PHYSICAL, CHEMICAL AND SENSORY PROPERTIES OF KENARI (*Canariun indicum* L.) SHELL LIQUID SMOKE-IMMERSED-BEEF ON DIFFERENT LEVEL OF DILUTION

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh tingkat pengenceran asap cair tempurung kenari terhadap sifat fisik, kimia dan sensoris daging. Daging sapi bagian *Longissimus dorsi* direndam dalam asap cair tempurung kenari pengenceran 1x, 2x, 3x, 4x, dan 5x selama 15 menit kemudian ditiriskan. Perlakuan diulang sebanyak lima kali dan dianalisis menggunakan Rancangan Acak Lengkap pola searah. Hasil yang diperoleh menunjukkan bahwa makin tinggi tingkat pengenceran maka sifat fisik, kimia dan sensoris semakin mendekati kualitas sampel kontrol. Tingkat pengenceran asap cair tempurung kenari mempengaruhi terhadap sifat fisik, kimia dan sensoris daging, kecuali kadar air dan protein. Kesimpulan bahwa semakin rendah tingkat pengenceran maka semakin mempengaruhi kualitas fisik, kimia dan sensoris daging kecuali kadar air dan protein.

Kata kunci : sifat daging sapi, asap cair, tempurung kenari, pengenceran

ABSTRACT

This research was aimed to study the effect of the dilution level of kenari shell liquid smoke to the physical, chemical and sensory properties of beef. *Longissimus dorsi* of beef immersed on Kenari shell liquid smoke on the level of dilution 1x, 2x, 3x, 4x, and 5x during 15 minutes with five replicates following Randomized Complete Design. The results showed that the higher level of dilution of liquid smoke kenari shell caused the physical, chemical and sensory properties which get closer to the quality of the control samples. The level of dilution affected almost all the properties, except the water and protein content. It was concluded that the lower levels of dilution caused the more affected into the physical, chemical and sensory properties of beef, except the water and protein content.

Keywords: beef properties, liquid smoke, kenari shell, dilution

INTRODUCTION

Smoked food products are found in many parts of Indonesia and the process is still traditional. Types of wood used as the fuel are different. For instance, preparation of smoked milkfish in Sidoarjo, East Java is conducted using mangrove wood, sawdust, baggase and wood used packing box. The smoked beef (se'i beef) in East Nusa Tenggara and fufu fish in North Maluku utilize the wood of Kosambi or *Kesambi* (*Schleichera oleosa*). Additionally, fufu fish in North Sulawesi employed the various of wood, coconut shell, coconut fiber and asar fish in Maluku used coconut fiber as the fuel.

The use of liquid smoke began to develop in the late of 1980s in order to replace the traditional smoking process (Pszczola, 1995). It is showed by the increasing of the research in the production of liquid smoke from various woods (Tranggono *et al*., 1996), coconut shell (Tranggono *et al*., 1996), *Vitis venivera* L. (Guillen and Ibargoitia, 1996), agricultural waste (Darmadji, 1996), *Fagus sylvatica* L. (Guillen and Ibargoitia, 1999), *Salvia* *lavandulifolia* (Guillen and Manzanos, 1999), spice solid wastes (Darmadji *et al*., 1999), rubber wood (Darmadji *et al*., 2000), cassava wood (Hadiwiyoto *et al.*, 2000) and oak (Guillen and Manzanos, 2002).

Researches in productions and applications of liquid smoke in food and non food products mainly use the agricultural and plantation wastes. Kenari is one of annual original Indonesian plantation whichis much found in Eastern Indonesia. Kenari shell has not been developed well yet. Thus, the shell is potential to be developed, especially by using the technology. By considering the texture, it hard texture so it can be applied as raw material in the production of liquid smoke. Pearson and Tauber (1984) stated that the hardwood was the best raw material in smoking process. In addition, Girard (1992) stated that the hardwood produced aroma and rich in acid and aromatic compounds.

