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Effectiveness of Majapahit Leaf Extract (*Crescentia cujete* L.) as a Natural Pesticide for Banana Leaf Roller Caterpillar (*Erionota thrax* L).

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ABSTRACT

This study aims to determine the effectiveness of Majapahit leaf extract (*Crescentia cujete* L.) on the feeding activity and mortality of the banana leaf roller caterpillar (*Erionota thrax* L.), and also the optimal concentration that affects the feeding activity and mortality of the banana leaf roller caterpillar (*Erionota thrax* L.). This research is a completely randomized design (CRD) experiment with four treatments and 3 replicates. In thos study, 60 third instar larvae of *Erionota thrax* L. were taken using the transect method from several villages in Purworejo district, Central Java. The pesticide from Majapahit leaves was made through a simple extraction method with four concentrations: 0%, 25%, 30% and 35%. The results showed that Majapahit leaf extract had an effect on feeding activity and mortality of the banana leaf rolling caterpillar. The optimal concentration of Majapahit leaf extract that affects feeding activity and pest mortality was 35%.

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1. INTRODUCTION

Banana (Musa spp.) is one of the horticultural crops that are favored by the public because they are easy to cultivate and have abundant profits. It is known that in 2005 the production of bananas has exceeded 72.5 million tonnes and Indonesia is capable of producing 6.20% of the total production and 50% of banana production in Asia (Suyanti & Supriyadi, 2010). Cultivation of banana plants is often constrained by problems such as pests and plant diseases. One of the pests that usually attack banana plants is the banana leaf roller caterpillar (Erionota thrax L.). This pest attack banana leaves by eating the banana leaf tissue and slowly disrupt the photosynthesis of banana plants. This can cause banana plants to have problems in growth and development. Losses due to this pest were noted to cause a decrease in banana fruit production by 10-30% (Hasyim et al., 2013).

The banana leaf roller caterpillar (Erionata thrax L.) is one of the various types of pests that are often found on banana plants with a fairly high density during the rainy season (Hasyim et al., 2013). The larvae of the banana leaf roller caterpillar are light green and covered and have a white powdery coating with a body length of about 7 cm. The eggs are yellow and are on the lower edge of the banana leaf. The pupa of this pest has a brownish yellow color with a length of 6 cm, while the imago is a moth which has a brownish yellow wing color with a length of 5-6 cm (Satuhu & Supriyadi, 1999: Abidin, 2016).

The life cycle of leaf roller caterpillars ranges from 5 – 6 weeks starting from the butterflies sucking banana flowers and copulating in the evening and morning and laying eggs at night. Eggs

are laid in groups of about 25 on intact banana leaves. Young caterpillars have a greenish color and are without a wax coating, while caterpillars that are quite mature have a large body size, are white and have a wax coating. The pupa is inside a roll of greenish leaves and covered with wax. The pupa is about 6 cm long and has a proboscis (Arief, 1994).

One effort to control this pest is to use synthetic chemical pesticides. Synthetic chemical pesticides are chosen by farmers because they are fast and efficient. The use of various types of synthetic pesticides usually causes problems for the environment such as causing poisoning effects for humans, killing non-target organisms such as pest predators, secondary pest explosions, resistance to Plant Pest Organisms, and also soil, water and air pollution (Darwiati, 2009: Abidin, 2016).

Therefore it is necessary to develop control methods that are more effective and environmentally friendly. The advantages of biopesticides are that the production technology is easy and affordable so that it can be applied on a household production scale, does not have a negative impact on the environment or living things so it is relatively safe to use, low risk of poisoning in plants so that plants are healthier and safer for consumption, do not trigger side effects. resistance (immunity) to pests so that it is safe for the balance of the ecosystem and healthier agricultural products and free from chemical pesticide residues (Hidayanti & Ambarwati, 2016). One of them is by utilizing plants in the surrounding environment as biopesticides. The Majapahit plant (*Crescentia cujete* L.), which belongs to the Bignoniaceae family, has potential as a biopesticide because it contains secondary metabolites in the leaf organs such as tannins, phenols, saponins, alkaloids, flavanoids, anthraquinones and cardenolides (Ejelonu et al., 2011).

