Chemistry and Materials Research
ISSN 2224- 3224 (Print) ISSN 2225- 0956 (Online)
Vol.8 No.3, 2016

www.iiste.org

Utilization of Coconut Fiber Waste as Insecticides against *Epilachna sparsa*

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Abstract

The coconut fiber waste in North Sulawesi is very abundant, but the use and development are still limited. The main issues that cause no growth in coconut fiber industy are the lack of product innovation and processing technology. Coconut husk pyrolysis produces a liquid smoke yield of 22%. Factional distillation liquid smoke coconut coir at 150^{o}C temperature produces the FS-150 fraction. Mortality test of fraction FS-150 caused 80% mortality of insects at a concentration of 10% solution and 60% at 5% concentration against *E. sparsa* insects. The results of GC-MS analysis of the fraction FS-150, identified 21 compounds that can be classified into three groups: phenolic compounds, acids, and carbonyl. The third group of the compound is a compound that is predicted to affect insect mortality *E. sparsa*, so that liquid smoke coconut husk fraction of FS-150 has the potential to be developed into a natural insecticide.

Keywords: *Pyrolysis, coconut coir, redistillation, insecticides, E. sparsa*

1. Introduction

One type of nature materials waste that has the potential to be used as an insecticides industrial raw material is coconut husk waste. In North Sulawesi coconut husks waste are very abundant, but the function and the utilization is still very limited, which is used as a rope, a broom and fuel only. The main problem that cause of not growing coconut coir processing industry due to lack of innovation and lack of product produced. Therefore coconut coir processing industry is not able to reach a wider market, thus abandoned by the local artisans because they are not prospective and less promising for the future.

One of the strategic effort that needs to be done to improve the economic value of the coconut husk waste is building coconut coir waste processing industry that can produce vegetation insecticide. The success of this effort will not only be good for floating craft byproduct coconuts in North Sulawesi, but also very significant in the search for solutions coconut husk waste into superior products that useful. If the effort of making this vegetation insecticide can be done well, is expected to grow new innovations to develop local creativity products made from coconut husks that will be in demand by the consumer society.

Utilization of coconut coir waste in the insecticide industry is the right solution for strategic and vegetation insecticide is needed by consumers, especially the farmers as a primary need in an effort to control crop pests. The presence of coconut coir vegetation insecticide is expected to have a positive market appreciation. It was certainly a positive impact for the development of coir waste utilization, so that the production of insecticidal activity of coconut coir can be run continuously. Of the solutions offered, the public interest is expected grow to assiduous his profession as an coconut husk insecticide entrepreneur, because it promises new jobs and a steady income for future.

2. Materials and Methods

The materials used for this study was 50 kg of coconut coir drawn at random from the Javanese village Tondano Minahasa regency. The cucumber leaf was use for pesticides medium test, and insect *E. sparsa* as bio-indicators.

Equipments

The equipment used for this research is a set of pyrolysis tools consist of pyrolysis reactor equipped with a diverter pipe smoke, water coolers, and container tool of liquid smoke. For liquid smoke re-distillation using 1 set of distillation factionalism tools, which is equipped with an electric bath, thermometer, distillate pipe, cooling pipe for condensate, petri dish, brush, flask, measuring cups, beaker glass, the volume pipette, pipette, and scales. Identification compounds liquid smoke coconut husk as a potential pesticide using a Gas Chromatography-Mass Spectra (GC-MS), brand of QP Shimadzu A 5050.

How to Research

1. Pyrolysis of Coconut Fiber.

As much as 50 kg of coconut fiber is inserted into the pyrolysis equipment, tools sealed, then heated for 4-5 hours at a temperature of 350 – 400°C. Distillate was collected and pyrolysis process is stopped until there is no liquid smoke distillate drips into the instrument shelter. Liquid smoke obtained was filtered with a view to removing physical impurities such as tar, and the filtrate is collected in the Erlenmeyer.

2. Redistilled Coconut Fiber Liquid Smoke

Re-distillation liquid smoke coconut coir done by fractional distillation based on differences in boiling point. Fractionation at the boiling point of 110 - 130°C (fraction 1 were coded FS-130), the boiling point of 130 - 150°C (fraction 2 were coded FS-150), the boiling point of 150 - 170°C (fraction 3 were coded FS-170), boiling point 170 - 170°C (fraction 4 were coded FS-190) and a boiling point of 190 - 210°C (fraction 5 were coded FS-210).

