

# Nutrition and Sensory Evaluation on Corned Fish from Mackerel Tuna (*Euthynus* sp.) Processed with Red Fermented Rice and Nitrite Salt

Theresia Dwi Suryaningrum\*, Diah Ikasari, and Syamdidi

Research Center for Marine and Fisheries Product Processing and Biotechnology

**Abstract** This study aimed to determine the effect of red fermented rice and nitrite salt as natural coloring on the sensory and nutritional properties of mackerel tuna (*Euthynus* sp.) corned. Fish fillet was added with salt, sugar, 1.5% (w/w) red fermented rice and 2.5% (w/w) nitrite salt, then incubated at 1-2°C for 2 days until the color of the meat became dark red. Afterward, the cured meat was washed and processed into corned fish by using 0, 1 and 2% Soy Protein Isolate (SPI). The quality of corned fish were observed based on the proximate values, pH, color, microbial content, sensory evaluation, fatty acid profiles and amino acid profiles. The results show that corned fish processed with red fermented rice and nitrite salt affected the proximate value, color value and sensory evaluation. Corned fish which processed using red fermented rice produced a sharper red color and preferred by panelist than corned fish processed using nitrite. Addition of SPI affected the red color intensity of the product and increasing panelist's preference for the products. Corned fish contained essential fatty acids and amino acids, therefore, it can be used as a source of amino acids to meet the needs of amino acids in the body. Based on this study, corned fish processed with red fermented rice and the addition of 2% SPI was chosen as the best formulation compared to other treatments.

## 1 Introduction

Corned food is one of the preserved products in canned form, which is widely used in Indonesian recipes. Generally in the market, corned products made from meat that has high myoglobin such as beef, mutton, and pork [1]. The typical color of corned beef on the market is generally red, which is the first factor in determining corned quality in visually [2]. Therefore when fish meat processes into corned, the color of product less reddish because fish has low myoglobin content. To get the red color in fish meat, it can be done using the curing process. The curing process aims to get products that have a good texture, aroma, and taste, stable product color, reduce shrinkage during the process, and extend the shelf life of meat products [3]. Nitrite is one of the food additives used for making corned beef which is added during the curing process. However, the use of nitrite in corned beef must also be considered, because nitrite can have a negative impact on health if consumed in excessive amounts. According to the USDA the maximum use of nitrite preservatives in processed meat products is not more than 200 mg/kg [4]. This is due to curing using nitrite which can be a pre-cancerous carcinogenic effect because it will react with amines or amides amine from animal protein components to form nitrosamine compounds [5]. Nitrosamine is one of the compounds cause of cancer [6]. Therefore the addition of natural dyes such as red fermented rice is safer and has a more antioxidant and stable red color.

Red fermented rice is a fermented rice by using *Monascus purpureusi* molds to produce red pigments [7] Red fermented rice does not only function as a red pigment, but also able to act as a meat preservative. Red fermented rice is also antimicrobial as well as enhancer flavoring [8]. Using red fermented rice as food coloring has several advantages, which can keep the colors more consistent and stable, soluble in water, and can be mixed with other pigments and safe for consumption [9]. The use of red fermented rice as a dye is also not toxic and does not interfere with the immune system [10]. Research on utilization of red fermented rice with a concentration of 1.5% on corned chicken produced the best appearance, color and taste product

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\* Corresponding author: [tdwisuryaningrum@yahoo.com](mailto:tdwisuryaningrum@yahoo.com)

compared to other treatments [11]. The other research using red fermented rice as a coloring on the quality of sensory corned fish shows that red fermented rice affects the color, taste and preferences of panelists, but does not affect the aroma and texture of corned fish produced [1]. As well as chicken sausage colored with red fermented rice produces preferred product compare beef sausages [12]. While the addition of 1.5% red fermented rice in processing beef sausages produces sausages that have color, aroma and taste and texture in accordance with the sausages in the market [13]. In the corned processing usually using fat or oil to obtain a compact, soft and juicy texture, improve the taste, aroma and appearance of the product [14]. But the addition of fat and oil often separates and accumulates on the bottom of the packaging. To overcome the separation of fat and oil, the addition of Soy Protein Isolate (SPI) is needed. Soy Protein Isolate is a binder in food products, which has the ability to form gels in water [15]. SPI is a high protein and able to improve the emulsion properties of corned dough which also expected to increase the binding capacity of water and fat so the corned product has the expected texture, taste and aroma [16].

Processing of corned fish requires a series of steps, namely curing, washing, stirring with spices and emulsion, steaming, packaging and sterilization. In this study corned fish was packed using a retort pouch in the form of a multi-layer aluminum foil bag instead of cans. Retort pouch that can be sterilized with high temperatures and short periods of High Temperature Short Time (HTST), at temperatures between 120–135°C. Retort pouch has several advantages and benefits compared to cans, its thin shape allows to reduce heating time, so it can avoid over cooking and the resulting product has better nutritional value and sensory properties [17]. This research aimed to study the physical properties and nutritional value of corned fish in pouch packs which was cured with red fermented rice and nitrite salt.

