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The effect of adding coconut shell liquid smoke by distillation and redistillation on the chemical, microbiological, and sensory properties of *pindang* layang fish (*Decapterus* spp.) during storage

ENDAH HIMAWATI, NUR HER RIYADI, GODRAS JATI MANUHARA♥
Department of Agricultural Product Technology, Faculty of Agriculture, Universitas Sebelas Maret. Jl. Ir. Sutami 36A Surakarta 57126, Central Java, Indonesia. Tel.: +62-271-646994, ♥email: godrasjati@yahoo.com

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Abstract. *Himawati E, Riyadi NH, Manuhara GJ. 2018. The effect of adding coconut shell liquid smoke by distillation and redistillation on the chemical, microbiological, and sensory properties of pindang layang fish (*Decapterus spp.*) during storage. Bioteknologi 15: 84-91. Pemindangan* (salted-boiled fish) is one way of processing fish with a combination of treatments between salting and boiling. But *pindang* layang fish (*Decapterus* spp.) only has a shelf life of about 2-4 days which quickly undergoes a process of decay. So we need a preservation technique that can minimize damage to *pindang Decapterus* spp.. Liquid smoke is a chemical that results from the distillation of smoke from burning biomass and acts as a disinfectant. Phenol, carbonyl, and organic acids in liquid smoke play an important role in fish preservation. Distillation liquid smoke is obtained from the first pyrolysis and has a fairly high content of tar compounds, while redistillation liquid smoke is the second product from the first distillation. The purpose of this study was to determine the effect of adding coconut shell liquid smoke by distillation and redistillation on the chemical properties (moisture content, pH, phenol), microbiological properties (TPC), and sensory properties (color, odor, texture, and overall) of *pindang Decapterus* spp. during storage. As well as knowing the best concentration of distillation liquid smoke (1%, 2%, 3%) and redistillation (25%, 30%, 35%) in maintaining the quality of *pindang Decapterus* spp. during storage. The analysis was carried out for 4 periods on 0,2,4,6 days. The experimental design used was a completely randomized design (CRD). The data obtained were analyzed by ANOVA at =5% and continued with the DMRT test if there was a significant difference. The results showed that the chemical characteristics were water content (61-67%), pH (5-7), phenol (0.226-0.566%), while microbiological characteristics (TPC) (1.85.104-3.15.105 Cfu/g). The sensory characteristics (color, odor, texture, and overall) of *pindang Decapterus* spp. with redistillation liquid smoke treatment were preferable to distillation liquid smoke treatment. In terms of chemical, microbiological, and sensory properties, the treatment of redistillation of liquid smoke was significantly different from that of the distillation of liquid smoke. A review of the chemical and microbiological properties of the 35% redistillation liquid smoke treatment was the best treatment, while from the sensory properties, the 30% redistillation liquid smoke treatment was the most preferred by the panelists compared to other treatments.

Keywords: *Decapterus*, distillation liquid smoke, *pindang*, redistillation liquid smoke

INTRODUCTION

The potential of Indonesian marine products, especially fisheries, is quite large, estimated at 6.7 million tons per year, consisting of 4.4 million tons in the waters of the archipelago and 2.3 million tons in the Indonesian Exclusive Economic Zone (ZEEI). Capture fisheries production from fishing at sea and in public waters in 2006 was around 4,468,010 tons (Direktorat Jenderal Perikanan Tangkap 2007). Meanwhile, aquaculture production in 2006 reached 2,625,800 tons (Direktorat Jenderal Perikanan Budidaya 2007).

Layang fish (*Decapterus* spp.) has the highest production compared to other types of fish, reaching 52% of the total catch, which is around 2,323,365 tons per year (Direktorat Jenderal Perikanan Tangkap 2007). In addition to high production, this fish has relatively low prices compared to other types. To add value to fishery products, *Decapterus* spp. has a high protein content of about 22%, 1% fat, and 109 calories of energy and is perishable; alternative processing or preservation needs to be made. Preservation aims to maintain the quality and stabilize the selling price of fish (Ridwansyah 2002). Traditional fish preservation in Indonesia includes salting, pemindangan, peda making, shrimp paste, petis, and others (Hadiwiyoto 1993).

Pemindangan (salted-boiled fish) is a method of processing, as well as a method of preservation, which is favored by the public because the final product has a distinctive taste and is not too salty (Winarno 2002). The material that is often used in pemindangan is *Decapterus* spp. (Purnomo et al. 2002), which has a fairly high nutritional content, namely the amount of protein 27%, fat 3%, energy 176 calories, water 60%, minerals 0.26%, and vitamin B 0.07 mg (Heruwati 1986). In the leaching process, fish are preserved by steaming or boiling in a tool containing salt at a rather high concentration (10-25%) and under normal pressure to inhibit or kill spoilage bacteria and enzyme activity (Afrianto and Liviawaty 1989). In addition, the fish collectors also preserve fish using chemicals that are harmful to health, such as formalin and H_2O_2; indeed, alternative natural preservatives must be sought, one of which is the addition of liquid smoke.

