Characteristics of liquid smoke from several kinds of waste

S Komarayati*, Gusmailina, D Hendra, and I Winarni
Forest Products Research and Development Center, Ministry of Environment and Forestry, Bogor, 16610, Indonesia

*Email: skyati55@gmail.com

Abstract. Research into making liquid smoke has been carried out using a 3 in 1 model furnace. The material used is waste consisting of wide leaf litter, a mixture of small leaf litter and mahogany bark. The results showed that the pH ranged from 3.82 to 4.69; specific gravity of 0.99. The content of phenol and acetic acid, liquid smoke, mahogany peel 0.34%, 0.62% and 0.86%, leaf litter mixture width 0.01% and 3.74% and small leaf litter mixture 0.06% and 0.88%. From the results of the GCMS pyrolysis test, it was known that the acid derivatives, phenols and other components. The highest acid derived compound was obtained from liquid smoke of mixed litter of 66.53% relative and the lowest from liquid smoke of mixed leaf litter which was 8.78% relative. The highest phenol derivative content is from liquid smoke of mahogany bark of 29.45% relative and the lowest of liquid smoke of mixed litter is 4.92% relative. Liquid smoke obtained can be used as a trigger for plant growth and prevention of disease pests inplants.

1. Introduction
Research into integrated charcoal production with liquid smoke has often been carried out using various kiln models, and raw materials from various materials, such as wood waste, coconut shell waste, nyamplung shell waste, bintaro shell waste, bamboo waste and others [1-6]. The materials and different kiln models will produce different characteristics and properties. In this research, a "three in one" model kiln is used, which is equipped with a cooling pipe.

Mahogany leaf litter is usually used as compost material with the addition of EM4. Several studies have shown that the results of macro nutrients, namely C-organic, N-total and K-total in the compost meet the compost quality standards in Indonesia as regulated in SNI 19-7030-2004 [7]. On the other hand, mahagony bark is also used as research material because the waste can be used as a source of energy/ fuel or made of liquid smoke. Where the liquid smoke produced is suitable for use as an organic material [8,9].

This paper presents the characteristics and content of the chemical components of liquid smoke from 3 types of waste consisting of wide leaf litter waste, small leaf litter waste and mahogany bark.
2. Materials and Methods

2.1. Materials
The study was conducted at the Chemistry Laboratory and the Integrated Proximate Laboratory, Forest Products Research and Development Center, Bogor. The material used is 3 types of waste originating from West Java, namely a mixture of wide leaf litter, a mixture of small leaf litter, and mahogany bark. There was no replication in this study. The equipment which is used to make liquid smoke is a "three in one" kiln (Figure 1) made of brick inside and stainless on the outside is equipped with a chimney to drain into the open-air uncondensed gas formed during the cooking time.

![Figure 1. "Three in one" kiln, for producing charcoal and liquid smoke](image)

2.2. Methods
The process of making liquid smoke took place at temperature of 400-450 C (Figure 1). The furnace is equipped with a smoke jet pipe, then the smoke is condensed. The resulting smoke condensation was called liquid smoke, which was then collected. Furthermore, the liquid smoke was testing / analyzed in laboratory.

Chemical components of liquid smoke such as acetic acid and phenol were analyzed using High Performance Liquid Chromatography (HPLC), while organic chemical components and their derivatives were analyzed by means of Gas Chromatography-Mass Spectrometer (GCMS) pyrolysis conducted at the Instrumentation and Proximate Integrated Laboratory, Bogor Forest Research Center.

3. Results and Discussion
The characteristic and content of the chemical components of liquid smoke can be seen in Table 1 and Table 2. The pH value of liquid smoke to the three types of waste ranges from 3.82 to 4.69. The range of pH values when compared with the quality of Japanese standard liquid smoke, all of them do not meet the requirements. The pH is too high, because the low pH of liquid smoke is the best, where the lower the pH of the liquid smoke, the higher the quality of the liquid smoke. Liquid smoke with low pH acts as an antibacterial and antioxidant [3].

