Potential of Some Plants as Bioinsecticides of the House Fly *(Musca domestica)*

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Abstract. Diarrhea is still a health threat because it causes illness and death, especially in toddlers. Diarrhea will increase due to consuming food contaminated with microorganisms, including through the intermediary of flies. The use of chemical pesticides can impact vector resistance, non-target insects, and health problems. The study aimed to evaluate plants effective as bioinsecticides to control house fly *(Musca domestica)*. The study used a completely randomized design factorial. House flies from residential areas are rearing in two stages. Three types of plant leaves (Averrhoa bilimbi, Catharanthus roseus, and Annona muricata) were extracted, and their effectiveness was tested through a bioassay-test. The experiment was carried out in two replications, at various doses (25, 30, 35, 40%) and contact time (15, 30, 60 min). The study found that the mortality of houseflies on exposure to Averrhoa bilimbi leaf extract (67.25), Catharanthus roseus (86.75), soursop (97.25). The treatments showed a significant effect on mortality ($P < 0.05$), with the highest level of effectiveness at a dose of 25%, for 15 min. Flavonoids are believed to be the compounds responsible for the death of flies.

Keywords: bioinsecticide · house fly · mortality · dose · Averrhoa bilimbi leaf

1 Introduction

Sanitation has a big role in the incidence of diarrhea and is a challenge for developing countries. The World Health Organization (WHO) declares diarrhea as a health threat. In Indonesia, diarrhea is still a public health problem. According to age characteristics, the prevalence of diarrhea in children aged < 1 year was 9%, 11.5% in children aged 1–4 years 6.2% in children aged 5–14 years, and 6.7% in children aged 15–24 years (Menteri Kesehatan RI, 2020). The coverage of diarrhea services has only reached 59.39% even though the 2019 target is 100% [13]. An increase in diarrheal disease can occur due to consuming contaminated food. A study found that the condition of the food storage area sold in the school environment in Bandar Lampung City was left open, this caused the food to be contaminated with microorganisms through the intermediary of fly vectors [8].

The density of flies arises as a result of population growth. The more people there are, the more waste is generated. The presence of garbage invites flies as vectors of disease. The threat of flies that come in contact with humans has an impact on disease

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transmission. The role of flies in disease transmission is generally mechanical, namely flies that land on dirt, dirt sticks to the fly's feet and land on food so that the food is contaminated. In the end, flies will cause public health problems in general, both in terms of aesthetics and disease transmission. The fly that is commonly found in residential areas is the house fly (Musca domestica). These insects reproduce quickly, usually perching on human and animal feces and other organic materials such as fresh or rotting meat, fruit, fish, and plants [17].

The use of chemical insecticides to control flies has a harmful effect on non-target insects, as well as exposure to humans and the environment. Therefore, it is necessary to look for vegetable insecticides as an alternative. Vegetable insecticides are a group of insecticides derived from plants, such as pyrethrum, pyrethrin, nicotine, rotenone, limonene, azadirachtin, and others. The use of plant-based insecticides, in addition to helping reduce fly populations, is also safe for humans and the environment [16].

The use of natural insecticides needs to be developed because Indonesia is rich in various types of plants that can be used as natural insecticides [5]. The advantages of vegetable pesticides compared to synthetic pesticides are the compounds contained in them. In a plant extract, there are several main active compounds and other less active compounds. The presence of less active compounds can synergize and trigger the overall extract activity. Some plants have the potential as insecticides because they contain several bioactive compounds, such as saponins, flavonoids, alkaloids, tannins, and alkenyl phenols. Until now, there have not been many studies examining the effect of various types of plants in controlling houseflies (Musca domestica).

2 Method

This research is an experimental study using a factorial design. The research was started by breeding flies, extracting plants, and measuring the content of active substances. Furthermore, the plant extracts were tested on the mortality of the house fly (Musca domestica). The variables studied were the concentration and length of contact on the mortality of the house fly (Musca domestica). The treatment variations were 6 concentrations (0%, 25%, 30%, 35%, 40% and 45%) and 4 contact times (15 min, 30 min, 60 min and 120 min). Replication was carried out twice.

