APPLICATION OF FILTRATION AND RE-DISTILLATION OF LIQUID SMOKE AS FLAVOURING AGENT ON TEXTURE, PROXIMATE AND SENSORY CHARACTERISTICS OF MILKFISH (Chanos chanos) FISHBALLS

by Diana Chilmawati

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APPLICATION OF FILTRATION AND RE-DISTILLATION OF LIQUID SMOKE AS FLAVOURING AGENT ON TEXTURE, PROXIMATE AND SENSORY CHARACTERISTICS OF MILKFISH (*Chanos chanos*) FISHBALLS

Wijayanti I[1]*, Swastawati F[1], Ambariyanto[2], Cahyono B[3] and D Chilmawati[4]

Ima Wijayanti

*Coresponding author email: imasetianto@gmail.com

[1]Fish Products Technology Department, Fisheries and Marine Science, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang, Jawa Tengah-50275, Indonesia

[2]Marine Science Department, Fisheries and Marine Science, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang, Jawa Tengah-50275, Indonesia

[3]Chemistry Department, Sain and Mathematics Faculty, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang, Jawa Tengah-50275, Indonesia

[4]Aquaculture Department, Fisheries and Marine Science, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang, Jawa Tengah-50275, Indonesia

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ABSTRACT

Liquid smoke is the condensation result of wood pyrolysis that contains many compounds formed by pyrolysis constituent process such as cellulose, hemicellulose and lignin that produces organic acids, phenols, and carbonyl compounds important in food preservation. The study of fishballs with liquid smoke as flavour is limited. Filtration and distillation of liquid smoke is estimated to give a different effect on the characteristics of fishballs. This study aimed to find out the effect of the liquid smoke on characteristics of milkfish fishballs (texture, proximate and sensory). The experiment was laid out in a factorial experimental design with two factors. The first factor was the type of liquid smoke (filtration and re-distillation) and the second factor was the concentration (1%, 3% and 5%) replicated three times. Test parameters used included: texture (hardness, deformation, gelstrength); proximate composition (water, protein, fat and ash content) and sensory characteristics (hedonic value). Parametric data analysis used ANOVA. Results showed interaction types and concentrations of liquid smoke gave significant effect on the hardness, deformation and gel strength ($P<0.05$). The highest hardness (3845.90±373.20 gf) was achieved by milkfish fishballs with 5% re-distillation liquid smoke, but not significantly different with 3% re-distillation. The highest deformation (1.770±0.21 cm) was attained by milkfish fishballs with 5% filtration liquid smoke while the best gel strength was achieved by milkfish fishball with 5% re-distillation liquid smoke. The types and concentration of liquid smoke yielded significant effect on moisture, fat and ash content ($P <0.05$) but no effect on protein content ($P>0.05$). The type and concentration of liquid smoke significantly affected hedonic values of milkfish fishballs ($P <0.05$). The best hedonic values were obtained in milkfish fishballs with 3% filtration liquid smoke and 5% re-distillation liquid smoke with total hedonic value of 7.38 and 7.04, respectively. Overall, milkfish fishballs with filtration and re-distillation liquid smoke were acceptable according to hedonic value. Liquid smoke types, both filtration and re-distillation can be used as flavoring agents on milkfish fishballs. The best results for using liquid smoke filtration and re-destillation on milkfish fishballs is recommended at 3% and 5%, respectively.

Key words: liquid smoke, filtration, re-distillation, milkfish, fishballs, proximate, texture, hedonic

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INTRODUCTION

Milkfish aquaculture is constantly being developed in Indonesia and its production has been increasing annually. In 2008, milkfish production reached 422,086 tons than increased in 2012 to 482,930 tons [1]. Milkfish have a high nutrition value among others: moisture 74.6%; protein 18.4%; fat 6%; ash 1%; calcium 4.8%; phosphorus16.9%; vitamin A 400-673 IU/100 g; folic acid 15µg/100 g and it can be processed into various products using traditional and non traditional methods [2]; for example, fishballs, nuggets and others. Product diversification of milkfish was developed to provide a variety of products and increase its value. There are several advantages of value adding, among others provide safe products; increasing shelflife; maintaining a high level of quality; opening new market opportunities and offering a solution for supply issues [3]. Fishballs are value added products from meat. The raw material for fishballs is usually beef. Fish can be used as raw material for fishballs, commonly called fishballs.