The Majapahit or Berenuk plant can grow up to 6-12 m in tropical climates. The flowers are yellow-green, cup-shaped, and emerge directly from the tree branches. This plant has leaves shaped like a spoon with a length of 5-18 cm and green. This plant also has large oval-shaped fruit that is brownish green in color with a diameter of 10-30 cm. The Majapahit plant has the same morphological characteristics as the plum tree in western India and Mexico (the calabash tree). This plant is also a perennial that is spread throughout the lowlands of Mesoamerica, Savannah and semi tropical rain (Islam et al., 2019). The content of secondary metabolites in the Majapahit leaf extract plays a role in reducing feeding activity. Chalista (2010) explained that the activity of the pests decreased or stopped due to the entry of certain chemical compounds that are capable of stimulates the insect nervous system. These compounds can damage certain tissues such as damage to the digestive organs.

Disruption of the pest's digestive system will cause the target pest to slowly be reluctant to eat and cause death (mortality) (Yunita et al., 2009) which explains that the higher the concentration of the biopesticide used, the content of secondary metabolites can cause lower number of pest feeding and also has higher repellent and biotoxin properties. It has also been found that Majapahit leaf extract was toxic to Grayak larvae (Spodoptera litura) instar II and LC 50 from this experiment, a concentration of 38.13% within 2 days (48 hours) (Fiskasari, 2014). In other research, it is known that Majapahit leaf extract has the potential as an anti-termite drug. The only fraction of Majapahit leaves that is most effective and efficient as a natural termite repellent is the chloroform fraction with a mortality rate of 96% in the concentration range of 2-10% (Nurhasanah, et al., 2014).

Based on Table 5, it is known that secondary metabolites play a role in reducing the percentage of feeding activity, including tannins as stomach poisons which reduce the ability to digest food in insect pests by reducing the activity of digestive enzymes. Terpenoid compounds have characteristics as antifeedants or food repellents. This is because it gives rise to a pungent odor that sticks to the banana leaf sheet, thereby reducing the appetite of the larvae and lack of nutrition which results in the larvae not being able to recognize their food source, slowly causing mortality in the larvae. Terpenoids have a chelating taste and are useful as antifeedants for insects. Antifeedant is a behavior modifying substance that can prevent feeding activity through direct action on the peripheral sensilla (taste organ) of insects (Fiskasari, 2014).

The inclusion of the active ingredients of tannins and terpenoids results in disruption of the secretion of digestive enzymes and trigger disruption of digestive metabolism. Alkaloids that enter the insect's body will interfere digestion organs and taste receptors in the insect's mouth (Javandira, et al., 2016). Alkaloids together with amino acids that contain many carboxyl and hydroxyl groups form strong complex bonds in proteins and other macromolecules. They create a very bitter taste

and is disliked by plant pests in the form of insects (Rismayani, 2013). Saponins can cause the working system of digestive enzymes and food absorption to decrease, this is triggered by an interaction between saponins and mucous cell membranes, this interaction can cause membrane permeability to change due to loss of enzyme binding activity on the membrane (Kurniawan et al., 2013: Fiskasari, 2019).

This study aims to determine the effectiveness of Majapahit leaf extract (*Crescentia cujete* L.) on feeding activity and mortality of banana leaf roller caterpillar (*Erionota thrax* L.), as well as the effective concentration which affect feeding activity and mortality of banana leaf roller caterpillar. This research is expected to be a useful study on Majapahit leaf extract as a biopesticide for banana leaf roller caterpillar pests.

2. RESEARCH METHOD

2.1. Types of research

This research is an in vitro experimental research using a quantitative approach to find out percentage of feeding activity and mortality of pest samples.

2.2. Time and Place of Research

This research was undertaken in March 2021- May 2021, in the Biology Laboratory of FMIPA UNY, Karang Malang, Caturtunggal, Depok, Sleman, Special Region of Yogyakarta.

