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CHARACTERIZATION OF LIQUID SMOKE FROM DRIED WATER HYACINTH USING GCMS (GASS CHROMATOGRAPHY-MASS SPECTROPHOTOMETRY) TO UTILIZE WEEDS AS FOOD PRESERVATIVE

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ABSTRACT

Water hyacinth is a weed in Rawa Pening because of its rapid growth. A handling effort is a very crucial thing and must be done immediately. This study aims to characterize organic compounds in liquid smoke from dried water hyacinth. Characterization of organic compounds from dried water hyacinth was carried out on water hyacinth liquid smoke which was pyrolyzed at 200°C and 600°C. Pyrolysis times were run at 2 hours and 6 hours. Liquid smoke from dried water hyacinth was distilled before testing its chemical composition using GCMS brand Shimadzu type QP 2010S. The results of liquid smoke characterization are used to decide that liquid smoke can be utilized as a food preservative. The test results report that the liquid smoke produced had an acid percentage ranging from 29.63% to 37.23%, phenol from 1.04 to 6.11%, and the remaining carbonyl compounds from 55.99% to 68.90%. The highest component value was obtained at 600°C pyrolysis and 6 hours. The conclusion is that liquid smoke from dried water hyacinth can be used as a food preservative because it contains acid, phenol, and carbonyl and is free of Benzo (a) pyrene, which can cause cancer. So that the requirement for liquid smoke as a preservative can be achieved, whereas acid is a food preservative. This study generates the acquisition of natural food preservatives to utilize weeds. The research helps us utilize weeds to resist the Rawa Pening environment and manufacture food preservatives.

Keywords: liquid smoke; organic compound; total acid; total phenol; water hyacinth

INTRODUCTION

The characterization of liquid smoke from dried water hyacinth is significant for further use. Liquid smoke has the potential as a natural food preservative, whereas water hyacinth has the potential to become liquid smoke. Semarang Regency, Central Java Province, has a lake Rawa Pening. This lake is one of the five priority lakes that must be maintained according to The National Medium Term Development Plan RPJMN 2020–2024, focusing on sustainable lake management due to water hyacinth. Excessive water hyacinth prevalence due to eutrophication requires management. Efforts to utilize and manage water hyacinth have been carried out for compost, animal feed, and biogas (Su et al., 2018), biogas (Sarto et al., 2019), textile industry biopsy (Vinicius et al., 2020), active carbon (Huang et al., 2014), and potential to be liquid smoke (Ratnani

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& Widiyanto, 2018). Unfortunately, all the efforts have not succeeded in keeping up with its high-speed growth. Therefore, water hyacinth in Rawa Pening is still very abundant in number.

Water hyacinth (*Eichhornia crassipes*) in Rawa Pening in Figure 1 can be seen filling most of the water bodies. Water hyacinth is very invasive, where biota species grow and reproduce in natural habitats or ecosystems that harm the aquatic environment. The annual growth rate of water hyacinth and biomass production ranged from 6437 to 8218 g DM m-2 year-1 due to the solar radiation, longer growing season, and higher air temperature (Eid & Shaltout, 2017). One clump of water hyacinth weighing 160 grams can cover 1 m^2 of mesocosm in 21 days (Prasetyo et al*.,* 2021). Diffusion of water hyacinth takes 12 days to reproduce the population in an 8% increase. This biomass can double in a week or two. It means that removing it is very scarce. Massive harvesting is needed to support the sustainability of the lake environment.

Figure 1. Rawa Pening in Indonesia

Water hyacinth (*Eichhornia crassipes*) is a floating aquatic plant widely found in tropical and sub-tropical areas that grow on the water's surface (Hashem et al*.,* 2020). Water hyacinth has brought many losses and negative impacts, such as a reduction in the amount of benthos, consumption of dissolved oxygen in the water, and pollution of water bodies. The lack of adequate and sustainable control methods causes water hyacinth to flourish and proliferate (Mukarugwiro et al*.,* 2021).

