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Phytochemicals, antioxidants activity, total phenolic and total flavonoid content of liquid smoke from tropical plants

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Abstract

Liquid smoke is condensation from the carbonization process and contains component of cellulose, hemicellulose and lignin. The problem is liquid smoke were only a side product on charcoal making process and the used of raw materials also liquid smoke productions are very limited. This research focused on the liquid smoke applications of 15 tropical plants. Research objectives in this study are utilized the 15 tropical plants leaves as raw material for liquid smoke production; analyzing the liquid smoke quality based on phytochemicals, antioxidant activity, total phenolic and total flavonoid content; also calculating the yield of liquid smoke. The phytochemical screening was evaluated by Harborne and Kokate methods. Total phenolic content was determined by Folin-Ciocalteu method, while total flavonoid content was determined by Colometric assay method. The results showed the liquid smoke from tropical plant leaves contains alkaloids, flavonoids and tannins. The IC_{50} value range from 0.026 ppm-0.431 ppm. The liquid smoke samples tested contained 0.0096 to 0.0415mg of Gallic Acid Equivalents (GAE)/g extract represented the total phenolic content. The flavonoid content of the liquid smoke samples were in range from 0.0006 to 0.1759mg of Quercetin Equivalents (QE)/g extract. The yield of liquid smoke range between 2.81%-49.66%.

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Introduction

In general, liquid smoke is a result of distillation or condensation of steam resulting from indirect or direct combustion of materials that contain lots of carbon and other compounds. Liquid smoke is condensation from through the carbonization process and consists of cellulose, hemicellulose and lignin (Li, 2018). Meanwhile, according to Faisal (2018), liquid smoke is a compound formed during combustion of cellulose, hemicellulose and lignin.

Liquid smoke consists of more than 200 different compounds including phenolics, ketones, organic acids, furan and pyran derivatives, esters, alcohols, aldehydes, ethers and benzene derivatives, sugar derivatives in varying concentrations (Jahanban, 2018). So that liquid smoke has the potential to provide benefits in the agricultural sector as insecticide (Mmojieje, 2015), antimicrobial (Lee, 2011), fertilizer (Zulkarami, 2011), soil enhancer (Lashari, 2013), plant growth and development (Mungkunkamchao, 2013).

Various benefits of liquid smoke, including as a food preservative such as noodles, tofu, fish and deodorizing, used in the production of traditional smoked fish (Nithin, 2020), but the benefits of liquid smoke need to be developed to be more easily applied by consumers.

In addition, liquid smoke can also function as an insecticide and vegetable fungicide to inhibit disease-causing pathogens in agriculture (Faisal, 2018). Based on research (Kasim, 2015), liquid smoke from coconut shells with concentrations of 1% and 2% can agglomerate latex and inhibit the growth of fungi on sit sheets made and prevent odors.

The problem that occurs today is that liquid smoke is only a by-product of the charcoal-making process so that the use of raw materials and the production of liquid smoke is still very limited. In addition, the research conducted so far has focused on the application of liquid smoke, not on the quality of the liquid smoke produced.

Based on the background, the idea arose to explore the leaves of tropical plants in the surrounding environment as raw materials for making liquid smoke, and do phytochemical analysis, antioxidant testing, TPC, TFC and liquid smoke yield calculations.

Material and methods

Collection and processing of plant material

Fifteen leaf samples of tropical plants: *Homalanthus* sp, *Bauhinia tomentosa*, *Chromolaena odorata*, *Artocarpus heterophyllus* Lamk, *Nephelium lappaceum, Leucaena leucocephala, Psidium guajava, Dimocarpus longan, Artocarpus altilis, Pometia pinnata, Lagerstroemis speciosa, Acacia mangium, Tectona grandis, Peronema canescens* and *Filicium decipiens*, taken in the vicinity of the Samarinda State Agricultural Polytechnic campus. Then the raw materials are cleaned and air-dried under the shade for 1-2 days (depending on the level of wetness of the raw materials). Each raw material is weighed as much as 5kg, then the liquid smoke is made through the carbonization process and the liquid smoke is purified through the distillation process.

Liquid smoke production and yield calculation

A total of 5kg of tropical plant leaves were put into a pyrolysis tube and burned directly for 8 hours. During the production of liquid smoke takes place, cooling water is circulated and temperature controlled. If the liquid smoke no longer drips, the combustion process is declared complete. The liquid smoke produced is grading 3 liquid smokes. The distillation process of grade 3 liquid smokes is carried out by boiling grade 3 liquid smokes to get grade 2 liquid smoke, then grade 2 liquid smoke is boiled again to get grade 1 liquid smoke. The boiling process is carried out for 3 hours. The yield of grade 3, grade 2 and grade 1 liquid smoke is obtained by dividing the liquid smoke produced by the raw materials entered and then multiplied by 100%.

