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By Erna Astuti



The Utilization of Fiddle-Leaf Fig Waste Into Food Preservative

Erna Astuti, Zahrul Mufrodi[✉]

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Department of Chemical Engineering, Universitas Ahmad Dahlan, Ring Road Selatan Street, Tamanan, Banguntapan, Bantul, Indonesia 55166

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Abstract

Fiddle-leaf Fig is a tree that is widely used as a protective or plants or shade. This plant is usually found on the side of the road, in the office area and as houseplants. The presence of fiddle-leaf fig leaves that fall from the tree will be a waste for the environment. This study proposes utilization of fiddle-leaf fig waste by pyrolysis method using pyrolysis triple condenser. Thermal analysis was done before experiments using a thermo gravimetric analyzer in the range of temperature of room temperature until 1000 °C. Process was carried out at heating temperature of 350°C, 375°C, 400°C, 425°C, 450°C, 475°C and 500°C. The product of pyrolysis were obtained from liquid coming out from the residue container, the first and second condenser, and the smoke is coming out from the third condenser. The smokes were absorbed with water. Further, all of the liquid were analyzed by gas chromatography mass spectrometry (GCMS). The analysis results show that the main components of pyrolysis liquid products are carboxylic acids, ketones, alcohols, and alkanes. There is gasoline and kerosene in the liquid, so it has the potential to become bio-oil. The largest potential of fiddle-leaf fig waste is as raw material for food preservative because it contains many carboxylic acid compounds.

INTRODUCTION

Environmental issues are one of the most important and most noteworthy issues in recent years. One of the most frequently highlighted environmental issues is global warming. One solution is to increase the preservative plants in the public area, on the side of the road, in the office area and in house. The planted tree has many benefits: as an oxygen producer, flood prevention and landslide, reduce air pollution and reduce global warming. One type of preservative plant is a fiddle-leaf fig tree. Fiddle-leaf fig (*ficus lyrata*) is a plant that is also referred as bush plants. This plant comes from tropical rain forests west and central Africa. This plant is the most studied and beautiful species and is known as an ornamental plant in Europe and North America. This plant is also widely grown in Indonesia. This plant can grow up to 9-12 m with a

leaf length of 30-45 cm and a width of 25 cm (Beffa, 2007). This tree produce organic waste in the form of dried leaves and dry twigs. The presence of fiddle-leaf fig leaves that fall from the tree will be a waste. The waste is potential to increase environmental problems so it needs to be converted into other more useful products. This research proposes the potential utilization of organic waste of fiddle-leaf fig leaves into food preservative by pyrolysis process.

Pyrolysis is a method of cracking a substance into a new substance by heating in a very limited amount of Oxygen. Pyrolysis is a major thermal process used to convert solids into different gases, liquids and solids. This is the first stage of the thermal splitting process before the gasification stage and the combustion stage (Kantarelis et al., 2012). Pyrolysis is divided into 3 types namely slow pyrolysis, intermediate and fast pyrolysis. Slow

[✉]Corresponding author:

Department of Chemical Engineering, Universitas Ahmad Dahlan,
Ring Road Selatan Street, Tamanan, Banguntapan, Bantul, Indonesia 55166
E-mail: zahrul.mufrodi@che.uad.ac.id

pyrolysis is a process of making charcoal that takes place at a temperature of 400°C - 800°C with a heating rate below 10°C per minute and takes a very long time. Fast pyrolysis or also known as flash pyrolysis is a method to produce bio-oil (Brownsort, 2009). Fast biomass pyrolysis is an effective process to produce bio-oils (Cavalloti et al., 2018). Rapid pyrolysis typically uses small feedstocks of less than 2 mm and has a shorter residence time (Brownsort, 2009). Intermediate pyrolysis is similar to the fast pyrolysis process but with a slightly longer residence time. This process was developed to utilize more difficult to handle raw materials such as waste of lumpu, grass and algae (Mahmood et al., 2013). Slow pyrolysis is produce liquid smoke with the greatest water content (70%), phenol, carboxylic acid and carbonyl. While fast pyrolysis produce organic vapor mixture such as acid, alcohol, aldehyde, ether, ester, ketone, furan, phenol, acetaldehyde, butanedion, methanol, and hydrocarbon (Serapiglia et al., 2017).

Some research on pyrolysis has been done. Sukiran et al (2009) conducts the process of fast pyrolysis empty palm oil bunch at optimum temperature of 500°C with 91-106 µm biomass particle size. This process obtained maximum bio-oil of 42.28%. In another study conducted by Ningrum (2011) using shell, bunch and palm fiber and 550°C, the maximum shell conversion was 62% and the maximum conversion of bunches was 50.7%. Debiagi et al. (2018) have done biomass pyrolysis and explained the yield, composition and active surface. The aim of this paper is determine the thermal analysis of fiddle-leaf fig and look for utilization of liquid produce from pyrolysis.

METHODS

Thermal Analysis

Thermal analysis of fiddle-leaf fig sample was done by using a thermogravimetric analyzer (Perkin Elmer, Pyris diamond). Sample was heated from 30 to 1000°C at a rate of 10°C /min in the presence of nitrogen.

