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CONTROL PEST OF LEAF CATERPILLARS (*Plutella xylostella*) IN DELIMA ROSE APPLES USING SOURSOP LEAF EXTRACT (*Annona muricata*)

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ABSTRACT

The increasing of pesticide use is in line with the increasing number of pest populations. However, the use of pesticides causes various negative impacts on the environment (soil, water, and air) such as pesticide-resistant pests, perishing of useful insects which are non-target pesticides, and the use of pesticide which can even lead to poisoning and death in humans. One of the environmentally-safe techniques to control pests is chemical, by the use soursop leaf extract. This study aims to determine the most effective concentration of soursop leaf extract (*Annona muricata*) in controlling leaf caterpillar (*Plutella xylostella*) in delima rose apples. The research was carried out in the plantation area of rose apples in tempuran village, Demak. The research method employed experimental research. The study was conducted using Completely Randomized Design. The data were obtained using probit analysis of LC_{50}. The most effective concentration of soursop extract (*Annona muricata*) on leaf caterpillars' mortality was 75 ppm. Soursop leaf extract (*Annona muricata*) has been proven to influence rose apples leaf caterpillars' mortality index. The LC_{50} value of soursop leaf extract was 75,16 mg/L. The result showed that soursop leaf extract (*Annona muricata*) is effective as a biopesticide material to control leaf caterpillar pest for delima rose apples.

Keywords: soursoap leaf extract, leaf caterpillar, delima apple rose

INTRODUCTION

The cultivation of rose apple plants was commonly developed by the people of Demak. Rose apple is one of the potential local fruit commodities. Rose apples that grow in Southeast Asia comes from the Java island and is known as 'Javanese Apple' (Morton, 1987, Zen-hong, et al. 2007) which is quite special because it has a big fruit shape and sweet taste (Morton, 1987; Hariyanto, 1991). The varieties of rose apple grown in Demak are delima and citra. Those varieties have been recognized nationally as the special and superior rose apples from Demak regency. Its attractive pink color, which indicates sweetness, as well as its own delicious aroma with a gentle tenderness of delima rose apples that always makes people addicted to eating it continuously. Delima rose apples are not as big as citra rose apples, but delima rose apple is more delicate, has a more distinctive aroma, and always causes a soft sensation when biting

However, due to the lack of serious handling from local government and fruit farmers, the products of delima rose apples experience a

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decreasing trend from year to year. The decline in the production of delima rose apples is likely due to the size of land, the amount of fertilizer, pests and working days. One of the most common causes of crop failure is pest attack. The main pests in the cultivation of rose apple plants are leaf roller (*Apoderus sp.*), leaf borer (*Acrocercopseugeniella*), white lice (*Pseudococcuscitrilus Cox*) and fruit fly (*Bractoceraalbistrigata*). Leaf caterpillar attacks the rose apple plants and it often decreases crop productivity. One of the preventions of pests is by using chemicals or synthetic pesticides. Pest control currently used by farmers still prioritizes chemical control with synthetic chemical pesticides both in dry and paddy fields periodically between 7 to 15 days depending on the condition of the attack. Initially, synthesis pesticides are considered to have several advantages. The use of synthetic pesticides has a negative impact on the environment even for its own users. Excessive use of chemical pesticides has a negative impact on the environment and people (Salaki et al., 2012; Li & Zhihui, 2008; Mamun & Ahmed, 2013).

Some of the negative impacts of pesticide use include pesticide-resistant pests, higher maintenance costs due to high prices of pesticides and excessive use which results in toxic to the environment, humans, and livestock (Khairil, 2017; Zarin et al, 2009; Bardin et al, 2008; Araar et al., 2009). One alternative in the prevention of pests that is safe for the environment and human can be done with biological control technique called biopesticide. The biopesticide is an integrated component of pest and disease control. In Indonesia, biopesticides are still less popular, the knowledge of biopesticides is equated with organic farming, whereas technology is widely available (Sumartini, 2017). Biopesticide by using soursop leaf extract (Annona muricata) is expected to eradicate pests in a safe and environmentally friendly way (Prado et al, 2014; Ribeiro et al, 2014). The content of plant compounds can show various kinds of biological activity in insects such as inhibition/rejection of food, spanking rejection activity, growth and development inhibitory activity, and death effect. Therefore, these biopesticides can be used to control plant pest organism (Hasnah, 2009).