Fishballs are produced by boiling the proteins in the fish become denatured, gelatinised and form a three dimensional network, which is accompanied by absorption of water. After boiling, grilling or frying, the fishballs achieves a good elastic and mouth feeling that can hide the fishy smell. One can hardly recognize the element of fish in a fishball. The taste known according to local taste preferences can be added to the fishballs [4]. Fishballs that exist today have original flavour. Adding a different flavour to the fishballs may provide a variety of products preferred by consumers. Fried fishballs have been studied to make variation in fishball production [5]. The addition of different flavours in the fishballs such as liquid smoke is expected to provide various products and attract consumers' interests.

Liquid smoke, which has become popular nowadays is the condensation result of wood pyrolysis that contains many compounds such as organic acids, phenols, and carbonyl compounds that have a role in food preservation [6]. It is used to give flavour, colour, and texture and in some cases, can increase the shelflife of the product. Liquid smoke is obtained from the reaction of the thermal degradation of cellulose, hemicellulose and lignin [7]. Smoking method largely provides the desired flavour and inhibits microbial growth. Liquid smoke has several advantages such as easy to apply and to be controlled, and more uniform product and environment friendly. In relation to consumer preferences, some people prefer the smell and taste of a strong smoke while others prefer the flavour of certain smoked materials [8].The Primary functional property of liquid smoke is to produce desired flavour and colour of the product due to the phenol and carbonyl compounds. Liquid smoke also contains harmful substances such as tar, compound benzo (a) pyrene, and carcinogens that damage essential amino acids and vitamins [9]; hence, it needs to be purified to reduce carcinogenic content. Refinement of liquid smoke is generally carried out using precipitation, filtration, absorption, and distillation or in combination [10]. Filtration and re-distillation (doubled distillation) of liquid smoke could be used to purify the liquid smoke. Anggraini and Yuniningsih [9] reported that re-distillation (doubled distillation) could reduce benzo (a) pyrene in liquid smoke. McDonald [11] noted that generally foods flavoured using liquid smoke will have less Polycyclic aromatic hydrocarbons PAH than foods that are conventionally smoked due

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to the purification process during condensate manufacture. Insoluble toxic compounds could be condensed and precipitated and largely removed by decantation and filtration. Study of liquid smoke as antibacterial and preservative has been done [9, 12, 13, 14, 15, 16]. The study of liquid smoke in different types of purification that applied in food is relatively limited. The purpose of this study was to determine the effect of various types of liquid smoke (filtration and re-distillation) and their concentrations on the texture, sensory and proximate characteristic of milkfish fishballs.

MATERIALS AND METHODS

Materials

Milkfish with average size of 200 ± 35 g were obtained from a farm in Indramayu West Java Indonesia. The fish were brought to the laboratory on Styrofoam trays and preserved on ice with a ratio of ice to fish of 1: 2 to maintain its freshness. The fish were frozen before being processed into fishballs. Liquid smoke purification was done by filtration and re-distillation. Filtered liquid smoke was obtained by filtering using Whatman filter paper no. 42. Re-distillation liquid smoke was obtained from liquid smoke that distilled twice. Chemicals used for the analysis include: H_2SO_4, HCl, NaOH, $HBrO_3$, Kjeldahl tablets, N-hexane (Merck Germany).

Preparation of milkfish fishballs

The fish were filleted then ground into minced fish. Seasoning used for milkfish fishballs were salt, garlic and pepper; crushed and mixed with minced fish (50%), tapioca flour, water ice and liquid smoke (filtration and re-distillation) at different concentrations (1%, 3% and 5%). The dough was shaped into round balls with a diameter of 2.5 cm and heated in two stages. The first stage was at a temperature of 45 ± 2.5ºC for 20 minutes, after which the temperature was raised to 80 ± 2.5ºC for 30 minutes then cooled in refrigerator for analysis the next day.