The liquid smoke could be applied as antibacterial, antioxidant and flavoring agents. In addition it also displayed the properties of antibactery (Estrada *et al*., 1998; Darmadji, 1996; Karseno *et al*., 2001; Milly *et al*., 2008), antioxidant (Estrada *et al*., 1998; Darmadji *et al*., 1999; Guillen and Cabo, 2004; Soldera *et al*., 2008), preservative (Sih-Yuwanti, 2005), organoleptic or sensory (Darmadji *et al*., 1999; Hadiwiyoto *et al*., 2000; Sisko *et al*., 2007), texture (Martinez *et al*., 2004; Martinez *et al*., 2007), physicochemical (Gonulalan *et al*., 2003; Martinez *et al.*, 2007), chemical and microbiology (Sisko *et al*., 2007), benzo(a)piren content (Hadiwiyoto *et al*., 2000; Darmadji and Triyudiana, 2006).

Research on the production of liquid smoke and its application on the food products have been much conducted. However, the utilization of kenari as raw material in the preparation of liquid smoke has not been intensively performed. The preliminary study on the identification of volatile compounds of kenari shell liquid smoke found that the three major components were 2-furancarboxaldehyde or furfural (55.87%), 2-methoxyphenol or guaiacol (10.99%) and phenol (5.90%). The results were different with those of liquid smoke from coconut. In this liquid smoke, the major components were phenol (44.13%), 2-methoxyphenol (11.5%) and 2.6-dimethoxyphenol (11.06%) (Tranggono *et al*., 1996).

Dilution treatment to liquid smoke would alter the contents of liquid smoke's chemicals. The profile changes depend on the nature of the compounds so the application to meet would be different. The changes, how the treatment effect the physical, chemical and sensory properties of liquid smoke-immersed-meat would be evaluated.

MATERIALS AND METHODS

Production of Liquid Smoke

Production of liquid smoke was done by pyrolysis. Pyrolysis furnace was equipped with a 1500 watt electric heater encircling reactor with a diameter of 20 cm and height of 40 cm which could be charged with as much as 4 kg of materials. Reactor cover was connected by pipeline to the cooling tubes used to condense the fumes and generate the liquid smoke. After all materials inserted into the furnace, it was then closed, condenser was set and cooling tube was streamed with cold water. Pyrolysis was carried out at a temperature of 420 °C for 100 minutes (Darmadji *et al*., 2000).

Liquid smoke which came out would flow to the cooling tubes through the pipe which was connected to reservoir bottle to collect the tar. Then into the cooling tubes, cold water was streamed using the aerator so the smoke would condense. The dew of liquid smoke which was still in a mixture with the tar was collected in the Erlenmeyer; liquid smoke is still mixed with tar in erlenmeyer stored. While the smoke that not condensed, removed through another tube. Liquid smoke, tar, and charcoal were weighed after the pyrolysis process done.

The obtained liquid smoke was centrifuged in 4000 rpm for 20 minutes (Kadir *et al*., 2010). The crude liquid smoke obtained was then analyzed to determine the amount of the volatile compound. The liquid smoke was subsequently diluted as much as 5 levels of dilution using aquabidest. Levels of dilution were as follows: 1x = without the addition of the aquabidest; 2x dilution = 1 part of liquid smoke : 1 part of aquabidest; dilution 3x = 1 part of liquid smoke : 2 parts of aquabidest; dilution 4x = 1 part of liquid smoke : 3 parts of aquabidest dilution and dilution 5x = 1 part of liquid smoke : 4 parts of aquabidest. The prepared samples were analyzed based on the research variables. Five levels of dilution were applied to beef.

Beef Immersed on Liquid Smoke

Longissimus dorsi beef was separated from the carcass and packed using vacuum with polypropylene plastic then stored in freezer for 48

Table 1. Physical Properties of Liquid Smoked-immersed-beef

Properties	Level of Dilution					
	1x	2x	3x	4x	5x	Control
Color						
L	27.65^{b}	29.65^{ab}	31.24^{ab}	32.93^{a}	32.5^{a}	32.86^{a}
a	5.24^{b}	4.81^{b}	5.01^{b}	5.56^{b}	5.64^{b}	9.79^{a}
b	8.30^{b}	7.33^{bc}	7.40^{bc}	7.03^{bc}	6.55^{c}	2.70^{a}
ΔE	10.05^{a}	8.46^{ab}	8.54^{ab}	7.62^{b}	7.41^{b}	-
Tenderness (N)	1.42^{b}	1.42^{b}	1.14^{bc}	1.00^{c}	1.12^{bc}	0.61^{a}
Water holding capacity (%)	26.80^{a}	32.85^{bc}	33.32^{c}	34.34^{c}	29.03^{a}	29.42^{ab}

Different letters in the same row indicates the significant differences (P<0.05)

hours. After that, the beef was stored in a cold room (3-4 °C) then was cut into small piece of about 5x5x2 cm.

