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Organoleptic Observation of the Preservation of Mackerel Fish using Liquid Smoke from Coconut Shell Pyrolysis

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ABSTRACT

Coconut shell liquid smoke is a by-product of a pyrolysis process of coconut shells to produce coconut shell charcoal. The liquid can be used as an alternative fish preservative. Traditionally, the fish preservation is conducted by direct smoking of the fish on a coal or biomass burning. However, due to the presence of benzopyrene compounds in the direct smoking process, the smoked fish product may pose a health risk as benzopyrine is carcinogenic. In this research, a free benzopyrene liquid smoke obtained from the pyrolysis of coconut shells which is called grade 1 liquid smoke is used for mackerel fish preservative. The aim of this research is to evaluate the effect of soaking time to the quality of preserved mackarel fish using organoleptic approaches. Five (5) pair of fresh mackerel fishes were cleaned and placed in a soaking container. There was also one (1) pair of mackerel used as a control. Approximately 3L of 3% (wt.) solution of liquid smoke from coconut shell pyrolysis was poured into the soaking container until the fishes were perfectly soaked. The fishes were soaked for 3, 5, 10, 15 and 20 minutes, respectively, and then they were stored at room temperature for observation. The control fish was stored in a container in room temperature without the addition of liquid smoke . Organoleptic observations, namely aroma, color and texture were carried out for soaked and control fishes in the first and 48th hours of the storage time. From the research, it was found that the optimum soaking time of mackerel fishes was 5 minutes. At this optimum soaking time, the organoleptic properties including aroma, color and texture of preserved fishes at the first hour of the storage showed only one level lower quality than a fresh fish. Furthermore, at 48th hours of the storage time, the preserved fishes showed a better performance of organoleptic characteristics (scale >4) compared to the control fish (scale ≅2).

Keywords: *benzopyrene, coconut shell pyrolysis, liquid smoke, mackerel fish preservative, organoleptic*

1. INTRODUCTION

Indonesia has the largest area of coconut trees (*Cocos nucifera*) in the world. There were 3.3 million hectares of coconut plantations which produced approximately 2,8 million tons of coconuts in 2021 (BPS, 2022). More than 90% of coconut plantations in Indonesia is community based plantations.

One component in a coconut seeds is a coconut shell; it takes approximately 12% of a whole coconut seed. Most of the coconut shells are disposed as a waste or burned which gives bad impacts to the environment. On the other hand, based on proximate analysis and calorific value of a coconut shell, it has a potential to be used as a fuel source by utilizing it to produce coconut shell charcoal. (Aladin, A., dkk, 2017).

The utilization of coconut shell into charcoal can be carried out by pyrolysis. Pyrolysis is a process of heating carbon-based solid materials at high temperatures (350 - 550^{o}C) without or with a minimum amount of oxyge. In the process of pyrolysis, in addition to the main product of charcoal, it also produces side products in the form of

smoke or mixed gases resulting from the degradation of cellulose, hemicellulose, carbohydrate and lignin compounds. The gas products of the degradation of micro compounds are carboxylic acid compounds (such as oxopentane acid, acetic acid, benzoic acid, formic acid, glycolic acid, hexadecanoic acid, hexanoic acid, propanoic acid, valeric acid), ketone compounds (such as 1-hydroxy 2- propanone, 2,5 hexanedione, 2-butanone, 2-ethylcyclopentanone, 2-methyl2-cyclopenten-1- one), phenol compounds and their derivatives, benzopyren, oxygenates such as furans and other hydrocarbons(Sholichah, E., dkk, 2014, Yunus 2011, Aladin, A., et al 2016).

In a conventional process of pyrolysis with the main target of charcoal products, the byproducts in the form of micro compounds of smoke or gas are usually left loose into the air so that it has the potential to pollute the environment. However, if the smoke product is channeled through a condenser, some of the condensable gases will condense to form a product called liquid smoke. It has been described in previous research (Aladin, A, et al (2017) that a set of pyrolysis reactor could produce charcoal and liquid smoke products simultaneously. This simultaneous pyrolysis reactor can produce approximately 55% (wt.) of charcoal products and grade 3 liquid smoke of approximately 40% (wt.) from a raw material of a coconut shell biomass waste.

Liquid smoke resulting from pyrolysis, depending on its raw material and grade (grades 1-3), can be used for various purposes. Grade 3 liquid smoke, which is liquid smoke obtained directly from the condensation of pyrolysis of biomass materials (such as coconut shells) or other carbon-based materials (such as coal), can be used as bio-pesticides or bio-insectiicides. Grade 2 liquid smoke is produced by a distillation process of grade 3 liquid smoke. Further distillation of grade 2 liquid smoke will result grade 1 liquid smoke. Benzopyrene compounds, toxic and carcinogenic compounds, are separated from the liquid smoke through distillation process. Double distillation processes to yield grade 1 liquid smoke are conducted to ensure that the liquid smoke is free from f benzopyrene compounds (Aladin, A., dkk, 2018; Yunus, 2011).