Liquid smoke is a chemical product of the distillation of

smoke resulting from combustion. Liquid smoke can be a disinfectant, so food ingredients can last longer without harming consumers (Amritama 2007). According to Darmadji (1996), the pyrolysis of coconut shells that have become liquid smoke will have phenol compounds of 4.13%, carbonyl of 11.3%, and acid of 10.2%. These compounds can preserve food for a long time because they mainly inhibit bacterial development. Preservation with liquid smoke has several advantages, including being more environmentally friendly because it does not cause air pollution, can be applied quickly and easily, does not require fogging installations, the equipment used is simpler and easier to clean, and the concentration of liquid smoke used can be adjusted to the desired level. Important volatile compounds are easily controlled if desired. The resulting product has a uniform appearance, plays a role in forming sensory compounds, and provides food safety assurance (Swastawati 2008).

The acid content in liquid smoke can affect the taste, pH, and shelf life of smoked products; carbonyl reacts with protein and forms brown coloration and phenol, which is the main constituent of odor and shows antioxidant activity (Prananta 2005). Fatimah (1998) states the groups of compounds that make up liquid smoke are water (11-92%), phenol (0.2-2.9%), acid (2.8-9.5%), carbonyl (2.6-4.0%), and tar (1-7%). The compound that makes up liquid smoke greatly determines the organoleptic properties of liquid smoke and the quality of smoking products.

Pemindangan is one of the preservation methods used by the community, but *pindang Decapterus* spp., the resulting product, only has a short shelf life of about 2-4 days (Moedjiharto 2002). It is necessary to add a safe preservative, namely by adding liquid smoke into *pindang Decapterus* spp.. Adding liquid smoke to *pindang Decapterus* spp. can increase shelf life to make it more durable, produce a distinctive odor, smell, color, a more compact texture, and loss of flavor on easier control (Maga 1987).

The purpose of this study was to determine the effect of adding coconut shell liquid smoke by distillation and redistillation to the chemical properties (moisture content, pH, phenol), microbiological properties (TPC), and sensory properties (texture, color, odor, overall) of *pindang* layang fish (*Decapterus* spp.) during storage and to determine the best concentration of distillation and redistillation liquid smoke in maintaining the quality of *pindang Decapterus* spp. during storage.

MATERIALS AND METHODS

Materials and tools

The main ingredients used to preserve *pindang* are *Decapterus* spp. from Pasar Gedhe Market, Surakarta, Central Java, Indonesia, and Nutrient Agar (NA).

Procedures

Preparation of distillation and redistillation of liquid smoke solutions

Before the preservation process, each type of preservative was diluted using distilled water. The concentrations of redistillation liquid smoke preservatives used were 25%, 30%, 35% and 1%, 2%, and 3% of the distillation used.

Making of pindang layang

The process of preserving the *pindang Decapterus* spp. carried out in this study is as follows: weeded and washed the *pindang Decapterus* spp. until clean, then arranged in the besek. Then, the besek was soaked (15-30 minutes) in a 25% salt solution. Next, the fish are removed and drained. The result is *pindang Decapterus* spp..

Preservation of pindang Decapterus spp.

The preservation of *pindang Decapterus* spp. is carried out with two types of liquid smoke, namely: (i) immersion in 25%, 20%, 35% redistilled liquid smoke for 15 minutes and (ii) immersion in 1%, 2%, 3 % for 15 minutes. Followed by draining, and placing into a naya/besek, then stored at room temperature. Furthermore, on days 0, 2, 4, 6, tests were carried out, including: (i) Chemical properties (moisture content, pH, phenol), (ii) Microbiological properties (TPC), and (iii) Sensory properties (color, aroma, texture, and overall). Each analysis was carried out on days 0, 2, 4, and 6. The method of each analysis can be seen in Table 1.

Data analysis

The experimental design used in this study was a completely randomized design (CRD) with two factors: a combination of concentration and preservative types; each analysis was repeated twice. The data obtained were analyzed by ANOVA to determine whether there were differences in treatment. If there were differences between treatments, proceed with the DMRT (Duncan Multiple Range Test) tests with a significance level of 0.05, using SPSS 13.0.

RESULTS AND DISCUSSION

Pemindangan fish (salted-boiled fish) is one way of processing fish with a combination of treatments between salting and boiling. The fish type commonly used as raw materials are seawater fish such as tuna (*Euthynnus* spp.), tengiri/mackerel (*Scomberomorus* spp.), kembung/ mackerel (*Scomber* spp.), and layang (*Decapterus* spp.). The raw material used in this research was *Decapterus* spp. because it has a high protein content of ± 22% and has a high catch yearly, reaching 2,323,365 tons or ± 52%.

