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Effectiveness of Organic Pesticides made from Cigarette Stub to the Attack Pest Intensity of *Terminalia cattapa*

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KEYWORDS

Biopesticides;
Agriculture;
Terminalia cattapa;
Tobacco;
Cigarette Stubs.

Abstract The high consumption of cigarettes, especially in Indonesia, will produce harmful waste for the environment called cigarette stubs. The waste of cigarette stubs reacts with any kinds of pathogenic fungus such as *Fusarium oxysporum, Colletotrichum gloeosporiodes*, *Rigidoporus lignosus*, and *Sclerotium rolfsii*. The usage of cigarette stubs as an alternative raw material for making organic pesticides can make cigarette stubs considerable as a recycled product that reduces the environment's waste. The results obtained by plants treated with biopesticides effectively resist pest attacks and support plants to naturally develop antibodies. The score of Intensity Attack (IS) from *Terminalia cattapa* plant applied by the biopesticides for 10 days observation results in the amount of 3.953%, with a total of 34 normal leaves and a total of 12 broken leaves. The other result of the *Terminalia cattapa* applied with chemical pesticides gives 12.31% of intensity attack and 12.18% of intensity attack without any treatment. This research concluded that tobacco could inhibit the attack pest of the *Terminalia cattapa* plant.

Introduction

A pesticide is one substance used to control any kind of pest in agriculture (Siswoyo *et al.*, 2018). Recently, some local farmers use synthetic pesticides for their plants and land to avoid pests' growth. Based on Djunaedy (2009) losses suffered by the Indonesian farmer, especially in agriculture, it reached billions of rupiah. They reduced productivity by up to 20 % caused by the attacks of pests and diseases. The main reason for synthetic pesticides is that synthetic pesticide is easy to find and applicable. But, there are harmful effects for long term usage of synthetic pesticides, such as disturbing the human's health, decreasing the immune level, and generating the disease like cancer (Corsini *et al.*, 2013; Gilden *et al.*, 2010; Martenies & Perry, 2013; Siswoyo *et al.*, 2018). The other negative impacts of using chemical pesticides are the disturbance of the natural balance and caused the emergence of resistant pests. Besides, residue's presence in the soil can be toxic for the non-target organism, which can be carried up to water sources and poison the surrounding environment, even to the food chain (Djunaedy, 2009). World Health Organization (WHO) notes that 3 million poisoned by pesticides until 2000 reach up to 220,000 fatalities. The negative impacts of using chemical or synthetic pesticides that have been explained above encourage us to provide an innovation made by organic and eco-friendly materials.

Tobacco is the main ingredient of cigarettes mostly found on the stubs, which is also one of the plantation commodities (Dewi *et al.*, 2018). In the year 2006, Indonesia's cigarette consumption in the amount of 215 billion, while in the year 2010 estimated in the amount of 213 billion *(Suharti et al.*, 2010). Based on the World Health Organization (WHO), the consumption of cigarettes in Indonesia per capita is 1,742

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cigarettes per person per year. The high consumption of cigarettes will produce harmful waste for the environment, which is cigarette stubs. The cigarette stubs contain the same ingredients as the whole cigarette: nicotine, phenol, and eugenol. Nicotine can be toxic for the organism, while eugenol does control the plant's pathogen effectively, and the phenol gives a good role as a mechanism protective tool to the pathogen (Dayan & Duke, 2003; Suharti *et al*., 2010; Vaya *et al*., 1997). Based on the research that (Noveriza & M. Tombe, 2003) did in 2003, the waste of cigarette stubs reacts with any kinds of pathogenic fungus such as Fusarium oxysporum, *Colletotrichum gloeosporiodes*, *Rigidoporus lignosus*, and *Sclerotium rolfsii*. The usage of cigarette stubs as an alternative raw material for making organic pesticides can make cigarette stubs considerable as a recycled product that reduces the environment's waste. Based on that explanation, this research aims to evaluate cigarette stubs' effectiveness as biopesticides to prevent the growth of pests like fungus.