Indonesia is also known as a maritime country with a sea area larger than its land, a country that produces a variety of fish. A favorite fish that is consumed by Indonesians, especially the people of South Sulawesi, is mackerel (*Scomber scombrus)* (Amir, M., dkk, 2013). Like other types of fish, mackerel does not last long without preservation. The fish is easily rotten if stored at a room temperature. In order to preserve it for several days, the fish is stored in a refrigerator under -10^{o}C. Another way of preserving the fish is by drying, acidifying and salting. There is also an illegal preservation method using formalin.

Traditional fishing communities preserve fish by smoking the fish directly on burning coal and/or biomass. The smoked fish has a durability of several days and gives a distinctive taste that could increase the taste of the fish. However, a direct smoking in the burning coal or biomass could pose a risk of cancer to consumers. As describe previously, a smoke of pyrolysis contains benzopyrene. Therefore, a healthier alternative of preserving fish than a direct smoking is conducted through the preservation of fish by soaking the fish using a solution of a grade 1 liquid smoke of coconut shells. This paper is limited to discuss the use of grade 1 liquid smoke from the pyrolysis of coconut shell biomass waste as a preservative of mackerel fish, particularly in discussing the effect of soaking time of fish in liquid smoke solutions using organoleptic approaches.

2. METHODS

Grade 3 liquid obtained from pyrolysis of coconut shell biomass waste material with pyrolysis operating conditions described elsewhere (Aladin et al., 2017) was used as a raw material. The grade 3 liquid smoke was first purified from toxic and carcinogenic substances (benzopyrene) by distillation in a distillation flask (15) on a heating stove (13) equipped with a leibigh condenser (5) which is connected to the inlet cooling water hose (6) and the cooling hose to the outside (7) and equipped with a thermometer (4) (figure 1).

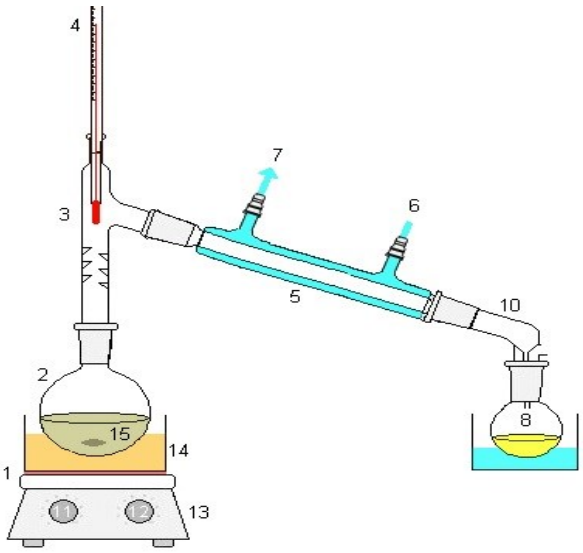

Fig. 1. Distillation apparatus

This distillation process was conducted at a temperature of 98 ^{o}C (first stage), and was stopped when the liquid's temperature starts to rise (second stage), or the residual liquid in the distillation flask appeared to be rather concentrated. Liquid distillate was collected in another container (8). This liquid was referred as grade 2 liquid smoke. Grade 2 liquid had a clearer color than garde 3 liquid smoke. The distillation process was repeated once again for grade 2 liquid smoke liquid with the same distillation process so as to obtain grade 1 liquid smoke. Grade 1 liquid smoke had clearer color than grade 2 liquid smoke.

Twelve (12) fresh mackerel fishes bought directly from the nearest fish market, with a uniform size and condition, were cleaned and weighed. Ten (10) fishes (the remaining 2 of the fishes were as controls) were

placed in a row in a soaking rectangular tray container. The size of the container was 50 cm (length) x 30 cm (width) x 5 cm (height). Grade 1 liquid smoke solution that had been diluted to 3% (Putri, GR, 2016) was poured into the container.

Fig. 2 Soaking of Mackerel Fish

With a soaking time of 2 minutes, 1 pair of fishes was first removed from the soaking container, then the soaking continously conducted for other fishes for soaking times of 5, 10, 15 and 20 minutes, respectively. All fishes removed from the soaking container were drained for 10 minutes. Then the drained fishes with a pair of control fishes (without soaking) were stored in a clean and sterile room for observation. Organoleptic observations were made in the first hour and 48 hours (2 days). The organoleptic observations included aroma (A), color (C) and texture (T) with respective scale values of 1-5 as presented at Table 1.

Table 1. Organoleptic Analysis Scale *

Scale	Color(C)	Aroma (A)	Texture (T)
1	Very pale	Very bad smell	Broken
2	Reddish pale	Bad Smell	Very soft
3	Pale	Fishy smell	Soft
4	Rather pale	Rather Fishy smell	Rather soft
5	Fresh color	Fresh smell	Fresh texture

3. RESULT

Mackerel fishes were preserved in a 3% of liquid smoke solution of grade 1 from the pyrolysis of coconut shell biomass waste. The observations of the effect of fish soaking duration on the preserved fish were studied using organoleptic properties. The effect of soaking time on the organoleptic characteristics of fish in the first hour of storage is presented in Figure 3.

