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Bioactivity of Kipahit Flower Extract *Tithonia Diversifolia* on Mortality and Eating Behavior of Larvae *Crocidolomia Pavonana*

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Received December 14, 2023; revised March 04, 2024; accepted April 19, 2024

ABSTRACT

Using of synthetic insecticides to control the *C. pavonana* pest could have negative impacts. As an alternative control, using plant extracts is relatively safer in controlling these pests. This research aims to study the bioactivity flower of kipahit *T. diversifolia* extract on mortality and feeding behavior of C. pavonana larvae. Extraction was carried out using the maceration method using methanol. Testing of Insecticidal activity and feeding inhibition are conducted using the residue method on leaves (application method). Feeding on treated leaves was carried out for 48 hours. the antifeedant assayed for 24 hours of exposure to instar III. The concentration - mortality relationship was analyzed using probit analysis. Data on development time are expressed as the average value ± standard deviation. The results showed that the activity of kipahit flower extract had an LC_{50} of 0.51% and an LC_{95} of 3.86%. These extract with choice method at the sub lethal dose tested inhibit the feeding activity by 24.90%, 53.96%, 76.34% respectively, while the no choice method inhibits feeding activity by 27.20%, 59.69% 86.40%, respectively.

Keywords: *Tithonia diversifolia, Crocidolomia pavonana,* insecticidal activity, mortality, feending inhibity.

Aktivitas Ekstrak Bunga Kipahit *T. diversifolia* terhadap Mortalitas Dan Perilaku Makan Larva *C. pavonana*

ABSTRAK

Penggunaan insektisida sintetik yang dilakukan terus menerus dalam pengendalian hama C. pavonana dapat menimbulkan dampak negatif. Sebagai alternatif pengendalian, penggunaan insektisida nabati dengan memanfaatkan ekstrak tanaman relatif lebih aman dalam mengendalikan hama tersebut. Penelitian ini bertujuan untuk mempelajari bioaktivitas ekstrak bunga kipahit *T. diversifolia* terhadap mortalitas dan perilaku makan larva *C. pavonana*. Ekstraksi bahan tanaman dilakukan dengan metode maserasi menggunakan methanol. Pengujian Aktivitas Insektisida maupun pengujian aktivitas hambatan makan dilakukan menggunakan metode residu pada daun (metode Pengolesan). Pemberian pakan pada daun perlakuan dilakukan selama 48 jam. Sedangkan uji aktivitas hambatan makan lama pemaparan selama 24 jam terhadap instar III. Hubungan konsentrasi – mortalitas dianalisis menggunakan analisis probit. Data lama perkembangan dinyatakan sebagai nilai rata-rata ± simpangan baku. Hasil penelitian menunjukkan bahwa aktivitas ekstrak bunga kipahit memiliki nilai LC_{50} sebesar 0,51% dan LC_{95} sebesar 3,86%. Perlakuan ekstrak bunga kipahit pada metode pilihan pada dosis sub lethal yang diuji dapat menghambat aktivitas makan larva instar III berturut-turut sebesar 24,90%, 53,96%, 76,34%, sedangkan dengan metode tanpa pilihan menghambat aktivitas makan berturut-turut sebesar 27,20%, 59,69%, 86,40%.

Kata Kunci: *Tithonia diversifolia, Crocidolomia pavonana*, aktivitas insektisida, mortalitas, hambatan makan.

INTRODUCTION

Crocidolomia pavonana (Lepidoptera: Pyralidae) is one of the important pests that attacks cabbage plants. *C. pavonana* attacks at the larval stage by damaging cabbage plants by eating new leaves at the growing point of cabbage plants so that the plants cannot form crops (Sastrosiswojo and Setiawati, 1993). As reported by Uhan (1993), *C. pavonana* attacks can cause cabbage yield losses of up to 65.8%. According to Sastrosiswojo (1995), cabbage yield losses due to *C. pavonana* attacks, if not controlled, can reach 100%.

Control carried out by farmers generally still uses synthetic insecticides. However, its use can cause many losses. Frequent and continuous use of synthetic insecticides can cause negative impacts such as pest resistance, pest resurgence, environmental pollution and residual residues in agricultural products that are dangerous for consumers. Therefore, it is necessary to have alternative control measures that are safe for the environment and non-target organisms, as well as reducing the use of synthetic pesticides. One way is to

use plant extracts as vegetable insecticides. (Dadang & Prijono, 2008).