Materials and Methods

Materials

The main material is tobacco leaves were supplied from a waste of cigarette stubs in Semarang, Indonesia. Then, part of organic plants such as papaya leaves, soursop leaves, fragrant lemongrass, garlic, sugar, and water. Also, chemicals (sodium benzoate).

Methods

The operating variables during the study consisted of control variables and independent variables. The control variable is the composition of the materials to make biopesticide. While the independent variable is the amount of the sugar as the crystal core to make the biopesticide into crystal (powder). This is a modified method from research conducted by (Mawuntu, 2016), it concludes that papaya leaves and soursop leaves are effective in controlling pests. Besides, fragrant lemongrass and garlic are potential to control the growth of pests because of citronellal content in fragrant lemongrass that has to dehydrate desiccant poison and the alliinase enzyme in garlic which converts alliin to allicin which can kill microbes effectively, such as germs that cause flu infection and fever (Sugiarti & Suprihana, 2017; Zahro *et al*., 2017).

The Production Process of Biopesticides: Cut all the materials (tobacco leaves, papaya leaves, soursop leaves, fragrant lemongrass, and garlic) into pieces to make it easy on the blending process. Put it all in the blender and add some water to it, then blend it. The extract was filtered, and the filtrate was added with preservatives (sodium benzoate). Then the solution was poured into a crystallizer to make it a powder with sugar as the crystal core.

Product Analysis: The product in the form of powder will be analyzed for the effectiveness of the work of biopesticides in their application to plants and Gas Chromatography-Mass Spectrophotometry (GCMS). The results obtained are then processed by the formula in Microsoft Excel as the equation below (Setiawan & Supriyadi, 2014).

$$IS = \frac{\sum(n \times v)}{Z \times N} \times 100\% \quad \text{(Equation 1)}$$

Where:

IS = *Intensity attack*
N = *Total of broken leaves based on attack category*
V = *Scale score on each attack category*
Z = *Highest scale score on each attack category*
N = *Total leaves observed*

Attack Category (n):

0 = *Nothing happen (normal)*
1 = *0 – 20% broken leaves*
3 = *20 – 40% broken leaves*
5 = *40 – 60% broken leaves*
7 = *60 – 80% broken leaves*
9 = *more than 80% broken leaves*

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Results and Discussion

The intensity of the attack was observed to determine the effect of biopesticide that treats on *Terminalia catappa* plant on pest activity, indicated by the damage to *Terminalia catappa* plants (or well-known as *Ketapang*), which were attacked by pests. The result of this research shown in Table 1.

Table 1. Pest Attack Intensity Calculation

Days	Biopesticides (Plant 1)				Chemical Pesticides (Plant 2)				Without Pesticides (Plant 3)			
	Total Normal Leaves	Total Broken Leaves	n	IS	Total Normal Leaves	Total Broken Leaves	n	IS	Total Normal Leaves	Total Broken Leaves	n	IS
1	41	15	26.79	4.10	38	10	20.83	1.33	60	20	25	1.70
2	41	14	25.45	3.82	25	13	34.21	2.63	52	28	35	2.74
3	40	14	25.93	3.92	24	13	35.14	2.74	47	33	41.25	5.95
4	39	13	25	3.73	22	12	35.29	2.76	42	38	47.5	7.67
5	36	12	25	3.73	19	14	42.42	6.21	42	38	47.5	7.67
6	36	12	25	3.73	18	14	43.75	6.55	37	43	53.75	9.85
7	36	12	25	3.73	16	16	50	8.42	35	45	56.25	10.90
8	36	12	25	3.73	15	17	53.13	9.54	34	45	56.96	11.22
9	35	12	25.53	3.84	14	18	56.25	10.83	33	46	58.23	11.81
10	34	12	26.09	3.95	13	19	59.38	12.31	32	46	58.97	12.18