Parameter Testing

Texture analysis (Hardness, deformation, gel strength) was done according to a method described by Balange and Benjakul [17] using a Texture Analyzer model TA-XT2 (LLYOID, UK). Hardness (hardness); deformation (elasticity/deformability), gel strength (gel strength) were measured using a spherical plunger (diameter of 5 mm, 60 mm / min speed deformation). The gel strength of milkfish fishballs was estimated by multiplying hardness and deformation. Proximate composition (water, protein, lipid and ash content) was determined using standard AOAC methods [18]. Hedonic testing was done according to Indonesian Standard SNI 01-2346-2006 [19] forsensory analysis. Hedonic testing of milkfish fishballs was carried out in a laboratory and done by 25 semi trained panellists. Samples were coded on each treatment using random tables to minimize subjectivity. Work instruction forms (questionnaires) were prepared to guide panelists. The hedonic test comprised 5 specifications, namely the appearance, flavour,colour, odour and texture on a 1 to 9 scale, namely: 1. Dislike Extremely; 2. Dislike Very Much ; 3. Dislike Moderately; 4. Dislike Slightly; 5. Neither Like nor Dislike ; 6. Like Slightly ; 7. Like Moderately ; 8. Like Very Much ; 9. Like Extremely.

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Experimental design

The experimental design of this study was a 2 by 3 completely randomized factorial design (CRD). The first factor was the type of liquid smoke comprising two types (filtration and re-distillation) and second factor was concentration of liquid smoke, namely 1%, 3% and 5%, repeated 3 times.

Data analysis

Parametric data were analysed using Analysis of Variance (ANOVA). Comparison of means was carried out by Tukey tests [20]. Non Parametric data such as organoleptic and hedonic data were analysed by Kruskall Wallis Test and continued by Mann Whitney test. Analysis was performed in SPSS for Windows Version 17.0, SPSS Inc., and Chicago, IL, USA).

RESULTS AND DISCUSSION

Texture

Textural characteristics of milkfish fishballs with different types and concentrations of liquid smoke are presented in Table 1. The results showed interaction of type and concentration of liquid smoke, significantly ($P < 0.05$) affecting the hardness and deformation, but no interaction on the gel strength ($P > 0.05$). However, each of these factors separately significantly affected the gel strength.

The hardness of milkfish fishballs with filtered liquid smoke showed no significant increase with increasing concentration and decrease in concentrations of 5%, whereas the hardness of milkfish fishballs with re-distillation liquid smoke increased with increasing concentrations of liquid smoke. The highest hardness was achieved with 5% re-distillation liquid smoke. Deformation of milkfish fishballs with filtration liquid smoke was higher than the re-distillation suggesting elasticity of fishballs. The highest deformation was accomplished by milkfish fishballs with 5% filtration liquid smoke. The control in this treatment had lower deformation than 3% and 5% both in filtration and re-distillation liquid smoke. Gel strength of milkfish fishballs with filtered liquid smoke were different compared to re-distillation liquid smoke due to phenolic content of filtered liquid smoke higher than re-distillation liquid smoke. The higher concentration of the liquid smoke also increased the gel strength of fishballs.

The hardness of fishballs in all treatments was higher than the control (without liquid smoke). This shows that liquid smoke could increased the hardness of fishballs. The hardness of milkfish fishballs with 5% filtration liquid was lower than the 3% one. The optimal concentration of filtration liquid smoke in milkfish fishballs in this study was 3%. The decrease of hardness in this study was similar to reports by Balange and Benjakul [17] that breaking force and deformation of surimi gel with increasing concentrations of phenolic compounds might be associated with self-aggregation of phenolic compounds, leading to the loss in capability of protein cross-linking. Hasan [21] also reported that an increase in the concentration of the phenol decreased the intensity of the albumin fluorescence. This shows that protein-phenol reaction decreased in higher concentration.