The density of liquid smoke produced was around 0.99, lower than the quality of Japanese liquid smoke [10]. Japan's standard liquid smoke quality for specific gravity is above 1.05. The yield of liquid smoke from litter waste is between 26-30%, while the mahogany bark is only 17%. This difference is due to differences in the water content of the material. This is in accordance with the research conducted by Satriadi [11] which stated that if the water content of the raw material is too high, it will require more heat supply to evaporate water in the raw material before the pyrolysis process occurs. As a result, the quality of wood vinegar produced will be low, due to the mixing of the condensation of water vapor and the condensation of pyrolysis and the use of more raw materials [12].
The highest acid content of each type of liquid smoke from 3 types of waste as follows: In liquid smoke of mahogany peel which is produced from large and small leaves is higher than liquid smoke of mahogany peel. This occurs in litter or leaves with little lignin content, whereas cellulose content is greater. According to Yatagai [10] in Komarayati and Wibowo [6], acetic acid from liquid smoke serves to accelerate the growth of phenol plants and their derivatives function to prevent pest and disease attacks.

Acetic acid contained in liquid smoke is an organic acid that is formed due to the pyrolysis process of chemical components of wood such as lignin, cellulose, and hemicellulose [4]. In addition to acetic acid, phenol is also present in everyday life phenol and its derivatives can be used for disinfectants and inhibitors [2,6,10]. The content of phenol in the liquid smoke of the mahogany peel is higher than the liquid litter smoke, because the level of lignin in the bark is higher than in the leaves [13].

Liquid smoke contains a variety of chemical components including: alcohol, aldehydes, ketones, organic acids such as furfural, formaldehyde that function as preservatives, phenols, quinols and pyrogalols act as antioxidants, antiseptics and anti-bacteria. The acid group which plays an important role in liquid smoke is acetic acid which can stimulate plant growth, while propionic acid can prevent the growth of fungi and also as a fish preservative. Acid compounds contained in liquid smoke are organic acids formed by the pyrolysis process of chemical components of wood such as lignin, cellulose and hemicellulose.

Alcohols, phenols and acetic acid are indicated as compounds that have synergy functions as protein denominations and can hydrolyze lipids, so that they can damage the cell membrane of the fungus's body tissues and inactivate enzymes secreted by fungi [4,5]. Phenol is a compound that has a characteristic odor, has antiseptic properties, the function of phenol, among others, in regulating the activity of certain enzymes, is toxic to insects, is toxic to plant predators [14]. In addition, phenols affect termites, are antifungal and bacterial [14]. Other compounds besides phenols, furfural compounds, function as pest control of the Nematode animal group. According to Rahimah [15] stated that liquid smoke contains alkaloids and secondary metabolites that can be used as pesticides.

From the analysis using the GCMS pyrolysis tool, it can be seen the derivative of the chemical components of each type of liquid smoke from 3 types of waste as follows: In liquid smoke mixed with wide leaf litter, the highest acid content is acetic acid (CAS) ethylic acid of 8.78 %; The highest phenol is phenol, 2 methyl (CAS) o-creosol at 13.27% and the highest neutral component, 20.25%, is carbon oxide (CAS) dry ice. In the small leaf mixture liquid litter smoke, the highest acid component is acetic

| Type of analysis | Sample Liquid/Smoke quality | Japanese standard* | Remarks |
|------------------|----------------------------|---------------------|---------|
| pH               | 3.91                       | 4.69               | 3.82    | 1.50-3.70 |
| Specific gravity | 0.99                       | 0.99               | 0.99    | > 1.05 |
| Smell            | strong                     | strong             | strong  | not murky |
| Colour           | yellow brownish            | reddish            | black   | yellow brownish |
| Transparency     | murky                      | murky              | murky   | not murky |