3. Pesticide Activity Test Coconut Fiber Liquid Smoke

Liquids smoke distillate FS-130, FS-150, FS-170, FS-190 and FS-210, respectively applied in insecticidal activity test against *E. sparsa*. Preliminary test of each fraction, insecticidal activity was tested at 20% concentration (w / w), and a 5-hour long observation determined. Fraction which showed the highest insecticidal activity continued to be researched and variation concentration (w / w) used were: 0% (control), 5%, 10%, and 15%. Older observations determined 5 hours. Insecticidal activity test is done in a petri dish, and the petri dish is placed on the base of the filter paper and gauze pads soaked in distilled water. Media test using cucumber leaves. Cucumber leaves dipped in the test solution liquid smoke coconut coir each solution at a concentration (w / w): 5%, 10%, and 15%. As for control, cucumber leaves only dipped in distilled water without the sample. Cucumber leaves are already ready to be used to test insecticidal activity, placed in a petri dish and then released 10 larvae of *E. sparsa* which have fasted for four hours. Petri dishes were closed and the duration of follow prescribed 1-5 hours. Calculation of insecticidal activity of liquid smoke coconut fiber is determined by the following formula:

$$\frac{death\ of\ E.\ sparsa\ (control - treatment)}{death\ of\ E.\ sparsa\ (control - treatment)} \text{x } 100\%$$

Results and Discussions

Coconut coir waste pyrolysis produces a dark brown liquid smoke, and after filtered using filter paper Wotman 400 mesh, liquid smoke color turned into maroon. Color change from dark brown liquid smoke into a maroon is presented in Figure 1.

(a) (b)

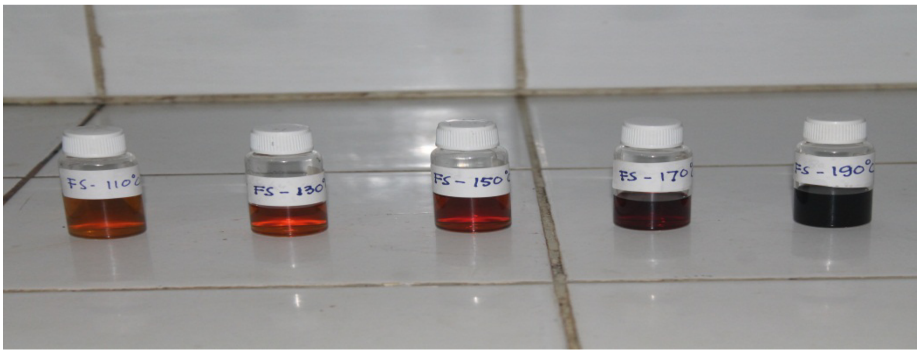
Figure 1 (a). Color of liquid smoke before it is filtered and (b) liquid smoke color after filtered.

Temperature pyrolysis coconut husk around 350 - 400°C and liquid smoke yield obtained was 22%. Wijaya, et al. (2008) explain that the composition of the yield obtained is also very dependent on the condensation system, it is also explained by Tranggono, *et al.* (1997), that the pyrolysis at too high a temperature and time that is too long will cause the formation of liquid smoke decreases because the temperature of the cooling water increase so that the smoke produced is not optimally condensed. The process of condensation will take place optimally when the water in the cooling system drained continuously so that the temperature in the cooling system is not increased.

Fatimah and Jake (2005), describes the pyrolysis of biomass is one of the alternative technologies developed in several areas of chemistry. In the pyrolysis process of the wood, lignin degradation occurs as a result of a rise in temperature so that the resulting characteristics of the compounds according to the type of wood. Fatimah (2004), describes the pyrolysis is an alternative technology as a source of hydrocarbons. Various pyrolysis techniques was developed not only for the conversion of materials into hydrocarbon polymers helpful but is also used for the synthesis of hydrocarbons made from biomass or plant. Pyrolysis often as thermolysis by definition is the process of adding a material to the action of high temperatures in the absence of oxygen.

In the process of pyrolysis, pyrolysis tube filled only a half of the coconut husk, this is done so that all the material in the pyrolysis tube gets burning heat evenly. After 30-40 minutes the heating process underway, smoke began to flow towards the coconut coir condenser pipe flowing water continuously so that the coconut husk smoke gas can be liquefied. During the pyrolysis process takes place there was small part coconut husk smoke can not be liquefied and flammable gas. Coconut husk pyrolysis process is stopped when there is no more smoke distillate liquid that drips into the reservoir container.