Table 1. Analysis method

Test	Method
Water content	Thermogravimetry (Sudarmadji et al. 1997)
pH	pH meter (Widowati 1986)
TPC	Total plate count (Fardiaz 1993)
Phenol test	Senter et al. (1989)
Organoleptic	Scoring (Kartika et al. 1988)

Pindang Decapterus spp. has a shelf life of about 2-4 days which quickly undergoes a perishable food; this is due to the high protein content and environmental conditions that are very suitable for the growth of spoilage microbes. A preservation technique is needed to minimize damage to *pindang Decapterus* spp. during storage. In this study, the preservative used was liquid smoke with a concentration of redistillation of 25%, 30%, 35%, and distillation of 1%, 2%, and 3%. The parameters observed were chemical properties, microbiological properties, and sensory.

Chemical properties of *pindang Decapterus* spp.

Water content

Moisture content is the amount of water contained in the material expressed in percent. Water content is also one of the most important characteristics of foodstuffs because water can affect appearance, texture, and taste. The water content in foodstuffs determines the freshness and durability. The high-water content makes it easy for bacteria, molds, and yeasts to breed, changing food ingredients (Afrianto and Liviawaty 1989).

The water content of *pindang Decapterus* spp. can be seen in Table 2. This table shows that all control treatments and adding redistillation and distillation liquid smoke on day 0 to day 4 decreased water content due to some of the water being evaporated because it was only stored at room temperature. Then, on the 6th day of control treatment and adding 1%, 2%, and 3% distillation liquid smoke, the water content increased because the fish had decayed. While in the treatment with the addition of redistillation liquid smoke, 25%, 30%, and 35% water content still decreased.

The statistical analysis shows that on day 0, all distillation and redistillation liquid smoke treatments did not have a significant difference. On day 2, the addition of 25% redistillation liquid smoke was not significantly different from the 30% redistillation liquid smoke and 3% distillation liquid smoke. Still, it differed significantly from the 35% redistillation liquid smoke, 1% distillation liquid smoke, and 2% treatment. Then for the 4th day, all redistillation and distillation liquid smoke treatments were not significantly different, except for the 25% redistillation liquid smoke treatment. On the 6th day, all treatments of distillation liquid smoke were significantly different from all treatments of redistillation liquid smoke.

The water content on day 6 for the control treatment and adding 1%, 2%, and 3% distillation liquid smoke increased due to the product's decay process. The process of spoilage is caused by the oxidation of fish fat which contains various unsaturated fatty acids, as well as the mineral content in salts such as iron and magnesium, these substances also play a role in accelerating fat oxidation. In addition to the activity of extremely halophilic bacteria (*Micrococcus, Serratia,* and *Sarcina*), which can grow at a salt content of 20-30%, producing water and mucus. Thus, the increase in water content on day 6 was caused by the result of the decomposition process by microbial activity (Supardi and Sukamto 1999).

Table 2. The results of the analysis of the water content (%) in the treated *pindang Decapterus* spp.

Treatment	Observation on day			
	0	2	4	6
Control	65.61 [a]	64.16 [ab]	62.68 [a]	64.87 [b]
Redistillation 25%	65.46 [a]	64.46 [ab]	64.37 [b]	62.28 [a]
Redistillation 30%	65.96 [a]	63.41 [a]	63.13 [a]	61.80 [a]
Redistillation 35%	66.46 [a]	65.81 [cd]	64.78 [b]	62.68 [a]
Distillation 1%	66.57 [a]	65.81 [cd]	65,16 [b]	66.98 [c]
Distillation 2%	66.86 [a]	66.50 [d]	65.46 [b]	66.93 [c]
Distillation 3%	66.46 [a]	65.02 [bc]	64.73 [b]	66.22 [bc]

Note: Numbers followed by the same letter show no significant difference at the 5% level (applies to the same column)

The spoilage process in the control was due to the very low content of antibacterial preservative contained in the material, while the spoilage in the addition of 1%, 2%, and 3% distillation liquid smoke was due to the addition of a very low concentration of liquid distillation smoke so that spoilage microbes were still present and can grow. In the additional treatment of 25%, 30%, and 35% redistillation liquid smoke, the water content continued to decrease until the 6th day; this was because the microbial activity in *pindang Decapterus* spp. was hampered by the addition of a fairly high concentration of liquid smoke.

According to the Indonesian National Standard (SNI-01-2717-1992), the value of water content that meets the quality requirements of *pindang Decapterus* spp. is 60%-70%. The water content of *pindang Decapterus* spp. in this study still meets the quality requirements according to SNI (1992) because the water content value ranges from 61.80% - 66.98%.

pH

Measurement of pH was carried out to determine the tendency of increasing/decreasing pH during storage. The amount of pH is related to the formation of alkaline compounds during storage and will affect microbial growth. In general, fish that is not fresh, the meat has a more basic (higher) pH than fish that are still fresh. This is due to the emergence of basic compounds such as ammonia, trimethylamine, and other volatile compounds (Hadiwiyoto 1993). The pH analysis of *pindang Decapterus* spp. can be seen in Table 3.