Pieces of *Longissimus dorsi* beef which had been prepared was placed in submersion container which was then added with solution of liquid smoke with different dilution levels until all the meat samples was immersed (the ratio of liquid smoke and meat samples = 1:1). The submersion was performed for 15 minutes. After the submersion had been done, the meat was drained until no longer dripping solution and was then analyzed. Control sample was sampled without treated in liquid smoke. Each treatment was conducted in 5 (five) replication at different time.

Data Collection

Analysis done was the color analysis using Minolta colorimeter (parameter L, a, b and the difference on total color could be calculated using the following formula : $\Delta E = [(L - L_0)^2 + (a + a_0)^2 + (b - b_0)^2]^{0,5}$) (Antoniewski *et al.*, 2007; Chiavaro *et al.*, 2009), tenderness using the universal testing instrument (Lloyd), water holding capacity using modified Hamm method (Swatland, 1984 in Soeparno, 2009), pH analysis by potentiometric method (AOAC, 1995), water, fat and protein content of smoked beef (performed by using foodscan analyzer) while sensory analysis (conducted by using scoring method).

Data Analysis

Physical and chemical properties of beef were determined by analysis of Completely Randomized Design (Steel and Torrie, 1980). The differences between treatment means were determined using Duncan's New Multiple Range Test. Sensory data of liquid smoke-immersed beef were tested with non-parametric analysis of Kruskal-Wallis test.

RESULTS AND DISCUSSIONS

Physical Properties of Kenari Shell Liquid Smoke-Immersed-Beef

Physical properties of liquid smoked-immersed-beef (color, tenderness and water holding capacity) are presented in Table 1.

Color

Values the color parameters (L, a and b) of liquid smoke-immersed-beef showed that there were differences in each treatments (Table 1). Statistical analysis showed that the level of dilution significantly affected (P<0.05) for all color parameters. The parameter value of L was positive and tended to increase by the increasing of the dilution level, which meant that the color was brighter. The value of a tended to decrease and the value was positive, which meant that the color was reddish. The value of b was positive, which indicated that the color of sample was blue.

ΔE values are obtained if there is a marked difference from the sample and tend to decrease. The color of the beef smoked tended to be bright by the increasing of the dilution level. The color of products ranged from golden yellow to dark brown. Dark color that occurred in the smoked product might be the non-enzymatic reaction, i.e. via the condensation between carbonyl as well as dicarbonyl of smoke and amino acids of food products. The different content of the both compounds led the different potential in browning (Darmadji *et al*., 1999).

Table 2. Chemical Properties of Liquid Smoked-immersed-beef

Properties	Level of dilution					
	1x	2x	3x	4x	5x	Control
pH	4.61^{a}	4.75^{ab}	4.93^{b}	5.18^{c}	5.4^{d}	5.77^{e}
Water content (%)	71.72	72.42	72.87	72.63	72.26	72.41
Fat content (%)	2.74^{a}	2.75^{a}	2.68^{a}	2.70^{a}	3.02^{a}	3.77^{b}
Protein content (%)	22.26	22.20	21.74	21.76	22.06	21.55

Different superscript in the same row indicated the significant differences (P<0.05)

Tenderness

The tenderness of the meat tended to decrease (became harder) after the immersion in the liquid smoke solution. Statistical analysis indicated that the level of dilution gave significant effect (P<0.05) to the tenderness of liquid smoke-immersed-beef. In the other word, the treatment of beef with liquid smoke could modify the tenderness. Martinez *et al*. (2007) showed that the immersion of salmon fish to the liquid smoke containing all traditional components was significantly different with the control for all the texture variables (including the tenderness). Research done by Martinez *et al.* (2004) showed that the liquid smoke containing low level of carbonyl and high level of phenol, could modifiy the tenderness of bacon. In addition, liquid smoke-immersed-bacon would be harder than the control.