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The increase of textural characteristics includes hardness, deformation and gel strength of milkfish fishballs with liquid smoke is probably caused by the phenol content in filtration and re-distillation liquid smoke. Budaraga *et al.* [10] reported that coconut shell liquid smoke contained 22.26% phenol. Phenol in liquid smoke can interact with proteins in fish forming the complex bonds and crosslinking which ultimately affects the texture of the fishballs. Bartolome *et al.* [22] reported that the phenolic components of high molecular weight can interact with proteins. Research of Rivero *et al.* [23] explained that the addition of tannic acid of phenolic components in the optimum amount can improve the texture of the chitosan film, which becomes stronger because of crosslinking. Harbourne *et al.* [24] also reported that the addition of phenolic components in milk protein had stronger gel strength than the control.

Proximate

The interaction between the type and concentration of liquid smoke significantly affected the moisture, lipid, ash and carbohydrates content ($P<0.05$), but not protein ($P>0.05$) (Table 2).

After adding different concentrations of liquid smoke, the water content in milkfish showed a different trend between liquid smoke obtained by filtration and re-distillation. In the filtration liquid smoke, the water content increased with increasing concentration. The water content of milkfish fishballs with re-distillation liquid smoke showed a decrease in the higher concentration. The highest water content in milkfish fishballs with re-distillation liquid smoke is at a concentration of 1%. The protein contents of milkfish fishballs with filtration and re-distillation liquid smoke were significantly different ($P<0.05$). Protein content on milkfish fishballs with filtration liquid smoke was higher than the re-distillation one, thus the concentration of liquid smoke affected the protein content of milkfish fishballs. The highest protein content in milk fish fishballs was at 5% liquid smoke. Fishballs added 1% and 3% liquid smoke were not significant different. Lipid content in the two types of milkfish fishballs increased with the concentration of liquid smoke. Lipid content of milkfish fishballs with filtration liquid smoke 5% showed the highest value and lowest in fishballs re-distillation at 1%. The ash content in fishballs with different concentrations of liquid smoke showed different trends for liquid smoke filtration and re-distillation. The filtration liquid smoke showed that ash content decreased with increasing concentration of liquid smoke. The highest ash content of milkfish fishballs was adding 1% filtration liquid smoke. The ash content of milkfish fishballs with re-distillation liquid smoke increased with increasing concentrations. The highest ash content in milkfish fishballs with re-distillation liquid smoke was at 5% concentration.

Overall, water content of milkfish fishballs with liquid smoke for both filtration and re-distillation fulfilled the requirements of SNI: 7266-2014 on quality and safety of fishballs, which requires a maximum moisture content of 65% [25]. The control of this treatment had high moisture content, hence, not satisfying the SNI requirement. This study was different from Zuraida *et al.* [13] who reported moisture content of 73.69% for fishball with 2.5% liquid smoke, but the pattern was similar. Fishballs with liquid smoke had lower moisture content than control (without liquid smoke). The use of liquid smoke in fishballs may result in water loss in the product [26]. Gomez-Guillen *et al.* [27]

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suggested that the use of liquid smoke in salmon fillets could cause the dissolution of connective tissue in the fish flesh, resulting in the discharge of water from fish flesh. The protein content in all treatments fulfilled Indonesian Standards which require a minimum protein content of 7%. The results of this study showed the average protein content of 10.34% -11.78% which is lower than Duman and Peksezer [28] who reported a protein fishballs from mosul bleak (*Alburnus mossulensis*) of 17.6% and Olayinka *et al.*[29] that reported protein content of fishballs from shrimp of 19.13%. The differences may probably be due to the diversity in fish species and fish meat concentrations used. Protein content of fish depends on species [30, 31]; season [30, 32]; and diet [33]. This research used 50% minced fish for fishballs while Duman and Peksezer [28] and Olayinka *et al.* [29] used 64% and 80.26%, respectively. Lipid content of fishballs in this research was lower than Duman and Peksezer [28] and Olayinka *et al.* [29] who reported lipid content of fishballs of 3.8% and 3.45%, respectively.The ash content in fishballs with the addition of liquid smoke filtration and re-distillation qualified for SNI fishballs, which requires a maximum ash content of 2% [25]. Ash content of fishballs in this study was higher than Duman and Peksezer [28] but lower than Olayinka *et al.* [29].

