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Application of Liquid Smoke for *Chikuwa tilapia*

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Abstract: Chikuwa is one of fish jelly products which is usually made by traditional process on charcoal to provide odour and flavour of smoke. One methods that becoming popular nowadays is using liquid smoke to give odour and flavour of smoke in fish product. The purpose of this research was to determine the effect of using liquid smoke to characteristics of chikuwa tilapia. In this research, lemongrass liquid smoke, coconut shell liquid smoke, and corncob liquid smoke were added in the dough then heated in the oven. Besides, the process of making chikuwa control by oven without addition of liquid smoke. The results showed that different of liquid smoke has significantly different to phenol content, proximate content, hardness, and hedonic test of chikuwa tilapia. The phenol content was between 47.57 ppm to 129.23 ppm, moisture content was 56.13% to 62.61%, protein content was 11.90% to 15.51%, lipid content was 0.96% to 1.98%, ash content was 3.02% to 4.27%, and hardness was 2176.06 gf to 2600,48 gf. Based on the hedonic test, it is known that chikuwa tilapia using coconut shell liquid smoke is preferred over chikuwa tilapia without the addition of liquid smoke and chikuwa tilapia using lemongrass and corncob liquid smoke.

1. Introduction

Tilapia is one of the leading commodities of freshwater fish in Indonesia. Based on Ministry of Marine Affairs and Fisheries Republic of Indonesia [1], the value of tilapia increased by 19.03% in the period of 2010 to 2014. In 2010, the value of tilapia production was 464.191 tons and 912.613 tons in 2014. One of the factors that influence the high demand for tilapia was due to the nutritional content. According to Agustini *et al.* [2], white flesh fishes has high protein myofibrillar such as actin and myosin which results good gel strength. Therefore, tilapia is suitable as a raw material for making fish jelly products, such as chikuwa.

Chikuwa is one of fish jelly products which usually processed by roasting and shaped like a tube.. The definition of chikuwa products is explained in Bhatkar *et al.* [3] that the traditional process of making chikuwa is by moulding fish paste on wood or bamboo then roasting it on charcoal until the surface is brownish. As a result of the roasting process it can provide the flavour and odour of smoke on the chikuwa product. Liquid smoke usually use an alternative methods to give flavour and odour of smoke to fish product. Liquid smoke can be use as flavouring agent in ham and fillet, for antioxidant agent in sausages and for antibacterials can be use in fish balls [4,5,6].

Liquid smoke is acetic acid that is acquired through pyrolysis process from material that consists of cellulose, hemicellulose, and lignin components [5]. The advantages are easy to apply, faster process, give distinctive characteristics to the final product in the form of odour, colour and flavour and do not



pollute the environment. The different of raw material can effect the quality of liquid smoke and the product with addition of liquid smoke. According to Swastawati *et al.* [7], smoke stingray with addition coconut shell and corncob liquid smoke can improve the quality of product. Therefore, this research is to determine the effect of addition liquid smoke in the the characteristic of chikuwa tilapia.

2. Research Methods

2.1. Materials

Tilapia fillets were collected in PT. Aquafarm (Semarang, Indonesia). Coconut shell liquid smoke, corncob liquid smoke, and lemongrass liquid smoke were obtained from PT. Asap Cair Multiguna (Semarang, Indonesia).

2.2. Methods

2.2.1. Production of Chikuwa

Production of chikuwa was based on modification the research of Bhatkar *et al.* [3]. Tilapia fillets were cut off into small dice shapes and then washing them in ice water. Furthermore, mixing tilapia meat 70% (w/w), salt 3% (w/w), sugar 2% (w/w), potato flour 15% (w/w), ice water 10% (v/w), and liquid smoke (lemongrass, coconut shell, or corncob) 2% (v/w). In this research, the process of making chikuwa without addition of liquid smoke too as a control. After mixing, then it is refined with a food processor. The dough that has been smooth, moulded with aluminum mold and oven using an electric oven. The first oven is done for 5 min, then the aluminum mold is released and oven again for 20 min. Chikuwa that has been cooked will be brownish in color.