Plant raw materials are obtained from hedge gardens in the neighborhood where the people of Bandar Lampung City live. The extraction was carried out at the Agricultural Product Technology laboratory of the Lampung State Agricultural Polytechnic. Each plant was taken 1 kg and dried (aired) for 7 days, after drying it was ground using a cooper and soaked in 4 L of ethanol for 24 h. The next day the solution is evaporated until the remaining thickens. Then diluted using aquadest according to a predetermined concentration. The liquid extract was sprayed over the entire surface of the test bottle and then allowed to stand for 1 h so that the bioinsecticide dries.

A total of 10 M. domestica flies (aged 3–5 days) which were cultured were put into a glass bottle with an insecticide during a predetermined contact period of 15 min, 30 min, 60 min, and 120 min. As a control, 10 flies from the colony were used which were put into bottles That were only treated with aqua dest solution. After completion of contact, the flies were transferred to a screen cage (25x25x25 cm3) and left for 24 h. In the cage,

the flies were fed a solution of 10% sugar water or liquid milk, and the cage was placed in a room with a temperature of 27–30 °C and a humidity of 75–90%. Furthermore, observations were made on the number of dead flies.

3 Result

The content of the active ingredients in the leaves of the Averrhoa bilimbi, Catharanthus roseus, and Annona muricata plants was examined by Gas Chromatography-Mass Spectroscopy (GCMS), spectrophotometry, and TLC scanner as shown in Table 1.

From Table 1 it can be explained that the active ingredients identified in 3 types of plants are saponins, flavonoids, and other ingredients. Annona muricata leaves contain the highest active ingredients, namely saponins (96%), flavonoids (47%), and other ingredients (100%). Averrhoa bilimbi leaves contain 85% saponins, 4% flavonoids, and 100% other ingredients. Catharanthus roseus leaves contain 77% saponins, 30% flavonoids, and 44% other ingredients.

Figure 1 Shows the highest fly mortality occurred after the flies were exposed to Annona muricata leaf extract through a bioassay test (97.25%). The mortality of flies after exposure to Catharanthus roseus leaves was 86.75% and the lowest mortality was in the treatment using Averrhoa bilimbi leaf extract (67.25%).

In Fig 2 High saponin content is not followed by high fly mortality. However, the higher the flavonoid content in the plants exposed, the higher the fly mortality.

The results of the statistical analysis obtained that the concentration and time each had an effect on fly mortality. There was no combined effect of concentration and time in killing flies (Table 2). Concentration has an effect of 83.53% and time of 10.94%.

Table 1. The content of active ingredients in plant extracts

Pant	Saponin	Flavonoid	Else
Averrhoa bilimbi Leaves	85%	4%	100%
Catharanthus roseus Leaves	77%	30%	44%
Annona muricata Leaves	96%	47%	100%

