period (S) treatment on the sensory description test of the peda aroma can be seen in Figure 4.

![Figure 4](image)

**Figure 4.** The effect of storage period (S) treatment on the sensory description of peda aroma. Descriptive sensory value of peda color: 1 = very pale, 2 = pale, 3 = neutral, 4 = bright, and 5 = very bright.

Figure 4 shows that the highest value of intensities of aroma perceived by panelist of the peda aroma was obtained in the treatment S1 (storage period of 2 months) which was 4.34 (=strong) and the lowest value was obtained in the treatment S2 with a value of 3.70 (=neutral approaching strong). During the initial storage period (0 months) there was an increase in peda aroma. The increase in aroma continued to last up to two months. According to [14] during the fermentation of fish, the degradation of proteins and fats resulted in metal ketone compounds, butyl aldehyde, and other compounds that produced a distinctive odor from the product produced. [15] added that in the storage of fermented products, the process of autolysis by digestive enzymes continues which results in the emergence of a distinctive aroma of peda caused by the formation of propionic acid. This is closely related to the shelf life of traditional peda with a shelf life of two months.

The level of acceptance of the panelists began to decline in the assessment of the 4-month at which the aroma value was 3.70 (=neutral approaching strong). This was caused by the process of decay and damage to fish meat characterized by the formation of foul-smelling compounds such as ammonia, indole and amines which are the result of protein breakdown by microorganisms [16]. The effect of chitosan addition treatment (K) on peda aroma can be seen in Figure 5.
Figure 5. Effect of chitosan addition treatment (K) on the sensory description of peda aroma. Descriptive sensory value of peda color: 1= very pale, 2= pale, 3= neutral, 4= bright, and 5= very bright.

Figure 5 shows the highest value of panelist acceptance of the peda aroma was obtained in the K2 treatment (2% chitosan addition) which was 4.16 (=strong) and the lowest panelist acceptance was obtained by treatment K1 (without chitosan addition) with a value of 3.89 (=neutral approaching strong). There was a tendency that the chitosan addition determines the scale of the aroma of fish produced.

The increased of aroma on the peda with 2% chitosan addition was suspected because chitosan can add aroma to the peda produced. In addition, the edible coating properties of chitosan can inhibit the release of volatile compounds of the aroma. This is in accordance with the statement of [17] who reported that chitosan as a polymer film from carbohydrates has gas permeable properties so it is very effective in controlling the diffusion of various gases.

In treatment K1 without the addition of chitosan, panelists tended to dislike the aroma of the products produced. This can occur because many volatile components that form the aroma have begun to evaporate so that the resulting aroma was not strong anymore. [11] added that salted fish products without the addition of chitosan as a coating can accelerate the oxidation of fat which causes rancidity, thereby reducing the sensory value of aroma.

3.3. Descriptive Sensory Evaluation of Peda Taste

The interaction effects of the pretreatment salt addition, the addition of chitosan, and the storage period (PKS) on the test description of peda taste can be seen in Figure 6. Figure 6 shows that the highest value of panelist acceptance of the peda taste was obtained in the treatment of P1K1S0 which was 4.88 (=strong approaching very strong) and the lowest value was obtained in the P2K2S2 treatment (interaction treatment of the pretreatment left the fish in room temperature for 6 hours before salt addition, the addition of chitosan with a storage perion of 4 months) which was 3.13 (neutral criteria).

Panelists tend to like the taste of peda resulted from P1K1S0 (the interaction treatments of soaked in water for 6 hours before salt addition, without chitosan addition, and storage period of 0 month). This is because the pre-treatment of immersion in water causes fish meat to become soft which makes it easier for the salt to be absorbed into fish meat so that it produces a good taste. This result was reinforced by [10] who said that the adequacy of salt in fermentation is very influential on the taste of the final product. Salt can inhibit the growth and development of decomposing bacteria that can cause unwanted odors that can reduce consumer acceptance.
Interaction between Pre-treatment, Addition of Chitosan and shelf life (PKS)

**Figure 6.** Interaction effects of pretreatment salt addition, addition of chitosan and storage period (PKS) on the *peda* taste. Descriptive sensory value of *peda* color: 1 = very pale, 2 = pale, 3 = neutral, 4 = bright, and 5 = very bright.

The treatment without the addition of chitosan has a good effect on the taste of *peda*. Chitosan coating functions as an inhibitor of bacterial growth, so there is a possibility that lactic acid bacteria are also inhibited. This is the reason that the treatment without the addition of chitosan has a good effect on the taste, which causes lactic acid bacteria to grow well in the treatment so that it produces the desired taste in the final product and improves the acceptance of panelist criteria.

**4. Conclusion**

The treatment of salt was added directly to the fish caused higher color value of sardine *peda*, followed by P1 (salt was added after soaking fish in water for 6 hours) and P2 (salt was added after leaving fish in room temperature for 6 hours), but *peda* color value decreased as the storage period increased, and the chitosan addition did not obviously affected the color of *peda*. Treatment P1 gave high aroma and taste values of *peda*, especially after 2 months of storage period and still good (scale of 3 = neutral) even after 4 months of storage period. The chitosan addition resulted in high value of *peda* aroma, oppositely caused the *peda* taste value to be lowered. Based on the descriptive sensory value of color, aroma, and taste of sardine *peda*, the best treatment of producing the *peda* was P1 = salt was added after soaking fish in water for 6 hours, and the *peda* generally still had high descriptive sensory value even after 4 months of storage period. addition of chitosan can extend the shelf life of the *peda* because the aroma of the *peda* that is stored for three months still produces a pretty good aroma.

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