## **2 Materials and methods**

### **2.1 Materials**

The material used in this research is mackerel tuna (*Euthynus* sp.) obtained from fishermen at landing fish place Pelabuhan Ratu, West Java, Indonesia. The fish was iced then brought to Jakarta, then was filled the next day. Other material used are spices such as 2.5% salt, 5% sugar, 5% powdered milk, 8% vegetable oil, 0.5% pepper powder, 0.5% nutmeg powder, and 2% onion. Packaging material pouch for corned fish was obtained from Unit Processing Fish in Pasuruan. Nitrite salt food grade containing with nitrite 6g/100g and red fermented rice obtained from drugstores in Jakarta.

### **2.2 Research methods**

This research was divided into 2 stages, preliminary and main research. Preliminary research was conducted to obtain the concentration of red fermented rice and nitrite salts as curing material. The fillet of tuna was added with salt 2.5% sugar 5% and red fermented rice (0.5, 1, and 1.5%) and nitrite salt (2%, 2.5%, and 3%). The meat was then incubated for 48 hours at the chilling room (temperature 1-2°C). The meat that has been cured was then observed the pH and color using a color reader. The concentrations of red fermented rice and nitrite salt which produce the best color will be used for the further research.

The main research: the variables were used in the main research are the concentration of red fermented rice (A) and nitrite salt (N) obtained from preliminary studies. Another treatment is the addition of Soy Protein Isolate (SPI) with concentrations of 0, 1 and 2%. So that a combination of treatments obtained are A0, A1, A2 and N0, N1, N2. This research was designed using a completely randomized design with 3 replications.

### **2.3 Production of Fish Corned**

Tuna fillet was added with 2.5% salt, 5% sugar and 1.5% red fermented rice and 2.5% nitrite salt (w/w). Tuna fillet was then incubated for 48 hours at 1-2°C, so that the color of meat become dark red. The cured meat then was washed and drained. After that, 5% powdered milk, 8% vegetable oil, 0.5% pepper powder, 0.5% fine nutmeg, 2% onion was added and stirred until homogeneous. The dough was then added with soy protein (0, 1 and 2%) then put in a baking pan measuring 20 x 6 x 5 cm. The dough was steamed for 30 minutes at 95°C. The cooked corned dough was cooled overnight at chilling temperature (1-2°C), and cut into size 10 x 20 cm and packaged in a pouch and sterilized using autoclave at temperature 121°C and pressure of 1 atmosphere, for 15 minutes and then chilled at room temperature

### **2.4 Observation**

Observations on the quality of corned fish were carried out on the proximate values including moisture content (SNI 01-2354.2-2006), ash content (SNI 01-2354.1-2006), protein content (SNI 01-2354.4-2006) and fat content (SNI 01-354.2354.3-2006), [18], pH [19]. Microbial tests were observed for the total viable count (SNI01-2332.3-2006), and *Staphylococcus* sp. (SNI 2332.9.2006) [20]. Sensory evaluation using hedonic tests with valuai 1-5 (SNI 01-2346 -2006) [21]. Observation of

colors using Color Reader (Minolta). The working principle of a color reader is a color exposure system using the CIE system with three color receptors, namely L\*, a\*, b\* Hunter. The letter L\* shows the brightness based on white, the letter a\* shows redness or greenness, and the letter b\* indicates yellowish or bluish [22]. Analysis Fatty acid profiles were carried out using Hewlett-Packard GC 5890 GC models and amino acids using HPLC.

### 3 Results and discussion

#### 3.1 Preliminary research

The results of the study shown that the color of fish meat after cured with red fermented rice and nitrite salt can be seen in Table 1. Table 1 shows that the highest brightness L\* value was obtained from the meat cured using 2.5% nitrite salt. Although the value of a\* in this meat is the lowest, but the brightness value is the highest, so that the red color of the meat is sharper and brighter than the other treatments. Fish meat that was cured with red fermented rice 1.5% produced the highest brightness (L\*) red color. While the fish meat cured with 1% and 2% red fermented rice produced red pale and dark red color product. So the best concentration for preliminary research was 2.5% nitrite salt and 1.5% red fermented rice. The Value of pH fish after cured at the chilling temperature (temperature 1-2°C) ranged from 5.6-5.72. This value of pH indicate that meat fish was not spoilage.

**Table 1.** The color of fish meat and pH after being cured with red fermented rice and nitrite salt at various concentrations

Treatments	Color Description	L*	a*	b*	pH
Nitrite salt 2%	Red pale color, slightly yellowish	33.32	10.88	12.86	5.61
Nitrite salt 2.5%	Red color	36.34	9.81	12.37	5.65
Nitrite salt 3%	Red color rather dark	31.62	10.39	11.55	5.74
Red fermented rice 1%	Red pale color	27.45	19.30	13.30	5.62
Red fermented rice 1.5%	Bright red color	33.27	18.76	13.13	5.72
Red fermented rice 2%	Dark red color	22.64	16.52	12.37	5.72

#### 3.2 Main research

##### 3.2.1 Freshness of raw materials

The mackerel tuna (*Euthynus* sp) fish was used in this study had a TVB of  $14.80 \pm 2.04$  mgN% and the pH was  $6.14 \pm 0.05$  which was classified as fresh fish because the TVB content was about 10-20 mg% [23]. Using fresh materials was expected to produce high-quality of corned fish. The proximate analysis of mackerel tuna were used in this research has moisture content of 73.33%, ash content 1.38%, protein content 25.23%, and fat content of 1.77%.