The application of extracts to inhibit the growth of pests has also been done in previous research such as garlic plant extracts to cope with snail pests (Rusdy, 2010); papaya leaf extract to inhibit plant pests (Setyawati & Julaily., 2013), inhibit larvae of Plutella xylostella (Siahaya & Rumthe, 2014; Yuliani & Kuswanti, 2013); ethanol extract of melinjo leaves (Moniharapon & Moniharapon, 2014); dan jengkol rind extract (Ambarningrum et al., 2011).

The toxic properties of plant compounds on insects may be in the form of antifeedants, repellent, cause death, inhibit spawning, interfere with development and reproduction (Princess, 2014). Active chemical compounds in the form of acetogenin contained in the leaves and seeds of soursop can be used to control the trips attack, suppress the intensity of the attack of green ladybugs and reduce the population. Acetogenin is also insecticidal (anti-insect-worm) and antifeeding or lowering appetite (Maryani, 1995). Therefore, it is necessary to investigate the effectiveness of bioactive compounds from soursop leaf extract whether or not it is able to inhibit the development of caterpillar leaves on delima rose apples.

METHODS

This research was conducted in the biology laboratory of FMIPA UNNES and the plantation area of delima rose apple plants in Demak. The selected approach to achieve the research objectives was through experimental studies. This experimental study used an independent variable of dead leaf caterpillar (*Apoderus sp.*), and a dependent variable of soursop leaf extract with various concentrations. The data were obtained by determining the value of LC_{50} through Probit analysis technique to know if there is a mortality difference of each treatment and find out low, efficient and environmentally friendly soursop leaf concentration.

RESULTS AND DISCUSSION

Mortality is a major change observed in the toxicity test. Animal mortality data were required to determine the LD_{50} value. Observation on leaf caterpillar mortality was done in 24 hours with an interval of 8 hours. Test of leaf caterpillar mortality was performed on 5 treatment groups with 5 replications. Each treatment was given 100 leaf caterpillars. The dead leaf caterpillars were calculated to find out the average of leaf caterpillar mortality index (table 1).

Table 1. Average of Leaf Caterpillar Mortality Index

Treatment	Concentration Log	Repetition	Total of Caterpillar	Result of Caterpillar Mortality	Average of Caterpillar Mortality Index
P0	0	1	20	4	2,6
		2	20	1	
		3	20	3	
		4	20	3	
		5	20	2	
P1	1,40	1	20	10	13,2
		2	20	13	
		3	20	15	
		4	20	15	
		5	20	13	
P2	1,70	1	20	16	16,4
		2	20	17	
		3	20	16	
		4	20	17	
		5	20	16	
P3	1,88	1	20	17	18,6
		2	20	19	
		3	20	19	
		4	20	20	
		5	20	18	
P4	2,00	1	20	20	19,4
		2	20	20	
		3	20	19	
		4	20	20	
		5	20	18	

Information:
P0 = Negative Control (without treatament)
P1 = Soursop Leaf Extract of 25 ppm Concentration
P2 = Soursop Leaf Extract of 50 ppm Concentration
P3 = Soursop Leaf Extract of 75 ppm Concentration
P4 = Soursop Leaf Extract of 100 ppm Concentration

Based on table 1, it can be seen that caterpillar mortality is increasing as the concentration increases. The highest mortality at P4 treatment was followed by P3, P2, P1 and P0 treatment. At P1 treatment (soursop leaf extract of 25 ppm concentration), the average leaf caterpillar mortality index reached 13.2. At P2 treatment (soursop leaf extract of 50 ppm concentration), the average of caterpillar mortality index was 16.4. At P3 treatment (soursop leaf extract of 75 ppm concentration), the average of caterpillar mortality index was 18.6. While at P4 treatment (soursop leaf extract of 100 ppm concentration), the average of caterpillar mortality index was 19.4. This means that the higher concentration of soursop leaf extract, the higher the rate of pest's death. This is due to the fact that soursop leaf extract contains *annonaceous acetogenin* compounds that could cause various effects on the growth and development of insects, among others: (1) inhibiting the development of egg, larva or pupa; (2) blocking the skin-changing process during the larval stage; (3) disrupting to the mating process; (4) eating rejection in larvae and adults; (5) preventing laying eggs; (6) making barren insects; (7) poisoning larvae and mature insects. The utilization of soursop is effective, seen from the fact that the higher the dose of soursop leaf extract is used, the higher the rate of caterpillars' death. According to the average of leaf caterpillar mor-

tality index presented above, then the probit analysis could be done as a follow-up. Probit analysis result of soursop leaf extract on leaf caterpillar can be seen in table 2.