Sensory

The hedonic values are shown in Table 3. Different type and concentrations of liquid smoke received different responses from the panelists. Milkfish fishballs with filtration liquid smoke were more preferred than the re-distillation one. The milkfish fishballs with 3% re-distillation liquid smoke were the most preferred by panelists.

In appearance, milkfish fishballs at 1% filtration liquid smoke were highly preferred by the panelists, while milkfish fishballs with re-distillation liquid smoke at a concentration of 5% were more preferred than others. Fishballs with filtration liquid smoke at all concentrations were really liked (7) in terms of colour and the highest value was at a concentration of 1% filtration liquid smoke. The texture of the milkfish fishballs with filtration liquid smoke at all concentrations scored moderately (7) and the highest value at a concentration of 3%. Odour of milkfish fishballs with filtration liquid smoke in all the concentrations was preferred by panelists and the highest value at a concentration of 3%. For taste, milkfish fishballs with filtration liquid smoke had been the most preferred at concentration of 3%; therefore, the more dense concentration of 5% had lowest taste value.

The appearance is related to the shape of fishballs that tend to compact with a smooth surface. The addition of liquid smoke in milkfish fishballs was highly preferred by the panelists on appearance. The colour of milkfish fishballs usually tends to be white, but with the liquid smoke, fishballs changed to greyish colour similar to the colour in beef meatballs. A report by Purba *et al.* [16] explained that fishballs with 1.5% liquid smoke were preferred by panelists compared to fishballs with a concentration of 0.5 %, 1.0 %, 2.0 % and 0 % (control). Maqsood *et al.* [34] reported that the addition of tannic acid phenol components improves texture on the hedonic value of fish sausages. Purba *et al.* [16] showed that in texture specification, fishballs with 1.5% liquid smoke were preferred by panelists above other treatments.

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Liquid smoke gave a specific odour and taste in milkfish fishballs. Characteristic odour and taste of liquid smoke in milkfish fishballs was highly preferred by the panelists. Liquid smoke can also reduce the fishy taste to the milkfish fishballs. Maqsood *et al.* [34] mentioned that the phenolic components can reduce the stench of the fish sausage during storage. The taste of milkfish fishballs with the highest concentration of filtration liquid smoke were less preferred by panelis. This may be due to the fact that filtration liquid smoke flavour was too strong causing most panelists liking it less. It could also be that liquid smoke gives strongly astringent taste at higher concentration. Ameko *et al.* [35] reported that liquid smoke from coconut shell had a moderate to slightly astringent flavour, but a strongly astringent flavour at higher concentrations.

Overall, milkfish fishballs with the addition of filtration liquid smoke at all concentrations were very liked by panelists and the highest hedonic value was 1%. Milkfish fishballs with re-distillation liquid smoke at concentrations of 5% were more preferred. This study used coconut shell to produce Liquid Smoke. Liquid smoke gives specific flavour in product. Ameko *et al.* [35] reported a flavour which was slightly fruity, smoked food, and phenolic; slightly scorched to moderately scorched, and slightly spicy for coconut shell liquid smoke. Its green wood flavour ranged from moderate to very slight.