Pyrolysis

Fiddle-leaf fig leaves were collected from main campus area of Universitas Ahmad Dahlan. The leaves were cleaned from sand and soil, and then were dried with the sun for 3 days. The leaves were cut to size about 2 mm. hereafter, the leaves were inserted in the pyrolysis equipment. The

process were run with variate temperature: 350°C, 375°C, 400°C, 425°C, 450°C, 475°C and 500°C. The product of pyrolysis were obtained from liquid coming out from the residue container, the first and second condenser, and the smoke is coming out from the third condenser. The smokes were absorbed with water. Further, all of the liquid were analyzed by gas chromatography mass spectrometry (GCMS).

RESULTS AND DISCUSSION

Thermal Analysis Results

In the begining of research, the analysis by thermogravimetric analysis (TGA) were done. TGA is a technique to measure the amount and rate in weight of the material as a function of temperature. This technique can exhibit the reduction of weight because of oxidation, decomposition et al. The thermal degradation behaviors at different compaction temperatures are represented in TGA and DTG curves and peaks (Wattana and Kittayaksakul, 2016). Thermogravimetric analysis, Differential Thermal Analyzer (DTA) and Differential Scanning Calorimetric (DSC) analyzer can be used to investigate the effects of reaction atmosphere on thermal chemical characteristics (Ram et al., 2014). The result of TGA of fiddle-leaf fig is expressed at the Figure 1.

As it can be seen in Figure 1, from ambient temperature to 230°C, moisture and light volatile matter is abolished. Hereafter the matter constantly decrease rapidly at temperature of 230°C to 350 °C. After that, the speed of weight loss is almost the same at temperature ranging of 350°C to 1000°C.

The DTA of fiddle-leaf fig was shown at Figure 2. The temperatures at which maximum rate of weight loss occurred are indicated by the position of the peaks in the curve (Wattana & Kittayaruksakul, 2016). As shown in figure 2, only one peak was formed from pyrolysis of fiddle-leaf fig leaves. The maximum temperature is 340°C.

Pyrolysis Results

In this research, liquid product identification was done by using GC-MS method. This identification was performed to determine the distribution of compound components and functional groups in the pyrolysis product of liquid. The result of the analysis by GC-MS method is presented in Table 1.

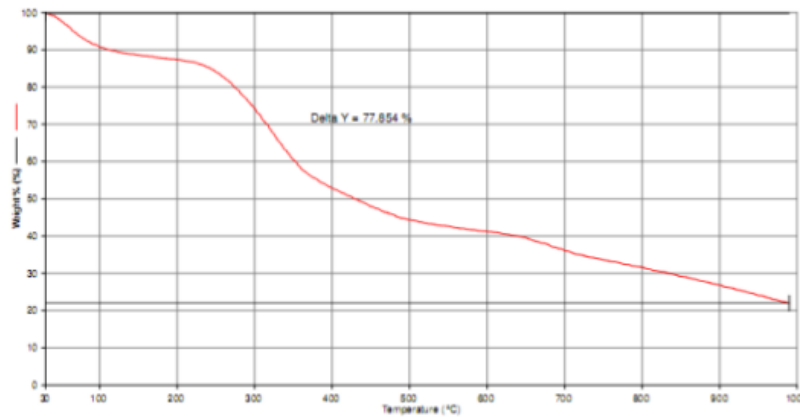


Figure 1. The effect of pyrolysis to the reduction of weight of fiddle-leaf fig.

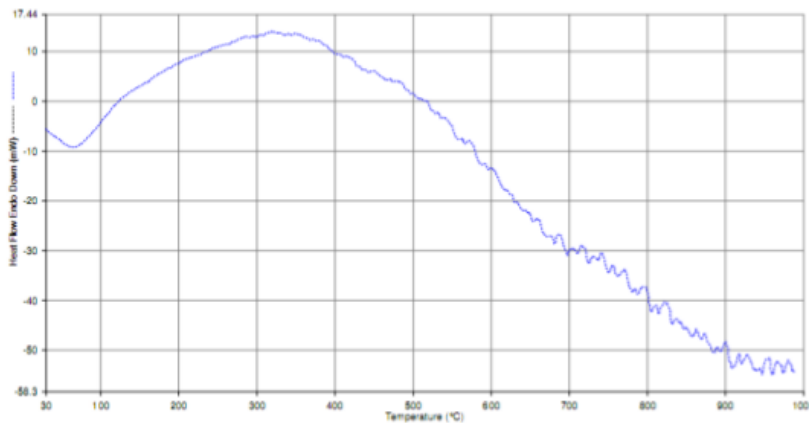


Figure 2. Differential Thermal Analyzer of fiddle-leaf fig.