From Table 3, it is known that from day 0 to day 6, all treatments increased. Then from Table 3, the average fish pH can be seen on day 0; generally, the average pH of fish with the control treatment was significantly different from the liquid smoke redistillation treatment but not significantly different from distillation. Still, on the 2nd day, the control significantly differed with all treatments (redistillation and distillation of liquid smoke). The use of redistillation liquid smoke has a significantly different effect from that of distillation liquid smoke. *pindang Decapterus* spp. preserved with liquid smoke redistillation has a lower pH (more acidic) than fish preserved with distillation liquid smoke. This is due to the relatively high concentration of redistillation liquid smoke added to the product, so the acid content also increases. The acidic

compounds in liquid smoke are mostly carboxylic acid derivatives such as furfural, furan, and glacial acetic acid, inhibiting microbial growth (Darmadji 1996). The higher the concentration of liquid smoke added to the product, the lower the pH value.

Table 3 show the average pH pattern of fish with redistillation liquid smoke preservative is more significant, which indicates a more acidic pH (pH 5-6), while the control pH pattern is almost the same as the addition of distillation liquid smoke (pH 6-7), which indicates tend to grow. This indicates that the control treatment and distillation liquid smoke conditions are getting worse because the concentration of liquid smoke added to the product is very low. According to Winarno (2002), in storage conditions, there will be changes in humidity and temperature, which are the determining factors for the speed of reshuffling of enzymes and bacteria in food which can cause changes in pH during a certain period. The increase in fish pH is also caused by a decay process in which the protein content of amino acids is converted into alkaline ammonia compounds.

Atmadjaja (1994) stated that fish pH values ranging from 6.0 to 7.0 and temperatures around 25-30ºC were ideal for the growth of spoilage bacteria. While a low pH can inhibit contamination of spoilage microorganisms, pathogenic microorganisms and poison-producing microorganisms will die (Sperling 1968).

Phenol levels

Phenol compounds are very important in smoked products because phenol plays a role in contributing to the specific odor and taste of smoked products (Girard 1992). Maga (1987) stated that phenols with higher boiling points would show better antioxidant properties than phenolic compounds with lower boiling points. The purpose of this phenol analysis was to determine the number of phenolic compounds attached to *pindang Decapterus* spp.. The phenol content of *pindang Decapterus* spp. can be seen in Table 4.

Table 4 shows that on all days of observation, the samples with the addition of redistillation and distillation liquid smoke (except the 1% distillation liquid smoke treatment on the 2nd and 6th days) had phenol levels that were significantly different from the control. The higher the concentration of liquid smoke added, both distillation and redistillation type liquid smoke resulted in increased phenol levels in *pindang Decapterus* spp. From days 0 to 6, the phenol content in *pindang Decapterus* spp. decreased; this was due to the phenol content in the material experiencing evaporation due to the storage process at room temperature (Sundari 2008). Even in the control treatment, there was phenol content due to the presence of phenolic compounds in water and salt from seawater and industrial and agricultural wastes (Romimohtarto 2009).

According to Girard (1992), the amount of safe limits in smoking products ranges from 0.06mg/kg to 5000 mg/kg or 0.0006 to 0.5%. Thus, the phenol content in *pindang Decapterus* spp. with the addition of this liquid smoke for the treatment of adding redistillation liquid smoke (0.471 to 0.566%) exceeds the safe limit. The same thing also happened in Sundari's (2008) study, which produced phenol levels of 0.4502 to 0.5269 % with concentrations of redistillation liquid smoke of 25%, 30%, and 35%. These levels also exceed the safe limit of phenol in foodstuffs (0.0006 to 0.5%). Phenol has acidic properties, is easily oxidized, volatile, sensitive to light and oxygen, and is antiseptic. The phenol levels will decrease, among others, by washing, boiling, and processing to make ready-for-consumption products (Sundari 2008).

Microbiological properties of *pindang Decapterus* spp.

The number of microbes in foodstuffs affects the speed at which food spoils. According to Hadiwiyoto (1993), the rate of microbiological deterioration of fishery products depends on the growth rate of existing microbes, especially spoilage bacteria. Bacterial growth is generally defined as an increase in the number of constituents in a cell or its mass, followed by cell multiplication so that the number of cells increases. The TPC of *pindang Decapterus* spp. can be seen in Figure 1.

Figure 1 shows that from day 0 to day 6, the TPC of all treatments increased. The addition of redistillation liquid smoke tends to produce significantly lower TPC than distillation and the control during storage. In addition, the higher the concentration of liquid smoke added to the product, the lower the value of TPC levels. This shows that 25-35% of redistillation liquid smoke significantly inhibits microbial growth, with better inhibitory ability than adding 1-3% distillation liquid smoke during storage.

Table 3. Results of pH analysis on *pindang Decapterus* spp.