2.3. Object of research

The research object was 60 third instar larvae of *Erionota thrax* L. which were taken using the transect method from several villages in Purworejo Regency, Central Java, namely Rowobayem, Winong and Pituruh Villages. Sampling used the transect method by making a 150 m long transect line at the edge of the rice fields. Along the transect line, 6 sample points were determined with a distance of 25 meters between sample points with 10 samples of banana leaf roller caterpillars per point (Yudi et al., 2016).

The characteristics of the sample to be taken were healthy caterpillars that are old enough to have a large body size with a length of 5-7 cm, are white and have a waxy layer (cuticle). The banana leaf roller caterpillar (*Erionota thrax* L.) was acclimatized for 3-5 days and fed with banana leaves by taking the caterpillar along with the banana leaf roll, the sample was then put in a jar and covered with furing cloth and tied with rubber.

2.4. Procedure

This research consists of two stages, namely the preliminary test and the main experiment. Preliminary tests were carried out to find specific concentrations of Majapahit leaf extract which have the most potential as biopesticide. Based on the results of the preliminary test, the concentration of the Majapahit leaf extract to be tested can be determined.

This research consisted of several stages: providing banana leaf roller caterpillar pests, preparing stock solution of Majapahit leaf extract, preparing several concentrations of Majapahit leaf extract, treatment application and data analysis. In the first stage, 60 samples of third instar larvae were supplied by the banana leaf rolling caterpillar using transects from several villages in Purworejo district, Central Java, such as Rowobayem, Winong and Pituruh villages. The banana leaf roller caterpillar then acclimatizes for 3-5 days. The second step is to prepare a stock solution of Majapahit leaf extract using a simple extraction method. The manufacturing procedure starts with the Majapahit leaves being cut into smaller pieces. Samples of 100 grams were taken, then added with 200 ml of water. The leaves were then grounded using a mortar and pestle. The grinded leaves were filtered and 1 ml of 90% alcohol was added to obtain 50% Majapahit leaf extract. The mixture was then squeezed and filtered using a filter, and left for 24 hours. The filtered mixture was used as a stock solution for Majapahit leaf extract (Mesa, 2017). The third stage is making different concentrations of Majapahit leaf extract. At this stage, various concentrations of Majapahit leaf extract were made with reference to the dilution method as follows (Safirah, 2016):

$$V1/K1=V2/K2$$

Information:
K1 : Concentration of Majapahit leaf starter.
K2 : Desired treatment concentration.
V1 : Volume of water to grind the leaves.
V2 : The volume of the mixture you are looking for.

The concentrations used in the preliminary test research were 0% (control), 10%, 20% and 30%. For the main treatment, the concentration used was based on the concentration that has the most effective percentage of feeding activity and mortality from the preliminary test.

Based on the preliminary test results, it is known that the most effective concentration of biopesticides for feeding activity and mortality of the banana leaf roller caterpillar was 30% with a percentage of feeding activity of 18.66% and a mortality percentage of 80%. So for the actual test, concentrations below 30% and above 30% were used (Mesa, 2017). Therefore we used the concentration: 0% (control), 25%, 30% and 35% of Majapahit leaf extract to be applied to pest samples.

The fourth stage was the application of the treatment by spraying handsprayer with Majapahit leaf extract onto pest samples and banana leaf sheets which had previously been weighed and cut into rectangles with a length of 10 cm and a width of 8 cm. The time of application of the biopesticide was done once during the day at 12.00-13.00 WIB. The banana leaf roller caterpillars were then put into a see-through jar along with the banana leaf sheet which has previously been sprayed with biopesticides according to the concentration treatment. Then the jar was closed using a furing cloth and given a label.

The fifth stage is the observation of percentage of feeding activity and pest mortality. Caterpillar feeding activity was calculated using the leaf weight parameter. The percentage of leaf weight consumed by banana leaf roller caterpillars in the study was calculated using the formula (Dono et al, 2010):

$$AM = BDM/BDT \times 100\%$$

Information :
AM : Feeding activity
BDM : weight of leaves eaten.
BDT : total leaf weight.

