Fatty acid profile and cholesterol level of smoked whiteleg shrimp (*Litopenaeus vannamei*) with different liquid smoke concentrations

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**Abstract.** Whiteleg shrimp (*Litopenaeus vannamei*) is an important marine products with high nutritional values but its high cholesterol content may have negative impact to human health. Certain processing techniques may be applicable to reduce the cholesterol content to lower the risk. One of them is smoking the shrimps with clove branches liquid. This research was aimed to determine the effect of clove branches liquid smoke concentrations on cholesterol levels of smoked whiteleg shrimps. The research materials were whiteleg shrimps and clove branches liquid smoke. The samples of shrimps were exposed to different levels of liquid smoke concentration, i.e. 0%, 5%, 10%, and 15%. The experiment showed that the use of the liquid smoke reduced cholesterol level, increased saturated fatty acid (*i.e.* capric acid, lauric acid, stearic acid), unsaturated fatty acid (linoleic acid, oleic acid), lipid content and reduced moisture content. It was concluded that the use of clove branches liquid smoke can reduce the cholesterol concentration in the smoked shrimps.

**Keywords:** cholesterol, fatty acid profile, liquid smoke, whiteleg shrimp

1. **Introductions**

Shrimp is one of favourite foods because of its taste and high protein content. Shrimps have nutrients in the form of protein, fat, moisture, energy, essential amino acids, fat composition, macro minerals, and micro minerals. Dayal et al (2013) showed that the nutritional content of 100 grams of shrimp in the form of protein was 19.4±0.56 grams; fat 1.15±0.19 gram; moisture 76.3±0.57 grams; and energy 89.0±1.12 kcal. Whiteleg shrimp (*L. vannamei*) contains 257.5±3.71 mg saturated fatty acids, 163.5±7.90 mg monounsaturated fatty acids and 321.0±5.23 mg polyunsaturated fatty acids. Besides of its high nutritional value, consuming shrimps has a high risk of health due to the presence of high cholesterol content of 188.26 mg/100g (Agustono et al 2015). The normal total cholesterol in human blood is 160-200 mg/100g. The higher cholesterol level in the blood, the greater the risk of atherosclerosis, *i.e.* thickening and hardening of the arterial wall caused by cholesterol accumulation (Eldiaz et al 2018).
One of the ways to reduce cholesterol levels in shrimp is by applying heat treatment and using natural ingredients, e.g. by adding antioxidants in the form of liquid smoke. This can be done by fumigating the shrimps using clove branches liquid smoke. Liquid smoke is a natural preservative containing phenol which is an antioxidant and commonly used as a food preservative. Swastawati et al (2018) showed that the phenol component and its derivatives in liquid smoke can act as antioxidants. The phenol contained in liquid smoke has antioxidant activity so as to prevent fat oxidation. Cholesterol content decreased because the phenol compounds in liquid smoke break the chain of fat oxidation (Swastawati 2007). This study was conducted to examined the effect of clove branches liquid smoke on the cholesterol content in the fumigated product, i.e. smoked whiteleg shrimp.

2. Material and methods

2.1. Material
This study used whiteleg shrimp and clove branches liquid smoke. The equipments were basins, measuring cups, digital scales, and a oven.

2.2. Methods
Whiteleg shrimp were weighed and cleaned then immersed with clove branches liquid for 15 minutes (following Sarastati et al 2014). The study was implemented using an experiment with completely randomized design with single factor (concentration of the liquid) and three replicates. The shrimps were divided into four groups of 3 pieces. Each group was immersed in different concentrations of the liqued of 0%, 5%, 10%, and 15%. After being drained, the shrimps were placed the oven for 1 hour at temperature of 100°C.

Data collected were results from the observation of hedonic testing, fatty acid profile, cholesterol level, lipid content, phenol content, and moisture content. The data were analyzed for normality and then tested using analysis of variance (ANOVA) with the help of SPSS 16 with α = 5%. The process of making smoked whiteleg shrimp and hedonic tests were carried out at the Fisheries Product Laboratory, Faculty of Fisheries and Marine Sciences, Diponegoro University. Testing of fatty acid profiles, cholesterol levels, fat content, phenol levels, and moisture content was carried out at the Chem-mix Pratama Laboratory, Bantul, Yogyakarta.