One of the plant families that has activity as a botanical insecticide is *Tithonia diversifolia* which is a member of the Asteraceae family which contains flavonoid, alkaloid and tannin compounds (Sapoetro, 2019). The results of research conducted by (Susanti *et al.*, 2015) show that *T. diversifolia* leaf extract has the ability to act as an antifeedant and anti-oviposition against whitefly pests.

Research on the activity of *T. diversifolia* kipahit flower extract on *C. pavonana* has been previously studied by (Tuti & Ratna, 2019), however there are differences between this research and research by (Tuti & Ratna, 2019) where in the testing (Tuti & Ratna, 2019) *T. diversifolia* flower extract was tested using *C. pavonana* instar I. The test method used leaf dipping method. The tests were carried out to see the insecticidal activity of single plant extracts, the insecticidal activity of mixed plant extracts to see (mortality) and also to see the inhibition of growth of *C. pavonana* larvae. Observations in the test were carried out for 144 hours (6 days). Meanwhile, in my research, this research used *T. diversifolia* kipahit flower extract which was tested using *C. pavonana* instar II in testing insecticidal activity, using *C. pavonana* instar III in testing eating inhibition activity. The test method uses the smearing method on the leaves. Tests were carried out to look at insecticidal activity (mortality), development time and feeding inhibition activity.

MATERIALS AND METHODS

Place and time of research

This research was conducted at the Pesticide Laboratory, Faculty of Agriculture, Tanjungpura University. The research was carried out from November 2022 to August 2023.

Planting and Maintenance Plants

Cabbage plants used for feed are planted in polybags. Cabbage seeds are sown in a nursery containing soil and manure mixed evenly in a ratio of 2:1. After 3 weeks of age, the seeds are planted in polybags containing a mixture of soil and fertilizer in a ratio of 2:1. Additional fertilization is carried out when the cabbage is 3-4 weeks old by applying 1 g of NPK fertilizer/plant. Plant care includes watering twice a day, weeding and mechanical pest control. After the plants are 2 months old, the plant leaves are used as test leaves and also as food for test larvae. The stages of procedures for planting and maintaining food plants are carried out as described in the research method (Firmansyah & Anwar, 2017).

Test Larvae

The larvae used as test larvae were *C. pavonana* larvae instar II to test insecticidal activity and instar III to test feeding inhibition activity. The larvae were obtained from the planting fields of cabbage farmers in Bogor and then reproduced in the Pesticide Laboratory, Faculty of Agriculture, Untan. During rearing, larvae were fed pesticide-free cabbage leaves in a plastic box with a screen window on top. cabbage is given every day while cleaning the container from old food residues. At the pupa stage, the larvae are placed in a plastic box filled with sterile sand to serve as a cocoon. When all the larvae have become pupae, the cocoon containing the pupae is moved into a plastic mesh box, the imago is given a 10% honey solution soaked in cotton wool and then hung in the middle of the cage with a rope. When the imago is about to lay eggs, a cabbage leaf is placed at the bottom of the cage which will be used as a place to lay the imago's eggs. The second instar larvae are used for insecticidal activity and the third instar larvae are used to test feeding inhibition activity and the rest are used for many further things. The stages of maintenance and propagation procedures for the test insects were carried out as described in the research method (Firmansyah & Anwar, 2017).

Test Extract

The test plants tested in this test were kipahit flowers originating from Porsea City, Toba Regency, North Sumatra. The flower of *T. diversifolia* that will be processed into extracts are selected from good and healthy kipahit plants. After the kipahit flowers are dried, they are ground with a blender until the result is powder. The resulting powder was sieved using a 1 mm sieve. To dissolve the active compounds found in kipahit plants, methanol is used as a solvent using the maceration (soaking) method. After the kipahit flowers have become powder, then soak them in methanol solvent for 3 x 24 hours. The ratio of soaking flower powder with methanol is until all the flower powder is completely submerged in methanol. After completing the soaking, continue by filtering the soaked kipahit flowers using a funnel lined with filter paper. The filter results were evaporated using a rotary vacuum evaporator at a temperature of 50°C at a pressure of 400-450 mmHg. The result of evaporation is a thick, dark black extract. The resulting extract is stored in a refrigerator at ±4°C until it is time to use. The stages of the kipahit flower extraction procedure were carried out as described in the research method (Firmansyah & Anwar, 2017).