Phytochemical Analysis

Grade 1 liquid smoke was tested for various phytoconstituents such as alkaloids, flavonoids, saponins, tannins, triterpenoids and steroids using the color test method (Harborne, 2006 and Kokate, 2001).

Antioxidant Analysis

The Arung method (2008) was used as a reference in testing antioxidant activity. In this test, a spectrophotometer was used at a temperature of 25°C (room temperature), a wavelength of 514 nm, a DPPH solution as a free radical.

Total Phenolic Content Assay

The total phenolic test was determined by the Folin-Ciocalteu test using the Javanmardi *et al.* (2003) with modifications. All samples were analyzed by duplicate (3 times).

Total Flavonoid Content Assay

The total flavonoid assay was determined by the aluminum chloride (AlCl3) colorimetric test using the method of Zou *et al.* (2004) with modifications. All samples were analyzed by duplicate (3 times).

Result and discussion

Result

Phytochemical Analysis

Based on phytochemical analysis (Table 1), alkaloids are found in 6 types of tropical plant leaves, namely *Homalanthus* sp, *Nephelium lappaceum, Psidium guajava, Acacia mangium, Tectona grandis and Filicium decipiens*. Four plant leaves contain flavonoid compounds, namely *Nephelium lappaceum, Pometia pinnata, Acacia mangium* and *Tectona grandis*. Tannin compounds are contained in the leaves of *Bauhinia tomentosa, Chromolaena odorata, Artocarpus heterophyllus Lamk, Leucaena leucocephala, Artocarpus altilis* and *Peronema canescens*. Liquid smoke from the leaves of 15 types of plants studied did not contain Saponins, Triterpenoids and Steroids.

Antioxidant, TPC and TFC Assay

In antioxidant testing, the IC_{50} value of liquid smoke of several types of tropical plant leaves ranges from 0.026 ppm-0.431 ppm, the smallest IC_{50} value is found in *Dimocarpus longan* while the largest is in the leaves of the *Chromolaena odorata* plant as described in Table 2. The smaller the IC_{50} value, the stronger the antioxidant properties of the plant.

The total phenolic value of liquid smoke ranged from 0.0096 mg GAE/g to 0.0415 mg GAE/g. The largest total phenolic is found in the tropical plant *Filicium decipiens* (Table 2). Total Flavonoid Content values ranged from 0.0006mg QE/g - 0.1759mg QE/g), the highest value of TFC was obtained from liquid smoke of *Nephelium lappaceum* leaves as shown as Table 2.

Table 1. Phytochemical Test Result of Liquid Smoke From Tropical Plant Leaves.

SL	Liquid Smoke	Phytochemical
1.	*Homalanthus* sp	Alkaloid
2.	*Bauhinia tomentosa*	Tanin
3.	*Chromolaena odorata*	Tanin
4.	*Artocarpus heterophyllus* Lamk	Tanin
5.	*Nephelium lappaceum*	Alkaloid, Flavonoid
6.	*Leucaena leucocephala*	Tanin
7.	*Psidium guajava*	Alkaloid
8.	*Dimocarpus longan*	
9.	*Artocarpus altilis*	Tanin
10.	*Pometia pinnata*	Flavonoid
11.	*Lagerstroemis speciosa*	
12.	*Acacia mangium*	Alkaloid, Flavonoid
13.	*Tectona grandis*	Alkaloid, Flavonoid
14.	*Peronema canescens*	Tanin
15.	*Filicium decipiens*	Alkaloid

Table 2. Antioxidant Test Result, TPC dan TFC.

SL	Liquid Smoke	IC_{50} (ppm)	TPC (mg GAE/g)	TFC (mg QE/g)
1.	*Homalanthus* sp	0,318	0,0107	0,0006
2.	*Bauhinia tomentosa*	0,169	0,0128	0,0065
3.	*Chromolaena odorata*	0,431	0,0131	0,0006
4.	*Artocarpus heterophyllus* Lamk	0,067	0,0346	0,0009
5.	*Nephelium lappaceum*	0,157	0,0406	0,1759
6.	*Leucaena leucocephala*	0,050	0,0373	0,0315
7.	*Psidium guajava*	0,059	0,0396	0,0250
8.	*Dimocarpus longan*	0,026	0,0378	0,0398
9.	*Artocarpus altilis*	0,336	0,0096	0,0056
10.	*Pometia pinnata*	0,039	0,0413	0,1074
11.	*Lagerstroemis speciosa*	0,057	0,0237	0,0981
12.	*Acacia mangium*	0,164	0,0200	0,0380
13.	*Tectona grandis*	0,055	0,0294	0,1093
14.	*Peronema canescens*	0,179	0,0224	0,0759
15.	*Filicium decipiens*	0,085	0,0415	0,0017

Yield

The highest yield of grade 1 liquid smoke was 49.66% in the liquid smoke of the leaves of *Chromolaena odorata* and the smallest yield of 2.81% in the liquid smoke of the leaves of *Nephelium lappaceum* (Fig. 1).