##### 3.2.2 Proximate analysis of corned fish

The result of proximate analysis corned fish can be seen in Table 2. The moisture content of corned fish obtained in this study ranged from 63.35 - 65.98% still above the moisture content of corned beef according IFRC [24] which is a maximum of 60%. The high moisture content in corned fish is due to the process of washing to remove the remaining red fermented rice or nitrite salts. Washing caused the meat absorb the water so that it affects the high levels of moisture content of corned fish. In this study, the moisture content of mackerel tuna which was used as raw material was 73.33%, still in range of moisture content of beef 71.73 - 74.63% [25]. The moisture content in food components can affect physical properties, which will affect the texture, appearance, smell, and taste [26]. Addition of soy protein to corned fish affect to reduce the water content of corned fish product but not significant. Moisture content is very important on storage time of food and is one of the causes of damage to food.

**Table 2.** Proximate analysis of corned fish using various treatment

Treatment	Moisture Content (%)	Ash Content (%)	Protein Content (%)	Fat Content (%)
A0	65.74 ± 0.56 <sup>a</sup>	2.03 ± 0.07 <sup>a</sup>	15.86 ± 0.32 <sup>a</sup>	4.58 ± 0.78 <sup>a</sup>
A1	65.98 ± 0.19 <sup>a</sup>	2.10 ± 0.06 <sup>a</sup>	16.14 ± 0.53 <sup>a</sup>	4.37 ± 0.27 <sup>a</sup>
A2	64.47 ± 0.73 <sup>a</sup>	1.97 ± 0.30 <sup>a</sup>	17.61 ± 0.34 <sup>b</sup>	4.81 ± 0.43 <sup>a</sup>
N0	64.40 ± 0.49 <sup>a</sup>	3.10 ± 0.56 <sup>b</sup>	16.24 ± 0.36 <sup>a</sup>	4.54 ± 0.11 <sup>a</sup>
N1	65.91 ± 0.35 <sup>a</sup>	3.23 ± 0.08 <sup>b</sup>	17.94 ± 0.29 <sup>b</sup>	5.75 ± 0.98 <sup>b</sup>
N1	63.35 ± 0.45 <sup>a</sup>	3.61 ± 0.10 <sup>b</sup>	18.18 ± 0.58 <sup>b</sup>	4.57 ± 0.68 <sup>a</sup>

Note :

- A0 = Corned fish was processed with red fermented rice and ISP 0%
- A1 = Corned fish was processed with red fermented rice and ISP 1%
- A2 = Corned fish was processed with red fermented rice and ISP 2%
- N0 = Corned fish was processed with nitrite salt and ISP 0%
- N1 = Corned fish was processed with nitrite salt and ISP 1%
- N2 = Corned fish was processed with nitrite salt and ISP 2%

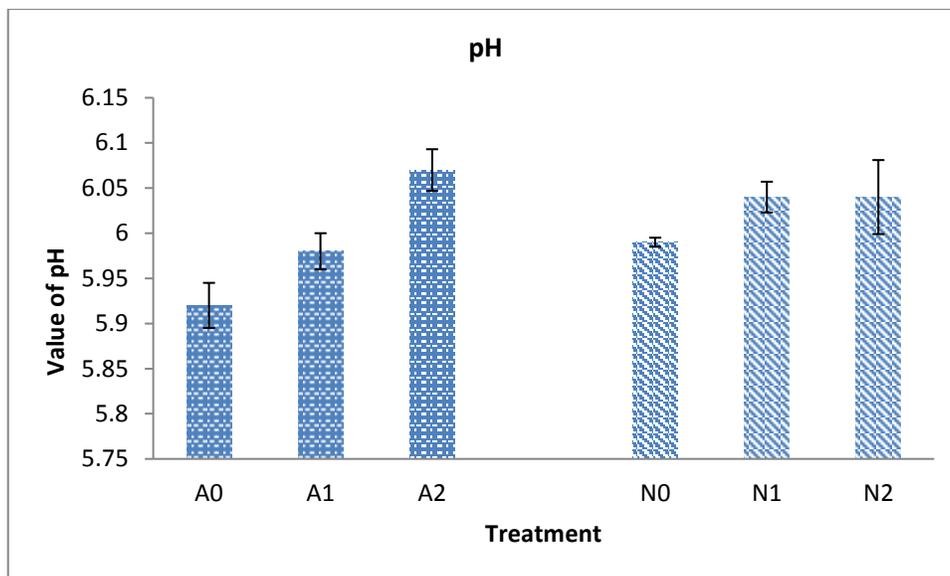
Corned fish processed with nitrite has a higher ash content and is significantly different from that treated with red fermented rice. The average ash content of mackerel corned fish at various treatments still comply with the requirements of ICRC for corned beef [24]. According to ICRC, the maximum ash content of corned beef is 3.5%. An exception was found in corned fish which was treated with nitrite and 2% soy protein isolate. In this treatment the ash content of the corned fish is 3.61% above the requirements for IFRC for corned beef. This high level of ash is probably due to the added soy protein isolate. This ash content were similar with the results research on red bean analogue meat by Utama and Anjani (2016), where the higher the substitution of soybean protein isolates, the higher the ash content of the product [27]. The fat content of corned fish ranged from 4.37 - 5.75%. This fat level is far below the fat content according to ICRC [24] for corned beef, which is a maximum of 12%. In this study corned fish was processed from mackerel tuna with a relatively low fat content of 1.77%, although during processing was added 8% of oil, but the fat content in corned fish product still quite low. Addition of fat to corned fish aimed to form the texture of products that are compact, soft, and juicy of the texture and improved taste and aroma [28]. Observation of protein shows that the addition of soy protein isolate has an effect on increasing the level of protein produced. Soy protein isolate is a product of low fat soy powder with a minimum protein content of 90% of dry matter [27]. According of research, corned fish processed using of a 1.5% soy protein isolate can increase protein levels in accordance with SNI for corned beef. The same study regarding the increase in soy protein isolate concentration towards frankfurters sausage also significantly increased the protein content of sausages [29]. The protein content obtained from corned fish that were cured with red fermented rice ranged from 15.86 to 17.61% while corned fish which was cured with nitrite salt ranged from 16.24 to 18.18%. According to Indonesian National Standard SNI 3775-2015 of corned beef, the protein content of this product at least is 17% [29].