2.2.2. Total Phenol

Total phenol was tested using method of Orak [8], 5 g of the sample was put into erlemeyer and diluted with distilled water to a volume of 100 ml. The solution is filtered and then centrifuged until a clear solution is obtained. Clear solution was taken after centrifuge was taken by 1 ml and put in a test tube then added 0.5 ml follin type, added 1 ml of saturated Na₂CO₃ solution and let stand for 10 min. The next step is added distilled water to a volume of 10 ml then in the vortex until homogeneous. The absorbance of the sample is read by a spectrophotometer (Thermo Spectronic, Genesys 20, USA) with a wavelength of 730 nm. The total phenol content of the sample was calculated using the standard gallic acid curve.

2.2.3. Proximate Content

2.2.3.1. Moisture Content

Samples were dried by using an oven for 24 h at 100 ± 5 °C until the weight of samples remained constant. The percentage of moisture content was calculated based on ratio of dry sample weight and wet sample weight by 100% [9].

2.2.3.2. Protein Content

Protein content were determined by using Kjeldahl Method [10]. Protein content formula (wb) are as follows :

$$\text{Crude protein (\%)} = \frac{(V_a - V_b) \text{HCl} \times N \text{HCl} \times 14,007 \times 6,25}{W \times 1000} \times 100\% \quad (1)$$

Note : N HCl = normality of HCl (0,02 N)

V_A = ml HCl for sample titration

V_B = ml HCl for blanko titration

W = sample weight (g)

14,007 = weight from nitrogen atom

6,25 = amount of nitrogen base in fish protein

2.2.3.3. Lipid Content

Determination of lipid content used was Soxhlet method based on AOAC [9] with modification, where the principle lipid separation from material was using organic solvent non polar n-heksan.

$$\text{Lipid content (\% (wb))} = \frac{C - A}{B} \times 100\% \quad (2)$$

Note : A = the weight of an empty round flask (g)
 B = sample weight (g)
 C = extraction of round bottom and fat flask (g)

2.2.3.4. Ash Content

According to Swastawati *et al.* [7], principle method for determination of ash content is oxidation all of organic materials and calculating the last ash with gravimetric method.

$$\text{Ash content (\% (wb))} = \frac{B - A}{\text{Example weight (g)}} \times 100\% \quad (3)$$

Note : A = heavy empty porcelain cup
 B = weight of cup with ash

2.2.4. Hardness

Chikuwa tilapia was measured using a texture analyzer (TA Plus Ametek Lloyd Instruments Ltd, Hampshire, UK). The texture was compressed by cylindrical probe of 1.27 cm diameter and the gel has 2.5 cm height.

2.2.5. Hedonic Test

Hedonic test of chikuwa tilapia were evaluated using a 5 point hedonic scale (the smallest value indicate the most unpleasant) for appearance, flavour, odour, and texture. For this purposes, 30 untrained panelists with ages between 20 until 22 years old were used to evaluate the product.

2.2.6. Statistical Analysis

The design of this study used a completely randomised design. The data were carried out by one-way analysis of variance (ANOVA), then using Tukey's test to comparison of means by using SPSS version 17.0 for windows (SPSS Inc., Chicago, USA).