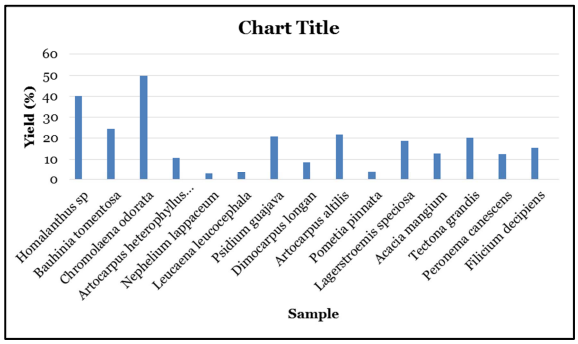

Fig. 1. Stem Diagram Grade 1 Yield of Liquid Smoke From Tropical Plant Leaves.

Discussion

Phytochemical Analysis

The pythochemical analisys showed alkaloids and flavonoids are known to be present in the liquid smoke of *Homalanthus* sp, *Nephelium lappaceum*, *Psidium guajava*, *Pometia pinnata*, *Acacia mangium*, *Tectona grandis* and *Filicium decipiens*. Alkaloid compounds can function as antioxidants, antifungals, anti-hyaluronidases, and anti-inflammatories (Habib, 2018). Liquid smoke from plants such as *Bauhinia tomentosa*, *Chromolaena odorata*, *Artocarpus heterophyllus* Lamk, *Leucaena leucocephala*, *Artocarpus altilis* and *Peronema canescens* are known to contain tannin compounds. Alkaloid compounds, flavonoids and tannins contained in liquid smoke indicate that liquid smoke has a good effect on health and plays an active role in disease prevention.

Plants containing flavonoid compounds are important sources of antioxidants because they have an ideal chemical structure to reduce free radicals. A number of experiments have conclusively demonstrated the potential of antioxidants in reducing the risk of various acute and chronic diseases such as cancer, heart disease and stroke by reducing free radical compounds involved in the pathogenesis of various diseases (Alhakmani *et al*. 2013).

Flavonoids have been tested in various diseases that affect the heart, brain, and other disorders, including those that cause cancer (Wei, 2015). Tannins have properties that are harmful but also beneficial for health because of their role as antioxidants and their ability to stimulate the immune system (Makkar, 2007).

Antioxidant, TPC and TFC Assay

Liquid smoke from several tropical plants that have been tested has IC50 values below 50 ppm and is included in the very strong category (Analianasari, 2022), this shows that liquid smoke has an effective ability as an antioxidant. The antioxidants found in liquid smoke from *Chromolaena odorata* leaves can play a role in the wound healing process (Putry, 2021), wound healing is due to the effects of antioxidants (Hashim, 2017).

The results of the TPC and TFC tests showed that the phenol and flavonoid content was present in the liquid smoke. Phenol compounds contained in liquid smoke are plant secondary metabolites which play a major role in delaying the oxidation process because of their potential as antioxidants (Kasote, 2015).

Liquid smoke from *Nephelium lappaceum* leaves with the largest content of Flavonoids proves that liquid smoke is an antioxidant, the results of research on Nephelium lappaceum leaf extract positively contain chemical compounds of flavonoids and phenols which act as antioxidants (Saharuddin, 2020). The antioxidant role of liquid smoke is demonstrated by phenolic compounds and acetic acid which act as hydrogen donors against free radicals and inhibit chain reactions (Cahyadi, 2012).

Yield

Based on the results of the research conducted, it was found that plant leaves containing sap were known to have a higher yield. The size of the yield value is determined from the raw material for liquid smoke and the distillation process. The distillation process causes a decrease in yield due to the remaining sediment in the distillation furnace so that the yield becomes smaller.

Conclusion

The liquid smoke of tropical plant leaves contains alkaloids, flavonoids and tannins. IC_{50} values ranged from 0.026 ppm to 0.431 ppm. The total phenolic value is between 0.0096mg GAE/g to 0.0415mg GAE/g. The highest TFC value was between 0.0006mg QE/g - 0.1759mg QE/g. The yield of liquid smoke is between 2.81%-49.66%.

Recommendation(s)

Based on the research, the liquid smoke of *Nephelium lappaceum* leaves has the potential and recommended for the advanced research.

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