### 3.2.3 pH Analysis

The results of pH analysis showed that pH of the corned fish was processed using red fermented rice and nitrite salt ranged from 5.92 – 6.04 and 5.99-6.04, respectively (Figure 1). The addition of soy protein isolate has an effect on increasing the level of pH cornet fish significantly. Corned fish without addition of isolate soy protein have a pH less than 6, which trend to be acids. In the processing of corned fish, the pH value of the product plays an important role in determining the texture of the product. This is because sarcoplasmic proteins from muscles are very easily damaged in acidic conditions and tend to lose the water binding capacity at pH below 6.2 [11]. In this study the pH of corned fish processed with red fermented rice tends to have an acidic pH, so in this study the texture of corned fish processed with red fermented rice has a harder texture. Red fermented rice was rice fermented using *Monascus purpureus* molds so that the color is red, with a pH ranging from 4-7 depending on the glucose content of the rice [30].

### 3.2.4 Microbial test on corned fish

The results of total viable count on corned fish product showed that corned fish packaged in retouch pouch, completely sterile and no bacterial growth. In this study sterilization was carried out using an autoclave with a pressure of 1 ATM and a temperature of 121°C, for 15 minutes, where the sterilization process can kill microorganisms including their spores, destruction of enzymes and other essential cell constituents [31]. The results of the analysis of total viable count on *Staphylococcus* spp. of corned fish, also showed that there are no bacteria. That microbes had died after undergoing the sterilization process (Table 3).



**Fig. 1.** pH analysis of corned fish at various treatments  
 Note: See the letter treatment in Table 2

**Table 3.** The results of total viable count and *Staphylococcus* spp. analysis of corned fish in various treatments

Treatment	Total Viable Count (cfu/g)	<i>Staphylococcus</i> spp. (cfu/g)
A0	0 (no bacterial growth)	0 (no bacterial growth)
A1	0 (no bacterial growth)	0 (no bacterial growth)
A2	0 (no bacterial growth)	0 (no bacterial growth)
N0	0 (no bacterial growth)	0 (no bacterial growth)
N1	0 (no bacterial growth)	0 (no bacterial growth)
N1	0 (no bacterial growth)	0 (no bacterial growth)

Note: See the letter treatment in Table 2

### 3.2.5 Color analysis of corned fish

Based on color analysis data using color reader corned fish in various treatments can be seen in Table 4. The color analysis shows that corned fish processed with red fermented rice produces a sharper red and yellow color significantly different with cornet fish processed using nitrite salt. The sharper red and yellow color which is indicated by a higher value of a<sup>+</sup>, b<sup>+</sup> and low L\*. Corned fish processed with nitrite salt produces a more pale red color that indicate by higher L\* value with lower a<sup>+</sup> and b<sup>+</sup> values. This study indicated that the red pigment of red fermented rice can be used as a red dyes on corned fish which approaches the color red in beef corned. Red pigment from red fermented rice was produced by *Monascus purpureus* and dominated by dark red [32]. Although corned fish were sterilized at 121°C for 15 minutes, the red color pigment of red fermented rice did not changes. Future stated that red fermented rice pigments were degraded as much as 55% at heating temperatures of 100°C for 8 hours. Red pigments of red fermented rice will damaged at temperatures above 150°C [33]. The addition of soy protein isolate has an effect on increasing the brightness intensity of sharper red and yellow colors indicated by increasing the values of a<sup>+</sup> and b<sup>+</sup>. Isolates soy protein is basically white, and when heated it will produce transparent white. Therefore, the addition of soy protein will cause the corned beef to be brighter so that the red color becomes more visible.