Table 2. Probit Analysis Result

Treatment	% Mortality	% Corrected Mortality	Average of Corrected Mortality	Probit Value
P0	20	0	0	0
	5	0		
	15	0		
	15	0		
	10	0		
P1	50	31,25	6,25	4,36
	65	60,61		
	75	61,86		
	75	61,86		
	65	56,12		
P2	80	33,33	6,67	5,41
	85	22,99		
	80	5,88		
	85	11,76		
	80	17,24		
P3	85	5,95	1,19	3,77
	95	12,05		
	95	17,86		
	100	18,07		
	90	11,90		
P4	100	18,07	3,61	5,33
	100	6,17		
	95	0,00		
	100	0,00		
	90	0,00		

The above table shows that the higher the concentration given to the leaf caterpillar, the higher the probit value. The probit value of each treatment can be used to determine the relationship between the caterpillar probit mortality and concentration log of soursop leaf extract as seen in figure 1.

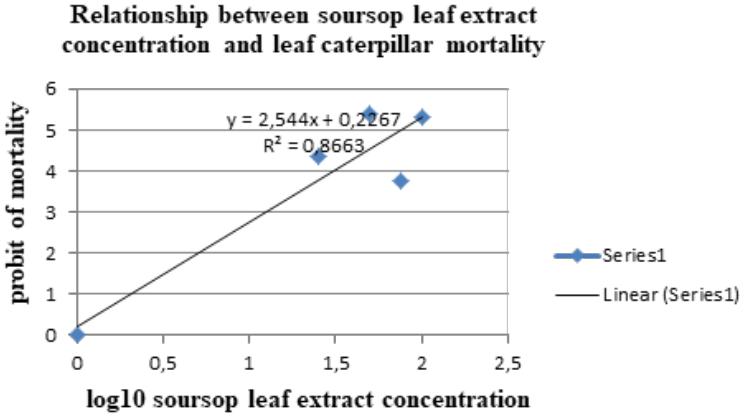

Figure 1. Relationship between Caterpillars' Probit Mortality and Concentration Log of Soursop Leaf Extract

The linear regression equation of Y = 2.544 X + 0.226 from figure 1 was employed to find the value of LC_{50}. The value of Y shows the probit value of death (mortality) of the caterpillar and X is the concentration log of soursop leaf extract. The results of the research obtained in table 2 then were tested statistically by ANOVA (Analysis of Variance) test which then continued with further Duncan test. The ANOVA test was used to find out the mean difference between two variation sources, namely the treatment group and the leaf caterpillar mortality group. The results of ANOVA test are as follows:

Table 3. Summary of ANOVA Result on Leaf Caterpillar Mortality

Variation source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	933.360	4	233.340	147.684	.000
Within Groups	31.600	20	1.580		
Total	964.960	24			

Information:
F Count <F 5% = Not significantly different (TN)
F 5% <F Count <F 1% = Real Different (*)
F Count> F 1% = Very Real Different (**)

The value of F Count was 147,684, bigger than F_{table} of 5% (2,87). Thus, it can be concluded that there was a very real difference between the treatments. After the ANOVA test was done, further Duncan test was carried out to compare the treatments. Since the dose groups had significant differences, these groups were tested using Duncan test. In addition, Duncan test aimed to know difference test of each treatment. To find out the treatments having the same effect, please see table 4 below.

Table 4. Leaf Caterpillar Mortality Result from Duncan test

Concentration	N	Subset for alpha = 0.05			
		1	2	3	4
0	5	2.6000			
25	5		13.2000		
50	5			16.4000	
75	5				18.6000
100	5				19.4000
Sig.		1.000	1.000	1.000	.326

Means for groups in homogeneous subsets are displayed.

According to table 4, it can be seen that P0, P1, P2, P3, and P4 treatment have significant differences among the treatment groups. This shows that there was an influence of soursop leaf extract (*Annona muricata*) to leaf caterpillar mortality index of delima rose apples.