Preliminary Test

The preliminary test is a basic test which aims to determine the activeness of the components contained in kipahit flower extract. The kipahit flower extract tested in the preliminary test was 0.5%, 0.75%, 1%. The test uses the residue method on the leaves (smearing method). Each treatment was repeated 5 times. The test method is to cut the cabbage leaves into round discs with a diameter of 3 cm using an iron punch tool. Both sides of the leaf surface were smeared with 50 µl of the extract solution (each surface ± 25 µl) using a microsyringe. After the solvent had evaporated, the

treated leaves were placed in a petri dish (diameter 9 cm) which had been lined with tissue. In each petri dish, 20 second instar larvae were placed. Control larvae were only fed leaves treated with methanol. The treated leaves were given for 48 hours, the larvae were then fed fresh leaves without treatment until the end of the IV instar. Observations were made every day regarding the death of second instar larvae to fourth instar larvae. Mortality for each treatment was determined by comparing the number of larvae that died after being given the treatment with the number of larvae at the start of the treatment. Preliminary test results show mortality values of 41%, 57% and 68% respectively.

Insecticide Activity Test

Tests were carried out using 5 concentration levels determined based on preliminary tests. The concentration of the test material extract tested in the follow-up test was 0.25%, 0.5%, 1%, 1.25%, 1.5%. Work and observations in the follow-up test are carried out as in the preliminary test. Each concentration and control was repeated 5 times. Observations were made by looking at the mortality and development time of surviving larvae during testing from instar II to the end of instar IV. Mortality for each treatment was determined by comparing the number of larvae that died after being given the treatment with the number of larvae at the start of the treatment. The concentration - mortality relationship was analyzed using probit using SAS software. Data on development time are expressed as the average value ± standard deviation. The testing was carried out as explained in the research method (Syahputra & Prijono, 2011).

Feeding Inhibition Activity Test

The feeding inhibition activity assay was performed in a similar manner to the mortality assay. The concentrations used in the test were obtained from the results of probit analysis, namely 0.155%, 0.44%, 1.25% which are the same as LC_{25}, LC_{50} and LC_{75}. Testing is carried out using choice and no-choice methods. In the preferred method, four round cabbage leaves with a diameter of 3 cm (including 2 treatment leaves and 2 control leaves) are placed alternately in a 9 cm diameter petri dish lined with tissue. In the no-choice method, two treatment leaves and two control leaves were placed in separate petri dishes. In each petri dish, 10 instar III *C. pavonana* larvae were placed. Each treatment was repeated 5 times. Extract and control leaf treatments were given for 24 hours. Before treatment, all leaf pieces were weighed to determine their fresh weight. For the correction factor for the wet weight of the treated leaves, two leaves were taken from each leaf used and the fresh weight was weighed. The leaf pieces were dried in an oven at 100°C for 1 day and weighed to determine the dry weight. and the proportions are calculated. The result of multiplying the proportion by the wet weight of the leaf is the initial dry weight of the leaf. The remaining treatment and control leaves were dried and weighed to determine the weight of the leaves eaten by the larvae. Testing was carried out as described in research methods (Syahputra & Prijono, 2011). The percentage of feeding inhibition (HM) is calculated using the formula: (Hassanali & Bently, 1987).

Choice Test	No Choice Test
$HM\ (\%) = [(K - P) / K] \times 100\ \%$	$HM\ (\%) = [1 - (P / K)] \times 100\ \%$

Information :

P = average weight of treated leaves eaten by test larvae

K = average weight of control leaves eaten by test larvae

Data on the weight of leaves eaten by test larvae after drying in the feeding inhibition activity test using the selected method were analyzed using a paired t-test at a real level of 5% with the aim of comparing LC_{25}, LC_{50}, LC_{75} with the control. Data on the weight of leaves eaten by the test larvae after drying in the feeding inhibition activity test using the no-choice method was analyzed by means of variance and followed by the Duncan test at a significance level of 5% with the aim of comparing control, LC_{25}, LC_{50}, LC_{75}. (Steel & Torrie, 1993).

RESULT AND DISCUSSIONS

Insecticidal Activity of *T. diversifolia* Kipahit Flower Extract Against *C. pavonana* Larvae

It can be seen that the results of testing the insecticidal activity of *T. diversifolia* kipahit flower extract against *C. pavonana* larvae have an increasing mortality value as the concentration of the extract tested increases (Table 1). Treatment of kipahit flower extract at the tested concentrations of 0.25%, 0.5%, 1%, 1.25%, 1.5% resulted in mortality values for larvae from instar II to the end of instar IV respectively of 33%, 41%, 68%, 76%, 86 %.