Treatment	Observation on day			
	0	2	4	6
Control	6.07 ^{cd}	6.82 ^{e}	7.40 ^{g}	7.63 ^{f}
Redistillation 25%	5.61 ^{b}	5.86 ^{b}	6.30 ^{c}	6.40 ^{b}
Redistillation 30%	5.53 ^{b}	5.60 ^{a}	6.20 ^{b}	6.31 ^{a}
Redistillation 35%	5.33 ^{a}	5.61 ^{a}	6.08 ^{a}	6.29 ^{a}
Distillation 1%	6.13 ^{d}	6.48 ^{d}	7.13 ^{f}	7.49 ^{e}
Distillation 2%	6.06 ^{cd}	6.32 ^{c}	7.02 ^{e}	7.35 ^{d}
Distillation 3%	6.02 ^{c}	6.27 ^{c}	6.95 ^{d}	7.27 ^{c}

Note: Numbers followed by the same letter show no significant difference at the 5% level (applies to the same column)

Table 4. The results of the analysis of phenol levels (%) in *pindang Decapterus* spp.

Treatment	Observations on day			
	0	2	4	6
Control	0.264 ^{a}	0.264 ^{a}	0.241 ^{a}	0.226 ^{a}
Redistillation 25%	0.471 ^{e}	0.460 ^{d}	0.416 ^{d}	0.399 ^{c}
Redistillation 30%	0.531 ^{f}	0.517 ^{e}	0.432 ^{e}	0.413 ^{d}
Redistillation 35%	0.566 ^{g}	0.547 ^{f}	0.494 ^{f}	0.449 ^{e}
Distillation 1%	0.283 ^{b}	0.271 ^{a}	0.241 ^{a}	0.227 ^{a}
Distillation 2%	0.312 ^{c}	0.292 ^{b}	0.252 ^{b}	0.242 ^{b}
Distillation 3%	0.340 ^{d}	0.311 ^{c}	0.265 ^{c}	0.249 ^{b}

Note: Numbers followed by the same letter show no significant difference at the 5% level (applies to the same column)

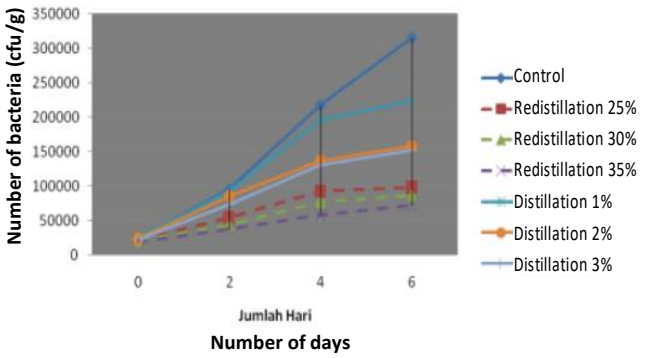

Figure 1. The average number of bacteria on *pindang Decapterus* spp.

The value of the total plate count of *pindang Decapterus* spp. from day 0 to day 6 has increased. On the 4th day of control treatment and adding 1%, 2%, and 3% distillation liquid smoke, it did not meet the threshold value following the SNI (1992) requirements for *pindang* microbiological quality with a maximum TPC per gram of 1.105 Cfu/g. This is because the value of the TPC content in the product (1.3.105-2.2. 105 Cfu/g) has exceeded the existing requirements limit.

While in the addition of 25%, 30%, and 35% redistillation liquid smoke, the value of TPC levels on day 4 to day 6 was about 5.8. 104-9.9. 104 Cfu/g still meets the requirements listed in SNI (1992) for *pindang* laying fish microbiological quality with a maximum TPC per gram of 1.105 Cfu/g. Thus, *pindang Decapterus* spp. in the treatment with the addition of redistillation liquid smoke (25%, 30%, 35%) stored until the 6th day was still suitable for consumption. This is because the high phenol content in the added liquid smoke can inhibit microbial growth and low pH, even though the water content in *pindang Decapterus* spp. is quite high.

Sensory properties of *pindang Decapterus* spp.

Sensory testing is one way of assessing a food product by humans as a measure using their five senses. The senses that play a role in this sensory test are sight (color), smell (smell), touch (texture), and overall level.

In this study, the sensory properties tested on 20 panelists were color, odor, texture, and overall. In general, the storage of *pindang* layang from day 0 to day 6 experienced a decrease in sensory value. This shows that the longer the *pindang* layang product is stored at room temperature, the more panelists dislike it because the product begins to experience changes that lead to a decline in color, odor, texture, and overall specifications.

Color

Color plays an important role in food acceptance, and color can give clues about chemical changes in food. According to Fennema (1985), color is the most important quality attribute; even though a product has high nutritional value, good taste, and texture, if the color is not attractive, it will cause the product to be less attractive. Color is the first parameter that determines the consumer acceptance level of a product. Subjective research with vision is still very decisive in color organoleptic testing; if the color seen by consumers is not attractive, it will result in low consumer ratings of the food product. The color of *pindang Decapterus* spp. can be seen in Table 5.