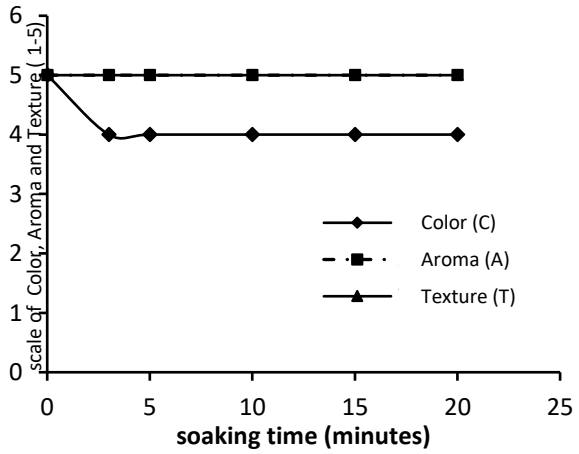

Fig. 3. Organoleptic scales of preserved fish soaked in 3% of liquid smoke solution at 1 hour preservation time.

It can be seen from the figure that the fish aroma after 1 hour soaking for both control and preserved fish are in the category of 5 of organoleptic scale. This means that both fishes are still fresh. Likewise, other organoleptic characteristics, namely texture, are still on the scale of 5, it is categoriesed as fresh. The scale values for the aroma and texture are all the same, so that it coincides together in the graph.

Unlike the case with color, once the fish is immersed in a 3% liquid smoke solution, the color changes, the fish eye immediately appears to be white. When compared to the eyes of the control fish, the eyes remain in clean-black color. Overall the color of the fish appeared rather pale in the first hour after soaking, compared to the control fish, the color was still very fresh as the typical color of mackerel. The color changes of the fish is influenched by the acidity of the liquid smoke; the liquid smoke has a low pH (pH 2-3). Although it is a diluted liquid smoke, it is enough to give effect to change the color of the fish, especially the color change of the eyes of the fish.

The effect of soaking duration on the organoleptic characteristics of the fish at 48 hours of storage (2 days) is presented at Figure 4. In the figure it can be seen that the scent of control fish (without smoking) has been putrid (scale 2). From the organoleptic's aroma scale, the fish is no longer suitable for consumption. Likewise, the color of the control fish is pale reddish (scale 2). The third organoleptic characteristic, namely the texture, gives a scale of 2. This shows that the fish is very soft, but has not broken.

For smoked fish with soaking time of 3 minutes and stored for 48 hours, the organoleptic characteristics give

a scale of 3 for color and a scale of 3.5 for aroma and texture. The 3 minutes soaking time gives a better quality of the preserved fish than the control. For smoked fish with soaking time of 5 minutes, the preservation effect is even better. The organoleptic scale values for color, aroma and texture of the preserved fishes are on average on scale 4. These values are much better than the control fishes on scale 2. Based on the organoleptic test, the fish with a scale of 4 are still suitable for consumption. Soaking the fishes with a longer soaking time than 5 minutes (10-20 minutes) do not provide a significant increase in preservation characteristic. Prolonging the soaking time (above 5 mintues) only increases the average of scale values of color, aroma and texture from 4 to 4.25.

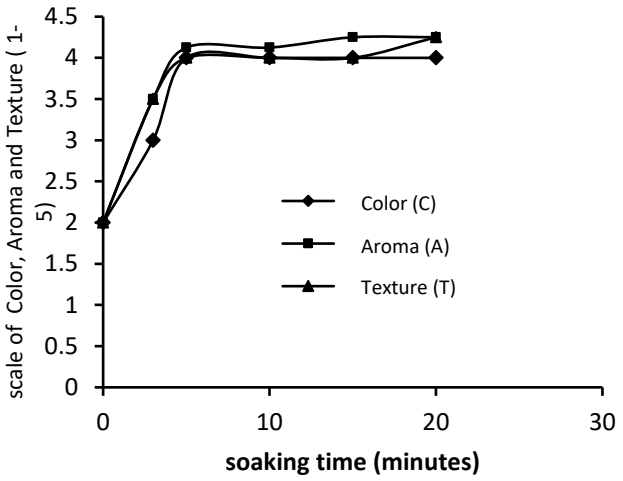

Fig. 4. Organoleptic scales of preserved fish soaked in 3% of liquid smoke solution with 48 hours soaking time

4. CONCLUSION

Organoleptic analysis is used to observe the quality of preserved mackerel fish using 3% solution of grade 1 liquid smoke from coconut shell pyrolysis for 48 hours storage time. It is concluded from the observations that the optimum soaking time is 5 minutes. The organoleptic characteristics show that after 24 hour storage, the scale of the preserved fishes is onle one (1) level lower than the scale of the fresh fish. The aroma of the preserved fish is a typical fresh smoked fish with a bit fishy (scale 4.25), the color of the fish is a bit pale and the texture is a bit soft. After 48 hours of storage, the average scale of the organoleptic of the preserved fish is 4, whereas the average scale of the control fish is 2. Based on the organoleptic characteristics, the fish preserved with 3% solution of liquid smoke of coconut shell is suitable for consumption when it is stored without refrigeration for 48 hours.

5. ACKNOWLEDGMENTS

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