


# Botanical Insecticides: Biosynthesis of Teak Wood Powder Waste and Mortality Test on Armyworms

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**Abstract:** Botanical insecticides are regarded as a promising alternative for plant protection from pests and pathogen attacks. Teak sawdust extract was produced from wood processing waste and could potentially be used as a botanical insecticide due to its containing secondary metabolites such as alkaloids, flavonoids, terpenoids, tannins, and anthraquinone. Based on the mortality test against corn armyworms, it was indicated that the effectiveness of botanical insecticides from teak sawdust waste extract was affected by concentration. The resulting optimum mortality percentage is 100%. The results indicated that extracts have strong potential as a botanical insecticide for the control of corn armyworms. Hence, these botanical insecticides have the potential to be utilized in the field by farmers due to their being environmentally friendly and non-toxic compared with synthetic insecticides.

**Keywords:** botanical insecticide; teak sawdust extract; armyworms; mortality.

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## 1. Introduction

Environmental pollution due to the use of pesticides has become a hot topic of discussion over the past decades. Currently, pesticides are extensively utilized in the agriculture sector with a wide range of active substances [1,2]. The use of pesticides could increase crop productivity, protect crops from damage from pest attacks, control diseases, and improve food quality. On the other hand, disproportionate use of pesticides, such as type, target, and dosage, will have an impact on environmental pollution and cause negative impacts on human health [3–5]. Pesticides are also dangerous to other living organisms through tainted water, food, or fresh air. Apart from the immediate or unimmediate impact of pesticides on non-target organisms, pests are resistant to pesticides [6].

The prospect of environmentally friendly techniques for monitoring pests has intensified with the utilization of natural products such as those obtained from plants. Botanical pesticides propose an excellent alternative to environmentally friendly chemicals as crop defense systems [7]. The utilization of botanical pesticides based on teak sawdust waste

extends a promising technology for the protection against pest and pathogen attacks. Wherein, in mechanism, botanical pesticides lead to an emphasis on pests and pathogens, hence accelerating the death level of the pests [8,9]. Some botanical pesticides that have been widely applied include ginger (*Zingiber officinale*) [10], garlic (*Allium sativum*) [11], rosemary (*Rosmarinus officinalis*) [12], turmeric (*Curcuma longa*) [13], thyme (*Thymus vulgaris*) [14], and peppermint (*Mentha piperita*) [2].

Generally, sawdust is a type of waste that is essentially produced from wood processing and isn't much utilized. Moreover, this waste is not biodegradable and causes waste problems. Every year, a huge total of teak sawdust waste is generated from manufacturing jambs, furniture, cupboards, beds, wood decorative items, etc. [15–17]. These remaining residues have no economic value and just become a large waste, which creates environmental problems. On the other hand, teak powder waste contains secondary metabolites, including phenol, alkaloids, terpenoids, flavonoids, and tannins, that potentially are bioinsecticides due to their toxicity properties against pests and pathogens [18,19]. These compounds are significant in the existence cycles of plants and act as protection against pest and pathogen attacks [20–22]. In addition, these compounds are composed of the alkaloid group, which is considered a primary compound existing at high concentrations, while the other matter is present at low concentrations. Many studies have been reported related to controlling pests and pathogens using different botanical pesticides such as neem- and pyrethrum-based botanical insecticides for pest management on bean aphids [23], combined with *A. attenuatus* and matrine as botanical insecticides against *M. usitatus* (Bagrall) [24].

In this work, we attempt to explore the potential of teak sawdust waste as an additive for insecticide. The teak waste extract is discovered to contain secondary metabolites such as alkaloids, flavonoids, terpenoids, saponins, tannins, and anthraquinone that act as insecticides, antimicrobials, antifungals against pests and pathogens. Apart from the insecticidal influence, we also evaluated the mortality activity against armyworms using teak sawdust extract.

## 2. Materials and Methods

### 2.1. Materials.

The materials used in this study were ethanol (C<sub>2</sub>H<sub>5</sub>OH) 96% (Merck), distilled water, and armyworm (*Spodoptera frugiperda*). Especially teak sawdust waste from wood processing, Kendari, Southeast Sulawesi, Indonesia.