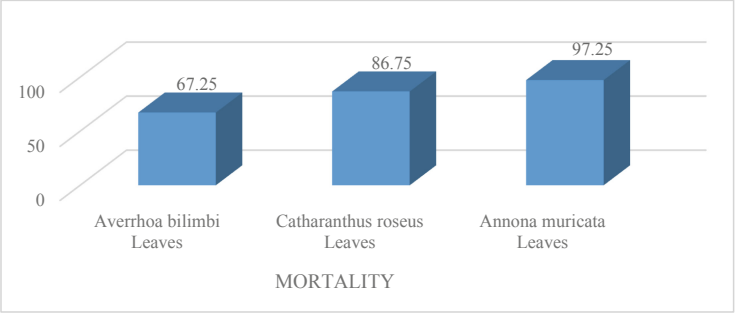

Fig. 1. Fly mortality by plant species

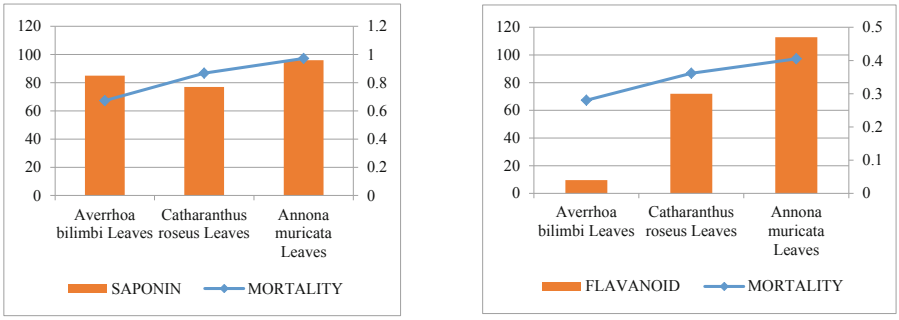

Fig. 2. Fly mortality based on Saponin and Flavonoid content

Table 2. Fly mortality based on concentration and contact time of plant extracts

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	458,653[a]	23	19,941	6,789	0,000
Intercept	3857,347	1	3857,347	1313,139	0,000
Concentration	417,653	5	83,531	28,436	0,000
Time	32,847	3	10,949	3,727	0,017
Concentratration * time	8,153	15	0,544	0,185	1,000
Error	141,000	48	2,938		
Total	4457,000	72			
Corrected Total	599,653	71			

a. R Squared =,765 (Adjusted R Squared =,652)

4 Discussion

The content of active ingredients in plants in the form of saponins, flavonoids, and other ingredients. Saponins and flavonoids have the potential to control weeds and compounds are widely used as herbicides [21]. Saponins and flavonoids have functioned as insecticides for insects. Flavonoid compounds have properties that are selective against pests so they are not harmful to humans, persistent in nature (leaving no residue) that are toxic, effective against hosts that are already resistant to insecticides, and compatible with other pests control techniques.

This study showed that the highest fly mortality occurred after the flies were exposed to Annona muricata leaf extract through a bioassay test (97.25%). The lowest mortality was in the treatment using Averrhoa bilimbi leaf extract (67.25%). Annona muricata leaf extract contained 96% of saponins and 47% of flavonoids. Averrhoa bilimbi leaf extract contained 85% of saponins and 4% flavonoids. Catharanthus roseus leaf extract contains 77% saponins and 3% flavonoids. It is clearly seen in Figs. 1 and 2 that the flavonoid content in plant extracts has a significant effect on fly mortality. The higher the flavonoid content, the higher the fly mortality.

The flavonoid compounds inhaled by the flies work as an antifeedant, which inhibits the work of taste receptors in the mouth area which will then cause the fly to fail to stimulate taste. As a result, flies cannot recognize the food around them, the activity of eating flies is low and causes the energy for the development of flies to be reduced and the growth process is also hampered. Flavonoids also work poison as respiratory poison.

When flavonoids are absorbed, flies experience an increase in biological functions, including protein synthesis, cell differentiation and proliferation, and angiogenesis. Flavonoids are inhaled in excess, causing mutagens and inhibiting certain enzymes in the work of hormone metabolism and energy metabolism [2–15]. Of course, this also affects insects, where flavonoids will damage the permeability of cell walls and inhibit the work of enzymes that affect the metabolic process in insects.

Saponins act as stomach poisons that trigger stomach irritation. Saponins that are absorbed by flies damage the skin mucosa and result in hemolysis of blood cells, breathing becomes obstructed and can lead to death [2]. Another effect caused by saponins on insects is in the form of external physical disturbances (cuticle). The waxy coating that protects the insect's body and will be lost due to saponins and causes death due to the loss of a lot of body fluids. Saponins also cause the activity of digestive enzymes and absorption to decrease and interfere with the body's metabolic processes. The content of flavonoids and saponins has been shown to have the ability as a bioinsecticide [12].

From various existing articles, Annona muricata leaves are used to repel and kill cockroaches [3–19]. One study tested the ability of Annona muricata leaves to control crop caterpillars [1]. This study proved that the high flavonoid content in Annona muricata leaf extract was able to cause the death of flies more than 80%.

Averrhoa bilimbi also attracted the interest of researchers because of its flavonoid and saponin content to be tested against insects. Several studies have been conducted to control mosquitoes, termites, and cockroaches [7–20]. Tests of Catharanthus roseus leaf extract with various concentrations have also been carried out on the death of larvae and mosquitoes [12], and pests on crops with significant yields [11]. This research proves that Catharanthus roseus leaf extract can also be used as a bioinsecticide against flies. However, of the 3 types of plants tested, Annona muricata leaves had the highest ability to kill flies.

5 Conclusion

The study found that the most effective type of plant used for fly control was Annona muricata leaf. The content of flavonoids in Annona muricata leaves has a dominant effect on the death of flies.

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