This plant can quickly cover the water's surface. Therefore it endangers biodiversity (Istirokhatun et al*.,* 2015). Huge sums of money are spent worldwide on selective weed eradication by manual harvesting and using it as energy production and animal feed (Sun et al*.,* 2020). This plant contributes to oxygen depletion, blockage in river channels and irrigation projects, higher greenhouse gas emissions, and encourages the breeding of flies and mosquitoes, damages native biodiversity and water quality (Liu et al*.,* 2020). Pyrolysis of water hyacinth into liquid smoke is offered in this study. The pyrolysis process generates liquid smoke. The pyrolysis process for water hyacinth can be carried out in a large capacity so that it can process large amounts of water hyacinth in one process. Pyrolysis is expected to be an alternative to balance its growth. Pyrolysis of biomass can occur due to lignin, cellulose, and hemicellulose. Biomass contains about 10–30% lignin, 20–50% cellulose, and 20–40% hemicellulose (Sagar & Kumari, 2013). The composition of lignin, hemicellulose, and cellulose in water hyacinth stems is 7.32%, 36.26%, and 20.64%, respectively (Ratnani et al*.,* 2021). Based on the composition test above, water hyacinth is suitable as raw material for liquid smoke. Further utilization can be obtained from test results using GCMS.

Characterization of organic compounds is carried out with the aid of GCMS (Gas Chromatography-Mass Spectrophotometry). Identification of organic compounds is carried out by looking at the chromatogram peak. It indicates that the liquid smoke produced is a varied mixture of natural organic compounds, both oxygenated and non-oxygenated, such as aromatic hydrocarbons, aliphatic hydrocarbons, phenolics, alcohols, ketonic, aldehydes, carboxylic acids, amide groups, and others. Other studies have examined lignin's role in producing aromatic compounds such as cresols, phenol, benzene, and more. The carbonyl and carboxylic groups' compounds are formed by the interaction of cellulose and hemicellulose, whereas phenols and their derivatives are formed by the interaction of hemicellulose and lignin (Zhang et al., 2018).

Carbonyl compounds, organic acids, phenols and are found in liquid smoke from wood condensation and get a part in food preservation (Wijayanti et al*.,* 2020). Liquid smoke is procured from the thermal degradation reaction of lignin, hemicellulose, and cellulose. It is used to impart taste, texture, and colour and can increase the shelf life of products. A smoking method is an effective way to avoid microbial growth and foul smells. Liquid smoke has several benefits, including its ease of use, uniformity, and environmental friendliness. Some people love the strong taste and smell of smoke, while others prefer the flavour of certain smoked ingredients. The main functional attributes of liquid smoke are to generate the desirable colour and flavour of the product because of the phenolic and carbonyl compounds. Tar, Benzo (a) pyrene compounds, and carcinogens that destroy essential vitamins and amino acids are also found in liquid smoke. As a result, it must be filtered to lower the carcinogenic content. Improving phenols, carbonyl compounds, and organic acids aims to preserve food (Nithin et al*.,* 2020).

Liquid smoke used as a marinade in the manufacture of smoked fish in a modern way will provide better product quality through immersion carried out on sea bass using Scansmoke 9015 and AFS-10 SOL flavours (Martínez et al., 2018). Dina et al. (2017) report that fish processed using liquid smoke has a better safety value than smoked fish treated with traditional smoking. The analyzed products smoked using traditional techniques contain significantly more PAHs than those smoked by industrial techniques or produced with smoked meat and fish flavourings (Zachara et al*.,* 2017). Applying corncob liquid smoke through different redistillations (without zeolite, redistillation, and activated carbon) can improve the quality of smoked milkfish (Swastawati et al*.,* 2016). Smoked pork using liquid smoke from wood has also been done with more satisfying results (Saldaña et al*.,* 2018). Applying liquid smoke to increase the quality of smoked skipjack fish employing liquid smoke from *sekampadi* and coconut shells has also increased the shelf life (Swastawati et al*.,* 2014).