Re-distillation of liquid smoke coconut coir done by factional distillation based on differences in boiling point. Fractionation at the boiling point of 110^{o}C (fraction 1 were coded FS-110), the boiling point of 130^{o}C (fraction 2 were coded FS-130), the boiling point of 150^{o}C (fraction 3 were coded FS-150), the boiling point of 170^{o}C (fraction 4 were coded FS -170) and a boiling point of 190^{o}C (fraction 5 were coded FS-190). Factionalism distilled liquid smoke coconut fiber are presented in Figure 2.



(a) (b) (c) (d) (e)

Figure 2. Results offactionalism distilled liquid smoke coconut fiber: (a) FS-110, (b) FS-130, (c) FS-150, (d) FS-170 and (e) FS-190.

Liquid smoke coconut coir is a liquid that is still high enough tar and brown so it is necessary re-fractional distilled to separate the compound components based on increase the boiling point. According Darmaji (2002), the result of condensation of liquid smoke contains tar which is still high and muddy color that needs to be distilled repeatedly. Liquid smoke which already re-distilled can be directly applied in food products such as fish and eels (Utomo et al., 2009, in Ayudiarti and Sari, 2010).

The fractionation results of coir liquid smoke and percent insecticidal activity against *E. sparsa* data are presented in Table 1.

Table 1. Results of fractionation of liquid smoke coconut husk and data percent insecticidal activity against *E. sparsa*

Fraction	Concentrations of solution. (%)	Percent of insect death (%)
FS-110	15 10 5	50 40 20
FS-130	15 10 5	50 50 20
FS-150*	15 10 5	100* 80* 60*
FS-170	15 10 5	40 30 20
FS-190	15 10 5	30 30 10

Results of mortality test against insect *E. sparsa* turns PS-150 has the highest insecticidal properties that cause 100% mortality of insects at a concentration of 15% solution, 80% mortality at a concentration of 10% solution and 60% mortality at a concentration of 5%. To determine the content of chemical compounds that are insecticides, the FS-150 was analyzed by GC-MS, whereas the other fractions that have insecticidal properties below 100% are not reported in this study. The results of the analysis component of insecticide compounds in liquid smoke FS-150 using GC-MS. In the GC-MS chromatogram reads any 21 peaks, meaning that the FS-150 liquid smoke in it identified 21 organic compounds and more chromatograms are presented in Figure 3 and Table 2.

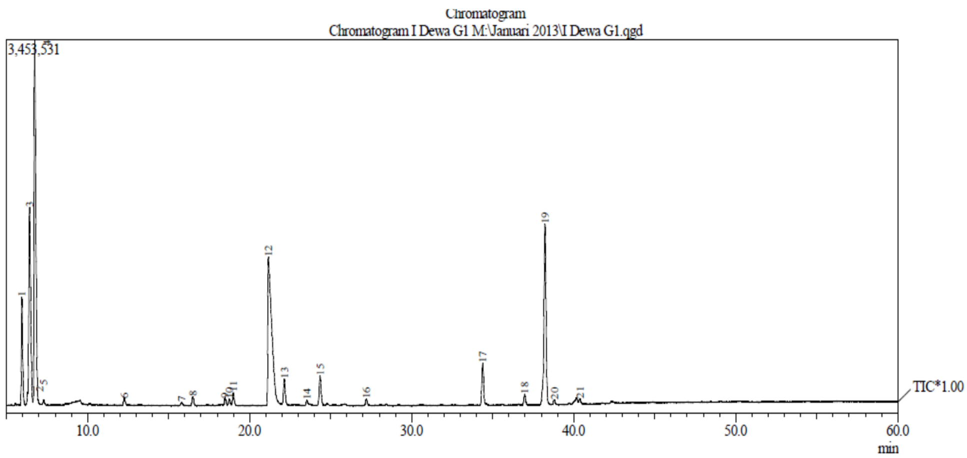


Figure 3, GC-MS chromatograms of liquid smoke coconut fiber FS-150.

Table 2 Identification of compounds from liquid smoke coconut fiber FS-150

Peak number	Component of compound	Retention time (minutes)	Areas wide (%)
1	Methyl acetate	5,944	5,97
2	Ethyl acetate	6,292	0,46
3	Methanol	6,413	14,96
4	Ethanol	6,737	26,57
5	2-pentanone	7,282	0,28
6	Ketocyclopentane	12,270	0,43
7	1,2-bis(vinyloxy) ethene)	15,800	0,07
8	2-prophanone, 1-hydroxy	16,490	0,48
9	2-methyl furan	18,477	0,38
10	3-methyl-2-cyclopenten-1-on	18,743	0,31
11	1-hydroxy-2-butanon	19,00	0,71
12	Ethyl acetate	21,159	24,24
13	Puraldehyde	22,143	1,76
14	Acetilpuran	23,534	0,19
15	Prophanoic acid	24,348	2,22
16	Butyrate acid	27,201	0,40
17	2-methoxy-phenol	34,385	3,07
18	2-methoxy-4-methyl-phenol (Cresol)	36,973	0,66
19	Phenol	38,229	16,42
20	4-ethyl-2- methoxy-phenol	38,812	0,21
21	4-methyl phenol	40,390	0,20