3. Results and discussions

3.1. Hedonic value
Average value of hedonic on smoked whiteleg shrimp with addition of different clove branches liquid smoke concentrations was shown at table 1.

| Table 1. Average value of smoked whiteleg shrimp. |
|--------------------------------------------------|
| Indicators                                    | Liquid Smoke Concentrations |
|                                                 | 0%      | 5%      | 10%     | 15%     |
| Appearance                                    | 6.93±0.83\textsuperscript{a} | 7.40±0.93\textsuperscript{b} | 7.87±0.73\textsuperscript{c} | 7.60±0.97\textsuperscript{c} |
| Aroma                                         | 6.03±1.43\textsuperscript{a} | 6.90±1.18\textsuperscript{b} | 7.60±0.62\textsuperscript{c} | 7.80±0.61\textsuperscript{c} |
| Taste                                         | 6.10±1.35\textsuperscript{a} | 7.20±0.92\textsuperscript{b} | 7.87±0.86\textsuperscript{c} | 7.40±0.67\textsuperscript{d} |
| Texture                                       | 6.07±1.74\textsuperscript{a} | 7.53±1.11\textsuperscript{b} | 7.73±0.98\textsuperscript{b} | 8.00±0.91\textsuperscript{b} |
| Average                                       | 6.28±1.34 | 7.26±1.04 | 7.77±0.8 | 7.70±0.79 |

Note: This data is the average result of thirty panelists±standard deviation.

The smoked whiteleg shrimp with the addition of the concentration of clove branches liquid smoke had a higher appearance value compared to the smoked whiteleg shrimp with no treatment (concentration of 0%). The smoked whiteleg shrimp with clove liquid treatment appeared to be brownish orange which
was more attractive to the panelists. Swastawati et al (2014a) showed that smoked fish have a cleaner appearance, attractive golden brown color, and a denser and more compact texture. The appearance and texture of the smoked fish was formed as a result of the reaction of the carbonyl group present in the smoke reacting with the protein and fat in the fish. Smoke had an important role in the formation of color and texture in smoked fish. The main carbonyl component in smoke that had an important role was phenol.

Smoked whiteleg shrimp with the addition of concentrations of clove branches liquid smoke 5%, 10% and 15% had a higher aromatic value compared to the control. According to previous study fish samples soaked using liquid smoke also experience a change in odor, the dominant fish with a fishy odor will turn into a distinctive smoky smell that can’t be replaced by other ways. The change in odor was caused by the presence of phenol compounds which were the desired specific aroma forming compounds in the smoked products.

Smoked whiteleg shrimp with the concentration of clove branches liquid smoke 5%, 10% and 15% had a better taste value compared to control. Smoked fish have a very specific taste, which was a delicious taste of fuming. The taste was produced by organic and phenol acids and other substances as helpers postulated by Mareta and Shofia (2011). Nanholy (2014) stated that functional properties found in liquid smoke such as for gave flavor and taste due to the presence of phenol and carbonyl compounds. Carbonyl compounds in smoke have a role in coloring and taste of smoked products. This group of compounds has a unique caramel-like aroma.

Smoked whiteleg shrimp with the concentration of clove branches liquid smoke 5%, 10% and 15% had a better texture value compared to control. The panelist preferred compact textures from the shrimps with treatment. This showed that smoked whiteleg shrimp with liquid smoke concentration was better products. Astati (2013) stated that liquid smoke contains phenol and smoke compounds that increased the binding capacity of meat and provides a compact texture.

3.2. Fatty acid profile
The addition of clove branches liquid smoke in the immersion prior to fumigation increased the portion of saturated fatty acid (i.e., capric acid, lauric acid, and stearic acid), except for liquid smoke of 15% (figure 1). The liquid smoke of 5% appeared to be more effective in increasing the fatty acid content than the liquid smoke of 10 and 15%. Budiarti et al (2016) reported similar effect in increasing the content of saturated fatty acid (i.e. stearic acid, palmitic acid, and myristic acid) for smoked eel after being immersed in different immersion period (i.e., 0, 15, 25 and 35 minutes). She found that the immersion period was 15 minutes was the most effective in increasing the fatty acid (i.e. 25.3%). These findings indicate that addition of clove branches liquid smoke increase the fatty acid content but to much concentration may not necessary result in better result. Swastawati et al (2014a) reported that the differences in fuel and fumigation methods used that can influence the chemical characteristics of smoked fish are produced.

The addition of clove branches liquid smoke in the immersion prior to fumigation increased the portion of unsaturated fatty acid (i.e., linoleic and oleic acid), except for liquid smoke of 5% (figure 2). Such increase can be driven by the presence of antioxidant (i.e. phenol) in the liquid smoke. Similar phenomenon was reported by Nashiruddin et al (2016) for smoked catfish. The antioxidants prevent the occurrence of rancidity so that it can prevent damage to unsaturated fatty acids.
Figure 1. Saturated fatty acid profiles of smoked whiteleg shrimp by different levels of liquid smoke concentration (liquid smoke 0%, 5%, 10%, 15%).

Figure 2. Unsaturated fatty acid of smoked whiteleg shrimp by different levels of liquid smoke concentration (liquid smoke 0%, 5%, 10%, 15%).

The phenol in coconut shell liquid smoke and corncob was thought to prevent the rancidity process which can maintain unsaturated fatty acids. Swastawati et al (2014b) reported that liquid smoke was able to act as an antioxidant because of the main carbonyl component which was dominated by phenols and their derivatives (e.g., phenol; 2 methoxyphenol; formic acid and 2.6 dimethoxyphenol). This components act as an antimicrobial and antioxidant by preventing the rancidity process, so that damage to unsaturated fatty acids can be avoided. The liquid smoke was effective to inhibit the oxidation of fat in very small amounts, so it can reduce fat oxidation (Prasetyowati et al 2014).