Table 1. Insecticidal activity of *T. diversifolia* kipahit flower extract against mortality of *C. pavonana* larvae.

Concentration (%) w/v)	N[a]	Mortality (%)[b]
kontrol	100	0
0.25	100	33
0.5	100	41
1	100	68
1.25	100	76
1.5	100	86

The kipahit flower extract tested showed that the death of the test larvae occurred on the first day after being given treatment, then continued to increase and was relatively stable on the second to the seventh day of observation and on the eighth to the last day of observation, the death rate did not increase because there were no dead larvae (Figure 1). Based on the graph of the development of larval death during treatment with *T. diversifolia* kipahit flower extract, it

shows that the active compounds in the extract work relatively quickly in causing the death of *C. pavonana*. extracts act as stomach poisons for larvae, so that if these compounds enter the body of *C. pavonana* larvae through the food consumed by the larvae, the larvae's digestive system will experience problems over time. can cause the death of *C. pavonana* larvae. The terpenoid compounds in kipahit plants function as repellants for insects, causing the insects to starve and then die (Kawura *et al*., 2022)

Based on visual observations, *C. pavonana* larvae that were given kipahit flower extract showed symptoms of disruption of larval activity. In treated larvae, after eating the treated leaves, the larvae appear unable to move so they do not appear active. Apart from that, in treated larvae, the larvae showed symptoms of inhibited skin molting process. In this test, the treated larvae showed that the larvae were unable to completely remove their bodies from their old skin, which over time resulted in the larvae dying. The treated larvae show signs of undergoing a skin change process with the characteristics of the body color becoming pale and the larvae's old scalp starting to come off from its old skin.

According to (Cahyadi, 2009), flavonoid compounds contained in *T. diversifolia* flower

The compounds contained in *T. diversifolia* flowers, especially saponins and flavonoids, have the potential to disrupt the life development of larvae because if they come into direct contact they can cause toxic effects which can then cause larval death (Kawura *et al*., 2022). Saponin compounds are terpenoid compounds that bind to free sterols in the digestive system. By reducing the amount of free sterols in the larva's body, it can disrupt the larval change skin process (Mulyana, 2002).

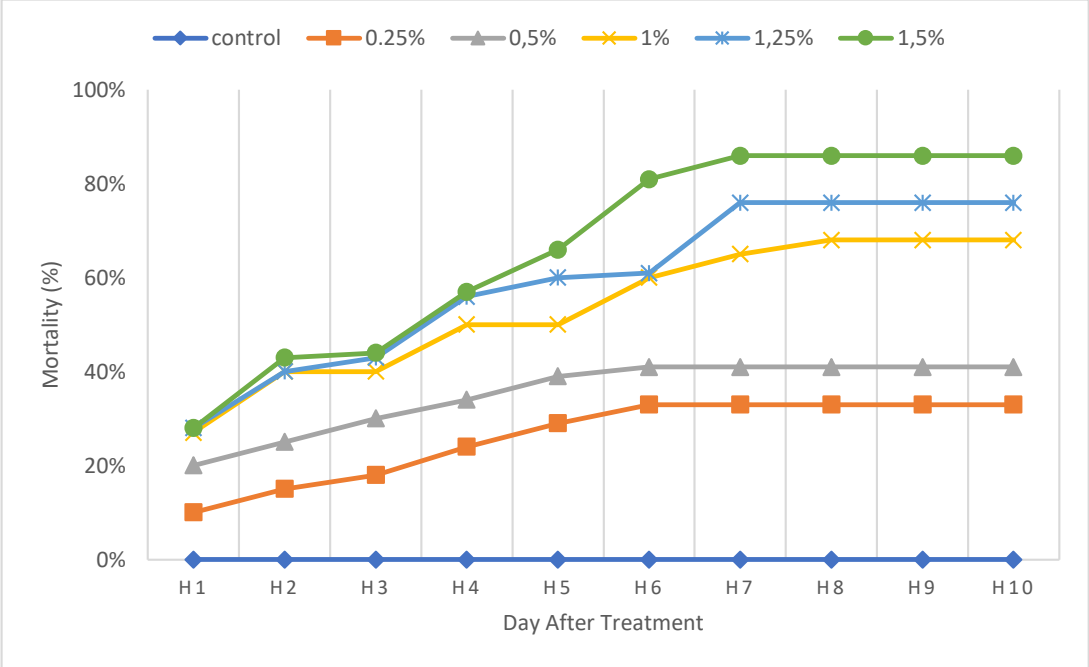

Figure 1. Mortality development of *C.pavonana* larvae in extract treatment kipahit flowers at various concentrations tested using the residue method on leaves