The pyrolysis volatiles obtained were phenols, esters, ketones, aliphatic, alcohols, aromatic hydrocarbons, acids, aldehydes, and alicyclic hydrocarbons nitrogen-containing sugars, furans, compounds, ethers, and organo-sulfur compounds. Pyrolysis is carried out at a temperature of 240°C. Temperatures of 200°C and 600°C have not been carried out (Yao et al., 2020). GCMS analysis is done only for fatty acid composition (Venu et al., 2019). GCMS analysis of the resulting liquid smoke shows that the number of phenols, nitrogen compounds, and alcohols increased while the number of esters decreased. Pyrolysis was carried out at 300°C - 600°C with water hyacinth as raw material harvested from a lake near Tonga district in Xiamen, China (Lin et al., 2018). Meanwhile, water hyacinth in Rawa Pening is polluted with PO_4, NO_3, As, Se, Cd, Mn, Cu, Pb, and H_2S. Water hyacinth overgrows to explore ways to utilize water hyacinth to make valuable products, one of which is as a food preservative in the form of liquid smoke. This study intends to characterize liquid smoke from dried water hyacinth so that it is suitable as a food preservative from water hyacinth to utilize weeds that are widely available in Rawa Pening. Previous studies on liquid smoke from water hyacinth have been carried out: an investigation of the chemical composition of liquid smoke from water hyacinth with catalyst-assisted potential as fuel (Zhang et al., 2018), bioethanol and biogas (Bote et al., 2020), and hydrogen gas (Tran et al., 2021). Research on the characterization of water hyacinth liquid smoke as a food preservative has not been carried out. This study used the help of GCMS and performed the pyrolysis of water hyacinth into liquid smoke at pyrolysis temperatures of 200°C and 600°C. This pyrolysis temperature was maintained at that milk for 2 hours and 6 hours. The resulting liquid smoke is a potential chemical composition as a food preservative. This study only tested the chemical compounds of liquid smoke pyrolyzed from dried water hyacinth from a food preservative review. Previous research used water hyacinth that did not come from Rawa Pening, Indonesia, at different temperatures and was reviewed for energy.

METHODS

This research method used a laboratory-scale pyrolysis reactor. The raw material for this liquid smoke is water hyacinth stems cut into pieces 5 cm. After cutting, water hyacinth was dried in the sun to dry. Enter the dried water hyacinth into the pyrolysis reactor as 550 grams in Figure 2, then heat. Heating is assisted by using a stove with LPG and setting the temperature and time. The selected pyrolysis time is 2 and 6 hours with temperatures of 200°C and 600°C (Sulhatun et al*.,* 2019). The smoke formed was then passed through the condenser until the liquid smoke was accommodated as liquid smoke.

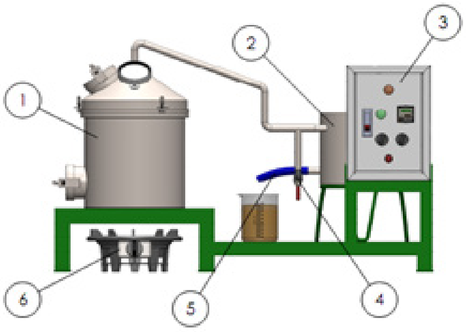


Figure 2. Reactor Pyrolysis

The research target was water hyacinth stems taken from Rawa Pening. The research was conducted in 2019. Water hyacinth was taken at the collection point in Rawaboni Village, Banyubiru District, Semarang Regency, Indonesia. The stems of water hyacinth that grow in Rawa Pening are chosen, long and old. Water hyacinth with long stems, and solid fibres, when aged, it is expected that the composition of organic compounds produced by liquid smoke will be formed in large quantities from this material. The resulting liquid smoke is then tested for its composition using GCMS. Identifying organic compounds assisted by GCMS did not use FTIR because FTIR described the functional groups in the constituents to be detected. The top view of the test using GCMS is in the form of a chromatogram image and a list of the compositions of organic compounds.

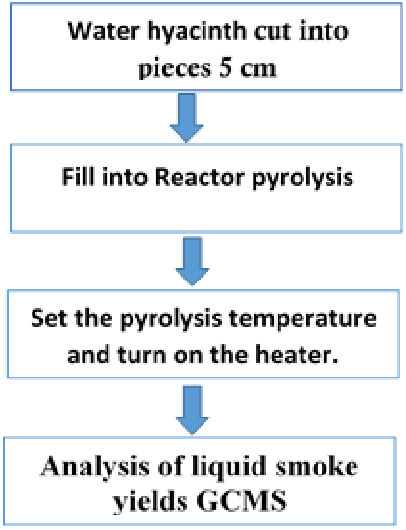


Figure 3. The Process Flow Chart

Instruments and analysis of this research used the help of GCMS to the liquid smoke formed from the pyrolysis process and redistilled. The results of the redistilled liquid smoke were analyzed for the content of organic compounds using GCMS to identify organic compounds contained in liquid smoke using GCMS with GC-MS QP2010S Shimadzu, USA, equipped with a Rxi-5 Sil MS column (film thickness: 30m×0.25 mm×0 .25 m) to determine the percentage of various organic compounds (Kumar et al*.,* 2019). Liquid smoke was fed into the column. The chromatogram peaks were observed and compared to the NIST library to identify the specified organic components. The peak chromatogram illustrates that the liquid smoke is a varied mixture of natural organic compounds, both oxygenated and non-oxygenated, such as aromatic hydrocarbons, aliphatic hydrocarbons, phenolics, alcohols, ketonic, aldehydes, carboxylic acids, amide groups, and others. The resulting compound is complex. The results of biomass decomposition are cellulose, hemicellulose, and lignin.