Water Holding Capacity (WHC)

Water holding capacity of the beef tended to decrease after it had been immersed in crude liquid smoke (dilution of 1x) and tended to increase by the increasing of dilution level of liquid smoke. Liquid smoke with the dilution level of 1x had high content of phenolic and carbonyl compounds. These compounds bonded with the beef protein, thus, there would no possibility for protein to bind water in big amount. On the other hand, in 2x, 3x and 4x levels of dilution, the content of these compounds began to decrease thus the protein could bind water in big amount. The WHC of sample with 5x dilution level showed that the value was close to that of control. There was inverse correlation between WHC and the chemical contents of liquid smoke. These data supported Maga (1978) who stated that WHC was inversely proportional than the concentration of carbonyl and phenolic compounds, while pH value did not affect the WHC.

Statistical analysis showed that the level of dilution significantly affected to the WHC (P<0.05). This corresponded to the carbonyl and phenolic compounds. The higher the phenolic and carbonyl contents, then the lower the WHC would be. The liquid smoke's components interacted with protein, thus there was no possibility for protein to bind the water in a huge amount. In addition, the source of smoke also affected the WHC of the product (Maga, 1987).

Chemical Properties of Kenari Shell Liquid Smoke-Immersed-Beef

Chemical properties of liquid smoked-immersed-beef (pH, water, fat, anda protein content) are presented in Table 2.

pH

The pH value of liquid smoked-immersed-beef tended to increase by the level of dilution with the range of 4.61-5.40 (pH of control: 5.77). This result were different with those of Gonulalan *et al*. (2003) which the sample was beef tongue which was immersed in commercial liquid smoke. The obtained pH was higher, i.e. 6.36. Martinez *et al*. (2007) employed the salmon fish (*Salmo salar*) which was treated with flavoring of commercial liquid smoke. In addition, the pH of control, liquid smoke containing all components and liquid smoke which the major components was phenolic compounds were 6.14, 6.12 and 5.96, respectively.

Statistical analysis showed that the dilution treatment significantly affected the pH of kenari shell liquid smoke-immersed-beef (P<0.05). The difference of pH was mainly due to the content of

Table 3. The Average Sensory Score of Liquid Smoke-immersed-beef*)

Properties	Level of Dilution					
	1x	2x	3x	4x	5x	Control
Aroma	4.09	3.63	3.57	3.31	3.41	2.33
Texture	2.21	2.63	2.88	2.99	3.12	3.68
Acceptance	2.37	2.57	2.68	2.64	2.69	2.71

*) significant effect (P<0.05)
Score of Aroma/taste: 1. Not very flavorful smoke, 2. Not flavorful smoke, 3. Less flavorful smoke. 4. Flavorful smoke, 5. Very flavorful smoke.
Score of texture : 1. Very rough, 2. Rough, 3. Rather smooth, 4. Smooth, 5. Very smooth
Score of acceptance :1. Really do not like, 2. Not like, 3. Rather like, 4. Like, 5. Very like

the penetrated organic acids. The acids existed on the liquid smoke might affect the pH value. The weak organic acid would dissociate to give H^+ and anion and decrease the pH of system (Pszczola, 1995). Furthermore, the source of smoke and the type of foods also affected the final pH value of product. The smoking treatment to pork gave the lower pH, while frankfurter formulation produced the higher pH (Maga, 1987).

Water Content

The average water content of liquid smoke-immersed-beef is displayed in Table 2. The statistical analysis showed that the level of dilution did not affect the water content of beef. The water content on each treatment was relatively the same. It was indicated that the immersion of beef to the liquid smoke solution could not affect this property. The results were in line with research of Gunolalan *et al*. (2003) on smoke beef tongue.

Fat Content

As shown on Table 2, the fat content of liquid smoke-immersed-beef tended to decrease on every level of dilution. Statistical analysis indicated that the dilution treatment significantly affected the fat content of beef which had been immersed to liquid smoke. The results were different with the research of Martinez *et al*. (2007) where there was no significant change on the fat content of the control on salmon fish (15.33 ± 0.27). The fish sample was treated with commercial liquid smokes: liquid smoke which the major component was phenol (15.32% ± 0.20) and liquid smoke which had all the traditional components (15.82 ± 0.13).