Observations and data collection were carried out every 24 hours for 3 days, namely at 0 hours, 24 hours, 48 hours and 72 hours after the application of the pesticide by weighing the leaves and calculating the percentage of feeding activity according to the formula above.

The percentage of mortality can be calculated using the following formula (Christiyanto, 2013):

$$P = X/Y \; x \; 100\ \%$$

Information :
P : percentage of deaths.
X : the number of dead pests.
Y : number of pests tested.

Observation and collection of mortality data were carried out at 24 hours, 48 hours and 72 hours after application based on the number of dead pest samples in each concentration treatment and the petridish replicates (Rizal et al., 2011).

The experimental research design used was completely randomized design (CRD) consisting of 4 concentration treatments with 3 petridish replicates for each treatment and each petridish replicate was filled with 5 samples of third instar larvae of banana leaf roller caterpillars.

2.5. Data analysis

To determine the effect of treatment on the observed parameters, the research data were calculated using one way ANOVA statistical analysis with a confidence level of 95%. Post hoc analysis was carried out using the Duncan Multiple Range Test to compare the most effective treatment between each treatment.

3. RESULTS AND DISCUSSION

3.1. Effectiveness of Majapahit Leaf Extract on Feeding Activity of Banana Leaf Roller Caterpillar

Based on Table 1, the most effective dosage/concentration of biopesticides from Majapahit leaf extract is 35% which can reduce the percentage of feeding activity up to 20.05%. In the control treatment (0%) the percentage of feeding activity was 63.13%, with the concentration of 25% ,the percentage of feeding activity was 32.78% and at concentration of 30%, the percentage of feeding activity was 26.47%.

Table 1. Feeding Activity of Banana Leaf Roller Caterpillar Pests

Treatment	Percentage of feeding activity of banana leaf roller caterpillars
K_0%	63.13%
K_25%	32.78%
K_30%	26.48%
K_35%	20.05%

Based on Table 2, the average percentage of feeding activity of banana leaf roller caterpillar pests in the third instar larvae phase is 26.33% with a standard deviation of 15.38%. This shows that any increase in the concentration of Majapahit leaf extract will cause a decrease in the feeding activity of banana leaf roller caterpillars in the third instar larvae phase.

Table 2. The average percentage of feeding activity of banana leaf roller caterpillars

Majapahit leaf extract concentration	Average Percentage of Feeding Activity ± SD
0% (Control)	44.95 ± 19.29
25%	25.27 ± 7.94
30%	19.63 ± 7.38
35%	15.46 ± 6.69
Total	26.33 ± 15.38

The one-way anova test is used to test a hypothesis whether two or more independent populations have the same average count or not. Therefore this statistical method includes multivariate analysis but is limited to testing one factor (Naseh, 1995).

Based on Table 3, it is known that the p-value is 0.047 < α (0.05) so that it rejects Ho, which means that there is a significant difference in the average percentage of pest feeding activity according to the concentration of Majapahit leaf extract. Because based on the one-way ANOVA test, there is a significant effect of Majapahit leaf extract on pests, it is continued with the Duncan test.

Table 3. One-Way ANOVA Test on the Effectiveness of Concentration of Majapahit Leaf Extract on Feeding Activity of Banana Leaf Roller Caterpillar Pests.

Sum of Squares		df	Mean Square	F	Sig.
Between Groups	1532.439	3	510.813	3.828	047
Within Groups	1067594	8	133.449		
Total	2600033	11			

Table 4. Duncan's Test on the Effectiveness of Concentration of Majapahit Leaf Extract on Feeding Activities of Banana Leaf Roller Caterpillar Pests

	Treatment	N	Subset for α= 0.05	
			1	2
Duncan	K- 35%	3	15.45867	
	K-30%	3	19.63133	
	K-25%	3	25.26933	25.26933
	Control	3		44.94800
	Sig.		.348	.070

The results of the Duncan test showed that at a concentration of 35% it was most effective in reducing the feeding activity of banana leaf roller caterpillars compared to 30% and 25%.