RESULTS AND DISCUSSION

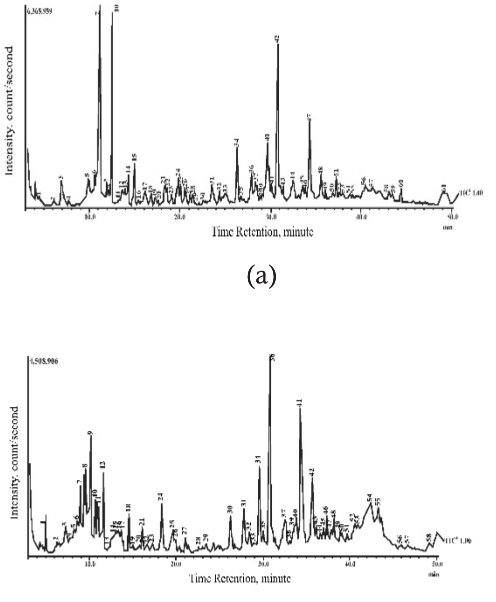
Pyrolysis results carried the composition of liquid smoke organic compounds from water hyacinth at 200°C and 600°C. The pyrolysis temperature was carried out at 2 and 6 hours. The organic compound composition of the liquid smoke product from the dried water hyacinth contains the main components of liquid smoke in acid, phenol, and carbonyl. This compound is produced from the thermal decomposition process of hemicellulose, lignin, and cellulose. The compounds in liquid smoke give the effect of aroma, colour, flavour, antimicrobial, and antioxidant. Research on coconut shells also provides an antimicrobial and antioxidant role so that liquid smoke can be utilized as a preservative (Indiarto et al*.,* 2020). Therefore, liquid smoke from water hyacinth can potentially be a preservative, so using water hyacinth weed can provide more benefits. Hopefully, this finding can balance the speedy growth of water hyacinth with its utilization. This effort can be a solution for realizing the lake environment the government expects.

Observations on the pyrolysis of water hyacinth liquid smoke were performed at a temperature of 200°C and the pyrolysis time occurred for 2 hours and 6 hours, as illustrated in Figure 4 (a). The observations of pyrolysis at 200°C for 2 hours showed 61 peaks. The highest organic compounds were seen at peak 7 (*acetic acid* 14,62%), peak 10 (*2-Propanone, 1-hydroxy-* 6,58%), peak 34 (*Phenol CAS izal* 3,17%), and peak 40 (*Butanoic acid, 2 Propenyl ester* 6,46%). The organic compounds produced by GCMS obtained the highest total acid, total phenol, and total carbonyl, as shown in Figure 4 (b). Pyrolysis of water hyacinth into liquid smoke at a time of 6 hours and a temperature of 200 °C shows 58 peaks, peak chromatograph at peak 7-9 (*Acetic acid* 13,26%), peak 12 (*2-Propane, 1-hydroxy* 2.53%), peak 34 (*Butanoic Acid 2-Propenyl ester* 3.21%), peak 41 (*Xanthosine* 7.19%), peak 42 (*2-H-Pyran-2 Methanol tetrahydro-CAS* 4.53%), peak 54 (*2-Deoxy-D-Ribose* 9.59%), and peak 55 (*Acetic acid, pentyl ester* 7.16%).