**Table 4.** Color analysis of corned fish at various treatment

Treatment	L*	+a*	+b*
A0	45.84 ± 0.32 <sup>a</sup>	17.4 ± 0.99 <sup>a</sup>	18.36 ± 0.88 <sup>a</sup>
A1	45.08 ± 0.65 <sup>a</sup>	18.36 ± 2.14 <sup>a</sup>	20.88 ± 1.08 <sup>a</sup>
A2	46.14 ± 2.53 <sup>a</sup>	21.62 ± 0.72 <sup>a</sup>	21.04 ± 1.07 <sup>a</sup>
N0	54.31 ± 2.5 <sup>b</sup>	8.63 ± 0.2 <sup>b</sup>	16.24 ± 1.98 <sup>b</sup>
N1	57.43 ± 1.38 <sup>b</sup>	7.74 ± 1.57 <sup>b</sup>	18.08 ± 2.45 <sup>b</sup>
N1	59.32 ± 0.81 <sup>b</sup>	8.13 ± 1.55 <sup>b</sup>	17.52 ± 0.71 <sup>b</sup>

Note :

L\* = shows light / dark, + a = shows redness + b show yellowish color

See the letter treatment in Table 2

### 3.2.6 Sensory evaluation

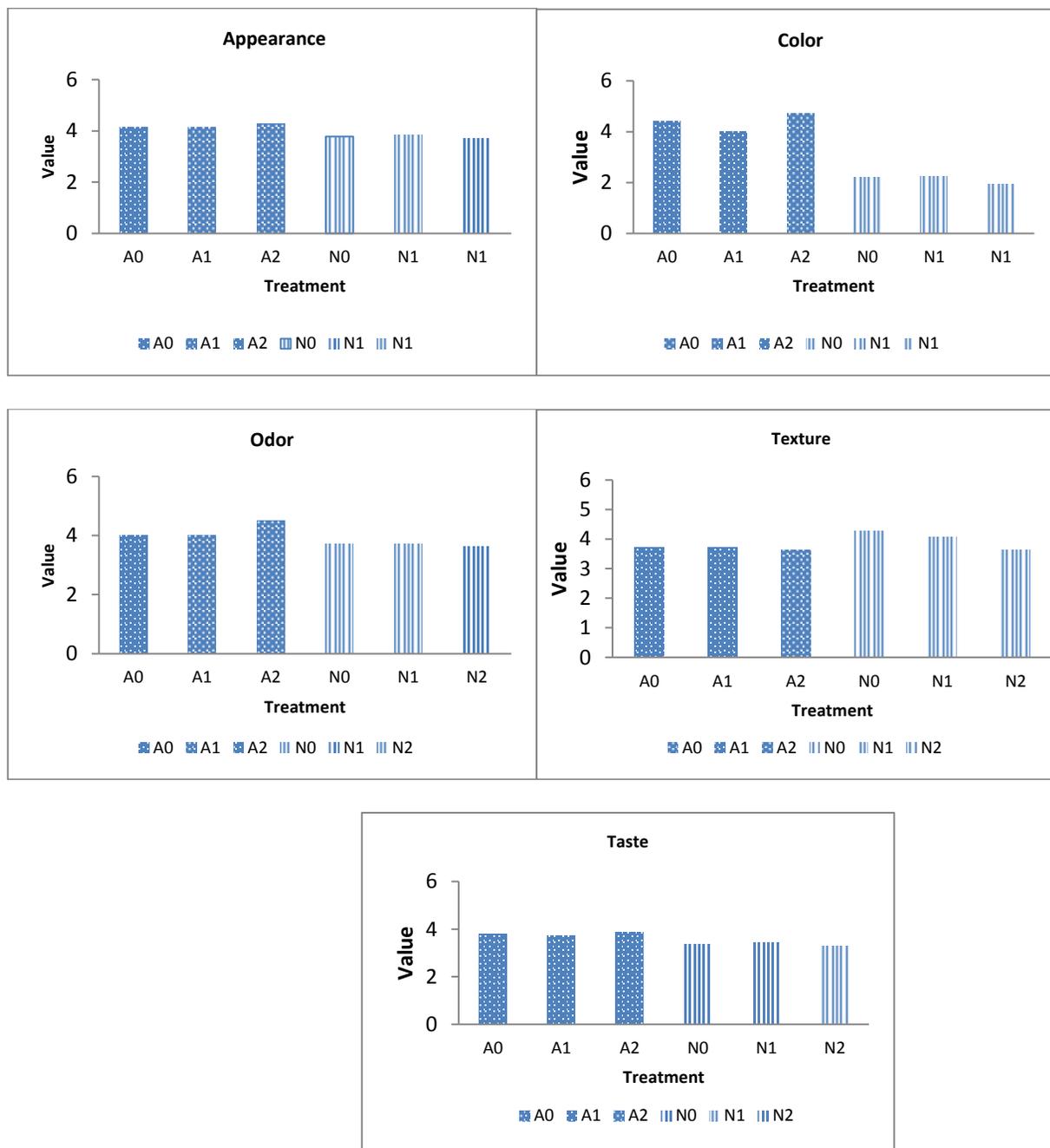
Sensory evaluation was performed on hedonic quality which included appearance, odor, color, texture and taste with a range of values of 1-5. The sensory analysis showed that panelists preferred the appearance, color, odor, taste of corned fish processed with red fermented rice and significantly different compared to nitrite salt. Only the texture, panelists prefers corned fish was processed with nitrite salt (Figure 2).

