Effectiveness of Papaya Seed Extract (*Carica papaya*) on The Antifeedant Activity of Growth-Inhibiting Factors in Armyworms (*Spodoptera litura*)

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Abstract. A study was conducted to analyze the antifeedant activity and the inhibitory effects on the growth of third-instar armyworms, as well as the duration of the transition from larvae to pupae. The experiment was carried out in the Zoology Laboratory, Department of Biology, FMIPA UNG, from June to October 2021, using a completely randomized design. A total of 552 third-instar armyworm larvae were used as samples. Five different treatments were employed in this study, Treatment A (Aquadest Control), Treatment B (CMC Control), Treatment C (Papaya seed extract 245 ppm), Treatment D (Papaya seed extract 489 ppm), and Treatment E (Papaya seed extract 734 ppm). Statistical analysis was performed using analysis of variance (ANOVA), followed by a Duncan test to determine significant differences between treatments. The results of the antifeedant activity analysis showed a significance value (*Sig.*) of 0.000, which is less than $\alpha = 0.05$. This indicates that papaya seed extract inhibits the feeding activity of third-instar armyworms. An increase in the extract dose resulted in higher antifeedant activity against third-instar armyworms. Analysis of the duration of the transition from larvae to pupae showed a significance value (*Sig.*) of 0.000, which is also less than 0.05. This suggests that the administration of the extract affects the time required for larvae to develop into pupae. As the dose increased, the duration of larval transformation into pupae also increased. The findings suggest that papaya seed extract inhibits the growth of armyworm larvae over a longer period and exhibits antifeedant activity against third-instar armyworm larvae. This indicates that papaya seed extract functions as an antifeedant compound capable of inhibiting armyworm larvae growth, making it a potential botanical pesticide.

Keywords: papaya seed extract, antifeedant, armyworms

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1 Introduction

Insects are a type of animal belonging to the phylum Arthropods, which have a widespread habitat on this earth. Besides bringing benefits to humans, insects can also cause harm. One type of insect that is harmful is the armyworm (*Spodoptera litura*). Armyworms are detrimental because they are pests that damage cultivated plants. Armyworms are pests that often cause reduced productivity and reduced crop yields or crop failure in food crops. The existence of this pest is a problem in efforts to increase food products.

Many armyworms attack cultivated plants in the generative phase, namely by attacking the flowers and young pods, while in the vegetative phase they eat the young leaves of the plant so that only the leaves remain. Plants commonly attacked by armyworm pests are corn, tomatoes, chilies, kale, cabbage, eggplant, spinach, soybeans and mustard greens. Armyworms can also attack plantation crops such as sugar cane and tobacco. Attacks from armyworm pests are able to eat up all the leaves and only leave the bones of the leaves. This can reduce plant productivity and even result in crop failure.

One of the efforts made by farmers to control armyworms that attack plants is by using synthetic insecticides. Synthetic insecticides are insecticides made from synthetic chemicals. The use of synthetic chemical-based insecticides can cause quite serious negative impacts. Synthetic insecticides have a negative impact on other ecosystems. The use of synthetic insecticides often has ecological impacts. This happens because synthetic insecticides can cause residual effects and result in pollution of soil, water and air. Apart from that, it can also cause pest resurgence, secondary pest outbreak. Excessive use of synthetic insecticides without appropriate dosages can contaminate crops which, if consumed by humans over a long period of time, can be carcinogenic and can even cause death [1]. Therefore, it is necessary to carry out efforts to control armyworm pests that are environmentally friendly [2]. Pracaya [3] reported that there are various types of plants that are known to contain botanical pesticides that can be used in pest control, namely, neem, papaya, duku, durian, tobacco, castor oil, cloves, garlic, starfruit, brotowali.

Papaya plants, leaves and seeds can be used as a vegetable insecticide. Erdi [4] reported that papaya (*Carica papaya*) leaf extract positively contained terpenoid alkaloid compounds, flavonoids and amino acids which were very toxic to plant-eating insects. Apart from that, Irvan [5] reported on the toxicity test of the crown of god flower extract (*Phaleria papuena*) which functions as a natural insecticide against armyworms (*Spodoptera litura*).