3. Results and Discussion

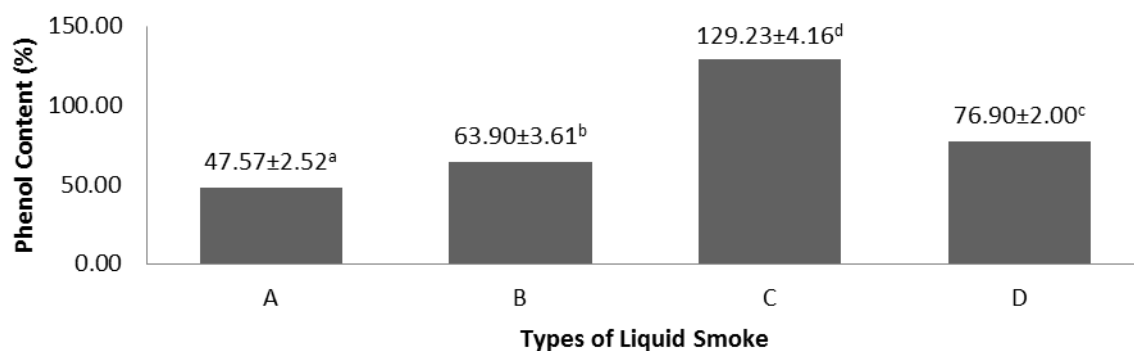
3.1. Total Phenol

Total phenol of chikuwa tilapia are shown in Fig. 1 where is the difference of liquid smoke has significantly different ($p < 0.05$). The results of total phenol showed the highest treatment in coconut shell liquid smoke (129.23 ppm) and the lowest in the control treatment (47.57 ppm). Variations in the levels of phenols contained in liquid smoke have an effect on the yield of total phenol in food. Total phenol in chikuwa tilapia added with liquid smoke correlated with total phenol of each liquid smoke. In this study, the total phenol of liquid smoke from lemongrass was 1.05%, coconut shell 6.70%, and corncob 2.55%. The difference in lignin content in the raw material of liquid smoke will affect the content of liquid smoke phenol compounds. The higher lignin content, the higher total phenol of liquid smoke [11].

The control treatment was detected to contain phenol even in small amounts. This is because in the chikuwa ingredients, potato starch contains phenolic compounds so that the chikuwa tilapia without

liquid smoke contains phenol. Pamulango *et al.* [12] stated that potatoes contain anthocyanin phenolic compounds which are derivatives of flavonoids.

All samples in this study had phenol content still within the safe limits allowed in food. The maximum phenol content is safe for consumption and is accepted by consumers, namely 0.02% to 0.1% or 200 ppm to 1000 ppm. Swastawati *et al.* [13] add that phenol content are said to be unsafe to consume if the value exceeds 317 ppm.



Note :

- A : No treatment or without addition of liquid smoke
- B : Lemongrass liquid smoke treatment
- C : Coconut shell liquid smoke treatment
- D : Corncob liquid smoke treatment
- The data is the average yield of three replications \pm standard deviation
- Different superscripts show significantly different ($p < 0.05$)

Figure 1. Phenol Content of Chikuwa Tilapia

3.2. Proximate Content

Table 1. Proximate Content of Chikuwa Tilapia

No	Parameter Proksimat	Treatment			
		A	B	C	D
1.	Moisture Content (%)	62.61±1.17 ^c	59.15±0.37 ^b	56.13±0.11 ^a	58.61±0.65 ^b
2.	Protein Content (%)	11.90±0.34 ^a	14.37±0.35 ^b	15.51±0.09 ^c	14.57±0.27 ^b
3.	Lipid Content (%)	0.96±0.22 ^a	1.90±0.63 ^a	1.98±0.67 ^a	1.91±0.24 ^a
4.	Ash Content (%)	3.02±0.05 ^a	3.61±0.04 ^b	4.27±0.17 ^c	3.14±0.02 ^a

3.2.1. Moisture Content

Moisture content of chikuwa tilapia are shown in Table 1 where is the difference of liquid smoke has significantly different ($p < 0.05$). The difference in the total phenol found in liquid smoke results in different moisture content. According to Hadanu and Apituley [14], each type of liquid smoke has different phenolic compounds depending on the type of wood. Many at least phenol that enters fish meat can affect the acceleration of evaporation. This is also reinforced by Zuraida *et al.* [6], that liquid smoke added to meatball products can cause water loss in the product.

The results for the moisture content of chikuwa tilapia showed that the highest moisture content was in the control treatment (62.61%) and the lowest was in the coconut shell liquid smoke treatment

(56.13%). According to the Ministry of Education, Culture, Sports, Science, and Technology-Japan in Kamaboko [15], the moisture content of kamaboko products such as chikuwa ranges from 69,9% to 75,8%.