Table 5 shows that all treatments decreased from day 0 to day 6 of color analysis. The decrease in color parameters in the redistillation liquid smoke treatment was not as significant as in the distillation and the control. Then from the results of statistical analysis, on the color parameter on day 0, all treatments of redistillation liquid smoke (25%, 30%, 35%) were not significantly different from the distillation liquid smoke treatment and the control. At the same time, the control treatment had a significant difference from distillation liquid smoke treatments of 1%, 2%, and 3%. Of all the treatments, the one with the highest value was the control treatment. On the day of manufacture (day 0), all treatments of *pindang Decapterus* spp. followed the quality standards of high-quality *pindang Decapterus* spp. according to Wibowo (2000), namely having a specific color of grayish white, whole fish, not broken, clean, and not moldy.

On the 2nd day, the redistillation liquid smoke treatment was not significantly different from the 1% and 2% distillation liquid smoke treatment. Then for the 4th and 6th days, all treatments with the addition of redistillation liquid smoke were significantly different from those of the control and distillation liquid smoke. The fastest decrease in color parameters was in the control treatment, while the slightest decrease was in the treatment with the addition of redistillation liquid smoke. For all treatments, the addition of redistillation liquid smoke has a score above 5 which means that consumers are in a neutral condition and rather like it, while for the control treatment and the addition of 1%, 2%, and 3% distillation liquid smoke, the score is below 3 which means that consumers are at the very dissatisfied rating, so the product has not been received. This is because the control product does not meet the quality standards of *pindang Decapterus* spp., where the color of the fish is yellow, not intact, and moldy. It can be concluded that the panelists preferred fish given the addition of redistillation liquid smoke compared to distillation and the control liquid smoke.

Odor

Kartika et al. (1988) state that odor can be defined as the result of the sense of smell response caused by the evaporation of slightly fat-soluble substances in a food product into the air so that it can be responded to by the sense of smell, namely the nose, and then recognized by the body-system as a certain scent. In the food industry, testing for odor (*aroma*) is important because it can quickly assess whether the product is acceptable. In addition, the odor can also be used as an indicator of damage to the product. The odor of *pindang Decapterus* spp. can be seen in Table 6.

Table 6 shows that from day 0 to day 6, the odor parameters in all treatments decreased. The decrease in odor parameters in the redistillation liquid smoke treatment was not as significant as in the distillation and the control liquid smoke treatment.

Table 5. Results of the color analysis on *pindang Decapterus* spp.

Treatment	Observations on day			
	0	2	4	6
Control	7.30 [b]	5.70 [c]	1.75 [a]	1.25 [a]
Redistillation 25%	6.75 [ab]	6.40 [c]	6.05 [d]	5.10 [c]
Redistillation 30%	6.90 [ab]	6.00 [c]	5.85 [d]	4.85 [c]
Redistillation 35%	6.90 [ab]	5.95 [c]	5.50 [d]	5.10 [c]
Distillation 1%	6.20 [a]	3.30 [a]	2.15 [ab]	1.40 [a]
Distillation 2%	6.20 [a]	4.90 [b]	2.45 [b]	1.60 [ab]
Distillation 3%	6.45 [a]	5.85 [c]	3.20 [c]	1.90 [b]

Note: Numbers followed by the same letter show no significant difference at the 5% level (applies to the same column). Description of quality attributes: 1. very much dislike (unacceptable), 2. strongly dislike, 3. dislike, 4. slightly dislike, 5. neutral, 6. somewhat like, 7. like, 8. very much like , 9. very much like it

Table 6. The results of the odor analysis on *pindang Decapterus* spp.

Treatment	Observation on day			
	0	2	4	6
Control	7.05 [c]	5.70 [d]	2.00 [ab]	1.10 [a]
Redistillation 25%	6.50 [bc]	5.95 [d]	6.20 [d]	6.05 [e]
Redistillation 30%	5.80 [ab]	4.65 [c]	5.10 [c]	5.35 [d]
Redistillation 35%	5.25 [a]	3.75 [b]	5.00 [c]	4.50 [c]
Distillation 1%	6.10 [b]	3.10 [a]	1.75 [a]	1.40 [ab]
Distillation 2%	6.10 [b]	4.45 [c]	1.95 [ab]	1.60 [b]
Distillation 3%	5.85 [ab]	4.70 [c]	2.45 [b]	1.80 [b]

Note: Numbers followed by the same letter show no significant difference at the 5% level (applies to the same column). Description of the quality attribute: 1. very strongly dislike (unacceptable), 2. very much dislike, 3. dislike, 4. somewhat dislike, 5. neutral, 6. somewhat like, 7. like, 8. very much like, 9. very much like it

The fastest decrease in odor parameters was in the control treatment, while the presence of phenolic compounds caused a slight decrease in the addition of redistillation liquid smoke. From the statistical analysis results, the odor parameters on day 0 and day 2 of the control treatment were not significantly different from the 25% redistillation liquid smoke treatment and significantly different from all treatments.