### 2.2. Preparation of teak sawdust extract.

In short, the simplisia were flushed with distilled water and then dried in an oven at 70°C. Furthermore, extraction was conducted in a cold way using 96% ethanol solvent for 72 hours. Forward, filtered to obtain an extract. The extract was evaporated by a rotary evaporator at 50 rpm at 40°C until a concentrated extract was achieved. The solvent used was distilled water at 1% with various concentrations, including (1000 ppm, 750 ppm, 500 ppm, 250 ppm, and 100 ppm) to obtain teak sawdust extract with different concentrations.

### 2.3. Determination of total flavonoid.

The test of total flavonoid content was conducted following the procedure described by Hayat et al. [25] with little modification. The extract solution was placed into a beaker, then

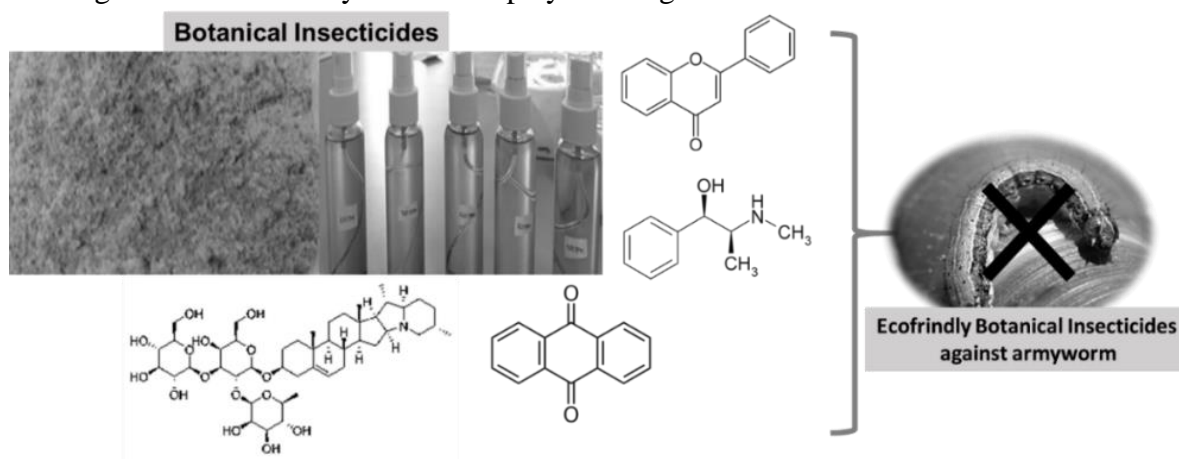
sufficient water and heat were added for 5 minutes. The mixture was appended with some Mg powder and 1 mL concentrated HCl. The presence of flavonoids was indicated by the existence of yellow, orange, or red color.

#### 2.4. Mortality test of a botanical insecticide.

Teak sawdust with various concentrations (1000 ppm, 750 ppm, 500 ppm, 250 ppm, and 100 ppm) was put in a receptacle. A total of 30 armyworms were placed in a glass container and fed corn leaves that had been sprayed with 5 variations of concentration. Observations were made for 3 days. The same treatment was also carried out without feeding. The following equation calculates the percentage of mortality:

$$\% \text{ Mortality} = \frac{R_1 - R_2}{R_1} \times 100\% \quad (1)$$

Explanation:  $R_1$  and  $R_2$  were the numbers of live armyworms before and after an examination. In summary, the mechanism of botanical insecticides from teak wood powder waste against the corn armyworm is displayed in Figure 1.



**Figure 1.** Illustration of the mechanism of botanical insecticides from teak wood powder waste against corn armyworms.

### 3. Results and Discussion

#### 3.1. Phytochemical analysis.

Phytochemical analysis of the teak sawdust showed the existence of alkaloids, flavonoids, terpenoids, saponins, tannins, and anthraquinones (as shown in Table 1).