Remarks: 1= Wide leaf litter mixture, 2= Litter mixture of small leaves 3= Mahogany bark [10]
acid (CAS) ethylic acid by 66.53%; The highest phenol is phenol, 4 methoxy (CAS) hqmm of 4.92% and the highest neutral component is nitrogen oxide (N$_2$O) (CAS) nitrous oxide which is equal to 1.68%. While in the liquid smoke of mahogany peel, the highest acetic acid (CAS) ethylic acid of 13.04%; The highest phenol is phenol (CAS) 1.68%. While in the liquid smoke of mahogany peel, the highest acetic acid (CAS) ethylic acid of 13.04%; The highest phenol is phenol (CAS) 1.68%. While in the liquid smoke of mahogany peel, the highest acetic acid (CAS) ethylic acid of 13.04%; The highest phenol is phenol (CAS) 1.68%. While in the liquid smoke of mahogany peel, the highest acetic acid (CAS) ethylic acid of 13.04%; The highest phenol is phenol (CAS) 1.68%. While in the liquid smoke of mahogany peel, the highest acetic acid (CAS) ethylic acid of 13.04%; The highest phenol is phenol (CAS) 1.68%.

| Chemical Component | Material |
|--------------------|----------|
| Acetic acids, %     | 3.74     | 0.88 | 0.62 |
| Phenol, %           | 0.01     | 0.06 | 0.39 |

Remarks: 1 = Wide leaf litter mixture, 2 = Litter mixture of small leaves, 3 = Mahogany bark [10]

4. Conclusion
We can conclude that from the research results it turns out that liquid smoke from the two types of litter is more suitable for use as organic liquid fertilizer and liquid smoke of mahogany peel is suitable for controlling pests and plant diseases.

References
[1] Nurhayati T, Roliadi H, and Bermawie N 2005 Production of mangium wood vinegar and its utilization J. For. Res. 2(1) 13-26
[2] Nurhayati T, Pasaribu RA, and Mulyadi DP 2006 roduksi dan pemanfaatan cuka kayu dari serbuk gergaji kayu campuran Jurnal Penelitian Hasil Hutan 24(5) 395-411
[3] Komarayati S, Gusmailina, and Pari G 2011 Produksi cuka kayu hasil modifikasi tungku arang terpadu Jurnal Penelitian Hasil Hutan 29(3) 34-47
[4] Wibowo S 2012 Karakteristik asap cair tempurung nyamplung Jurnal Penelitian Hasil Hutan 30(3)
[5] Aisyah I, Juli N, and Pari G 2013 Pemanfaatan asap cair tempurung kelapa untuk mengendalikan cendawan penyebab penyakit antraknosa dan layu Fusarium pada ketimun Jurnal Penelitian Hasil Hutan 31(2) 170-8
[6] Komarayati S and Wibowo S 2015 Karakteristik asap cair dari tiga jenis bambu Jurnal Penelitian Hasil Hutan 3(2) 167-74
[7] Hadiwidodo M, Sutrisno E, Handayani DS, and Febriani MP 2018 Studi pembuatan kompos padat dari sampah daun kering tpt undip dengan variasi bahan mikroorganisme lokal (mol) daun J. Presipitasi Media Komunikasi dan Pengembangan Teknologi Lingkungan 15(2) 78
[8] Anggraeni I, Darwati W, and Intari SE 2006 Hama Dan Penyakit Hutan Tanaman (Pusat Penelitian dan Pengembangan Hutan Tanaman, Badan Penelitian dan Pengembangan Kehutanan)
[9] Utami S, Anggraeni, and Ismanto A 2009 Pemanfaatan cuka kayu (wood vinegar) untuk pengendalian larva secara invitro
[10] Yatagai 2002 Utilization of charcoal and wood vinegar in Japan Journal of Food Science Utilization of Charcoal and Wood Vinegar in Japan
[11] Satriadi T 2016 Rendemen dan kualitas cuka kayu dari kulit tiga jenis meranti (Shorea Spp.). Enviroscientiae 8(2) 102-7
[12] Sudoyoono S, Pertwi, and Munawwar 2007 Perbaikan proses produksi pada industri kecil cuka kayu di desa Sembawa kabupaten Banyuasin Sumatera Selatan Prosiding seminar pembahasan hasil kegiatan Iptek dan Vaver LPM Unsri
[13] Falah S, Suzuki T, and Katayama T 2008 Chemical constituents from Swietenia macrophylla bark and their antioxidant activity Pakistan J. Biol. Sci. 11(6) 2007-12
[14] Darmawan UW 2014 Cuka kayu sebagai pengendali hama dan penyakit tanaman *Majalah FORPRO*

[15] Rahimah DS 2014 Asap usir elmaut *Majalah Trubus*