The results of the probit analysis showed that kipahit flower extract had an LC_{50} and LC_{95} value for larvae from instar II to final instar IV of 0.51% and 3.86%, respectively. (Table 2). The LC_{50} LC_{95} value shows that this concentration value is able to kill the larvae tested each 50% and 95%, respectively.

Table 2. Parameters of the relationship between concentration and mortality of *T. diversifolia* kipahit flower extract against *C. pavonana* larvae

a ± Gb	b ± Gb	LC_{50}(CI(95%)(%)	LC_{95}(CI(95%)(%)
-2.10 ± 1.17	1.91 ± 0.30	0.51 (0.58 – 1.60)	3.86 (2.77 – 6.36)

Information: a = intercept of the regression line, b = slope of the regression line; y = a + bx, GB = Standard error, LC = Lethal concentration, CI = Confidence interval.

Kipahit flower extract can influence larval development from instar II to the end of instar IV (Table 3). The development time of the surviving larvae was extended after eating the treated leaves and as the test concentration increased. Kipahit flower extract treatment at a concentration of 1% to 1.5% resulted in lengthening of the II-IV instar larval stage from 1.45 to 1.83 days compared to the control treatment. Therefore, it can be confirmed that the active compounds contained in *T. diversifolia* flower

extract can inhibit larval development. The effect on the length of larval development shows that the kipahit flower extract consumed by *C. pavonana* larvae can have a negative impact on the life of *C. pavonana* larvae. The saponin compound contained in T. diversifolia flower extract has the effect of inhibiting the larval molting process and slowing down the larval development process (Syah & Purwani, 2016).

During observations it was seen that the treated larvae seemed to eat more untreated (control) leaves than treated leaves. This shows that kipahit flower extract has an inhibitory effect on larval feeding. Apart from that, control larvae also showed greater activity than treated larvae. The combination of the effects of the compounds contained in kipahit flower extract with the inhibition of feeding and food poisoning in kipahit flower extract is directly related to the process of larval food digestion and larval development. This can also influence the length of larval development (Afifah *et al*., 2015).

Table 3. Insecticidal activity of *T. diversifolia* kipahit flower extract against development of *C. pavonana* larvae

Concentration (% w/v)	Average length of development ± SD (Day) (N)[a]					
	Instar II	N	Instar II - III	N	Instar II - IV	N
Control	1.95 ± 0.67	100	3.03 ± 0.73	100	4.03 ± 0.48	100
0.25	2.64 ± 0.41	90	3.69 ± 0.36	71	4.62 ± 0.43	67
0.5	2.83 ± 0.44	80	3.84 ± 0.26	61	4.86 ± 0.11	59
1	3.78 ± 0.15	73	4.64 ± 0.21	50	5.48 ± 0.11	32
1.25	4.62 ± 0.08	60	4.72 ± 0.16	39	5.62 ± 0.08	24
1.5	4.80 ± 0.07	57	4.84 ± 0.09	19	5.86 ± 0.05	14

Information: [a]SD = Standard deviation, N = Number of larvae that survive at the indicated larval development stage.

Feeding Inhibitory Activity of *T. diversifolia* Kipahit Flower Extract Against *C. pavonana* Larvae Selected Method Choice Test

It can be seen in (Table 4) that the test results of *T. diversifolia* kipahit flower extract treatment at the concentration levels tested using the selected method can inhibit the feeding activity of third instar larvae with feeding inhibition values of 24.90%, 53.96%, 76.34 respectively. %. The effect of suppressing larval feeding on kipahit flower extract on *C. pavonana* larvae was related to each extract concentration tested. The higher the concentration tested, the stronger the effect of inhibiting larval feeding on the treatment. The concentrations used in the choice and no-choice methods have equally high concentrations, however, if seen from the feeding resistance values in the choice method (Table 4) and the no-choice method (Table 5), the test is to determine the feeding resistance activity of *C. pavonana* larvae is more effective using the no-choice method test, this is because in the no-choice method test where the larvae are forced to eat their food, because the larvae cannot choose other food leaves other than the food leaves contained in the petri dish, which causes the food resistance value to be high because the larvae The test can only eat the treatment leaves, whereas in the choice method test the larvae can choose the leaves of the control food, causing the food resistance value of the choice method test to be low because the test food chooses the control food.

