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Toxicity of *Jatropha curcas* and *Cymbopogan nardus* Extracts Against Pests Callosobruchus chinensis on Mung Beans

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Abstract

Callosobruchus chinensis L. is an important pest on mung beans. Alternative control of *C. chinensis* using botanical insecticides from extracts of *Jatropha curcas* and *Cymbopogon nardus*. The purpose of the research was to compare the toxicity of extracts and determine their compatibility. Toxicity testing methods use to contact, fumigation, and seed dressing methods. The research data was tested by probit analysis. The results showed that the toxicity of the contact method extract was more toxic than fumigation and seed dressing. The highest LC_{50} and LC_{95} values for the *C. nardus* extract applied with the contact method were observed at 72 HAT at 0.17% and 0.40% more toxic than the *J. curcas* extract at 0.21% and 2.14%. The best mixed extract of *J. curcas* and *C. nardus* was at a ratio of 2:1 with strong synergistic interaction (LC_{50}) and weak synergy (LC_{95}).

Keywords: botanical insecticides; callosobruchus chinensis; cymbopogon nardus; jatropha curcas

Introduction

Mung beans are a species of legume that is widely used in Indonesia as a protein and mineral source. Mung beans, on the other hand, are a legume that can be attacked by pests after harvest and during storage. According to (Nurbaekah, Sumadi, & Nuraini, 2018) , *Callosobruchus chinensis* L. is the most common post-harvest pest that damages mung beans, with losses of up to 70%. As a result, mung beans aren't very useful.

Chemical pesticides are commonly used to manage pests, but this practice can contaminate stored mung beans with harmful chemical residues. As a result, it is vital to obtain safer and more environmentally friendly insecticides, such as botanical insecticides. Herbivore rejection, prevention, toxicity, and growth inhibition are all possible with botanical pesticides produced from secondary metabolites (Anggraito *et al*., 2018).

Indonesia, which is located in the tropics, has a diverse flora that can be exploited as a source of botanical pesticide raw materials. According to (Saenong, 2016), over 400 thousand different varieties of chemical plants have been found in Indonesia, with 10,000 of them containing secondary metabolites. *Cymbopogon nardus* and *Jatropha curcas* are examples of plants that produce secondary metabolites.

J. curcas and *C. nardus* have a lot of potential as insecticides. According to (Devappa *et al*., 2012), the phorbol ester compound from *J. curcas* oil has a contact toxic action and decreases the feeding activity of *Spodoptera frugiferda* larvae. The leaf powder of *J. curcas* protects bambara beans against *Callosobruchus subinnotatus* (Dattijo *et al*., 2018). According to (Hasan, Harahap, & Hidayat, 2018), *C. nardus* is

poisonous to *Callosobruchus maculatus*. *C. nardus* oil contains monoterpenes such as limonene, citronellal, and geraniol, which can help plants defend themselves against pests (Maryani, Dono, & Yulia, 2019). The toxicity of botanical pesticides derived from these two plants to *C. chinensis* is still limited. The purpose of the research was to compare the toxicity of extracts of *J. curcas* and *C. nardus* on several application methods to control *C. chinensis*

Research Methods

Insect Culture

The *C. chinensis* population used was from Plant Laboratory 1 at Lampung State Polytechnic. Five pairs of Imago *C. chinensis* were inserted into a container holding mung bean seeds to breed. *C. chinensis* was bred to create a novel *C. chinensis* imago. The emergent imago was utilized as a test insect.

Extraction

The pressing process was used to extract *J. curcas*. A grinding machine was used to process dried *J. curcas* seeds. It was then heated for 10 minutes at 100 °C before being pressed using a hydraulic press until the oil was extracted. The distillation process was used to extract *C. nardus. C. nardus* was chopped, then air-dried for three days before being distilled via distillation. Distillation is carried out for 6 hours at 130 °C, until no oil droplets remain. The oil is left for a while after distillation to ensure that the water and oil are thoroughly separated

Emulsification Formulation

The formulation of emulsification using a low-energy emulsification method with phase inversion. The extracts of J. curcas and Tween 80 in a ratio of 1:1 were homogenized and then added with distilled water little by little to a volume of 100 ml, accompanied by stirring using a magnetic stirrer at a speed of 730 rpm at room temperature (Nuryanti *et al*., 2018). In the emulsification of the formulation of C. nardus extract, using the same procedure as in the emulsification of the formulation of *J. curcas*.

Toxicity *Testing of Extracts Against C. chinensis*

This preliminary test was conducted to determine the value of lethal concentration (LC). In this test, each extract was tested against *C. chinensis* by the contact application method, fumigation, and seed dressing at concentrations of 0.125, 0.25, 0.5, 1, and 2%. Observations in this test were made by taking *C. chinensis* mortality data with observation times of 24, 48, and 72 hours. The research data was tested by probit analysis (Finney, 1982).

Follow-up Test, To estimate the concentration utilized in the follow-up test, five concentrations of each type of extract were made based on the LC_{50} and LC_{95} values from the preliminary test probit data. The method of application is the same as that employed in the preliminary test.