Table 1 Results of GC-MS analysis of liquid products in percent weight (%)

Funct. group	% weight													
	350°C		425°C			450°C			475°C		500°C			
	U (%)	B (%)	UP (%)	DP (%)	BD (%)	UP (%)	DP (%)	BD (%)	TD (%)	BD (%)	TD (%)	BD (%)	HAD (%)	BD (%)
Alkane	-	-	41.4	21.5	-	43.9	7.6	2.5	5.4	-	2.7	-	4.3	6.6
Alkene	-	-	23.3	-	-	23.0	34.8	-	3.6	-	6.4	-	-	4.8
Alcohol	39.1	40.4	2.0	20.2	-	4.3	13.0	-	15.3	-	23.9	-	65.2	6.9
Keton	32.5	6.4	2.1	16.2	7.5	-	10.7	2.6	13.6	-	17.8	3.6	4.4	7.2
Aromatic	4.2	10.9	25.2	-	81.3	22.3	-	-	4.8	-	8.0	-	3.9	3.6
Carboxilic acid	9.2	13.1	3.8	21.6	-	-	13.8	91.5	20.4	91.5	31.6	82.7	6.6	51.8
alkil halide	-	8.2	-	-	-	-	13.4	-	-	-	-	4.0	5.3	-
Ester	-	6.4	-	4.2	4.4	-	-	-	-	-	-	-	-	3.5
Eter	-	3.9	-	6.1	-	-	-	-	-	-	-	-	-	-
Phenol	0.1	0.4	-	-	-	-	2.5	-	0.6	0.1	0.28	-	0.7	-

abbreviation:

A = Upper Phase B = Bottom Phase
 UP=Upper Phase Distillate DP = Down Phase Distillate
 BD= Bottom Distillation Result TD = Top Distillation Result

Table 2. The composition of each of the pyrolysis results.

Atom C	% weight													
	350°C		425°C			450°C			475°C			500°C		
	condensor		Residue			Residue			Residue			Residue		
	U (%)	B (%)	UP (%)	DP (%)	BD (%)	UP (%)	DP (%)	BD (%)	TD (%)	BD (%)	TD (%)	BD (%)	HAD (%)	BD (%)
C1-C4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C4-C7	-	-	-	-	-	-	1.88	-	0.15	-	4.59	-	0.06	-
C7-C11	-	-	1.81	-	-	1.11	1.88	-	0.15	-	4.59	-	0.06	-
C10-C16	0.04	-	6.40	3.83	0.04	4.44	36.95	-	-	0.02	3.04	0.01	0.19	0.12
C12-C19	0.04	-	5.89	4.89	0.04	4.14	36.95	0.05	-	0.02	3.04	0.01	0.19	0.12
C16-C28	0.04	-	1.64	4.89	0.04	1.40	37.13	0.12	-	0.02	3.04	0.17	0.19	0.12
>C25	-	-	0.19	-	-	0.23	-	0.27	-	-	-	0.01	-	-

Table 1 show that the major components of pyrolysis liquid products are carboxylic acids, ketones, alcohols, phenols and alkanes. The pyrolysis fluid from this experiment can burn. The alcohol compounds contained in this pyrolysis product can increase the burning capability of the liquid product, but since this liquid product still has water content, the combustion process of this liquid product is still relatively long. At pyrolysis temperature of 500°C, there are ethanol compounds that come out on first condenser. With the existence of these compounds then this material has the potential to be used as bioethanol. The pyrolysis product contains many carboxylic acids in the top yield distillation residue of 500°C. Table 1 also determines that the main product of pyrolysis at temperature of 450°C and above is carboxylic acid. Carboxylic acid compounds have many benefits in the food, pharmaceutical and other industries. Food ingredients that are often used in the food industry are acetic acid, benzoic acid, propionic acid, sorbic acid and epoxide compounds. All of these acids include the carboxylic acid function group. Jarboe et al (2013) state these carboxylic acids are routinely used as food preservatives. So the product of pyrolysis of fiddle-leaf fig leaves has potential to be a food preservative. Phenol is in the upper phase of distillate residue of 450°C. Maqsood et.al (2013) determined that phenolic compounds are potential to be natural food additives in fish and fish products. Development of rancid odor and unpleasant flavor, changes of color and texture as well as lowering nutritional value in fish can be prevented by using this additives.

This research also evaluate carbon bond from the liquid that produce from pyrolysis. The composition in the pyrolysis results are listed in Table 2.

Table 2 shows that there is no C1-C4 in all results. The gasoline content (C7-C11) is obtained from pyrolysis temperature of 425°C up to 500°C.

The largest gasoline content is obtained at 450°C. Meanwhile kerosene content is obtained at all temperatures. The highest kerosene were obtained at 450°C. It can be concluded that pyrolysis of fiddle-leaf fig also has the potential to produce bio-oil. Bio-oil can be developed into biodiesel. Fiddle-leaf fig pyrolysis potential to be a food preservative is greater than the potential for biodiesel.

CONCLUSION

Analysis of the number of atoms of liquid pyrolysis results stated that there is gasoline and kerosene in the liquid, so it has the potential to become bio-oil. The pyrolysis product also contains many carboxylic acids so it has potential to be a food preservative and pesticide. Fiddle-leaf fig leaves can be used as raw material to produce bio-oil, food preservatives. The largest potential of fiddle-leaf fig leaves waste is as raw material for food preservative because it contains many carboxylic acid compounds.

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