Table 1 presents the *Terminalia catappa* plant's intensity data that pests attacked 10 days after treatment. At the beginning of the treatment, the intensity of the attack increased in proportion to the increase in pest instances which requires more food. Entering the second and third observations, the intensity of pest attacks began to slow down. According to (Sinaga 2009), this occurs because the function of alkaloid compounds, triterpenoids, saponins, and flavonoid glycosides in the content of biopesticides can inhibit the feeding power of larvae/pests (antifeedant). The way these compounds work is by acting as stomach poisoning. Therefore, when these compounds enter the pest's body, their digestive organs will be disturbed. The data above and the use of the formula to find the intensity of pest attack shows that the highest intensity of pest attack has resulted in plant 3 without any treatment. The second place is occupied by plant 2 that treated with chemical pesticides. The third place is occupied by plant 1, which is given our artificial biopesticide and has the lowest intensity attack, which is 3.953%.

This is the same as the expression from (Aradilla, 2009) which says that several factors influence this found internally and externally that can inhibit pest attacks on existing plants, which include internal types of active compounds in materials, the qualitative and quantitative composition of active compounds, and the total average content of active compounds, while external factors include extraction method, material size, material hardness, material dryness, solvents used in extraction, heavy metal content and pesticide content according to their manufacture so that they can inhibit pests intensity attack against the tested plants.

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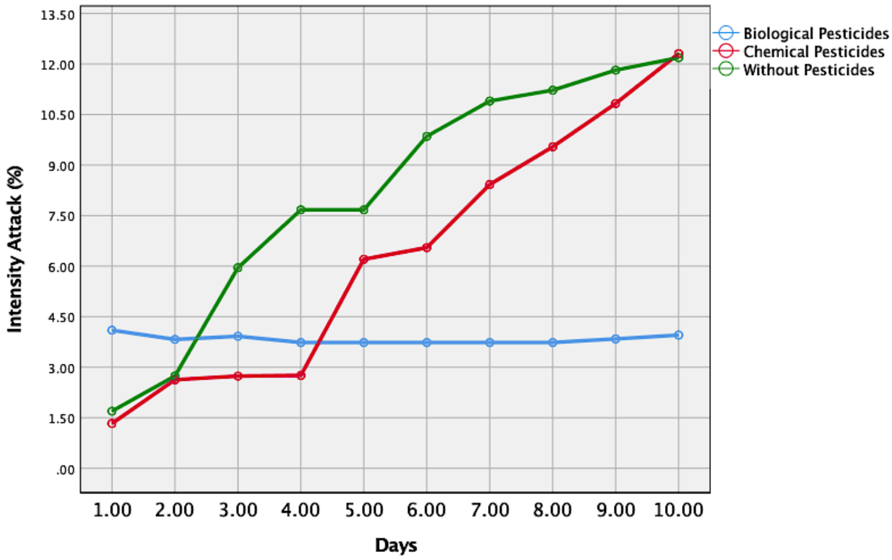

Figure 1. Graph of Pest Attack Intensity in 10 Days Observation

From the graph above (Figure 1), it can be concluded that plants given biopesticides can repel pests, while plant 2 and plant 3 have almost the same line graph that increasing, which means that the content of chemical pesticides in plant 2 cannot help the plant to protect from pests. Plant 3 is a plant that uses its natural protection, but its protection is not sufficient to fulfil it; therefore, assistance is still needed to protect plants from pests and diseases. This is the same thing expressed by (Setiawan & Supriyadi, 2014) namely that in a plant there are primary and secondary metabolite compounds. Secondary metabolite compounds are plant chemical compounds that are not universally found in all higher plants but are limited to certain plant taxa with certain concentrations. These secondary metabolite compounds do not play an important role in plant growth and development, but there are large variations and numbers of secondary plant metabolites. Examples of secondary compounds are flavonoids, terpenoids, and alkaloids that protect plants from pests and diseases.

Gas Chromatography-Mass Spectrophotometry or well-known as GCMS, is a chemical tool that is widely used in the analysis of compounds in medicinal plants such as essential oils, fatty acids, hydrocarbons, lipids, and others (De Fatima, 2006; Kaushik *et al*., 2002; Lal & Verma, 2006; Marston, 2007; Surahmaida *et al*., 2018). This method is simple, sensitive, and effective in separating the components of a mixture; also GCMS can identify bioactive compounds (Mariswamy et al., 2011; Surahmaida et al., 2018). In Table 2, it can be seen the active compounds identified in biopesticides by GCMS. The three largest active compounds identified were Benzoic acid (CAS) with 95.39% area; 6,6-DIDEUTERO-NONEN-1-OL-3 with 2.09% area; and Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-(CAS) with 0.44% area.

