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Test of effectiveness Gadung tuber extract (*Dioscorea hispida Dennst.*) against cacao pod sucker pest (*Helopeltis* Spp.) in the laboratory

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Abstract

One of the obstacles in cacao cultivation is the presence of cacao pod sucking pest (*Helopeltis* spp.) which may lead to decrease the production 50-60%. Using vegetable pesticides extracts of gadung tuber (*Dioscorea hispida* Dennst.) is an alternative for controlling cacao pod sucking pest (*Helopeltis* spp.). This study aims to obtain an effective concentration of gadung tuber extract to control *Helopeltis* spp. The research was conducted at the Plant Pest Laboratory, Faculty of Agriculture, Riau University. The study was conducted from September 2021 to November 2021. This study used a completely randomized design (CRD) with five treatments and three replications in order to obtain 15 experimental units. The treatments that given were the concentration of gadung tuber extract 0%, 70%, 80%, 90% and 100%. Observation parameters consist of the initial time of death, lethal time 50, daily mortality, total mortality, temperature and humidity. The results showed that the concentration of 90 g.l-1 water or 9% is an effective concentration for controlling cacao pod sucking pest (*Helopeltis* spp.) with an initial time of death of 4.66 hours, a lethal time of 50 at 14 hours and total mortality 86.66%.

Keywords: *Dioscorea hispida* Densst; *Helopeltis* spp.; *Theobroma cacao* L.; Botanical pesticide

1. Introduction

Cacao pod sucking pest (*Helopeltis* spp.) is one of the main pests in cacao plantations. *Helopeltis* spp. attacks can reduce cacao fruit production by 50 - 60%[1]. Cacao bean production in Indonesia is known to have decreased from 2019 to 2021. This can be captured from the cacao bean production in 2019 is 734,795 tons then dropped to 688,210 tons in 2021[2]. Using plant-based insecticides is one of the controls that can be done to prevent and reduce the attack of *Helopeltis* spp.

Gadung tuber (*Dioscorea hispida* Dennst.) is one type of plant that can be utilized as a plant-based insecticide with the chemical active components cyanide, dioscorine, diosgenin, and dioscin [3]. These compounds have a high toxicity that can affect the neurological system of the organism that consumes them[4]. The combination of 75% papaya leaf extract and 25% gadung tuber extract can cause total mortality of *Helopeltis* spp. nymphs at 75.76%[5]. The plant-based insecticide gadung tuber extract concentration 8% in water solvent is able to cause 82% total mortality of *Leptocorisa oratorius* Fabricius pests in the laboratory[6]. The concentration of 9% in water solvent is an effective concentration to control *Leptocorisa oratorius* Fabricius pests in upland rice plants in the field with total mortality 85%[7].

This study aims to get an effective concentration of gadung tuber extract (*Dioscorea hispida* Dennst.) to control cacao pod sucking pest *Helopeltis* spp. in the laboratory.

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2. Material and methods

2.1. Description of the study area

The research was conducted at the Plant Pest Laboratory, Faculty of Agriculture, Riau University, Kampus Binawidya, Simpang Baru, Bina Widya, Pekanbaru. The research was conducted for three months from September to November 2021.

2.2. Materials and Equipment

The materials that used in this study were gadung tubers, fifth stage of *Helopeltis* spp. nymphs, fresh and pesticide-free cucumber fruits and cacao pods, aquadesh and cream soap.

The tools that used in this research are plastic jars (20 cm high and 18 cm wide), gauze, knife, blender, measuring cup, sieve, basin, 250ml hand sprayer, stirrer, analytical scales, mask, gloves, thermohygrometer, stationery, documentation tools, and SAS application.

2.3. Research Methods

This study used a completely randomized design (CRD) with five treatments and three replications in order to obtain 15 experimental units. In each experimental unit, 10 fifth stage of *Helopeltis* spp. nymphs were infested with the treatments that given were this following concentrations of gadung tuber extract:

- G0 = Concentration of gadung tuber extract 0%
- G1 = Concentration of gadung tuber extract 7%
- G2 = Concentration of gadung tuber extract 8%
- G3 = Concentration of gadung tuber extract 9%
- G4 = Concentration of gadung tuber extract 10%

2.4. Research Implementation

2.4.1. The Breeding of Helopeltis spp.

Nymphs and imago of *Helopeltis* spp. were obtained from cacao fields in Jorong Taratak, Kubang, Payakumbuh. Cucumber fruits that have good quality, fresh, young, full, injured were used as food and egg-laying sites for *Helopeltis* spp. according to the Kilin method[8]. Five pairs of imago *Helopeltis* spp. and cucumber fruit were placed in plastic jars 20 cm high and 18 cm wide and then covered with gauze. Cucumber fruits containing eggs were transferred to another jar and reared until they became nymphs. Nymphs were transferred into other jars at a density of 20 per jar. The nymphs were reared until they reached the fifth instar and could be used as test insects.