Based on Figure 1, it is known that the higher the concentration of Majapahit leaf extract, the lower the percentage of feeding activity of the banana leaf roller caterpillar third instar larvae phase. From the graph it is known that the lowest percentage of feeding activity is at a concentration of 35% of 20.05%.

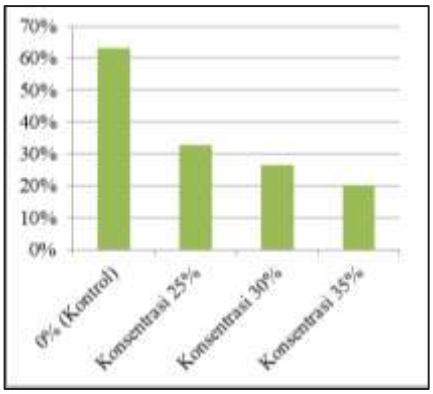

Figure 1. The percentage of feeding activity of banana leaf roller caterpillars.

Based on Figure 2, the results of feeding activity show that the test larvae slowly eat banana leaves. In the control treatment the larvae were very greedy and almost all the banana leaves were eaten. This is in contrast to the test larvae in the treatmenst of 25%, 30% and 35% concentrations of Majapahit leaf extract. In these three treatments it was seen that the test larvae were reluctant to eat banana leaves and preferred to stay in the banana leaf roll or stick to the wall of the jar.

Figure 2. Observation of the feeding activity of banana leaf roller caterpillars

Even though the third instar larvae phase eats more leaves than the previous instar phase, during this phase the banana leaf roller caterpillar larvae became feeding more actively because they require more energy in growth, movement and food reserves before entering the pupal phase (Mesa, 2017).

Majapahit leaf extract contains bioactive compounds (Table 5) that are antifeedant and repellent, thereby effective in reducing feeding activity and causing a lack of nutrients consumed by *Erionota thrax* L. larvae. Based on the results of other studies, it is known that these compounds are derived from plant secondary metabolites.

The absorption process of biopesticides which have a toxic effect on the stomach mostly takes place in the midgut. The middle digestive tract is the main insect digestive organ, because this

section of the digestive tract plays a role absorption of nutrients and secretion of digestive enzymes. This is supported by the middle digestive organ (midgut) which has a structure without a cuticle layer, while the front (famoregut) and final canal (hindgut) are covered with a cuticle layer (Sastrodiharjo, 1979: Fiskasari, 2019).

The feeding activity of pests also decreased or stopped due to the entry of certain chemical compounds such as plant secondary metabolites which are capable of stimulating chemoreceptors to then proceed to the insect nervous system. These compounds can damage certain tissues such as damage to the digestive organs (Chalista, 2010).

Based on this explanation, Majapahit leaf extract is effective against the feeding activity of the banana leaf rolling caterpillar. The active ingredients contained in Majapahit leaves interact with each other such as saponins, terpenoids, tannins, alkaloids and amino acids affecting the feeding activity of pest larvae. If this happens continuously, it will result in dead pest larvae lacking a source of nutrition.

3.2. The Effectiveness of Majapahit Leaf Extract on Mortality of Banana Leaf Roller Caterpillar

Based on Table 6 the results of observations of banana leaf roller caterpillar pest mortality in the third instar larval phase, it is known that the most effective concentration of biopesticides from Majapahit leaf extract is 35% with the highest percentage up to 86.67%. In the control treatment (0%) the percentage of mortality was 0%, the concentration of 25% the percentage of mortality was 53.33% and the concentration of 30% the percentage of mortality was 73.33%.

Table 6. Observation Results of Banana Leaf Roller Caterpillar Pest Mortality

Treatment	Percentage of Mortality of Banana Leaf Roller Caterpillars
K_0% (Control)	0%
K_25%	53.33%
K_30%	73.33%
K_35%	86.67%

Based on Table 7 it is known that average mortality percentage of third instar larvae of the banana leaf roller caterpillar pest is 34.44% with a standard deviation of 29.38%. This shows that any increase in the concentration of Majapahit leaf extract will cause mortality of the third instar larval stage of the banana leaf roller caterpillar pest.