The papaya seed part has a bitter, spicy taste and a strong aroma, making papaya seeds less desirable as a food ingredient. This is based on previous research conducted by Nafi'ah [6] regarding the use of papaya seed extract (*Carica papaya* L) as a vegetable larvicide against the death of third instar Anopheles and *Aedes aegypti* mosquito larvae. According to research conducted by Utomo [7], papaya seeds contain carpain alkaloids which are toxic to larvae. If used in large quantities, they can cause nerve paralysis, stoppage of the nervous system, and cardiac arrest and can cause death of the larvae. The use of plant-based

insecticides is highly recommended to replace the role of synthetic insecticides. Botanical insecticides are insecticides whose basic ingredients come from plants or natural ingredients. The papaya plant (*Carica papaya*) has the potential as a vegetable insecticide because it contains alkaloids, terpenoids and flavonoids which are very toxic to insects [8].

The prospects for vegetable insecticides, especially papaya seeds, are quite promising considering the increasing public interest in organic agricultural products. Until now there have been no reports revealing the use of papaya seed extract to reduce the population of armyworm pests (*Spodoptera litura*). Therefore, researchers are interested in conducting research on the toxicity test of papaya seed extract vegetable insecticides against armyworms. Besides that, papaya seeds are still considered waste by the community and have not been used optimally.

2 Method

2.1 Time and Place of Research

This research was carried out at the Zoology Laboratory, Biology Department, Mathematics and Natural Science Faculty, Universitas Negeri Gorontalo from July to October 2021.

2.2 Tools and Materials

This research is a laboratory experimental study with a completely randomized design. The research object was third instar armyworm larvae. The equipment used is a rotary evaporator, blender, measuring cup, petridish dish, beaker, glass funnel, aluminum foil, handsprayer. The materials used were papaya seeds, 96% ethanol, 170 third instar armyworm larvae, gauze, filter paper, label paper.

2.3 Procedures

Making papaya seed extract Papaya seeds are washed and cleaned then dried in the air until the water content is reduced and the scales remain. The dried papaya seeds were ground using a blender and weighed 1000 grams. Then the finely ground papaya seeds are extracted according to the Harborne method [9]. The extract was made in 3 concentrations, namely 245 ppm, 489 ppm and 734 ppm.

Testing papaya seed extract on the antifeedant activity of armyworm larvae The application of antifeedant biotest pesticides on armyworms was carried out on test leaves (cabbage leaves) which had been applied with papaya seed extract according to the treatment. How to apply the extract using a brush, smear it on the back of the test leaf on the left half, while the control solvent on the right half, then dry. The test leaves were then placed in a petri dish that

had been lined with gauze. Into each petri dish, 3-5 *Spodoptera litura* larvae were inserted which had been fasted for 4 hours. Observations were made after 24 hours of application. The calculation is done by taking the test leaves and then calculating the area of the leaves consumed by the test animals. The way to calculate the area of a leaf is to make a transparent plastic circle with a diameter of 3.5 cm and divide it into small squares measuring 0.2 cm.

Testing Papaya Seed Extract to inhibit larval growth To observe larval growth inhibition, use the same dose as testing antifeedant activity. III instar armyworm test animals were placed in a glass container or glass covered with gauze, and filled with cabbage leaves. Each container contains one caterpillar. Each treatment with 10 repetitions. Observations of changes occurring in armyworms were carried out every 12 hours.

2.4 Data Analysis

Data analysis of antifeedant activity and the time required for the change from larva to pupa using ANOVA (Analysis of Variance). Further tests used the Duncan test, to determine the differences between treatments.

3 Result and Discussion

3.1 Analysis of The Antifeedant Activity of Papaya Seed Extract on III Instar Armyworms

The results showed that the antifeedant activity of papaya seed extract on third instar armyworms increased along with increasing concentration of papaya seed extract. The results of the statistical test using ANOVA, obtained a significance value (*Sig.*) of 0.00 which is less than $\alpha = 0.05$, so it can be concluded that there is an influence of papaya seed extract on the antifeedant activity of third instar armyworms. Next, to see the differences between treatments, the Duncan test was carried out. Duncan's test results can be seen in Table 1.

