Quality of brine boiled Indian mackerel (Rastrelliger sp.) with different cooking methods and additions of liquid smoke

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Abstract. Indian mackerel (Rastrelliger sp.) is an important commodity and widely processed into brine boiled fish involving salt in the process. Improper cooking process could reduce nutritional value including amino acids lysine. This study was aimed to process brine boiled fish with two different methods. Effects of concentration of liquid smoke and processing methods were evaluated. Brine boiled fish with the addition of 5% liquid smoke with steaming and boiling methods had higher levels of lysine (0.12% and 0.05% compared to brine boiled fish 0%). Brine boiled fish with the addition of 5% with steaming and boiling methods had higher levels of dissolved protein which were 0.08% and 0.06% compared to brine boiled fish 0%. Brine boiled fish 5% with the steaming method produced lower moisture content i.e 1.82%, and 1.18% compared to brine boiled fish 0%. The best quality brine boiled fish was obtained with the steaming method and the addition of 5% liquid smoke, produced 0.56% of lysine content, 0.65% of dissolved protein content and 72.43% of moisture content, and organoleptic value was 7.51 < μ < 7.99.

Keywords: brine boiled fish, Indian mackerel, liquid smoke

1. Introduction

Indian mackerel (Rastrelliger sp.) is a small pelagic fish that has a large population. Mackerel has an economical price with high nutritional value and can be processed into various kinds of processed products such as Ajifurai, Peda, Salted, and brine boiled fish. One of the fish preservation methods commonly carried out by the community is brine boiled fish, an industry of brine boiled fish in Indonesia 2017 of 11.561 unit or 19.13%, but its processing brine boiled fish uses a fairly high temperature of 70°C-105°C. If the temperature is too high, it could damage the nutrient content one of which is amino acid lysine. The materials that can maintain the amino acid content of lysine in brine boiled fish is needed, one of the ingredients is liquid smoke. Liquid smoke is the result of the pyrolysis process of a corncob. Liquid smoke can be used as an antibacterial and flavoring. This is affected because liquid smoke contains phenols and organic acids which can inhibit microbial growth which can damage the amino acid lysine before the cooking process.
2. Materials and methods

2.1. Materials
The raw materials used in this study were fresh Indian mackerel, salt, and corncob liquid smoke. The chemicals used for testing were distilled water, NaHCO₃, Ninhydrin, HCl, Ether, NaOH, CuSO₄, Aquadest. The tools used is basins, "reyeng" bamboo baskets, stopwatch, trays, Erlenmeyer, measuring cups, thermometers, volumetric flasks, spectrophotometer, test tubes, clamping devices, desiccator, analytical scales, cups, dan oven.

2.2. Methods
The study began with an organoleptic test of fresh Indian mackerel. After being decratoio of suitable for consumption, then mackerel was processed by cutting off its head and viscerating and washing it under running water. After that, the mackerel was soaked in 0% and 5% liquid smoke with salt solution then stored at 5°C in the refrigerator for 25 minutes. Then the mackerel was arranged in "reyeng" bamboo baskets, then the fish was cooked with different cooking treatments, steaming and boiling with a temperature of 60°C -70°C with a cooking time of 15 minutes. The cooked brine boiled fish was then cooled and analyzed for each parameter.

The research method used was experimental laboratories using a Factorial Completely Randomized Design (RALF) pattern, which was the addition of liquid smoke and a different cooking process, using two factors. Analysis of non-parametric data was used to analyze data produced from sensory testing of Indian mackerel brine boiled fish. The analysis of non-parametric data was Kruskal Wallis-Dunn's Multiple Comparison and carried out further tests using Mann-Whitney. The study was conducted from April to June 2019 at the Faculty of Fisheries and Marine Sciences, Diponegoro University. The process of producing liquid smoke and the redistillation process was carried out at PT. Asap Cair Multiguna, Semarang. Appearance testing fresh fish and boiled fish hedonic were done in the processing laboratory Faculty of Fisheries and Marine Affairs, Diponegoro University. Testing of lysine levels, dissolved protein levels, and moisture content were carried out in the Pratama Chem-Mix laboratory in Yogyakarta.

3. Result and discussion

3.1. Organoleptic result of fresh Indian mackerel (Rastrelliger sp.)
Organoleptic values performed on fresh Indian mackerel obtained a confidence interval between 8.04< µ < 8.18 at a 95% confidence level. Following the scoresheet specifications of the fresh fish, brine boiled fish have convex eyeball, shiny clear corneas just like specific fish species. Gills with deep red with a little transparent mucus. The flesh with the incision was a brilliant specific type and strong flesh tissue. A fresh and specific type of smell. Solid and compact fish texture. These characteristics indicated that fresh mackerel was still fresh and suitable for further processing into other products. Najih et al (2014) stated that the characteristics of fresh fish had the same characteristics as live fish or fish that have just been caught and had not undergone physical changes, the characteristics of fresh fish were bright clear eyes, convex and clear corneas, bright red gills, brilliant incisions of the meat, mucus layer on the surface were thin and clear, and fish scales were still strongly attached to the fish. Fish had the odor of fish specifications and the texture of solid and flexible fish meat when pressed would return to normal.