Research Results and Discussion

The results showed that the concentration of treatment with extracts of *J. curcas* and *C. nardus* tested by contact, fumigation, and seed dressing methods had a toxic effect on imago *C. chinensis* (Table 1, 2). The lower the value of lectal concentration (LC), the more the extract has a higher toxicity. The toxicity of the extract of *J. curcas* which was applied by the contact method was higher than the toxicity of the extract which was applied by the method of fumigation and seed dressing. The values of LC_{50} and LC_{95} in the extract of *J. curcas* which were applied using the contact method were highest at the observation 72 hours after

treatment (HAT) of 0.21% and 2.14%. The fumigation method was 1.29% and 54.31%, while the seed dressing method was 0.32% and 30.50%. This indicates that the extract of *J. curcas* applied by the contact method has the most toxic effect compared to other methods

Table 1
Estimation of probit analysis parameters of Jatropha curcas and Cymbopogon nardus extracts against Callosobruchus chinensis by several methods at LC_{50}

Methods	*Lethal Consentration*	HAT[a]	*J. curcas* (%)	*C. nardus* (%)
Contact	LC_{50}	24	0,53	0,21
	LC_{50}	48	0,34	0,18
	LC_{50}	72	0,21	0,17
Fumigation	LC_{50}	24	6,43	2,93
	LC_{50}	48	2,90	1,57
	LC_{50}	72	1,29	0,92
Seed dreassing	LC_{50}	24	4,80	4,66
	LC_{50}	48	1,60	1,82
	LC_{50}	72	0,32	0,61

Note: HAT = Hours After Treatment

Table 2
Estimation of probit analysis parameters of Jatropha curcas and Cymbopogon nardus extracts against Callosobruchus chinensis by several methods at LC_{95}

Methods	*Lethal Consentration*	HAT[a]	*J. curcas* (%)	*C. nardus* (%)
Contact	LC_{95}	24	3,51	0,53
	LC_{95}	48	2,13	0,39
	LC_{95}	72	2,14	0,40
Fumigation	LC_{95}	24	130,72	70,94
	LC_{95}	48	92,81	34,12
	LC_{95}	72	54,31	9,66
Seed dreassing	LC_{95}	24	254,62	350,83
	LC_{95}	48	143,29	116,14
	LC_{95}	72	30,50	13,65

Note: HAT = Hours After Treatment

J. curcas extract contains secondary metabolite compounds including curcin, lectin, phorbol ester, esterase, and lipase (Asmanizar *et al*., 2020). Phorbol ester and curcin are the main chemical compounds found in *J. curcas* which work as contact poison, stomach poison, and nerve poison (Banjarnahor *et al*., 2016). The mechanism of the chemical content enters the digestive tract of pests and interferes with metabolic processes in the body of pests. So that the pests experience paralysis, no appetite, and eventually die.

The highest LC_{50} and LC_{95} values in the *C. nardus* extract applied with the contact method were observed at 72 HAT of 0.17% and 0.40%, fumigation of 0.92% and 9.66%, seed dreassing of 0.61 and 13.65%. Based on

the LC values, it shows that insecticides from *C. nardus* extract which were applied by the contact method had a higher toxicity effect than other methods. In addition, the toxicity test of the *C. nardus* extract applied by contact method was more toxic than the *J. curcas* extract because the LC_{50} and LC_{95} of the *C. nardus* extract were smaller than that of the *J. curcas* extract. *C. nardus* extract had the ability to kill *Crocidolomia pavonana* larvae (kontambunan, Salaki, & Tarore, 2019) [12]. In addition, *C. nardus* can control plant lice, insects *(Sitophilus sp, Callosobruchus sp.)* and nematodes (fahrudin, 2018) [13]. *C. nardus* oil has an LC_{50} of 0.36% against *Mizus persicae* (Maryani, Dono, & Yulia, 2019) .

Citronella is the most abundant chemical in *C. nardus* (kontambunan, Salaki, & Tarore, 2019). Insecticides containing citronella as an active ingredient are classed as contact poisons and stomach poisons (Una & Wahyuni, 2019) [14]. Insecticides classed as contact poisons enter the target insect's body through the cuticle, trachea, sensory glands, and other organs linked to the cuticle. Citronella acts by inhibiting the enzyme acetyl cholinesterase, causing the amino acid serine in the enzyme's asteratic core to be phosphorylated. The accumulation of acetylcholine causes poisoning symptoms, which include motor nervous system abnormalities, convulsions, and respiratory paralysis, all of which lead to death (Kamelia *et al.,* 2020).

Conclusion

The insecticide toxicity of *J. curcas* and *C. Nardus* extracts to the imago of *C. chinensis* which was applied by the contact method was more toxic than the extracts which were applied by the fumigation and seed dreassing methods. The highest LC_{50} and LC_{95} values for the *C. nardus* extract applied with the contact method were observed at 72 HAT, namely 0.17% and 0.40% more toxic than the *J. curcas* extract, which were 0.21% and 2.14%.

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