CONCLUSION

The addition of liquid smoke with different types (filtration and re-distillation) and concentrations (1%, 3%, and 5%) gave significant effect on the hardness, deformation, gel strength, moisture, fat, ash, and hedonic perception, but did not significantly affect the protein content of milkfish fishballs. Adding liquid smoke (filtration and re-distillation) was increasing the hardness, gel strength and hedonic scale but reducing deformation, moisture, fat and ash content of milkfish fishballs compared with control. Higher concentration gave higher value of hardness, gel strength and hedonic scale until 3% for filtration liquid smoke and 5% for re-distillation liquid smoke. The best treatment was achieved on milkfish fishballs with liquid smoke filtration of 3% and re-distillation liquid smoke at a concentration of 5%. Overall, milkfish fishballs with filtration and re-distillation liquid smoke were highly acceptable. Liquid smoke types, both filtration and re-distillation can be used as flavoring agents on milkfish fishballs. The best results for using liquid smoke filtration and re-destillation on milkfish fishballs is recommended at 3% and 5%, respectively.

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Tabel 1: Texture characteristics of milkfish fishballs with different types of liquid smoke and concentration of liquid smoke

Parameter Texture	Concentration	Type of Liquid Smoke		
		Control	Filtration	Re-distillation
Hardness (gf)	1%	**1656.54±98.75**	2804.24±403.34^{cd}	3144.80±163.10^{bc}
	3%		2813.88±196.13^{cd}	3446.30±47.6^{ab}
	5%		2413.06±88.85^{d}	3845.90±373.20^{a}
Deformation(cm)	1%	**1.613±0,069**	1.580±0.200^{bc}	1.337±0.13^{c}
	3%		2.3633±0.05^{a}	1.623±0.04^{bc}
	5%		2.477±0.02^{a}	1.770±0.21^{b}
Gel Strength (g.cm)	1%	**2679.38±278,60**	4484.66±124.90^{b}	4197.09±361.15^{b}
	3%		6644.30±347.74^{a}	5593.46±118.56^{a}
	5%		5975.3±190.76^{a}	6804.47±998.91^{a}

Different letters indicate significant differences between treatments (P<0.05)

Tabel 2: Proximate content of milkfish fishballs with different types of liquid smoke and concentration of liquid smoke

Proximate	Concentration	Type of Liquid Smoke		
		Control	Filtration	Re-distillation
Moisture	1%	**69.84±0.65**	59.64±0.21^{b}	59.55±0.55^{b}
	3%		61.58±0.86^{a}	58.59±0.12^{bc}
	5%		61.56±0.21^{a}	57.52±0.17^{c}
Protein	1%	**11.00±0.28**	10.78±0.19^{Ac}	10.34±0.31^{Bc}
	3%		10.73±0.34^{Abc}	10.71±0.06^{Bbc}
	5%		11.91±0.45^{Aa}	11.78±0.30^{Ba}
Lipid	1%	**0.6±0.12**	0.634±0.026^{b}	0.424±0.017^{c}
	3%		0.543±0.046^{bc}	0.457±0.035^{c}
	5%		0.949±0.087^{a}	0.568±0.045^{b}
Ash	1%	**2.01±0.04**	1.69±0.087^{b}	1.42±0.018^{c}
	3%		1.43±0.15^{c}	1.49±0.032^{bc}
	5%		1.41±0.10^{c}	1.95±0.049^{a}

Different letters indicate significant differences between treatments (P<0.05)

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Tabel 3: Hedonic values of milkfish fishballs with different types of liquid smoke and concentration of liquid smoke

Spesification	Concentration	Type of Liquid Smoke		
		Control	Filtration	Re-distillation
Appearence	1%	**7.41**	7.76	5.64
	3%		7.31	5.91
	5%		6.85	7.08
Colour	1%	**7.20**	7.50	5.79
	3%		7.25	6.23
	5%		7.02	6.83
Texture	1%	**7.05**	7.22	4.89
	3%		7.36	5.66
	5%		6.75	7.22
Odour	1%	**7.25**	7.01	4.83
	3%		7.56	5.58
	5%		7.26	6.93
Taste	1%	**7.5**	6.68	4.63
	3%		7.43	5.48
	5%		6.43	7.13
Total	1%	7.282	7.234	5.156
	3%		7.382	5.772
	5%		6.862	7.038

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