Research on the percentage of organic compounds received support from previous research conducted on liquid smoke from elephant grass (*Saccharum munja*) containing *phenol, 2-methoxy-* (10,56%), *2-dione* (3,92%), *n-hexadecanoic acid* (3,63%), *acid* (13,78%), *3-methyl cyclopentane-1,* , *n-hexadecanoic acid* (3,63%), (*E)-9-octadecenoic acid ethyl ester* (6,74%), and *linoleate ethyl* *ester acid* (3,06%). Organic compounds are mainly released from hemicellulose and cellulose at low temperatures, 200–400 °C and 300–450 °C. Lignin is full of aromatic rings with various branches. The chemical bonding activity in lignin degrades over a wide temperature range of 100-900°C. The decomposition temperature of pinewood, cellulose at 240–350°C, and lignin at 280-500°C, and hemicellulose at 200–250°C. The predominant product was the Torrefaction of shrubs, straw, and water, followed by large amounts of acetic acid, small amounts of trace phenols, methanol, lactic acid, hydroxyl acetone, furfural, and formic acid (Niu et al., 2019). Temperature and time greatly affect the pyrolysis process of water hyacinth into liquid smoke. The formation of acetic acid is estimated by the thermal decomposition process of hemicellulose and cellulose (Sulhatun et al., 2019). The formation of acetic acid can occur due to a broken xylem ring through *marculescue decarboxylation* (Guo et al., 2020). Catalytic thermochemical conversion of lignin to higher value aromatic chemicals, such as aromatic hydrocarbons, phenols, and vanillin (Yin et al., 2020).

Analysis using GCMS is to see the chromatogram image. The chromatogram peaks show that the attained liquid smoke is a varied mixture of natural organic compounds, both oxygenated and non-oxygenated, such as aromatic hydrocarbons, aliphatic hydrocarbons, phenolics, alcohols, ketonic, aldehydes, carboxylic acids, amide groups, and others (Mishra & Mohanty, 2018). The decomposition of complex biomass elements such as cellulose, lignin, and hemicellulose, and interactions between numerous degradation products, contribute to the complexity of this liquid smoke product (David & Kopac, 2018). This organic compound is helpful in various applications. Other studies have examined lignin's role in producing aromatic compounds such as phenol, cresols, benzene, etc. The carbonyl and carboxylic groups' compounds are formed by the interaction of cellulose and hemicellulose, whereas phenols and their derivatives are formed by the interaction of hemicellulose and lignin. Furthermore, the biomass's extractive component causes the production of alkanes in the liquid smoke (Zheng et al., 2020).

The composition of organic compounds for water hyacinth liquid smoke contains phenol, carbonyl, and acetic acid. Acetic acid is usually the primary compound, formed by the fragmentation of the acetyl substituents in hemicellulose and, to a lesser extent, by secondary cracking of saccharides (Alvarez et al., 2019). Wood pyrolysis was reviewed using GC-MS. The main compounds were formic acid (4.90 wt%), and furfural (3.46% by weight), acetic acid (19.06 wt%), and 1,2-benzenediol (4.43 wt%), (Solikhah et al., 2017). Phenol and acetic acid significantly affect the pH value of liquid smoke, as one of the quality parameters of the liquid smoke produced. Acetic acid can affect the pH of liquid smoke and the shelf life and taste of smoked products (Saldaña et al., 2019). Water hyacinth contaminated with chromium positively affected the liquid smoke produced. GC-MS analysis showed that alcohol and phenol increased while the ester decreased. It suggests that chromium promotes lignin bond breaking and alters protein degradation. After pyrolysis, chromium can move from a toxic ionic state to an amorphous state in charcoal (Chowdhury et al., 2017).



(a)

(b)

Figure 4. GCMS Results of Liquid Smoke at a Temperature of 200°C for 2 hours (a) and a Temperature of 200 for 6 hours (b)

Hadanu et al. (2016) report the components of organic compounds of liquid smoke from coconut shells through pyrolysis at a temperature of 350-420°C using GC-MS (gas chromatography and mass spectrometry). The peak of detection by GC-MS was in 19 organic compounds. Organic compounds were identified based on the percentage composition of their functional groups: benzene (3.73%), alcohol (1.81%), phenol (90.75%), and carbonyl (3.71%). Pyrolysis of water hyacinth at a temperature of 240°C in a laboratory-scale furnace shows the presence of organic compounds in the form of acids, phenols, ketones, and aromatic hydrocarbons (Ledesma et al., 2020). This method cannot accommodate large quantities of water hyacinth, so, using this method, the amount of water hyacinth that will be processed into liquid smoke cannot compensate for the presence of water hyacinth in Rawa Pening, which is very abundant and grows very fast. In addition to the different amounts of pyrolysis, the washing method used and the origin of the raw materials used were from previous studies.