Table 2 shows that the chemical components of liquid smoke coconut husk can be grouped into three main dominant components, namely phenol, carbonyl, acid, and the three groups of compounds synergized so that could potentially be insecticide. Phenol and its derivatives can be bacteriostatic or bactericidal because it can inactivate essential enzymes, coagulate SH group and the NH group of proteins (Karseno, et al., 2002, in Zuraida, 2009). Phenol components (phenol, methyl phenol and guaiacol) and acid components (benzoate acid derivative) is a component that is identified in a coconut shell liquid smoke that acts as an antibacterial (Zuraida, 2009). Acid and phenol are the main components of liquid smoke affecting termite mortality. Acid content in the liquid smoke is also deadly and effective in inhibiting the growth of microbes in food products by means of the acidic compounds penetrate the cell walls of microorganisms that cause cells of microorganisms into lysis later died. Cresol or compound 2-methoxy-4-methyl-Phenol contained in the liquid smoke coconut coir is one of the phenolic compounds in the industry to kill kinds of insects, and commonly added as a disinfectant in cleaning products. Material liquid smoke contains active substances that function as antimicrobial or disinfectant and insecticides can also be used as a dipping medicine in dealing with cases of the disease in animals (Utami, *et al.*, 2008). Carbonyl group of compounds acting as flavor concentrates for food products and insect repellent. Carbonyl content of the average liquid smoke from coconut husk was 10.26% (Mappiratu, 2009). Liquid smoke can act as antimicrobials and antioxidants, then liquid smoke can be used as a preservative, anti white ants and antifungal and can be used for clumping rubber and natural pesticides (Yuwanti, 2003; Darmadji 2006 in Mappiratu, 2009). Liquid smoke coconut husk containing phenol 3.03%, 10.26% and acid carbonyl acetate 9,22%, and has an acidity (pH) of 3.16 (Mappiratu, 2009). Besides, Zuraida *et al.*, (2011) explain that liquid smoke coconut shell has antibacterial activity and it can be used as an effective preservative agent for fish ball. Liquid smoke is an effective preservative agent for meatballs (Arnim, *et al.*, 2012) and able to make life of tofu become longer for three days in 1.5% of concentration (Purba, et al., 2014). Pyrolysis temperature coconut shell and liquid smoke distillation affect concentration and liquid smoke characteristic (Lombok, *et al.*, 2014).

One of the fragmentation pattern of compound cresol or 2-methoxy-4-methyl-phenol (peak number 18) contained in the liquid smoke coconut husk is used to kill insect species, and commonly added as a disinfectant in cleaning products. Mass spectroscopy fragmentation compound 2-methoxy-4-methyl-phenol presented in Figure 4.