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Table 2. Analysis Result of Bioactive Compounds inside Biopesticide made from Cigarette Stub

Peak	R. Time	Area %	Name
1	3.522	0.14	1,3-Dioxolane, 4-ethyl-5-hexyl-2,2-bis(trifluoromethyl)-, trans- (CAS)
2	4.458	95.39	Benzoic acid (CAS)
3	4.827	0.17	2-UNDECENE, 4,5-DIMETHYL-, [R*,R*-(E)]-
4	6.563	0.44	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)- (CAS)
5	6.847	0.13	Ethyl iso-allocholate
6	7.651	2.09	6,6-DIDEUTERO-NONEN-1-OL-3
7	7.785	0.40	1-Butanol, 3-methyl-, nitrate (CAS)
8	8.617	0.15	1,2-Dithiole-1-oxide
9	10.985	0.16	1-(3,4-DIHYDROXY-5-HYDROXYMETHYL-TETRAHYDRO-FURAN-2-YL)-4,5-DIHYDROXY-1
10	12.172	0.14	HEXADECAMETHYLCYCLOOCTASILOXANE
11	15.295	0.15	2-Furanoctanoic acid, 5-hexyltetrahydro-, methyl ester (CAS)
12	17.110	0.17	Stigmastane-3,6-dione, (5.alpha.)- (CAS)
13	18.184	0.20	Hexadecanoic acid, methyl ester (CAS)
14	21.335	0.15	24,25-Dihydroxycholecalciferol
15	21.750	0.12	.alpha.-iso-methyl ionone
		100.00	

From the GCMS result shown in Figure 2, one of the most active compounds that dominate the content of biopesticide is benzoic acid. Sodium benzoate based on (Hong *et al*., 2009; Williams & Lock, 2005) is one in each of the artificial additives widely utilized in the food trade and is usually recognized as safe (GRAS-generally recognized as safe). Sodium benzoate is a salt of benzoic acid employed as a very important preservative within the food industry against bacteria, fungi, and yeast with a natural pH scale of 4.5. Also, these substances are often used in the pharmaceutical and cosmetics industries. The benzoic acid compound that was indicated by GCMS analysis as the largest compound in biopesticides was due to the addition of preservatives in the form of sodium benzoate. Sodium benzoate is well-known for its effectiveness against yeasts, moulds, and bacteria, potentially being a bacteriostatic and anti-fungal preservative under acidic conditions (Amalia *et al*., 2020; Castle *et al*., 2004; Pongsavee, 2015).