**Table 1.** Chemical constituents of teak sawdust extract.

	Tests	Result
Alkaloids	Mayer's test	+
	Wagner's test	+
	Dragendroff's	+
Flavonoids	Magnesium chloride	+
Terpenoids	Liebermann-burchard's	+
Steroids	Liebermann-burchard's	-
Saponin's	Emulsion test	+
Tannin's	Ferric chloride test	+
	Anthraquinone	+

- : not detected; and + : detected.

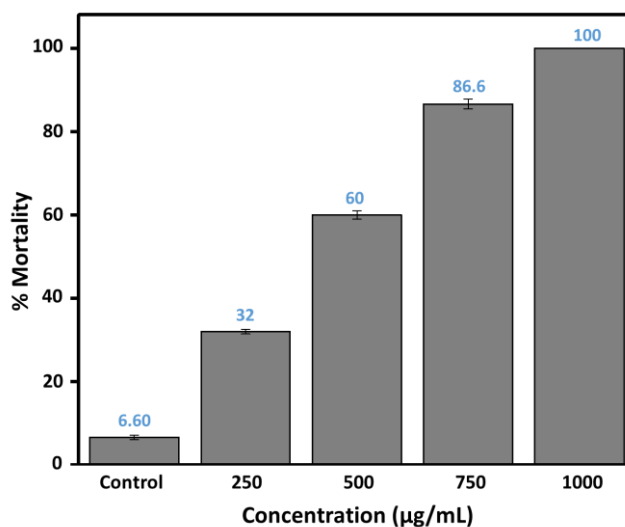
### 3.2. Bioactivity tests.

The potential of ethanol extract from teak sawdust waste as a botanical insecticide was studied by observing the mortality value of the corn armyworm. Figure 2 shows the percentage of corn armyworm (*Spodoptera frugiperda*) mortality for treatment without food. This treatment was intended to observe the ability of teak sawdust waste extract to kill armyworm pests in hungry conditions (without feeding). Based on Figure 2, we can see that there is a significant effect on the ability of the armyworm to respond to the extract of teak sawdust waste. This can be seen from the resulting mortality value. The higher concentration of the extract (1000 ppm) causes the corn armyworm pest-killing process to reach a maximum of around 100%.

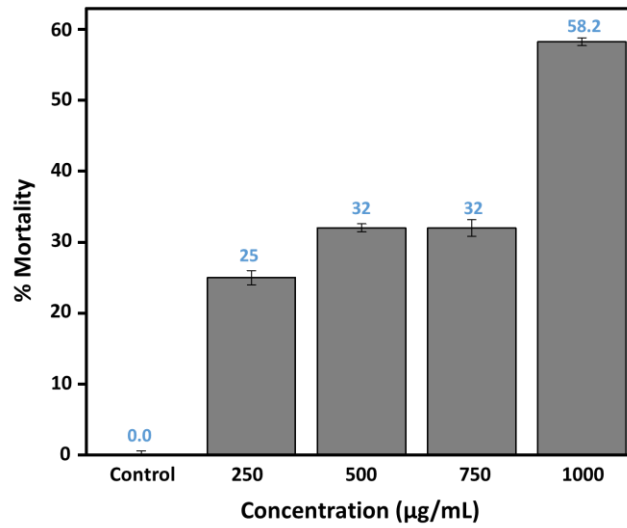
After knowing that the ethanol extract of teak sawdust gave a good response to the mortality of corn armyworms in conditions of starvation, further observations were made on conditions where corn armyworms were given a food source. The type of food used is the leaves of the corn plant. Based on Figure 3, it can be seen that the awarding of food sources affects the percentage mortality of the corn armyworm. The presence of a food source allows armyworm pests to survive; nevertheless, based on this, it appears that extract concentration has an effect on the percentage mortality of corn armyworm. Concentration (1000 ppm) resulted in a high mortality value of 58.25%. Although the percentage of this mortality is lower when compared with mortality without providing food sources, overall, the ethanol extract of teak sawdust waste was effective in killing armyworms and interfering with the work response of pests [26].

Figure 4 shows the percentage mortality of the ethanol extract in the food immersion treatment with various extract concentrations. In this observation, the immersion time was kept constant, namely 2 minutes. It can be seen that soaking food at different concentrations affects the percentage mortality of corn armyworms. The higher the concentration of the extract, the higher the percentage of mortality [27,28]. The extract concentration of 1000 ppm achieved the highest mortality percentage, namely 33.20%.