On day 0, the control treatment had the highest score of the other treatments, then for the second day, the control treatment and 25% redistillation liquid smoke had the highest score from the panelists, which was around 6-7, which means the panelists were in a condition of somewhat like to like. For day 4, the control treatment was not significantly different from all distillation treatments but significantly different from all redistillation liquid smoke treatments. The highest value was from adding 25% redistillation liquid smoke, namely > 6, then for the control treatment and distillation liquid smoke < 2, which means the panelists did not like it very much. Then for the 6th day, the control treatment was not significantly different from the 1% distillation liquid smoke treatment and significantly different from all treatments. The lowest value of this treatment was in the control treatment, a score of 1.1 which means that the panelists strongly disliked it. The highest score was in the 25% redistillation liquid smoke treatment; the score was ± 6, which means the panelists somewhat liked the product.

From the data above, it can be concluded that on the 0th and 2nd days, the control treatment was the most preferred, while the liquid smoke treatment that used high concentrations was somewhat like; this was due to the addition of a high concentration of liquid smoke into the product which would produce a pungent smoke odor. But for the 4th and 6th day, the most preferred treatment was the addition of redistillation liquid smoke. This is because the longer the storage of the smoke odor will evaporate, while in the control treatment, the odor is rotten. According to Wibowo (2000), the high-quality standard of *pindang Decapterus* spp. is the specific odor of *pindang Decapterus* spp., without rancid, sour, and rotten odors. So that the control treatment and the addition of distillation liquid smoke on the 4th and 6th days were not suitable for consumption because they were not following the quality standards of *pindang Decapterus* spp..

The presence of phenolic compounds causes the odor of the liquid smoked fish. According to Girard (1992), phenol compounds play a significant role in giving smoke odor. Daun (1979) stated that the flavor characteristics of smoked products were caused by the presence of phenolic components absorbed on the product's surface.

Texture

The texture is a sensation of pressure that can be observed using the mouth (when bitten, chewed, and swallowed) or by palpation with the fingers (Kartika et al. 1988). To feel the texture of a product, the sense of touch is used. The sense of touch used for food is usually in the mouth using the tongue and the parts in the mouth; it can also be using the hands to feel the texture of a food product. The texture is also one of the determinants of quality that needs to be considered. The texture of the *pindang Decapterus* spp. can be seen in Table 7.

Table 7 shows that from day 0 to day 6, the texture parameters in all treatments decreased. The decrease in texture parameters in the redistillation liquid smoke treatment was not as significant as in the distillation and the control. The higher the concentration of liquid smoke added to *pindang Decapterus* spp., the better the texture. The fastest decrease in texture parameters was in the control treatment, while the slightest decrease was in the treatment with the addition of redistillation liquid smoke.

From the texture analysis results, it can be seen that, on day 0 and day 2, all redistillation liquid smoke treatments were not significantly different from the 3% distillation liquid smoke treatment. For day 0, the control treatment had a higher value than the other treatments. On the 4th and 6th days, all treatments of redistillation liquid smoke were significantly different from all treatments of distillation and the control.

On days 0 and 2, the control treatment and redistillation of liquid smoke were the most preferred. All treatments on days 0 to 2 still met the quality standards of *pindang Decapterus* spp.. According to Wibowo (2000), the high-quality standard of *pindang Decapterus* spp. is compact, dense, dry enough, not runny/muddy, and with no visible

bacteria or mold. From the 4th day onwards, the control treatment and all the distillation treatments did not meet the quality standards of *pindang Decapterus* spp. because the product had molds visible, and the texture was not compact, so the panelists gave a score of 2-3, which meant the panelists were in a state of dislike and very strong dislike. However, in contrast to the redistillation liquid smoke treatment, the product was still following the quality standards of *pindang Decapterus* spp., so the panelists still gave a score of 5-6 which means the panelists were in a neutral condition and somewhat liked it. From the data above, it can be concluded that the addition of redistillation liquid smoke is preferred by panelists and can maintain quality longer than other treatments.

Overall analysis

The overall preference test assesses all quality factors, including color, odor, and texture, which is intended to determine the level of panelists' acceptance of the product.

Table 8 shows that from day 0 to day 6, the overall parameters in all treatments decreased. The decrease in overall parameters in the redistillation liquid smoke treatment was not as significant as in the distillation and the control. The higher the concentration of liquid smoke added to the *pindang Decapterus* spp., the more preferred by the panelists. The fastest decrease in overall parameters was in the control treatment, while the slightest decrease was in the treatment with the addition of redistillation liquid smoke.

From Table 8, the results of the overall analysis can be seen that on day 0, the redistillation liquid smoke treatment was not significantly different from the 2%, 3% distillation liquid smoke, and the control treatments. For the 2nd day, all the redistillation liquid smoke treatments were not significantly different from the control treatment. For days 0 and 2, the control treatment had a higher value than the other treatments. On the 4th and 6th days, all treatments of redistillation liquid smoke were significantly different from all treatments of distillation and control liquid smoke. For the 4th and 6th days, the most preferred treatment was the addition of redistillation liquid smoke; the panelists gave a score >5, which means the panelists were in a neutral condition. From the data above, it can be concluded that the redistillation liquid smoke treatment is the most preferred by the panelists and the treatment that has the longest shelf life compared to the control and the addition of distillation liquid smoke.