3.2.2. Protein Content

The difference type of liquid smoke cause significantly difference in protein content of chikuwa tilapia ($p < 0.05$) (Table 1). The results for the protein content of chikuwa tilapia has the highest protein content in the coconut shell treatment (15.51%) and the lowest average was in the control treatment (11.90%). According to Swastawati *et al.* [7], the lower of moisture, the higher crude protein and lipid of smoked fish. It's because heating processed could reducing moisture which can give some effect like denaturation of protein and suspended minerals. Lasindrang [16] also explained that the addition of liquid smoke in a product can cause an increase in protein due to the nature of acidic liquid smoke so that the protein becomes insoluble. During the heating process can also cause shrinkage of water so that protein content will increase per unit weight of material [17].

3.2.3. Lipid Content

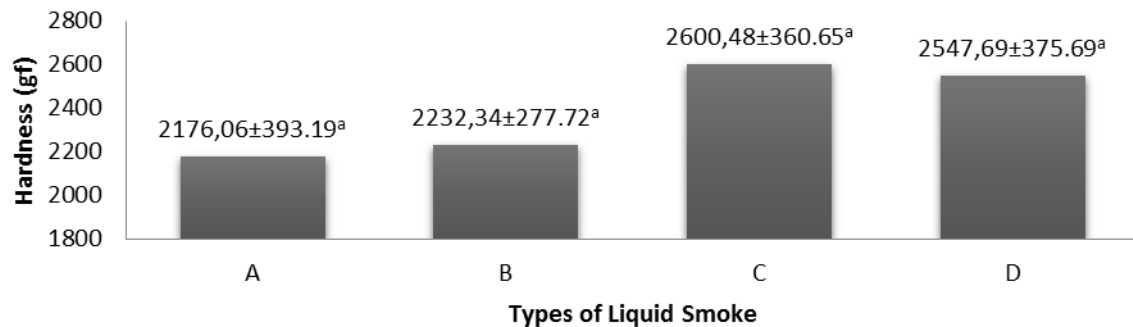
Lipid content of chikuwa tilapia are shown in Table 1 where is the difference of liquid smoke has no significantly different ($p > 0.05$). Liquid smoke has some advantages like antimicrobial and antioxidant. According to Budaraga *et al.* [5], liquid smoke contains many compounds that can grouped into phenol, acids, and carbonyl. Antioxidative components of the smoke are phenolic compounds that act as hydrogen donors and are usually effective in very small amounts to inhibit the oxidation reaction.

3.2.4. Ash Content

Table 1 shows that the addition of different types of liquid smoke causes significantly difference in ash content ($p < 0.05$). The ash content of chikuwa tilapia produced in this study ranged from 3.02% to 4.27%. This is influenced by the mineral content contained in a food ingredient. According to Bhattacharjee *et al.* [18], ash is an inorganic residue from food by combining organic components in its product. Hasanah and Suyatna [19] added that around 96% of food ingredients consist of organic matter and water, while the rest are mineral elements. Based on the research of Youssef *et al.* [20], the source of minerals, such as calcium, calium, zinc, iron, and magnesium indicated in smoke fish and the raw materials for liquid smoke.

3.3. Hardness

Hardness value (Fig. 2) is no significantly different ($p > 0.05$) due to liquid smoke concentration, material dose, temperature, roasting time, and the distance used are the same. Besides, using potato strach can maintain the texture of chikuwa tilapia. According to Liu *et al.* [21], addition of potato starch can reinforcing the surimi gels and positively related to chikuwa tilapia. The results of the haardness values obtained are different from studies of Sari *et al.* [22], that differences in texture occur because of differences in texture occur because of differences in moisture content in each concentration of liquid smoke added to smoked catfish. If the concentration of liquid smoke is low then the moisture content in smoked fish is high so the texture value is low. The highest gel strength of fish jelly product positively correlated with hardness [23].