Table 7. Average Percentage of Banana Leaf Roller Caterpillar Pest Mortality

Concentration of Majapahit Leaf Extract	Mean Mortality Percentage ± SD
0% (Control)	0.00 ± 0.00
25%	28.89 ± 23.41
30%	53.33 ± 20.00
35%	55.55 ± 27.76
Total	34.44 ± 29.38

Based on Table 8 it is known that the p-value is 0.036 <α (0.05) so that it rejects Ho, which means that there is a significant difference in the average percentage of pest mortality according to the concentration of Majapahit leaf extract. This shows that there is an effect of the concentration of Majapahit leaf extract on the mortality of banana leaf roller caterpillar larvae.

Table 8. One Way ANOVA Test Effectiveness of Concentration of Majapahit Leaf Extract on Mortality of Banana Leaf Roller Caterpillar Pests.

Sum of Squares		df	Mean Square	F	Sig.
Between Groups	6058985	3	2019.662	4,701	.036
Within Groups	3437007	8	429,626		
Total	9495993	11			

Table 9. Duncan Test on the Effectiveness of the Concentration of Majapahit Leaf Extract on Mortality of Banana Leaf Roller Caterpillar Pests

			***Subset for alpha*= 0.05**	
	Treatment	**N**	**1**	**2**
Duncana	Control	3	.0000	
	K-25%	3	28.8900	28.8900
	K-30%	3		53.3300
	K-35%	3		55.5567
	Sig.		.126	.169

The results of the Duncan test showed a significant difference in each concentration effect of Majapahit leaves (*Crescentia cujete* L.) showing that at a concentration of 35% it was most effective against the mortality of the banana leaf roller caterpillar pest.

Based on figure 3, it is known that the higher the concentration of Majapahit leaf extract, the higher the mortality percentage of the banana leaf roller caterpillar. From the graph it is known that the highest percentage of mortality is at a concentration of 35% of 86.67%.

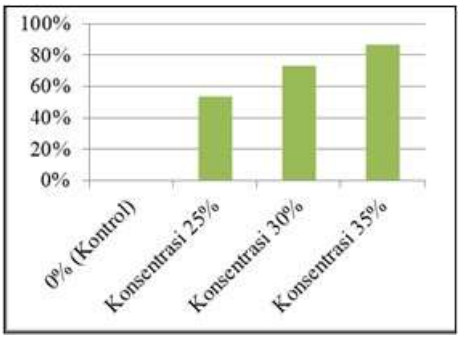

Figure 3. Mortality Percentage of Banana Leaf Roller Caterpillar

At 24-72 hours of observation, the mortality of the banana leaf roller caterpillar pest can be seen in Figure 4. It was found that most of the caterpillars at 24-72 hours were able to survive and entered the pupal phase with a mortality percentage of 0%.

Figure 4. Mortality of Banana Leaf Roller Caterpillars in the Control Treatment

Figure 5. Mortality of Banana Leaf Roller Caterpillars in 25% Majapahit Leaf Extract Concentration

Figure 5 shows one of the samples of banana leaf roller caterpillar pests with 25% of Majapahit leaf extract. It is known that at the 24-72 hour observation, some of the banana leaf caterpillars died and some started to enter the pupal phase.

Larvae that died due to the pesticide, showed black discoloration and hardening of the body, while the surviving larvae became slow and insensitive to touch. Symptoms of poisoning observed in the larvae are slow movement of the larvae, the body shrinks, the color of the body turns black and can cause death. At the end of the observation (72 hours) there were dead pupae with the characteristics of the pupa turning black.