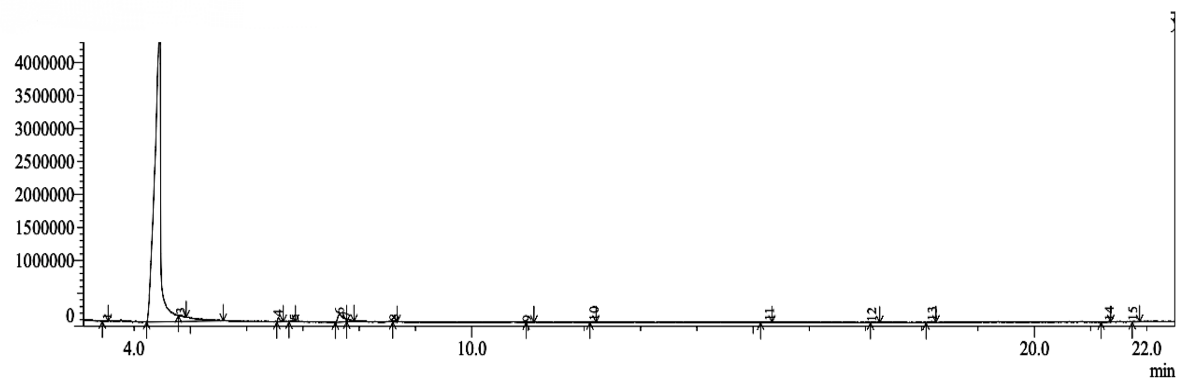

Figure 2. GCMS Result of Biopesticide made from Cigarette Stub

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Benzoic acid, which is usually used in the form of its sodium salt, sodium benzoate, has long been used as an antimicrobial additive in foods (Takayuki & Bjeldanes, 1993) and reportable to perform as fragrance ingredients, pesticides, the potential of Hydrogen adjusters, preservatives, solvents, and viscosity decreasing agents in cosmetic products (Gottschalck, 2006; Johnson *et al*., 2017). Benzoic acid has been classified by the Food and Drug Administration relating to its use within the following kinds of OTC drug products (Food and Drug Administration (FDA), 2010): acne, anti-fungal, oral health care, and skin protectant. The FDA has classified sodium benzoate regarding its use in menstrual/diuretic OTC drug products (Food and Drug Administration (FDA), 2010). Pesticide products containing benzoic acid as the active ingredient are registered with the Environmental Protection Agency to be used in the extermination of dirt mites (U.S. Environmental Protection Agency (EPA), 2010). It can be seen in Table 3.

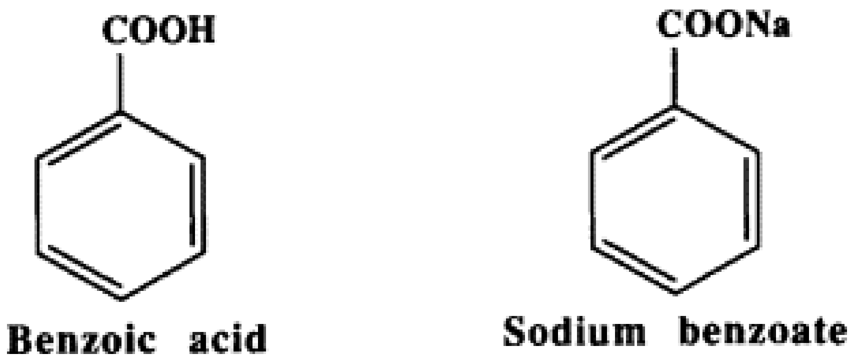

Figure 3. Structures of Benzoic Acid and Sodium Benzoate (Takayuki & Bjeldanes, 1993)

Table 3. Properties of Benzoic Acid and Sodium Benzoate
(Johnson et al., 2017; O'Neil, 2010; OECD Screening Information Data Sets, 2001)

Properties	Benzoic Acid	Sodium Benzoate
Form	Monoclinic plates	White granules
Molecular weight	122.12	144.1
Density	1.321	-
Melting point	122.4°C	330.6°C
Boiling point	249.2°C	464.9°C
Water solubility	2.9 g/L	1 g dissolves in 1.8 mL water

The next bioactive compound that dominates the result is Pyridine ($C_{10}H_{14}N_2$). Pyridine is an alkaloid that can be used as an insecticide. Alkaloid compounds have an alkaline nature containing one or more nitrogen atoms and are usually cyclic systems. Alkaloids contain carbon, hydrogen, and nitrogen atoms and generally contain oxygen, and are the plants' metabolic products (Siswoyo et al., 2018). Pyridine is employed as a solvent and forms many various products akin to medicines, vitamins, food flavourings, pesticides, paints, dyes, rubber products, adhesives, and waterproofing for fabrics. Pyridine may also be formed from the breakdown of the many natural materials within the environment (Agency for Toxic Substances and Disease Registry (U.S. Public Health Service), 1992).

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Conclusions

The utilization of cigarette stub as raw material for biopesticide is considered effective in resisting pest attacks and supporting plants to develop their antibodies naturally. The pests intensity attack resulting from plant 1 is 3.953% of 10 observation days. The GCMS result that benzoic acid and pyridine is the dominating compound that formed biopesticide.

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