**Figure 2.** Hardness of Chikuwa Tilapia

3.4. Hedonic

Table 2. Hedonic Test of Chikuwa Tilapia

Spesifikasi	Perlakuan			
	A	B	C	D
Appearance	3.43±0.50 ^a	3.73±0.45 ^b	4±0.64 ^{bc}	4.1±0.61 ^c
Taste	3.26±0.63 ^a	3.5±0.71 ^b	3.96±0.61 ^{bc}	4.03±0.53 ^c
Aroma	3.57±0.63 ^a	3.5±0.51 ^a	3.77±0.57 ^a	3.87±0.57 ^a
Texture	3.53±0.51 ^a	3.47±0.68 ^a	3.53±0.63 ^a	3.46±0.51 ^a

3.4.1. Appearance

Based on Table 2, it can be seen that the lowest value of the chikuwa tilapia appearance was in the control treatment ($p < 0.05$), which was equal to 3.43 and the highest value was in the corncob treatment of 4.1. The addition of liquid smoke showed an increased value of preference for the appearance of tilapia compared to the control. The appearance of chikuwa tilapia is generally shaped like a tube with a hollow center and the outer part is wrinkled, white, and has a brown ring on the outside. Chikuwa with liquid smoke lemongrass are light brown stems on the outside. Chikuwa tilapia with coconut shell liquid smoke are a brownish-coloured and chikuwa tilapia with corncob liquid smoke are brown. The appearance of chikuwa tilapia with addition of liquid smoke is preferred over control because the appearance of chikuwa is more brown due to the content of carbonyl and phenol in liquid smoke which plays a role in colour giving. According to Swastawati [24], the colour difference between products is due to the correlation between the amount of carbonyl and the type of raw material liquid smoke used. Jamilatun *et al.* [25] also added that the cause of the product is golden yellow to brownish because of the chemical reaction between carbonyl compounds and amino acid groups. In this research, the carbonyl content of lemongrass liquid smoke was 0.76%, coconut shell liquid smoke was 3.35%, and corncob liquid smoke was 20.24%.

3.4.2. Taste

Taste is one of the important factors in determining consumer acceptance of a product. Based on this study it is known that the use of different types of liquid smoke in chikuwa tilapia gives a significantly difference ($p < 0.05$) to the hedonic value of taste, where the most preferred chikuwa tilapia taste is

chikuwa with addition of coconut shell liquid smoke (Table 2). Chikuwa tilapia as control has a specific taste of tilapia, while chikuwa with the addition of lemongrass, coconut shell, and corncob liquid smoke has a distinctive taste of smoke. The addition of liquid smoke gives a distinctive taste of smoke and is one of the innovations in chikuwa tilapia products. In this case, the components of phenol, acid, and carbonyl compounds found in liquid smoke provide a distinctive taste of smoke in the products [26]. According to Varlet *et al.* [27] that guaicol, 4-methyl guaicol, and 2,6-dimethoxy phenol which play a role in giving smoke flavour.

3.4.3. Aroma

Aroma is one attraction in determining the good taste of a food. Based on the hedonic test on the aroma of chikuwa tilapia, the results showed that the use of different types of liquid smoke did not significantly difference the aroma of chikuwa tilapia ($p > 0.05$) (Table 2). This is because the concentration of liquid smoke is used in small amount, causing the aroma of smoke not to appear. Swastawati *et al.* [17] state that the method and concentration of liquid smoke have an effect on consumer acceptance of the aroma of fish meatballs. Nevertheless, based on the research of Saloko *et al.* [26], phenol compounds contribute significantly to aroma products which are preserved by smoked.

3.4.4. Texture

Based on Table 2, it can be seen that the use of different types of liquid smoke does not provide a significant difference in the preference value for the texture of chikuwa tilapia. This is caused by the use of liquid smoke in small amount and there is no difference between the temperature and heating time used in making chikuwa. According to Ernawati [28], there are several factors that influence the texture of the product, which is smoked temperature which can cause protein coagulated so that the texture is more compact and chewy.

4. Conclusion

The addition of three liquid smoke has significantly different on phenol content, moisture content, protein content, ash content, and panelist preference levels for appearance and taste specifications, while on lipid contents, hardness, and panelist preferences level for aroma and texture specifications has no significant differences. Chikuwa tilapia with the addition of coconut shell liquid smoke is the most preferred by panelists based on the appearance and taste.

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