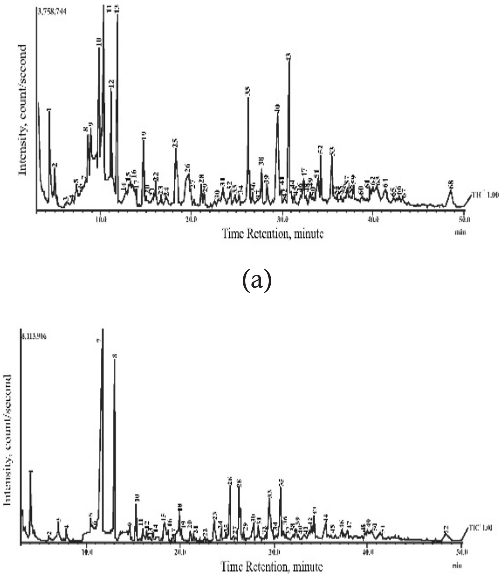
Liquid smoke also has a reasonably high polyphenol content. Apart from being antioxidants, polyphenols are also suitable antimicrobials. Liquid smoke from water hyacinth and liquid smoke from coconut shells contain phenols and the microscopic structure of microbes. This phenol content indicates an effect on growth inhibition of *C. albican S. aureus,*and *E. coli*. The highest percentage of inhibition is shown by liquid smoke, with the highest total phenol content of 1.5 (Kailaku et al*.,* 2017). This study results in a total phenol content of 05.69%, which is expected to be a better antimicrobial. The carbonyl compounds in the liquid smoke are the remainder of the total acid and phenol. From the results above, there is a bright hope for water hyacinth to be immediately utilized as liquid smoke so that the environmental management process of Rawa Pening will be resolved soon. Allegations that water hyacinth is a weed will soon disappear because the benefits are excellent if pyrolysis. The pyrolysis results will be used as a food preservative, thus adding water hyacinth weed benefits.

The results of this pyrolysis liquid smoke will be used for preservatives in food products. The requirement as a preservative is that the liquid smoke does not possess Benzo (a)pyrene. The distillation process is one way of purifying liquid smoke by separating a solution based upon its boiling point. Distillation of liquid smoke is performed to remove harmful compounds such as polycyclic aromatic hydrocarbons (PAHs) and tar. Benzo(a)pyrene has a high boiling point of 312°C, so in the distillation process at a temperature of 150°C - 200°C, Benzo (a)pyrene does not evaporate and remains in the distillate flask. Liquid smoke from water hyacinth, the presence of these compounds was not detected from the Benzo (a)pyrene test using HPLC. This compound must be removed from liquid smoke because it harms human health. After all, it is a carcinogen (Tsekos et al., 2020). Liquid smoke from water hyacinth is categorized as food-grade because Benzo (a)pyrene and liquid smoke from bamboo are not found. Benzo(a)pyrene assay was not detected in liquid smoke from water hyacinth.

Other supporting research on the composition of volatile fraction organic compounds was examined using the GCMS technique on five tropical wood species: *Padouk Merah (Pterocarpus soyauxii), Okan (Cylicodiscus gabunensis), Ozouga (Sacoglottis gabonensis*)*, Tali (Erythrophleum suaveolens)*, and *Azobé (Lophira alata).* Furfural*, fenol,2-metoksi-, creosol, and fenol,4-etil-2-metoksi* in aromatic compounds have been detected in a more significant proportion in all samples. Pyrolysis was carried out at 400°C for 60 minutes. The results show that this wood is appropriate for exploitation in the smoked food industry because it produces smoke that contains most of the aromatic substances classified among odour active compounds and taste (Sokamte et al., 2020). Research on water hyacinth liquid smoke has also been observed at a temperature of 400°C and 4 hours. The results of the observations were reported to contain 2.44% total phenol, 41.45% total acid, and 56.10% total carbonyl (Ratnani et al*.,* 2021).