Protein Content

The protein content of liquid smoke-immersed-beef in every level of dilution was relatively same and ranged between 21.55 and 22.26% (Table 2). The results were consistent with those of Sisko *et al*. (2007) which stated that the chemical compositions of trout fish (*Salmo gairenerii*) were relatively stable, where the protein content ranged between 22.4 and 24.2%.

Statistical analysis implied that the dilution treatment did not significantly affect the content of beef protein. This indicated that the immersion of beef into the liquid smoke did not affect the content of protein in the beef.

Sensory Properties of Kenari Shell Liquid Smoke-Immersed-Beef

Sensory properties of liquid smoked-immersed-beef (aroma, texture and acceptance) were tabulated in Table 3. Sensory scores of aroma and taste either liquid smoke-immersed-beef had relatively same trends (Table 3). The scores tended to decrease by the increasing of the dilution level. This indicated that both aroma and taste of smoke would decrease by the increasing of dilution. Sensory properties correlated with the level of volatile compounds contained in the liquid smoke and the liquid smoke-immersed-beef tended to decrease by the increasing of dilution level. The sensory scores of aroma and taste were 3 and 4, which showed that the sample had little smoke aroma. Quantitative analysis of volatile compounds of kenari shell liquid smoke-immersed-beef was conducted to determine the concentration of furfural, phenol, 2-methoxyphenol and and 2,6-dimethoxyphenol. 2,6-Dimethoxyphenol could not be detected in liquid smoke-immersed-beef with dilution level of 5. On the other hand, the volatile compounds were not detected in the control. The increasing of dilution (1X, 2X, 3X, 4X and 5X) might decrease the concentration of furfural (771.56; 180.17; 131.95; 47.45 and 49.11 ppm), phenol (361.47; 155.70; 74.26; 25.63 and 22.8 ppm), 2-methoxyphenol (2.49; 1. 18; 0.64; 0.32 and 0.23) and 2,6 dimethoxyphenol (1.71; 9.8; 5.85; 0.01 and 0.00 ppm) in the liquid smoke-immersed-beef (Yusnaini *et al*., 2012)

Analysis of Kruskal-Wallis showed that the level of dilution had significant effect ($P<0.05$) to the aroma of both liquid smoke and liquid smoke-immersed-beef. According to Shahidi and Naczk (1995), phenolic compounds existed on the smoke played important role in the production of flavor on the smoked foods. Phenolic compounds detected on the kenari shell liquid smoke-immersed-beef were 2-methylphenol (o-cresol), 2-methoxyphenol (guaiacol), 2-methoxy-6-methyl phenol and 2-methoxy-4methylphenol (2-methoxy-p-cresol) (Yusnaini *et al*., 2012).

The average score of sensory test of kenari shell liquid smoke-immersed-beef (Table 3) was lower than that of control sample, which indicated that texture of sample became less tender. Sensory analysis of the texture of liquid smoke-immersed-beef gave the scores of 2 and 3, which showed that the texture was rough and rather smooth. In addition, the control had the value of 4, which implied that it had smooth texture. Kruskal-Wallis analysis showed that the dilution level significantly affected the beef's texture after the immersion in the liquid smoke. Kostyra and Baryłko-Pikielna (2006) stated that the carbonyl derivatives also gave contribution in modifying the texture of smoked foods.

The tenderness (Table 1) had a correlation with the texture sensoric test (Table 3). Tenderness of liquid smoke-immersed beef was higher with the increasing of dilution. This was in line with the results of panelist texture test, which was smoother with the increasing of dilution.

Acceptance panelist acceptance to the samples of liquid smoke-immersed-beef (Table 3) had the scores of 2 and 3, which showed that some panelists did not like and rather like. The dislike of panelists might be due to the strong aroma and taste of the liquid smoke. Kruskal-Wallis analysis indicated that the level of dilution had significant effect ($P<0.05$) to the acceptance panelist to the liquid smoke and liquid smoke-immersed-beef.

CONCLUSIONS

The level of dilution affected the physical, chemical and sensory properties (except the water and protein contents) of smoked beef. The water content of liquid smoke-immersed beef was relatively same at each treatment as the components of liquid smoke interacted with beef protein so as not to possible for protein to bind water in a huge amount. In addition, the components of liquid smoke did not damage the protein of beef.

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