Table 1. Average Antifeedant Activity of Papaya Seed Extract on III Instar Armyworms

Symbol of Experiment	Mean Antifeedant Activity (%)
A	5.71 a
B	6.63 a
C	15.86 b
D	23.35 c
E	45.55 d

From Table 1, Treatment A served as the control group, using only distilled water (Aquades). Treatment B was another control group using Carboxymethyl

Cellulose (CMC). Treatment C involved the administration of papaya seed extract at a concentration of 245 ppm, while Treatment D used a higher concentration of 489 ppm. Lastly, Treatment E applied the highest concentration of papaya seed extract at 734 ppm. These treatments were designed to assess the antifeedant activity and growth inhibition effects of papaya seed extract on the larvae.

The observation results showed that the best concentration that could increase the antifeedant activity of armyworms was at a concentration of 734 ppm, with the highest percentage of leaf area due to antifeedant activity, namely 45.55%. The antifeedant activity is thought to be due to secondary metabolites as toxic compounds contained in papaya seed extract. The results of chemical content analysis show that papaya seed extract contains secondary metabolite compounds, flavonoids and terpenoids. From observations, antifeedant activity was also shown by the caterpillars avoiding leaves that had been smeared with papaya seed extract and remaining silent on the edge of the gauze.

In this observation, armyworm larvae given papaya seed extract showed symptoms of stopping eating. Papaya seed extract contains flavonoids. Flavonoids can reduce appetite, so that nutritional needs cannot be met, which can result in death of the larvae [10].

3.2 Analysis of The Effect of Papaya Seed Extract on The Duration of Transformation of Third Instar Armyworm Larvae into Pupae

The effect of papaya seed extract on inhibiting larval growth with indicators of the duration of the change from caterpillar to pupa phase is shown in Figure 1.

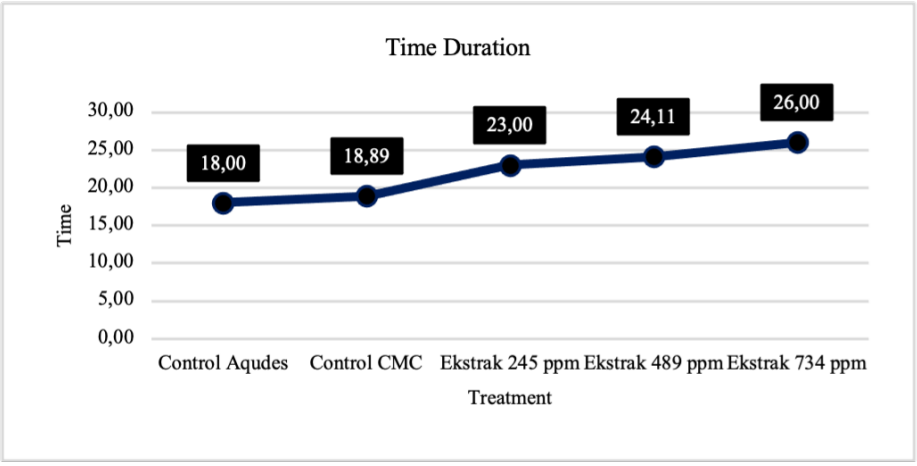

Fig. 1. Average Duration of Time for The Third Instar Armyworm to Change into A Pupa

The data in Figure 1 shows that papaya seed extract increases the time duration for larvae to change into pupae. This indicates that there is an obstacle to the growth of larvae into pupae due to the compound content in papaya seed extract. This is in line with research by Tika, reporting that the use of papaya seed extract (*Carica papaya*) has the potential as a biolarvicide because it contains secondary metabolic compounds in the form of alkaloids, saponins, flavonoids and tannins which can inhibit and kill Culex sp larvae.

Secondary metabolic compounds, especially saponins, can inhibit larval growth. The saponin content in papaya seeds works as a stomach poisoning (stomach poisoning) where the substance enters the larva's body through the digestive system (mouth) and then poisons the larvae. Apart from that, saponin is very influential as a contact poison which can be seen in the physical disturbance of the outer part (cuticle) of the larvae, namely washing away the wax layer that protects the body parts of the larvae, thus disrupting the growth of the larvae into pupae [11].

4 Conclusion

There is an effect of papaya seed extract (*Carica papaya*) on the antifeedant activity of third instar Armyworm (*Spodoptera litura*). The higher the dose of papaya seed extract (*Carica papaya*), the higher the antifeedant activity of Armyworm (*Spodoptera litura*) instar III. The time required for the larvae to change into pupae was longer in the treatment given papaya seed extract compared to the group not given papaya seed extract.

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