Figure 6. Mortality of Banana Leaf Roller Caterpillars in 30% Majapahit Leaf Extract Concentrations

Figure 6 is one of the samples for observing the mortality of banana leaf roller caterpillar pests with 30% of Majapahit leaf extract. It is known that some of the banana leaf caterpillars died after 24-72 hours of observation and some started to enter the pupal phase. The dead larvae turn black and harden, while the surviving larvae become slow-moving and insensitive to touch. At 24-72 hours of observation, there were dead pupae with the characteristics of the pupa turning black.

Figure 7. Mortality of Banana Leaf Roller Caterpillars in the Treatment of 35% Majapahit Leaf Extract Concentrations

Figure 7 is one of the samples for observing the mortality of banana leaf roller caterpillar pests with a 35% concentration of Majapahit leaf extract. It is known that some of the banana leaf caterpillars were observed for 24-72 hours most died and some started to enter the pupal phase. The dead larvae change color to black and their bodies harden, while the surviving larvae become slow and insensitive to touch. At 24-72 hours of observation, there were dead pupae with the characteristics of the pupa turning black.

Gradually the larvae exposed to the pesticide begin to be reluctant to eat the banana leaf, the caterpillar's movement slows down and moves away from the banana leaf. Slowly the banana leaf roller caterpillar larva stops moving and die. There are banana leaf roller caterpillar larvae that die in the third instar larval phase but there are larvae that can survive to the pupal phase. Most of these pupae also died with the characteristic of not moving when touched and changing their color to blackish brown. Both dead larvae and pupae became soft and watery and emit a pungent odor.

The increase in mortality in this study is supported by the results of other studies. The average mortality of armyworms (*Spodoptera litura*) was known to increase in the average mortality

in each type of insecticide treatment, one of which was Majapahit fruit extract at various concentrations. This is related to the concentration used, the higher the concentration, the higher the increase in toxic effects (Safirah, 2016).

The percentage of larval mortality increased with the increase in concentration of the given Majapahit leaf extract. This is in accordance with the results of Fiskasari (2014) which states that the higher the concentration used as a treatment, the content of secondary metabolites in the extract becomes more so that the toxicity is higher which causes a higher percentage of larval mortality.

Secondary metabolites that play a role in increasing the percentage of mortality include flavanoids, terpenoids, saponins, tannins, alkaloids, phenols and the bioactive component isopropyl myristate.

Flavanoids have the effect of inhibiting larval growth, as well as affecting the performance of three main hormones in insects, namely brain hormones, ecdysone hormones and growth hormones which prevent larval movement and metamorphosis can be inhibited. Terpenoids also cause neurological disorders by inhibiting the performance of the cholinesterase enzyme, so that it can cause coordination of muscle work and decreased convulsions and death in larvae in the developmental phase towards imago (Kurniawan et al., 2013: Fiskasari, 2019).

Terpenoids are absorbed in the middle digestive tract which functions as a site for enzymatically destroying food. The entry of these compounds results in disruption of the secretion of digestive enzymes, with disruption of digestive enzymes, digestive metabolism will be disrupted. If this happens continuously, it will cause the larvae to die due to lack of nutrition (Jumar, 2000: Fiskasari, 2019).

Saponin is a material that has characteristics similar to detergents because it has the ability to damage the larval body membrane. Detergent ingredients can increase the penetration of toxic compounds because they easily dissolve lipophilic materials with water. Saponins not only interfere with the epicuticular layer but can interfere with the endocuticular protein layer so that toxic compounds have the opportunity to enter the larval body (Yunita et al., 2009: Fiskasari, 2019).

Saponins are able to inhibit the activity of proteolytic enzymes, causing a decrease in the activity of digestive enzymes and protein utilization (Suparjo, 2008). Changes in the color of the larvae's body from brown to black like burns are caused by highly toxic phenolic compounds (Cania, 2013). Phenol is a compound that has a very pungent aroma, can dissolve in water and other organic solvents and decomposes at high temperatures. Phenol enters the body of the larvae and triggers withering of the nerves (Dinata, 2008).