2.4.2. Making the Extract of Gadung Tuber (Dioscorea hispida Dennst.)

The gadung tubers that used were from Siabu, Salo, Kampar, Riau, Indonesia. Fresh gadung tubers were peeled using a knife then cut and weighed according to the treatments which were 70 g, 80 g, 90 g and 100 g. Then blended until smooth with 100 ml of aquades. Smooth gadung tubers were placed into a jar and then added 900 ml aquades to make the volume be 1000 ml (1 liter). One gram of soap cream was added to each solution then stirred until homogeneous and allowed to stand for 1 hour. The solution was filtered and then put it into different hand sprayers according to the treatment concentration.

2.4.3. Helopeltis spp*. nymph infestation*

Helopeltis spp. nymphs were infested into 20 cm high and 18 cm wide jars with 10 individuals for each experimental unit. Fresh, pesticide-free cacao pod were added to the jars as food. *Helopeltis* spp. nymphs were removed using a brush. Treatment application was done 1 hour after infestation.

2.4.4. Treatment Application

Treatment application was conducted 1 hour after *Helopeltis* spp. nymph infestation using a hand sprayer by sprayed gadung tuber extract into jars according to the treatment concentration.

Observation

Observation parameters consist of the initial time of death (hours), lethal time 50 (hours), daily mortality (%), total mortality (%), temperature and humidity (%).

3. Results and discussion

3.1. Initial Time of Death (hours)

The results of variance showed that the treatment of several concentrations of gadung tuber extract (*Dioscorea hispida* Dennst.) gave a significant effect on the initial time of death of *Helopeltis* spp. nymphs. The average results of the initial time of death of *Helopeltis* spp. after Tukey's further test at the 5% level can be seen in Table 1.

Table 1 Initial time of death of *Helopeltis* spp. nymphs after application of several concentrations of gadung tuber extract (hours)

Concentrations of gadung tuber extract (%)	Initial time of death (hours)
0	77.00 a
7	13.00 b
8	7.00 c
9	4.66 cd
10	1.00 d

The numbers in the columns followed by unequal lowercase letters are significantly different according to Tukey's test at the 5% level after being transformed into $\sqrt{y}$.

Table 1 shows that the application of several concentrations of gadung tuber extract can caused the death of *Helopeltis* spp. nymphs with an initial time of death range at 1 - 13 hours after application. Increasing several concentrations of gadung root extract makes the initial time of death of *Helopeltis* spp. nymphs tend to be faster. The treatment of 0% gadung tuber extract concentration until the end of observation (77 hours) showed that none of the *Helopeltis* spp. nymphs had died.

Application of 10% gadung tuber extract concentration is the highest concentration that given to *Helopeltis* spp. nymphs. At this concentration, the initial time of death tends to be faster, which 1 hour after application but is not significantly different when compared to 9% concentration. This is presumably due to the high content of active ingredients of cyanogenic glycoside compounds at this concentration. Cyanogenic glycoside compounds form HCN in the blood that will bind oxygen, so that *Helopeltis* spp. nymphs will lack oxygen and experience death. A concentration of 100 g.l-1 water of gadung tuber extract is known to caused an initial time of death of 1.00 hours after application[7]. Gadung tubers have cyanogenic glycoside compounds that can cause death in insects faster according to the concentration used, because they have high toxicity and interfere with the nervous system if they enter the insect's body[4].

The application of gadung tuber extract with a concentration 7% can lead to the initial time of death of *Helopeltis* spp. nymphs at 13 hours after application which is the longest initial time of death when compared to concentrations of 8%, 9% and 10%. This is because the 7% concentration is the lowest concentration so there are fewer active ingredients of HCN cyanogenic glycosides that contained in it. The size of the concentration extract that is given will cause the effect on pests and the performance of the pesticide[9].

Glycoside compounds form HCN or cyanide acid through hydrolysis and enter the body of *Helopeltis* spp. nymphs through respiratory toxins. HCN will affect the blood cells or body fluids of insects known as himolimph. Himolimph is unable to form antibodies in free quantities to suppress anti-genes. This results in the destruction of hemosid cells contained by the hemolymph. Furthermore, the process of transporting foodstuffs, metabolite products, pH regulation, osmotic pressure is inhibited and irregular[10].

3.2. *Lethal time* 50 (LT_{50}) *Helopeltis* spp. (hours)

The results of the LT50 variance showed that the treatment of several concentrations of gadung tuber extract (*Dioscorea hispida* Dennst.) caused a significant effect on the required time to kill 50% of *Helopeltis* spp. nymphs that tested. The results of the average lethal time 50 *Helopeltis* spp. after Tukey's further test at the 5% level can be seen in Table 2.

Table 2 *Lethal time* 50 (LT_{50}) of *Helopeltis* spp. nymphs after application of several concentrations of gadung tuber extract (hours)

Concentrations of gadung tuber extract (%)	*Lethal time* 50 (hours)
0	77.00 a
7	39.33 b
8	22.33 c
9	14.00 d
10	4.33 e

The numbers in the columns followed by unequal lowercase letters are significantly different according to Tukey's test at the 5% level after being transformed into $\sqrt{y}$.