The application of agricultural systems by combining the technology of biopesticide and biological fertilizers has the prospect of increasing land supporting capacity, optimizing the use of fertilizers and suppressing soil infectious diseases (Prabowo, 2008). The effect of soursop leaf extract has also been tested to overcome *Spodopteralitura* pests with low concentration (8%). The effectiveness test of soursop leaf extract (*Annona muricata*) on the mortality of leaf caterpillars in rose apples plants studied in this study was an initial effort to obtain environmentally friendly biopesticide to manage pathogenic disease in the field. Soursop leaf extract (*Annona muricata*) is known to have anti-insect properties and have toxicity. An examination of soursop leaf extract as biopesticide to mortality of peach leaf lice in chili plants has also been studied (Dwi, 2016);

caterpillars and grasshoppers in long bean plants (Khairil, 2017); the pest of the pearls in the rice plant (San, 2016); and the pest of soybean powder (Harinta et al., 2016).

Soursop leaf extract (*Annona muricata*) showed high activity effect of mortality. The value obtained was high enough for inhibiting mortality on leaf caterpillar pests, because soursop leaves have the toxic compounds. The bioactive compounds found in soursop are annonaceous acetogenin. These compounds are found in seeds, bark, fruit and soursop leaves. In soursop leaf, there have been found 18 types of acetogenin and they have been proven in vitro as cytotoxic. Biopesticide compounds are expected to have high activity against certain target organisms, in other words, they have a narrow spectrum. Oppositely, the natural predators are hopefully less affected. These compounds are toxic to pest organisms but they do not have any adverse environmental effects and are harmless to humans. Acetogenin compounds have the peculiarity of being contactual poison against pest organisms. Toxic compounds could kill pests quickly (Koleva et al, 2013; do Prado et al., 2014; Riberio et al, 2014; Souza et al., 2017). The chemical compounds in soursop leaves which have contractual poison properties are expected to prevent/control pest of leaf caterpillars in rose apple plants instead of using chemical compounds. The use of water as a solvent for extracting soursop leaves is very appropriate because water is easy to obtain and safe to use.

In the treatment of P1 (soursop leaf extract of 25 ppm concentration), the average of corrected mortality was 6.25. In P2 treatment (soursop leaf extract of 50 ppm concentration), the average of corrected mortality was 6.67. In P3 treatment (soursop leaf extract of 75 ppm concentration), the average of corrected mortality was 1.19. In P4 treatment (soursop leaf extract of 100 ppm concentration), the average of corrected mortality was 3.61. In P0 treatment (negative control), the average of corrected mortality was 0. It can determine the probit value of each treatment. Probit value was used to determine the value of LC_{50}. The calculation results obtained the LC_{50} value of 75.16 mg/L (75.16 ppm). The correlation between log concentration of soursop leaf extract and caterpillar mortality was shown at R^2 value of 0.866. The value of R^2 shows that the effect of soursop leaf extract was very significant to eradicate leaf caterpillars (pests) of delima rose apples. This is in line with the Meyer et al. (1982) who reported that an extract showed toxic activity if it could cause 50% of animals' mortality at a concentration of less than 1000 ppm. Based on the statement, the soursop leaf extract is declared toxic.

The results of the analysis of variance showed that among the treatment groups, the results appeared to be very various in terms of the mortality of the caterpillar. Therefore, it is necessary to conduct further Duncan test to know the difference between each treatment group. Given the soursop leaves extract of 75 ppm and 100 ppm concentration showed no significant difference, and given the soursop leaf extract of 25 ppm concentration was significantly different with the extract of 50 ppm concentration. Moreover, the soursop leaf extract at 50 ppm concentration was significantly different at 75 ppm and 100 ppm concentration. This evidence showed that the giving of soursop leaf extract of 75 ppm concentration is effective, efficient and cheap to eradicate caterpillars. Treatment of 0 ppm (without treatment) showed the lowest mortality index of caterpillar among all treatments. This indicated that without the addition of soursop leaf extract, leaf caterpillar of delima rose apples could not be eradicated.

CONCLUSION

Based on the research result of the effectiveness of soursop leaf extract (*Annona muricata*) on leaf caterpillar mortality index, it is concluded that:

1. The most effective concentration of soursop leaf extract (*Annona muricata*) in killing leaf caterpillar in delima rose apples is the extract of 100% concentration.
2. Soursop leaf extract (*Annona muricata*) has the effect on mortality index of leaf caterpillars in delima rose apples. The LC_{50} value of soursop leaf extract was 75,16mg / L.

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