Observations of the composition of organic compounds at a temperature of 600°C and 2 hours of the results of the GCMS test are presented in Figure 5(a). It is reported based on the figure that the chromatogram is reported as follows: peak 1 (*2-propanone CAS acetone* 2.82%), peak 8 (*Acetic acid* 2.31%), peak 9 (*Acetic acid* 2.72%), peak 10 (*Acetic acid* 10.87%), peak 11 (*Acetic acid 10.48*%), peak 12 (*2-Propanone, 1-hydroxy* 6.07%, peak 13 (*Propanone, 1-hydroxy* 3.99%), peak 19 (*1,2 Ethanediol* 2.38 %), peak 25 (*2-Furancarboxaldehyde* 2.94%), peak 26 (*furfuryl alcohol* 2.50%, peak 35 (*Phenol CAS izal* 3.65%), peak 40 (*Butanoic acid, 2-propenyl ester* 4.72%), and peak 43 (*Pentanal* 4.38%).The results of the GCMS test at a temperature of 600°C and a time of 6 hours are as follows: 52 peaks in Figure 5(b). The chromatogram image with details on the composition of the largest organic compounds is peak 1 (*2-propen-1-ol* 4.06%), peak 5 (*formic acid* 4.65%), peak 7 (*Acetic acid* 22.52%), peak 8 (*2-propanone 1- hydroxy* 9.07%), peak 10 (*1,2- Ethanediol* 2.68%), peak 15 (*2-furancarboxaldehyde CAS Furfural*2.29%), peak 18 (*Furfuryl Alkohol*2.86%), peak 26 (*Aziridine* 4.41%), peak 28 (*Phenol CAS Izal* 5.08%), peak 33 (*Butanoic acid, 2 Propenyl Ester* 6.05%), and peak 35 (*Pentanal* 4.79%).

There have been various studies on the characteristics of liquid smoke created from different types of biomass waste through the use of coconut shells, palm kernel oil, and sugar cane. However, the characteristics of liquid smoke with various temperatures are rarely examined. Because temperature changes might yield varied organic compound compositions, understanding the influence of pyrolysis temperature on the generated liquid smoke is critical. If pyrolysis temperature is too high and uncontrollable, more than 400°C, it will show carcinogenic components, such as Benzo (a)pyrene (Faisal et al*.,* 2018). Ratnani et al. (2021) report that the content of Benzo (a) pyrene in water hyacinth liquid smoke resulting from pyrolysis at a temperature of 400°C did not detect this presence compound. Hence, it is safe as a food preservative or food additive. The liquid smoke that has passed the distillation process can remove harmful smoke components that form polycyclic aromatic hydrocarbons (PAHs). This component is carcinogenic in high doses (Essumang et al*.,* 2012; Desniorita & Maryam, 2015).



(a)

(b)

Figure 5. The Liquid Smoke in the GCMS Results at a Temperature of 600°C at 2 hours (a) and 6 hours (b)

Volatile chemicals in liquid smoke flavours cause thermal degradation of essential wood components (cellulose, lignin, and hemicellulose). The main compounds generated from hemicellulose and cellulose include aldehydes, ketones, diketones, esters, acids, and furans. Pyrolysis of lignin, on the other hand, results in the creation of phenol, phenol, 2-methoxy-, phenol, 2,6-dimethoxy-, and their derivatives. Acids, phenols, and carbonyls in liquid smoke can be employed in the food industry. These organic compounds can restrain the growth of bacteria such as Escherichia coli, Bacillus subtilis, Staphylococcus aureus, and Pseudomonas fluorescence. Phenolic compounds can also play as antioxidants by stabilizing free radicals. Liquid smoke gives smoked products a specific aroma and better colour quality (Keryanti et al*.,* 2020).

The role of organic acids from pyrolysis of wood carbohydrates is vital regarding food taste, colour, texture, and microbiological stability. GC/MS analysis of liquid smoke discovered some phenolic and carbonyl compounds identified as the most active aromatic compounds. The effect of temperature on the compounds present in the liquid product obtained from the biomass sample by pyrolysis was examined concerning the yield and composition of the liquid smoke product (Usino et al., 2020). Ulva Lactuca (UL) and Macroalgae Salvinia auriculata (SA) are potential sources to produce third-generation biofuels with suitable physicochemical properties (Wu et al*.,* 2021).

Liquid smoke and smoked food products often have a smell and taste dominated by a group of compounds called phenolic compounds. They are primarily generated from lignin's thermal decomposition. Lignin contains phenolic hydroxyl resulting from pyrolysis. Phenolic hydroxyl can promote the removal of side chains in lignin during pyrolysis and reduce the stability of lignin (Ma et al*.,* 2020). Phenolic compounds, carbonyl, and acetic acid in liquid smoke cause a lower pH (acidic) and damage bacterial cell membranes. Liquid smoke from palm shells has the property of inhibiting Streptococcus bacteria, as well as liquid smoke from cinnamon can inhibit the Salmonella growth (Desvita et al*.,* 2020). Cocoa liquid smoke contains the main components of arenofuran and pyrazine, which can give antifungal properties to cocoa liquid smoke and a different taste and aroma (Janairo & Amalin, 2018).