Based on Table 2, it can be seen that the application of several concentrations of gadung root extract gave a significant difference to the lethal time 50 (LT50) of *Helopeltis* spp. nymphs with range 4.33 hours – 77.00 hours after application. Concentrations of 7%, 8%, 9% and 10% gadung tuber extract were able to cause death in 50% of the *Helopeltis* spp. nymph population at 39,33 hours after application, 22,33 hours after application, 14,00 hours after application and 4,33 hours after application. Meanwhile, the 0% concentration or control treatment was not able to cause the death of 50% of the *Helopeltis* spp. nymph population until the end of observation (77.00 hours) after application.

The application of gadung tuber extract with a concentration of 10% was able to kill 50% of the *Helopeltis* spp. nymph population fastest at 4.33 hours after application and is significantly different from the application of gadung tuber extract concentrations 0%, 7%, 8% and 9%. This is assumed because the high content of cyanogenic glycoside active ingredients contained in these concentrations so the time required to kill 50% of *Helopeltis* spp. nymphs became faster. The higher concentration that given makes the content of active ingredients that can enter the body of the insects higher and death becomes faster[11].

The application of gadung tuber extract with a concentration 7% resulted the longest lethal time 50 of *Helopeltis* spp. nymphs at 39.33 hours and significantly different from other treatments. This is because 7% gadung tuber extract concentration is the lowest treatment concentration so the active ingredients that contained are also less compared to other treatments and it took longer to reach lethal time 50. The concentration given will determine the performance of a plant-based pesticide which the lower the concentration will take longer to influence the insects[12].

3.3. Total mortality of *Helopeltis* spp. (%)

The observation of *Helopeltis* spp. nymphs total mortality showed that the treatment of various concentrations of gadung tuber extract had a significant effect on the total mortality of *Helopeltis* spp. The average results of Tukey's further test at the 5% level can be seen in Table 3.

The numbers in the columns followed by unequal lowercase letters are significantly different according to Tukey's test at the 5% level after being transformed into √y.

Table 3 shows that the increase in several concentrations of gadung tuber extract caused the total mortality of *Helopeltis* spp. nymphs tends to be higher with range of 60-100%. The application of gadung tuber extract with the concentration 7% caused a total mortality at 60%. Increasing the concentration of gadung tuber extract to 8% increase the total mortality of *Helopeltis* spp. nymphs to 76.66%, but not significantly different from the application of 7% gadung tuber extract. The increasing in the total mortality value of *Helopeltis* spp. nymphs is assumed because of the higher cyanogenic glycoside (HCN) content at the 8% concentration compared to 7% so the ability to kill *Helopeltis* spp. nymphs become higher as well. The increasing concentration is directly related to the increasing toxicity of the ingredients then leading to a higher killing ability[13].

Table 3 Total mortality of *Helopeltis* spp. nymphs application of several concentrations of gadung tuber extract (%)

Concentrations of gadung tuber extract (%)	Total mortality (%)
0	0.00 d
7	60.00 c
8	76.66 bc
9	86.66 ab
10	100.00 a

The numbers in the columns followed by unequal lowercase letters are significantly different according to Tukey's test at the 5% level after being transformed into $\sqrt{y}$.

Increasing the concentration of gadung tuber extract to 9% caused the total mortality of *Helopeltis* spp. nymphs also increased, with the value 86.66% but was not significantly different from the application of 10% gadung tuber extract which was able to caused the total mortality of *Helopeltis* spp. nymphs by 100%. The concentration 9% gadung tuber extract is an effective concentration to control *Helopetis* spp. nymphs in the laboratory because it has been able to make the total mortality of *Helopeltis* spp. nymphs above 80%. A plant-based pesticide extract can be said effective if it is able to cause insect mortality by ≥ 80% at a concentration level ≤ 10% in water solvents[14].

The dioscorin alkaloid compound or cyanide acid (HCN) in gadung tuber extract is a toxic compound for *Helopeltis* spp. nymphs, causing the death of the test insects. This compound is thought to enter the body of *Helopeltis* spp. nymphs through feeding activities and direct contact so that it disrupts the activity and metabolism of the test insects to cause convulsions and death. The death of the test insects was caused by the content of dioscorine which caused convulsions and dioscin which caused neurological disorders in the insects[15].

4. Conclusion

Test of effectiveness gadung tuber extract (*Dioscorea hispida* Dennst.) against cacao pod sucker pest (*Helopeltis* Spp.) in the laboratory concluded that umbi gadung extract was effective at concentration 9% to control *Helopeltis* spp. because it was able to caused total mortality by 86.66% with an initial time of death of 4.66 hours after application and the lethal time 50 (LT50) at 14 hours after application.

Compliance with ethical standards

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Disclosure of conflict of interest

There are not any conflicts of interest of this study.

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