Panelists give an appearance of corned fish processed using red fermented rice with value of 4.14 - 4.28 which means between likes and very likes. While corned fish processed with nitrite salt, panelists give a value of appearance only 3.71-3.78 between neutral and likes. Corned fish processed with fermented rice produces more attractive appearance with a sharper red color compared to corned fish was processed with nitrite salt that produce a pale color and less attractive appearance.

For color evaluation, panelists give score of corned fish processed with red fermented rice ranged from 4 - 4.71 which means between likes and very likes. The color of corned fish processed with red fermented rice produces a distinctive red color like corned beef which is preferred by panelists. Color is the most important sensory characteristic of processed meat products that influences consumer decision buying and affects their perception of the product [34].

According to Lukman [12], other advantages of using red fermented rice as a coloring are its stability at high temperatures, so it does not change during cooking process. While corned fish was processed with nitrite salt, panelists give score of color ranged from 1.91 to 2.25 which means between very dislike and dislike. This low color value was caused by a pale pink color that is different from the common color of corned beef. The addition of soy protein isolate on corned fish resulted in an increase of color values for corned fish by the panelists. This is due to corned fish which was processed with the addition of a soy protein isolate produced bright red color and more attractive. While the addition of soy protein isolates for corned fish processed with nitrite salt produced more pale red color and not attractive, so that the panelists give a low value.

Panelists prefer the odor of corned fish processed with red fermented rice rather than nitrite salt. Panelist give value 4-4.5 between likes and very likes for corned fish processed with red fermented rice, while corned fish processed with nitrite salt had a value of 3.64-3.71 between neutral and likes. This is due to a sharper savory smell on corned fish which was processed with red fermented rice. The addition of the soy protein isolates on corned fish processed with red fermented rice give higher odor values. This is due to the addition of soy protein isolates can bind the savory aroma of glutamic acid from corned fish during cooking [35]. The results of this study are the same as the results of the study on chicken sausages that the addition of soy protein isolate can improve aroma of the product [14].



**Fig. 2.** Sensory analysis of corned fish at various treatments  
 Note: See the letter treatment in Table 2

In this study, panelists preferred taste of corned fish processed with red fermented rice rather than nitrite salt. Panelists give the taste score for corned fish processed with red fermented rice ranging from 3.71 to 3.85, better than processed with nitrite salt which ranged from 3.28 - 3.42. The taste of corned fish actually produced by amino acid and oligopeptide compounds. According to Tisnajaya [8], protease enzyme from *Monascus purpureus* molds take place the hydrolysis of protein into oligopeptida. Furthermore protease enzyme will break down protein into amino acids like glutamic acid. Glutamic acid is the most important amino acid as a flavor enhancer, which plays a role in the formation of savory flavors in food [36, 37]. Based on the taste analysis, corned fish processing with red fermented rice can improve the taste of the product. The results of this study are the same as the results of research by Wahyuni et al. [38] on beef sausages using red fermented rice as a coloring. The addition of concentration soy protein isolate in corned fish processed with red fermented rice increased the value of taste. While for corned fish processed with nitrite salt, the higher the concentration of soy protein isolate added, the lower the value of taste.

The expected corned fish texture should be compact but soft and easy to break down. The results of the sensory evaluation showed that panelists preferred texture of corned fish processed using nitrite salt compared to red fermented rice. Panelists give texture values to corned fish processed with nitrite salt of 3.64 – 4.28 while corned fish processed with red fermented rice was 3.64 -3.71. This is due corned fish processed with red fermented rice has a harder texture, and is not easily to break compared to corned fish processed with nitrite salt. The addition of soy protein isolate affected the decreasing value of the texture, the free water in meat is not released all then affected the increasing hardness of the texture produced

### 3.2.7 *The profile fatty acid of corned fish*

The results of the analysis of fatty acid profiles in corned fish in various treatments can be seen in Table 5. The average percentage of saturated fatty acids was ranged from 37.7-41.17%, while the monounsaturated fatty acids was ranged from 35.58 to 38.72. Polyunsaturated fatty acids are relatively small, ranging from 2.12-3.08%. However, the content of omega-3 essential fatty acids (EPA and DHA) ranged from 1.85-2.04%, omega-6 ranged from 0.1-0.16%, and omega-9 fatty acids ranged from 0.6-1.57%.