According to Girard (1992), the effects of acids are less specific but generally affect the overall organoleptic quality. Daun (1979) added that the main effects of liquid smoke are changes in color, odor, bactericidal properties, and antioxidant properties. According to Hadiwiyoto (1993), phenol is a compound that can provide odor, taste, and color, as well as antioxidant and preservative effects.

The organoleptic value of *pindang Decapterus* spp. decreased with increasing storage time. This is due to the decomposition of compounds in fish such as protein, amino acids, lactic acid, and reducing sugars by decomposing bacteria, resulting in a foul odor. In addition, there are spoilage bacteria found in fish meat and bacteria from the outside environment.

Table 7. The texture analysis results on *pindang Decapterus* spp.

Treatment	Observation days on			
	0	2	4	6
Control	7.30 ^{c}	6.20 ^{c}	2.35 ^{a}	1.20 ^{a}
Redistillation 25%	6.85 ^{abc}	5.60 ^{bc}	6.05 ^{c}	5.30 ^{c}
Redistillation 30%	6.95 ^{bc}	6.25 ^{c}	6.10 ^{c}	5.80 ^{d}
Redistillation 35%	6.95 ^{bc}	5.60 ^{bc}	6.15 ^{c}	5.65 ^{cd}
Distillation 1%	6.35 ^{ab}	4.35 ^{a}	2.50 ^{ab}	1.30 ^{a}
Distillation 2%	6.20 ^{a}	5.15 ^{b}	2.70 ^{ab}	1.40 ^{a}
Distillation 3%	6.55 ^{ab}	5.25 ^{c}	3.05 ^{b}	1.90 ^{b}

Note: Numbers followed by the same letter show no significant difference at the 5% level (applies to the same column). Description of quality attributes: 1. very much dislike (unacceptable), 2. strongly dislike, 3. dislike, 4. slightly dislike, 5. neutral, 6. somewhat like, 7. like, 8. very much like , 9. very much like it

Table 8. The overall analysis on *pindang Decapterus* spp.

Treatment	Observation days on			
	0	2	4	6
Control	7.35 ^{c}	6.05 ^{d}	2.20 ^{a}	1.10 ^{a}
Redistillation 25%	7.00 ^{bc}	5.75 ^{cd}	5.75 ^{c}	5.00 ^{c}
Redistillation 30%	6.75 ^{abc}	6.05 ^{d}	5.70 ^{c}	5.00 ^{c}
Redistillation 35%	6.70 ^{abc}	5.45 ^{cd}	5.55 ^{c}	4.65 ^{c}
Distillation 1%	6.05 ^{a}	3.90 ^{a}	2.20 ^{a}	1.65 ^{b}
Distillation 2%	6.20 ^{b}	4.80 ^{b}	2.55 ^{ab}	1.00 ^{a}
Distillation 3%	6.25 ^{ab}	5.20 ^{bc}	2.90 ^{b}	1.95 ^{b}

Note: Numbers followed by the same letter show no significant difference at the 5% level (applies to the same column). Description of quality attributes: 1. very much dislike (unacceptable), 2. strongly dislike, 3. dislike, 4. slightly dislike, 5. neutral, 6. somewhat like, 7. like, 8. very much like , 9. very much like it

Based on the research that has been carried out, it can be seen that: (i) In the control treatment and the 6th-day observation of redistillation liquid smoke, the water content value increased, while in the distillation liquid smoke treatment, it still decreased. (ii) On the 6th day of observation, the water content of the redistillation liquid smoke treatment significantly affected the distillation liquid smoke treatment. (iii) During the storage of the redistillation liquid smoke treatment, the increase in pH (0.8) was not as significant as the distillation liquid smoke treatment (1.4), which was stated at the level of 0.5%. (iv) Total Plate Count (TPC) in the redistillation liquid smoke treatment was significantly different from the distillation liquid smoke treatment; the longer the storage time, the higher the number of bacteria. (v) In the control treatment and distillation, liquid smoke can only maintain quality until the 4th day in terms of the Total Plate Count (TPC) 1.3. 105-3.2. 105 Cfu/g exceeds the standard of SNI (1992), while the redistillation liquid smoke treatment can maintain quality until the 6th day. (vi) Based on the sensory properties (color, odor, texture, and overall), the panelists preferred the redistillation liquid smoke treatment to the distillation liquid smoke treatment. (vii) In terms of chemical, microbiological, and sensory properties, the redistillation treatment can maintain the quality longer (6th

day) and is preferred by the panelists compared to the distillation liquid smoke treatment. (viii) From the chemical and microbiological properties, the 35% redistillation liquid smoke treatment can maintain its quality longer than the other treatments. (ix) In terms of sensory properties, the 30% redistillation liquid smoke treatment is preferred by panelists over other treatments. (x) The higher the phenol content contained in the liquid smoke, the better the quality of the chemical, microbiological, and sensory properties.

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