3.2. Lysine content of brine boiled Indian mackerel (Rastrelliger sp.)
Lysine is one of the essential amino acids that cannot be formed in the human body. The results of the value of lysine levels are seen in figure 1.
Based on the figures, the addition of liquid smoke and different cooking processes affected the levels of lysine in brine boiled fish. Brine boiled fish 5% liquid smoke with steaming and boiling process produced higher levels of lysine rather than 0% liquid smoke with boiling and steaming cooking process. The addition of liquid smoke before the cooking process could also help to control the growth of decay microbes which could reduce the lysine amino acid. According to Megawati et al (2014), the largest lysine content in smoked fish with a concentration of 5% liquid smoke, high lysine content which was 1.02% due to the presence of liquid smoke which inhibited the growth of decomposing microorganisms which could degrade lysine and liquid smoke could increase the digestibility of protein in brine boiled fish. Sumpono et al (2017) also stated that liquid smoke was the result of condensation containing phenol, acetic acid, and carbonyl which had antibacterial benefits.

![Figure 1](image)

**Figure 1.** Lysine content of Indian mackerel brine boiled fish with the addition of liquid smoke and different cooking processes.

The steaming process was one of the cooking processes that used water vapor that came from boiled water while boiling was the cooking process using water media directly so that it could cause damage the cell wall so that the water could enter the brine boiled fish cells. According to Kusnandar (2010), the heating process with a high temperature of 80°C-160°C could decrease the level of lysine by about 50-90%. Alyani et al (2016) also stated that the cause of a decrease in lysine content in brine boiled bandeng fish due to the physical treatment carried out in processing such as boiling processes in processing which could cause heat which directly interacted with brine boiled fish.

### 3.3. Dissolved protein content of brine boiled Indian mackerel (Rastrelliger sp.)

The result of dissolved protein content can be seen in figure 2. The differences in the data obtained affected by liquid smoke and the difference in the cooking process. The figure showed the difference in the cooking process, which was boiling and steaming, was different. Brine boiled fish processed by the boiling process had a low dissolved protein compared to cooking with the steaming process. Brine boiled fish with the steaming process would reduce the water in mackerel due to the evaporation during cooking salt boiled fish with a difference of 0.08% with 5% liquid smoke and 0.06% with 0% liquid smoke. According to Irawati et al (2016), dissolved protein content decreased by 6.12% for 120 minutes of cooking. This was due to the cooking process, the heat could cause the protein in the fish to be hydrolyzed and easily dissolved. This was confirmed by Dewi et al (2019) which stated that protein in fish would decrease because at high temperatures alkaline groups or acid groups would be damaged causing a decrease in protein. Widiastuti et al (2019) stated that acidic compounds could affect protein denaturation because proteins lose their properties in binding fluids in fish.
Figure 2. Dissolved protein content of Indian mackerel brine boiled fish with the addition of liquid smoke and different cooking processes.

3.4. Moisture content brine boiled Indian mackerel (Rastrelliger sp.)

Moisture content is one of the chemical properties in a material that shows the water content in food. The content can be seen in figure 3. The difference in the process of cooking brine boiled fish could affect the yield of moisture content in Indian mackerel brine boiled fish. Brine boiled fish with the cooking process by steaming produced a lower moisture content compared to the cooking process with the boiling process. The decrease in water content in brine boiled fish is influenced by the evaporation of water in the material during the cooking process because of the pressure difference between the material and the cooking medium. According to Nilasari et al. (2017), evaporation of the material was influenced by the difference in vapor pressure between water in the material and water vapor in the air, the water in the material usually had a greater pressure, so there was a mass transfer of water from the material into the air.

Figure 3. Moisture content of brine boiled fish Indian mackerel with the addition of liquid smoke and different cooking processes.

The addition of liquid smoke could affect the moisture content in brine boiled fish during the cooking process. Moisture content in brine boiled fish with the addition of liquid smoke with a concentration of 5% obtained a lower yield compared to brine boiled fish with a concentration of 0%, because liquid smoke could attract free moisture to release in fish, so the greater the concentration of liquid smoke, which was used to soak the brine boiled fish, the moisture content in the brine boiled fish would be lower. According to Ardianto et al. (2014), fish with the addition of liquid smoke with a high concentration in the processing process would increase the moisture content of this material because liquid smoke could bind free moisture to the material during the processing process. According to Dheko et al. (2017), the lowest water content was owned by beef sei’i quality with a moisture content of 42.02% with the addition of liquid smoke and control 67.61%.
3.5. The result of panelist preference (hedonic) for brine boiled Indian mackerel (Rastrelliger sp.)