The results showed that corned beef containing saturated fatty acids was dominated by palmitic acid. Palmitic acid is a dominant saturated fatty acid [39]. The palmitic acid content in corned fish processed with red fermented rice was ranged from 32.82 to 34.21% lower than corned fish processed with nitrite salt which about 33.2-36.31%. The palmitic acid content is slightly higher than mackerel tuna about 32.90 %. According Ibrahim et al. [40], the increase of palmitic acid content is originated from palm oils which added on the processing of corned fish. The palmitic acid content of the palm oil ranged from 37.9-41.7% [41]. Palmitic acid composed of 16 carbon atoms ( $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$ ), which are clumpy and white at room temperature. Therefore saturated fatty acids have unpleasant properties, which cause blood to become thick so that it is easy to clot and cause hardening of the arteries [42]. Stearic acid is the second most important saturated fatty acids, stearic acid varies from 3.82 – 34.21 %.

The treatment does not affect the content of the monounsaturated fatty acids produced. Monounsaturated fatty acid content is dominated by oleic acid ( $\text{C}_{18}\text{H}_{34}\text{O}_2$ ) which ranges from 35.52 to 38.39%. According of Ibrahim et al. [38], the content of oleic acid of mackerel tuna is 17.40%. The increase of the oleic acid content is originated from palm oils which added on the processing of corned fish. The oleic acid content of the palm oil ranged from 33.8-47.5% [39]. Oleic acid or omega-9 has a protective power that can reduce LDL and increase HDL cholesterol and is more stable than omega-3 and omega-6, and can prevent the occurrence of coronary heart disease (CHD) [43] Oleic acid content in corned beef is higher when compared with oleic acid content in Salmon at 16.75% and Sea bass 8.09% [44].

The results of the analysis of polyunsaturated fatty acids are relatively small in number, ranging from 2.16 to 3.08 consisting of essential fatty acids such as omega 3, omega 6 and omega 9 which are dominated by DHA and EPA. While the amount of omega 6 is so small that the comparison between omega 3 and omega 6 is still above 10: 1. Epidemiological studies show that consumption of fat which has a ratio of omega-3 and omega 6 fatty acids to less than 10: 1 is considered unhealthy. Corned also contains omega 9 acid in high enough quantities, so it is a healthy food because it can block eicosanoids compounds and can prevent negative omega-6 stimulation.

**Table 5.** Fatty acids profile of corned fish in various treatments

No	Fatty Acid	A0	A1	A2	N0	N1	N2
1	Caproilic Acid C 8 :0	0.02	0.02	0.02	0.02	0.02	0.02
2	Capric Acis C10 :0	0.02	0.02	0.02	0.04	0.02	0.02
3	Lauric AcidC12 : 0	0.18	0.16	0.18	0.2	0.21	0.2
4	Myristic Acid C 14 :0	0.9	0.79	0.89	0.96	0.98	0.89
5	Pentadecanoic Acid C 15 : 0	0.05	0.04	0.06	0.06	0.06	0.05
6	Palmitic Acid C16 : 0	34.21	32.82	33.05	36.31	35.81	33.2
7	Heptadecanoic Acid C17 :0	0.11	0.1	0.12	0.11	0.11	0.11
8	Stearic Acid C18 :0	3.6	3.41	3.45	3.63	3.6	3.52
9	Arachidic Acid C20:0	0.25	0.24	0.24	0.26	0.25	0.26
10	Behenic Acid C22 : 0	0.05	0.05	0.06	0.06	0.06	0.06
11	Lignoceric Acid C : 24 :0	0.06	0.05	0.05	0.05	0.05	0.05
	Saturated Fatty Acid (SFA)	39.45	37.7	38.14	41.7	41.17	38.38
12	Palmitoleic Acid C16- 1	0.21	0.19	0.24	0.21	0.21	0.22
13	Cis-10 -Hepadecanoic acid C17 :1	0.03	0.02	0.03	0.03	0.03	0.03
14	Oleic Acid C 18 : 1n9C	37.65	36.51	35.52	38.39	36.94	35.25
15	Cis 11- Eicosenoic Acid C 20 :1	0.09	0.08	0.09	0.09	0.07	0.08
16	Nervonic Acid C24 :1	0.02	0	0.02	0	0	0
	Mono Unsaturated Fatty Acid (MUFA)	38	36.8	35.9	38.72	37.25	35.58
17	Elaidic Acid C 18 : 2n 9 t	0.06	0.06	0.52	0.84	1.55	1.36
18	Linolelaidic Acid C18 : 2n9t				0.03	0.07	0.06
19	Linolenic Acid C 18 : 3 n3	0.17	0.16	0.17	0.19	0.18	0.19
20	Cis 11-14-Eicosadienoic acid C20 :2n3	0.08	0.06	0.07	0.07	0.06	0.1
21	Arachinoid Acid C20 : 4 n 6	0.16	0.15	0.14	0.12	0.11	0.1
22	Eicosapentaenoic Acid C20 : 5n3	0.26	0.23	0.29	0.21	0.19	0.19
23	Docosahexaioic Aicd C22: 6 n3	1.43	1.46	1.51	1.07	0.92	0.94
	Poly Unsaturated Fatty Acid (PUFA)	2.16	2.12	2.7	2.53	3.08	2.94
	ω -3/ ω -6	12.1 :1	12.7 :1	14.5.:1	12.8:1	12.2 :1	14.2 :1

### 3.2.8 Amino acid profile of corned fish

The quality of a food product can be assessed by comparing the amino acids that arrange the protein. There are two types of amino acids that arrange proteins, namely essential amino acids and non-essential amino acids. Essential amino acids are amino acids that cannot be synthesized by the body so they must be inserted from outside the human body, while non-essential amino acids are amino acids that can be synthesized by the human body with other amino acid raw materials [45].