3.3. Cholesterol
The effect of addition of liquid smoke was visible in reducing cholesterol levels of the smoked whiteleg shrimp: the higher the concentration of liquid smoke the lower the cholesterol content (figure 3). The concentration of liquid smoke was 5% because it reduced cholesterol levels by 45.35 mg/100g when compared to no treatment or 0% concentration) while the 15% concentration reduced 114.36 mg/100g cholesterol. Hutomo et al (2015) reported similar effect of addition of liquid smoke for smoked eel. The diagram of the analysis of cholesterol in smoked whiteleg shrimp is shown in figure 3.
Figure 3. Cholesterol content of smoked whiteleg shrimp by different levels of liquid smoke concentration.

3.4. Lipid
Different concentration of liquid smoke was 0%, 5%, 10%, and 15% resulted in the lipid content in the smoked whiteleg shrimp (figure 4). Fumigation with the addition of liquid smoke was able to maintain the quality of ingredients while maintaining lipid nutritional value. Nashiruddin et al (2016) reported similar effect from coconut shell liquid smoke on levels of lipid for smoked catfish. This is presumably because smoking using liquid smoke can maintain the quality of smoked catfish and maintain fat nutritional value without changing the fat composition itself. It can also due to the reduction of water content, if the water content is lower then the fat content of the smoked fish is higher and vice versa.

In this case, by reducing the water content, the product will have higher lipid content in the smoked whiteleg shrimp. Novia et al (2012) reported phenol compounds contained in coconut shell liquid can maintain lipid from damage. Increasing the concentration of phenol in the product that the process of lipid damage can be inhibited.

Figure 4. Lipid content of smoked whiteleg shrimp by different levels of liquid smoke concentration.

3.5. Phenol
The phenol concentration was strongly influenced by the concentration of liquid smoke (figure 5). The highest number of phenol levels found in smoked whiteleg shrimp was 15% liquid smoke concentration that was 207.2 ppm, but the addition of liquid smoke which was effective in increasing phenol levels in smoked whiteleg shrimp was the addition of 5% liquid smoke concentration because it can increase...
phenol levels by 34.56 ppm. This indicated that the higher the concentration of liquid smoke in the product, the higher the phenol content of the product. Arizona et al (2011) reported that the phenol level in meat increased from 0.16% to 0.21% after being given the addition of liquid smoke treatment. The higher the concentration of liquid smoke added to the meat, the higher the phenol content of meat.

Figure 5. Phenol content of smoked whiteleg shrimp by different levels of liquid smoke concentration.

The amount of phenol content found in smoked whiteleg shrimp was determined by the amount of liquid smoke concentration used or added. Hadiwiyoto et al (2000) stated that in the fumigation of liquid the amount of smoke that penetrated on fish tissue depends on the concentration of the smoke solution and the length of the immersion of the fish into the smoke solution. The results of phenol levels were higher along with the amount of liquid smoke concentration. The content of liquid smoke phenol compounds in the process will increase with the addition of liquid smoke concentrations postulated by Indiarto et al (2012).

3.6. Moisture

The addition of liquid smoke was able to intensify the reduction of the moisture of the smoked whiteleg shrimp (figure 6). The addition of 15% liquid smoke concentration in smoked whiteleg shrimp was the smallest moisture content compared to other concentrations. The greater the concentration of liquid smoke, the smaller the value of the moisture content. Budiarti et al (2016) reported that the moisture content of the control (0 minute immersion) and the treatment of differences in immersion time with liquid smoke for 15 minutes, 25 minutes, and 35 minutes in smoked eel products respectively were 43.24%, 35.20%, 30.39%, and 26.42%. Reduction in moisture content of the four products was mainly caused by fumigation but the addition of liquid smoke appeared to make the moisture much lower. Ardianto et al (2014) stated that the moisture content in arabushi was reduced due to the addition of the concentration of liquid smoke during immersion. The greater the concentration of liquid smoke used for immersion, the smaller the value of the moisture content. This was because liquid smoke can bind the free water that was present in fish during the processing.

The oven process also helped in reducing the moisture content of smoked whiteleg shrimp. Anwar et al (2014) stated that the sample that dried in the oven had a longer resistance than fresh samples, because drying will reduce the moisture content in the sample, so it can prevent fungal growth so that the chemical composition in the sample did not change.
Figure 6. Moisture content of smoked whiteleg shrimp by different levels of liquid smoke concentration.

4. Conclusions

The use of the liquid smoke reduced cholesterol level, increased saturated fatty acid (i.e. capric acid, lauric acid, stearic acid), unsaturated fatty acid (linoleic acid, oleic acid), lipid content and reduced moisture content.

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