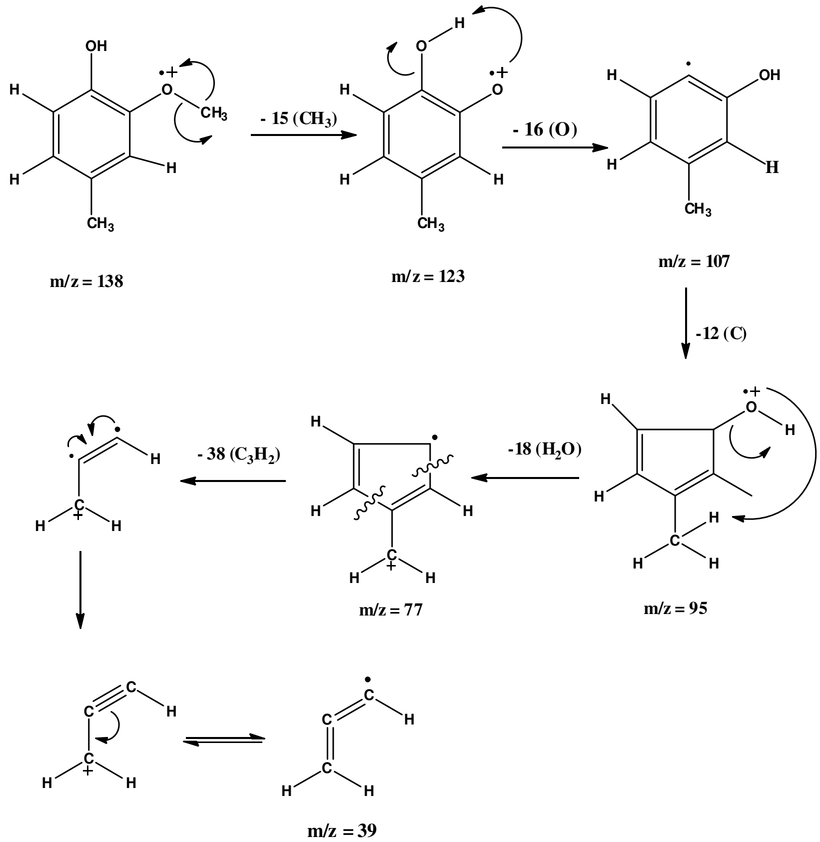


Figure 4. Fragmentation mass spectroscopy compound cresol or 2-methoxy-4-methyl-phenol

Identification of GC-MS spectra, the peak 18 compound with a retention time of 36.973 minutes and 0.66% abundance fragment patterns showed similarities compound 2-methoxy-4-methyl-phenol (cresol) in accordance with the data reference library Wiley229.LIB. Comparison of mass spectra of compound 18 with compound stem 2-methoxy-4-methyl-phenol is shown in Figure 5.

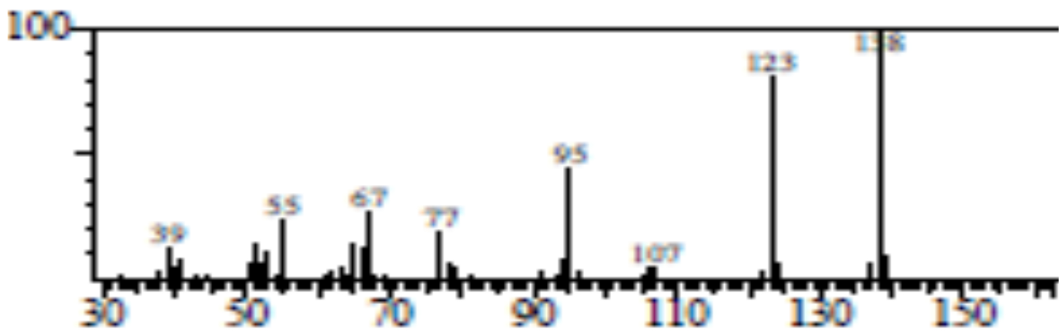


Figure 5. Mass spectra peak 18 compound 2-methoxy-4-methyl-phenol

Compound 18 has a peak at the top of the base with the compound represented by the data library Wiley 229.LIB at m / z = 138 Both of spectra show the same molecule ion peak at m/z = 138 which states the molecular weight of the compound. $-CH_3$ Release (15) in the molecule m/z = 138 produces a molecular ion fragment m/z = 123 molecule m/z = 123 bond termination occurs with the release of O (16) generating molecule fragment ion m/z = 107. Termination bond with the release of C (12) molecule ion fragments m/z = 95 Termination $-H_2O$ bond and release (18) generating molecule fragment ion m / z = 77 Termination of bond with the release $-C_3H_2$ (38) produces a fragment ion molecule m/z = 39. Molecule m/z = 39 perform realignment through electron transfer process to form a more stable molecule ion the alkyne and diene

Based on a common base peak at m / z = 138 (100%) and common ion molecule M + = 138, as well as the similarities of the fragment compounds it can be concluded that peak 18 is identical 2-methoxy-4-methyl-phenol with a molecular weight of 138 and has the molecular formula $C_8H_{10}O_2$.

CONCLUSION

Pyrolysis of coconut coir produce liquid smoke yield by 22% and the magnitude of the yield obtained is very dependent on the temperature of pyrolysis and condensation system of the equipment used. Test insect mortality against *E. sparsa* turns liquid smoke coconut fiber fraction (FS-150) showed insecticidal activity of insect caused the death of 80% in solution concentration of 10%, and mortality of 60% at a concentration of 5% solution. The results of GC-MS analysis of the fraction of liquid smoke coconut fiber (FS-150), identified 21 compounds that can be classified into three groups: phenolic compounds and their derivatives, acetic acid and its derivatives, carbonyl compounds and their derivatives. Group of phenolic compounds, acids and carbonyls are the main compounds that affect insect mortality *E. sparsa*, so that liquid smoke coconut fiber has the potential to be developed into a natural insecticide.

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