There is a bioactive component isopropyl myristate with a peak area of 95.97%. This bioactive component is colorless and odorless which has potential as a pesticide as explained in a study that a bioactive component with another name decamethylcyclopentasiloxane (IPM/D5) is able to kill head lice (*Pediculus humanus*) in less than 10 minutes. This is due to Isopropyl myristate causing disruption of the waxy coating that protects the flea's exoskeleton, triggering uncontrolled dehydration and death (Barnett, et al., 2012).

Based on the results, Majapahit leaf extract (*Crescentia cujete* L.) is effective against the mortality of the banana leaf roller caterpillar (*Erionota thrax* L.). The active ingredients contained in Majapahit leaves interact with each other such as flavanoids, terpenoids, saponins, tannins, alkaloids, phenols and the bioactive component isopropyl myristate. If this happens continuously it will result in the larvae dying due to deficiency. The higher the source of nutrition and the poison, the higher the percentage of larval mortality.

3.3. Optimal Dosage of Majapahit Leaf Extract which is Effective on Feeding Activity and Mortality of Banana Leaf Roller Caterpillar

Based on Table 10, it is known that the feeding activity of the third instar larvae of the banana leaf roller caterpillar pest after the application of pesticide from Majapahit leaf extract has the lowest percentage of feeding activity at a concentration of 35%, which is 20.05%. In the control treatment (0%) the percentage of feeding activity was 63.13%, the concentration of 25% the percentage of feeding activity was 32.78% and the concentration of 30% the percentage of feeding activity was 26.47%. From these results, the percentage of feeding activity of banana leaf roller caterpillar pests is getting lower.

Table 10. Optimal Concentrations of Majapahit Leaf Extract that are Effective on Feeding Activity and Mortality of Banana Leaf Roller Caterpillars

Treatment	Feeding activity Percentage	Mortality Percentage
K_0% (Control)	63.13%	0%
K_25%	32.78%	53.33%
K_30%	26.48%	73.33%
K_35%	20.05%	86.67%

It was found that the highest mortality percentage was at a concentration of 35% of 86.67%. In the control treatment (0%) the percentage of mortality was 0%, the concentration was 25% the percentage of mortality was 53.33% and concentration of 30% the percentage of mortality is 73.33%. From these results, the percentage of banana leaf roller caterpillar pest mortality is higher.

From the two results, the optimal concentration of Majapahit leaf extract that affects feeding activity and mortality of banana leaf roller caterpillars is a concentration of 35% Majapahit leaf extract. There is a relationship between the two research results, namely the lower the percentage of feeding activity, the higher the percentage of mortality, and vice versa. This can be seen from the percentage of mortality at a concentration of 35% which was 86.67% but the percentage of feeding activity was the lowest compared to other treatments, namely 20.05%. Yunita et al. (2009) explained that the higher the concentration used in the treatment, the higher the content of secondary metabolites, so it is suspected that the Majapahit leaf extract has antifeedant, repellent and biotoxin properties. Banana leaf roller caterpillars will die due to lack of nutrition. Therefore, efforts to reduce the level of disturbance from human activities in and around habitats, and encourage the use of environmental services that prioritize conservation. and sustainable must be continuously improved.

4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that Majapahit leaf extract (*Crescentia cujete* L.) has an effective effect on the feeding activity of the banana leaf rolling caterpillar pest (*Erionota thrax* L.). The Majapahit leaf extract effectively affects the mortality of banana leaf caterpillar pests and the optimal concentration of Majapahit leaf extract which affects feeding activity and mortality of banana leaf roller caterpillars is a concentration of 35%. For scientists, it is necessary to further test the effectiveness of Majapahit leaf extract (*Crescentia cujete* L.) as a biopesticide for other types of pests, directly to the community's agricultural land so that it is more applicable and requires specific phytochemical tests for secondary metabolites found in Majapahit leaves. For the community, it is hoped that farmers will start reducing the use of synthetic chemical pesticides and start switching to using more environmentally friendly biopesticides such as biopesticides from Majapahit leaf extract and in the future the community will be able to develop plant-based pesticides that have been researched so that they are not only environmentally friendly because they do not leave harmful chemical residues.

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