The result of panelist preference (hedonic) for Indian mackerel brine boiled fish can be seen in table 1.

| Treatment | Appearance | Odor | Flavor | Texture | Confidence Interval |
|-----------|------------|------|--------|---------|---------------------|
| AK        | 7.53±0.819<sup>a</sup> | 8.4±0.932<sup>a</sup> | 7.37±1.188<sup>a</sup> | 7.3±1.028<sup>a</sup> | 7.18<µ<7.68          |
| AR        | 7.6±0.96<sup>a</sup>  | 7.3±1.15<sup>b</sup>  | 7.37±1.09<sup>a</sup> | 7.87±0.93<sup>a</sup> | 7.28<µ<7.82          |
| BK        | 7.8±0.924<sup>a</sup> | 7.7±0.749<sup>ab</sup> | 7.73±0.98<sup>a</sup> | 7.76±0.897<sup>b</sup> | 7.51<µ<7.99          |
| BR        | 7.67±1.178<sup>a</sup> | 7.53±1.074<sup>ab</sup> | 8.13±1.008<sup>ab</sup> | 7.6±1.13<sup>a</sup> | 7.46<µ<8.02          |

Note: Superscripts with different letters indicate a (*) significant difference between treatments (p<0.05).

Based on the table, overall the panelists liked the physical condition of brine boiled fish with a favorite value between 7 and 8. The level of preference for brine boiled fish with the addition of 0% and 5% liquid smoke concentration with different cooking processes.

3.5.1. Appearance. Processing of brine boiled fish with the addition of liquid smoke and the different cooking process did not affect the appearance of brine boiled fish Indian mackerel. This was because the brine boiled fish with the concentrations of 0% and 5% and the difference in cooking processes had the same appearance, namely intact appearance, intact stomach, and silver and slightly yellowish. This was influenced by the smoke component attached to the brine boiled fish. According to Hadinoto and Kalanus (2017), salt boiled fish with the addition of liquid smoke was very favored by panelists because of the presence of smoke components that line the outside and the combined process of soaking salts that caused fish meat to be savory and caused more attractive in the appearance, texture, and color specifications.

3.5.2. Odor. Based on the results of the Mann-Whitney test, it was also seen that the level of preference of the panelists resulted that the differences in the addition of liquid smoke and the different cooking process affected the Odor of brine boiled fish. This was influenced by differences in the concentration of liquid smoke given to brine boiled fish, brine boiled fish with 0% liquid smoke had a distinctive smell of brine boiled fish while brine boiled fish with a concentration of 5% had a distinctive odor of smoke derived from phenol compounds that permeate mackerel during processing to make brine boiled fish. According to Susanto (2014), fish soaked in liquid smoke would produce a distinctive odor of wood, the odor of wood contained phenol, carbonyl and acid compounds that could produce the odor of smoke that was favored by panelists. Wicaksono et al. (2014) also stated that the presence of phenol compounds in liquid smoke that seep into salt boiled fish could affect the odor of the fish.

3.5.3. Flavor. Five percent of liquid smoke had a taste that was more enjoyable and much favored by panelists. It was influenced by the components of liquid smoke that seep into fish meat during soaking compared to brine boiled fish with a concentration of 0%. This was also influenced by the binding of water on the fish during processing and influenced by the cooking process that could change the structure of proteins that could increase the digestibility of brine boiled fish. According to Nursiwi et al. (2013), the taste was one of the factors that determined the quality of a product that would be consumed or not by the consumers, thus the taste could affect the level of acceptance of the panelists. According to Setyastuti et al. (2015), the distinctive taste of smoked fish was caused by phenol compounds found in liquid smoke interacting with amino acids and fish meat proteins. According to Handayani et al. (2017), the taste produced by brine boiled fish had a savory and specific
type of salt boiled fish. This was influenced by the level of maturity in the fish and the evaporation of water in the material so that the distinctive taste in the fish would be felt.

3.5.4. Texture. Based on the panelists' favorite results, it appeared that hedonic testing produced an average that did not affect the texture, this meant that the addition of liquid smoke with different cooking processes had no difference in texture. Brine boiled fish Indian mackerel had a dense and compact texture after cooking with different treatments. This was influenced by the denaturation of protein in fish which resulted in the moisture in the material coming out and producing a denser and thicker fish texture. Hermiastuti (2013) stated that steaming before storage aimed to reduce the water content in the raw material so that the texture of the material became compact.

4. Conclusion

The conclusion obtained from this study was the effect of the addition of 5% liquid smoke to brine boiled fish produced higher lysine content compared to 0% liquid smoke and the steaming process produced higher lysine content compared to the boiling process. The addition of 5% liquid smoke also affected dissolved protein content because it produced higher content of dissolved protein compared to 0% liquid smoke and was supported by steaming compared to boiling. Moisture content with the addition of 5% of liquid smoke had lower moisture content than 0% of liquid smoke. This was influenced by the different cooking processes, namely steaming and boiling. Moisture content on the boiling process had higher water content than the steaming process.

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