There was a difference in the weight of leaves eaten by larvae between treated leaves and control leaves (Table 4). Because when the larvae are around cabbage leaves, the treated leaves are quickly avoided by the larvae compared to untreated leaves. The larval activity was caused by the effects of treatment with Kipahit flower extract. Leaves treated with kipahit flower extract will experience a change in odor, disrupting the larvae's feeding signals. After the larvae moved away from the treated cabbage leaves, they immediately moved to untreated (control) cabbage leaves. It was seen that the larvae immediately ate pieces of cabbage leaves without treatment (control) and carried out their feeding activities without interference, causing the larvae to eat more control leaves.

The results of testing kipahit flower extract using the chosen method also showed an increase in the larval feeding inhibition value along with increasing concentrations tested, where the feeding inhibition value was 24.90% at a concentration of 0.155% (LC_{25}) and the feeding inhibition value increased to 76.34% at a concentration of 1.25%. (LC_{75}) (Table 4). In testing, the feeding inhibitor compound in *T. diversifolia* kipahit flower extract was able to prevent larvae from eating leaves treated with kipahit flower extract.

It can be seen in (Table 4) that the larvae tested seemed to eat less of the treated leaves which caused the leaf weight values obtained to decrease as the concentration tested increased. The reduced feeding activity of the larvae is thought to be caused by the active compounds contained in *T. diversifolia* flower extract which come from the flavonoid group, where this compound is one of the compounds that has a bitter taste and is toxic to the larvae. (Robinson, 1995).

T. diversifolia kipahit flower extract also has antifeedant properties, which works by stimulating the larvae's eating resistance nerves located in the larvae's mouth so that it can interfere with the larvae's feeding stimulation (Mordue Luntz *et al.*, 1998).

Table 4. Effect of *T. diversifolia* kipahit flower extract on eating inhibition *C. pavonana* larvae using the choice test method.

Concentration (%, w/v) ~ LC	Average weight of leaves eaten (mg) ± SD[b]		HM[c] (%)
	Treatment	Control	
0.155 (LC_{25})	62 ± 9.8 b	83 ± 8.3 a	24.90
0.44 (LC_{50})	32 ± 10.3 c	69 ± 8.6 ab	53.96
1.25 (LC_{75})	16 ± 8.5 c	70 ± 4.7 ab	76.34

Information: [a] The number of larvae used at each concentration level is 30 individuals, [b] SD = Standard Deviation, for each concentration, the means followed by the same letter are not significantly different according to paired t-test ($\alpha = 5\%$). [c] HM = Eating inhibition HM (%) = [(K – P) / K] × 100 %.

Feeding Inhibitory Activity of *T. diversifolia* Kipahit Flower Extract Against *C. pavonana* Larvae Method No Choice Test

The test results showed that treatment of *T. diversifolia* kipahit flower extract with the concentration tested in the no-choice method could inhibit the feeding activity of third instar larvae with feeding inhibition values of 27.20%, 59.69%, 86.40% respectively (Table 5). The inhibition of larval feeding activity is due to the active compounds contained in the test extract. Some of these compounds can also affect the larvae's nervous system, causing their feeding activity to decrease or even stop eating. The test larvae can be said to be hampered in their feeding activities if the test larvae do not eat the treated leaves or only eat a few treated leaves, causing the weight value of the treated leaves to be low compared to the weight value of the untreated leaves. Testing kipahit flower extract using the no-choice method also showed that the eating inhibition activity increased along with increasing concentrations tested, namely where the inhibition value was 27.20% at a concentration of 0.155% (LC_{25}) and the eating inhibition value increased to 86.40% at a concentration of 1.25%. (LC_{75}) (Table 5).

It is clear from the data on the average weight of leaves eaten by larvae tested using the choice method (Table 4) and without choice (Table 5), showing that the average leaf weight eaten by larvae on leaves without treatment (control) in the choice method and without choice has a different average leaf weight value, this is because in the choice method, treatment leaves and control leaves are placed in the same petri dish so that the larvae can choose which food to eat, whereas in the method without choice, treatment leaves and leaves controls were placed in separate petri dishes which meant that the larvae did not have the same food preferences. This is what causes the average value of leaf weight eaten by control leaf larvae in the no-choice method to be higher than in the choice method. Overall, the value of feeding inhibition activity for third instar *C. pavonana* larvae in the no-choice test was higher than the value of feeding inhibition activity in the choice test due to whether the larvae were forced to eat or not eat. If the test larvae decide not to eat then the eating resistance value will be high and if the larvae decide to eat this will affect the weight of the leaves eaten by the test larvae.