Carbonyl compounds, including lactones, ketones, aldehydes, and diketones, are the most diverse organic compounds in liquid smoke. The carbonyl compounds in liquid smoke include: 2-methyl-2-cyclopean-1-, 1- (acetyloxy)-2-propanone and 5,9-Dodecadien-2-one, 6,10-dimethyl. The carbonyl compounds in liquid smoke are furans. They perform a vital role in the scent and flavour that smoke delivers to foods, as well as helping to attenuate the phenolic compounds' powerful sensory smells. Furan compounds in water hyacinth liquid smoke were detected in all test results in 2-Furancarboxaldehyde CAS Furfural from water hyacinth liquid smoke was produced from the thermal decomposition of cellulose and hemicellulose (Gonz et al. 2020)

Water hyacinth as liquid smoke can be a solution because of its acid and phenolic content as a food preservative. Efforts to control water hyacinth in Rawa Pening can occur because this pyrolysis requires water hyacinth in balance with the growth of water hyacinth. An additional benefit is that the liquid smoke produced will be helpful as a food preservative for fish produced from Rawa Pening. Processed food products, especially fish, have the possibility to continue to be increased. Liquid smoke consisting of acids, phenols, and carbonyls can make smoked fish. Smoked fish produced from Rawa Pening will be its charm and characteristic. Water hyacinth control based on local stakeholders will support the success of water hyacinth control in the lake. In management, direct participation by stakeholders, from planning to evaluating various programs carried out in water hyacinth control projects, is necessary (Pratiwi et al*.,* 2018). Based on the decision by stakeholders, water hyacinth is harvested in bulk, and the harvest that has been obtained can be used as liquid smoke.

Water hyacinth causes silting and obstruction of water flow and damages the Rawa Pening lake ecosystem. Facing the difficult situation caused by the water hyacinth plant in Rawa Pening, with the findings of this study, it is hoped that the community will gain new insights into the use of liquid smoke to support fishery products. Furthermore, this can reinstate public awareness to preserve and look after the environment and natural resources as a supporter of the life force that provides goodness and prosperity to the community (Suryanto et al*.,* 2020). The utilization of large-sized water hyacinth assists in decreasing their growth and brings advantages that can be used to provide maintenance needs. Environmentally friendly development policies as a form of sustainable tourism can be achieved by implementing strategic plans, the Lake Ecosystem Rescue Movement, and fundamental and subsequent activities (Purwanto et al*.,* 2020).

This study concluded that the liquid smoke from dry water hyacinth by pyrolysis was satisfactory after being studied for its characteristics. Liquid smoke that can be utilized as a food preservative is smoke that meets the amounts of acid, phenol, and carbonyl. The pyrolysis temperature of 200–600°C generally produces a suitable chemical composition as a preservative. Studying the benzo A. Pyren further is necessary to determine its PAH content. Besides PAH, the characteristics of liquid smoke produced can be seen from wet water hyacinth.

CONCLUSION

Characterization of liquid smoke from dry water hyacinth with encouraging results of GCMS test presents that the percentage of liquid smoke is in the range of 29.63%-37.23%. The phenol content from 1.04-6 -6.11%, and the rest is carbonyl compounds between 55.99-68.90%. Water hyacinth liquid smoke which was pyrolyzed at 200°C for 2 hours, contained 32.78% acid, 5.59% phenol, and 61.60% carbonyl. Pyrolysis at a temperature of 200°C for 6 hours detected the composition of organic compounds of 30.60% acid, 1.04% phenol, and 68.40% carbonyl. Pyrolysis of liquid smoke from dry water hyacinth at a temperature of 600°C for 2 hours obtained the 29.63% organic acid, more diminutive than at 200°C, 4.45% phenol, and carbonyl 55.99%. More remarkable results were obtained at a pyrolysis temperature of 600 °C for 6 hours. The total smoke obtained was 37.33%, the total phenol was 6.11%, and the total carbonyl yield was 56.55%. Open to opportunities to utilize water hyacinth in Rawa Pening, which is detrimental to the environment, into a functional product, namely as a food preservative, will positively impact the environment. Depth research is needed to develop the benefits.

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