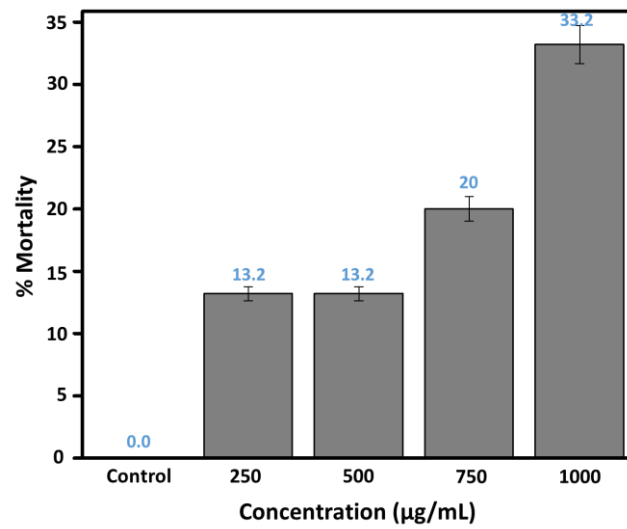
Figure 5 shows the percentage mortality of ethanol extract in the food immersion treatment with time variations. In this experiment, the extract concentration was kept constant at 1000 ppm. Based on Figure 5, soaking food at different times affects the percentage of corn armyworm mortality. In this case, an immersion time of 2.0 minutes gave the highest mortality percentage, namely 33.20%.



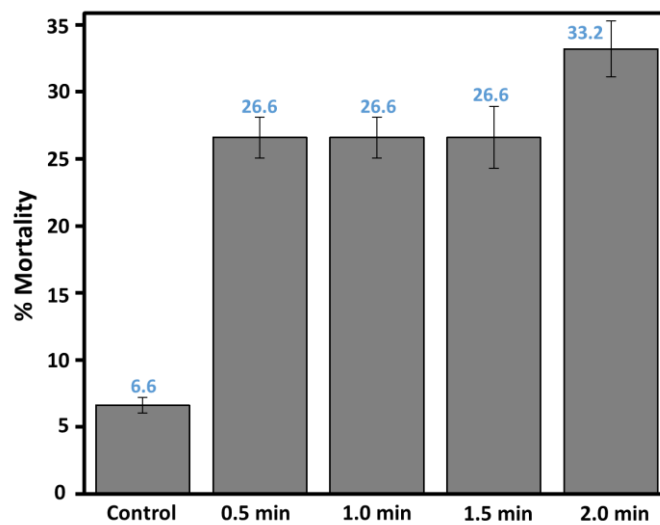
**Figure 2.** Mortality percentage of corn armyworm for treatment without food.



**Figure 3.** Mortality percentage of the corn armyworm for food treatment.



**Figure 4.** Mortality percentage of corn armyworm for food soaking treatment with various concentrations of extract solutions.



**Figure 5.** Mortality percentage of corn armyworm for food soaking treatment at various times.

## 4. Conclusions

In this work, we have studied the potential of teak sawdust extract as a botanical insecticide agent for pest and pathogen attack protection. The teak sawdust was obtained from wood processing and contains a secondary metabolite that is potentially a botanical insecticide. Furthermore, for the first time, the teak sawdust extract could be a candidate substance for environment-friendly, non-toxic, and safe botanical insecticides to protect against pest and pathogen attacks. Its activities were mostly a consequence of the main components, such as flavonoids and tannins. Based on the mortality test against corn armyworms, it was indicated that the effectiveness of botanical insecticides from teak sawdust waste extract was affected by concentration. The resulting optimum mortality percentage of 100%. Moreover, these substances are biodegradable, eco-friendly, and do not cause resistance effects to pests and pathogens.

## Author Contributions

All authors have read and agreed to the published version of the manuscript.

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Not applicable.

## Informed Consent Statement

Not applicable.

## Data Availability Statement

Data supporting the findings of this study are available upon reasonable request from the corresponding author.

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## Conflicts of Interest

The authors report no financial or any other conflicts of interest in this work.

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