From this test it can be concluded that in both the choice method test and the no choice method test, *T. diversifolia* kipahit flower extract has the same strong feeding inhibition activity in influencing the feeding activity of *C. pavonana* larvae. If related to field conditions, *C. pavonana* larvae will be able to differentiate between plant parts that contain plant insecticides and plant parts that do not contain plant insecticides.

The results of visual observations showed that there were larvae that died after the cabbage leaves were exposed to kipahit flower extract treatment. This happened because the larvae refused to eat cabbage leaves because the test leaves contained compounds contained in the test extract which caused the larvae to refuse to eat and over time caused the larvae to die. Apart from that, there are also larvae that eat the treated leaves but over time the larvae die. This occurs because there are compounds contained in *T. diversifolia* flower extract which work as stomach poisons so that larvae after eating the treated leaves will die due to the effects of these compounds. Larvae that eat treated leaves will experience inhibition of their feeding activity, causing earlier death compared to larvae that do not eat treated leaves. Visual observation showed that the larvae tested still ate the treated leaves, although only a little. This may indicate that the active compound that inhibits larval feeding contained in *T. diversifolia* flower extract acts as a primary feeding inhibitor, resulting in the larvae being tested not immediately dying from starvation, but because of their low feeding activity, the larvae can survive until they die.

Table 5. Effect of *T. diversifolia* kipahit flower extract on eating inhibition *C.pavonana* larvae using the no choice methoda[a].

Concentration (%, w/v) ~ LC	Average weight of leaves eaten (mg) ± SD[b]	HM[c] (%)
Control	77 ± 9.1 a	
0.155 (LC_{25})	56 ± 3.8 ab	27.20
0.44 (LC_{50})	31 ± 13.4 bc	59.69
1.25 (LC_{75})	10.5 ± 2.0 c	86.40

Information: [a] The number of larvae used at each concentration level is 40 individuals, [b]SD = Standard Deviation, for each concentration the mean followed by the same letter is not significantly different based on Duncan's test (α = 5%). [c] HM = Eating inhibition (%) = [1 – (P/K) x 100%].

CONCLUSIONS

Based on research that has been carried out, *T. diversifolia* kipahit flower extract has insecticidal activity against *C. pavonana* larvae. Apart from having a lethal effect, kipahit flower extract also has the effect of inhibiting larval feeding activity. Apart from that, the research results show that the activity of kipahit flower extract has an LC_{50} value of 0.51% and LC_{95} value of 3.86%. In the treatment of *T. diversifolia* kipahit flower extract with the concentration tested using the selected method, it can inhibit the feeding activity of third instar larvae with feeding inhibition values respectively of 24.90%, 53.96%, 76.34%, whereas with the method without the choice of feeding inhibition values owned respectively 27.20%, 59.69%, 86.40%.

REFERENCES

Afifah, F, Rahayu YS, & Faiza U. 2015. Efektivitas kombinasi filtrat daun tembakau *(Nicotiana tabacum)* dan filtrat daun paitan *(Tithonia diversifolia)* sebagai pestisida nabati hama walang sangit *(Leptocorisa oratorius)* pada tanaman padi. *Lentera Bio*. 4(1): 25-31. https://fotografi-tp.unesa.ac.id/index.php/lenterabio/article/view/10885/10421.

Cahyadi, R. 2009. Uji toksisitas akut ekstrak etanol buah pare (*Momordica charantial*) terhadap larva *Artemia salina Leach* dengan metode *Brine Shrimp Lethality Test* (BST). Skripsi. Semarang. Universitas Diponegoro.

Dadang & Prijono D. 2008. Insektisida nabati: prinsip, pemanfaatan dan pengembangan, departemen proteksi tanaman. Fakultas Pertanian. Institut Pertanian Bogor.

Firmansyah, E, & Anwar R. (2017). Aktivitas insektisida ekstrak *Tithonia diversifolia (Hemsl.) a Gray (Asteraceae)* terhadap ulat daun kubis *Plutella xylostella (L.) (Lepidoptera: Yponomeutidae)*. Jurnal Hama dan Penyakit Tumbuhan Tropika, 17(2), 185-193. https://doi.org/10.23960/j.hptt.217185-193.