**Table 6.** Amino acid content of corned fish in various treatments

No	Parameter	A0	A1	A 2	N0	N 1	N2
Essential amino acid							
1	Histidine	6.07	5.73	5.92	6.6	7.91	6.57
2	Leucine	8.83	8.77	8.79	8.68	8.83	8.71
3	Lysine	7.72	8.43	7.58	9.17	6.93	8.82
4	Methionine	2.89	2.96	2.67	2.57	3.2	2.62
5	Phenylalanine	4.62	4.65	4.71	4.79	4.71	4.77
6	Threonine	5.03	4.92	4.9	4.86	5.23	4.84
7	Valine	6.21	6	6.18	5.97	6.08	6.09
8	Isoleucine	5.79	5.6	5.73	5.55	5.56	5.6
Sum of essential amino acid		47.16	47.06	46.48	48.19	48.45	48.02
Non-essential amino acid							
1	Alanine	6.34	6.27	6.24	6.04	6.34	6.02
2	Arginine	6.48	6.54	6.5	6.53	6.21	6.5
3	Aspartate Acid	11.11	10.99	11.28	10.63	10.66	10.72
4	Glutamic Acid	16.08	16.12	16.5	15.91	16.55	16.05
5	Serine	4.27	4.31	6.24	4.3	4.31	4.22
6	Glycine	5.03	5.13	5.03	4.79	3.79	4.77
7	Tyrosine	3.58	3.64	3.44	3.47	3.66	3.52
Sum of non-essential amino acid		52.89	53.00	55.23	51.6	51.52	51.8

The results of the analysis of the amino acid profile of corned fish in various treatments can be seen in Table 6. Based on this analysis, corned fish does not contain cysteine and tryptophan. Both of them are essential amino acid. The content of cysteine and tryptophan on this product might be relatively small compared to other essential amine acids which is caused unreadable at the time of analysis. Corned fish which is processed with red fermented rice and nitrite salt did not affect the amount of amino acids content. While the addition of soy protein isolate has an effect on the increasing number of essential amino acids contained in corned fish produced.

Corned fish just only contains a small variety of non-essential amino acids, namely alanine, arginine, aspartic acid, glutamate acid, serine, glycine, and tyrosine. Non-essential amino acids dominated by glutamic acid cause a taste of umami (savory) in corned beef produced. Glutamic acid is one of the dominant sources of umami taste in the delicious taste of broth and will have an impact on the perfection or authenticity and complexity of the taste of "umami" which is the fifth basic taste besides sweet, salty, sour, and bitter taste [37].

Based on the standard pattern of essential amino acids released by FAO for body requirements [47], the chemical values of essential amino acids in each type of corned fish can be seen in Table 7. Chemical values are calculated based on the number of amino acids in corned fish divided by the number of standard amino acids multiplied by 100. Amino acids whose chemical values are less than 80 are limiting factors as a source of essential acids for the body. Based on the results of calculations carried out, all amino acids in corned fish can be used as a source of amino acids to meet the needs of amino acids in the body, except methionine which is processed with red fermented rice with the addition of 2% soy protein isolate and nitrite salt with no additional soy protein isolate and 2% soy protein isolate. Therefore, if corned fish is used as a source of essential amino acids, it must be added from other sources containing amino acids which are the limiting factor.

**Table 7.** Chemical value amino acid of corned fish at various treatment

Essential Amino Acid	FAO Standard (%)*	A0	A1	A2	N0	N1	N2
Histidine	-	-	-	-	-	-	
Isoleucine	4	144	140	143	138	139	140
Leusine	7	126	125	125	124	126	126
Lysine	5,5	140	153	137	166	126	160
Met +Cysteine	3,5	82	84	76.2	73	92	74
Phe + Tyr	6	136	138	135	137	140	138
Threonine	4	125	123	122	121	130	121
Valine	5	124	120	123	120	121	121

FAO, 2011 [47]

## 4 Conclusion

Corned fish was processed with red fermented rice and nitrite salt has an effect significantly to the proximate (ash, protein and fat content), color and sensory evaluation, and has no effect to the pH, fatty acids profile and amino acid profile. Corned fish processed using red fermented rice produces a sharper red color and better sensory characteristic (appearance, odor, color and taste) compared with corned fish processed with nitrite salt. The addition soy protein isolates affected the increasing of pH, the intensity of the red and yellow sensory characteristic and non-essential amino acids in corned fish processed with red fermented rice. Corned fish contains quite complete of essential fatty acids, and essential amino acid in corned fish can be used as a source of amino acids to meet the needs of amino acids in the body. Based on this study, corned fish processed with red fermented rice and added with 2% soy protein isolate resulted the best product. But using this formula the texture of the product has a harder texture, therefore it is necessary to improve texture for future research.

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