Hassanali I & Bentley M. 1987. Comparison of the insect antifeedant activities of some limonoids. Di dalam: Schmutterer H & Ascher KRS (eds.), Natural Pesticides from The Neem Tree (*Azadirachta indica A. Juss*) and Other Tropical Plants. Proceeding of The Third International Neem Conference Nairobi, 10 – 15 July 1986. Eschborn: GTZ. p. 683 – 689.

Kawura A, Mowidu I, & Hs ESD. (2022). Mortalitas walang sangit akibat aplikasi ekstrak daun paitan. *Agropet*, 19(2), 9-15.

Mordue (Luntz) AJ, Simmonds MSJ, Ley SV, Blaney WM, Mordue W, Nasiruddin M & Nisbet AJ. 1999. Actions of azadirachtin, a plant allelochemidal, against Insect. *Pesticide. Sci*ence 54: 277-284. https://doi.org/10.1002/(SICI)1096-9063(1998110)54:3<277::AID-PS801>3.0.CO;2-I.

Mulyana, 2002. Ekstraksi Senyawa Aktif Alkaloid, Kuinone, Dan Saponin dari Tumbuhan Kecubung Sebagai Larvasida dan Insektisida Terhadap Nyamuk *Aedes aegypti*. Skripsi Departemen Kimia, Fakultas Matematika dan Ilmu Pengetahuan Alam, Institut Pertanian Bogor.

Robinson T. 1995. Kandungan organik tumbuhan tinggi. padmawinata K, Alih bahasa. Bandung: ITB.

Sastrosiswojo S, & Setiawati W. 1993. Hama-hama Tanaman Kubis dan Cara Pengendalian. *Balai Penelitian Hortikultura Lembang*. 39-41.

Sastrosiswojo, S. 1995. Sistem pengendalian hama terpadu dalam menunjang agribisnis sayuran dalam prosiding Seminar Ilmiah Nasional Komoditas Sayuran. Balitsa. 24 Oktober 1995. Hlm 69-81.

Steel RGD & Torrie JH. 1993. Prinsip dan prosedur statistika suatu pendekatan biometrika. Sumatri B, Alih bahasa. Jakarta: PT. Gramedia Pustaka Utama.

Susanti, D, Widyastuti, R. & Sulistyo, A. 2015. Aktivitas antifeedant dan antioviposisi ekstrak daun *tithonia* terhadap kutu kebul. *Agrosains*. 17 (2), 33-38. https://doi.org/10.20961/agsjpa.v17i2.18666.

Syahputra E, & Prijono D. (2011). Perkembangan dan hambatan makan larva *Crocidolomia pavonana* yang diberi sediaan fraksi diklormetan kulit batang *Calophyllum soulattri*. *Jurnal Agroteknos*, 1(3), 135-140. https://ojs.uho.ac.id/index.php/agroteknos/article/view/2248.

Syah BW, Purwani KI. 2016. Pengaruh ekstrak daun belimbing wuluh (*Averrhoa bilimbi*) terhadap mortalitas dan perkembangan larva

Spodoptera litura. *Jurnal Sains*. 5(2): 23-28. DOI: 10.12962/j23373520.v5i2.20528

Sapoetro TS, Hasibun R, Hariri AM, & Wibowo L. (2019). Uji potensi daun kipahit (*Tithonia diversifolia A. Gray*) sebagai insektisida botani terhadap larva *Spodoptera litura F*. Di laboratorium. *Jurnal Agrotek Tropika*. 7(2): 371-381. http://dx.doi.org/10.23960/jat.v7i2.3260.

Tuti HK, & Ratna ES. (2019). Aktivitas ekstrak averrhoa bilimbi, annona squamosa, dan tithonia diversifolia terhadap mortalitas dan penghambatan pertumbuhan larva Crocidolomia pavonana (Lepidoptera: Crambidae). *Jurnal Hortikultura Indonesia*, 10(1), 46-54. DOI: http://dx.doi.org/10.29244/jhi.10.1.46-54.

Uhan, TS. 1993. Kehilangan hasil panen kubis karena ulat krop kubis *(Crocidolomia binotalis Zell)* dan cara pengendaliannya. *Jurnal Hort*. 3(2):22-26.