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The feeding activity and attack intensity of armyworms on mustard leaves with yam seed extract under laboratory conditions

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ABSTRACT

The purpose of this study was to determine the effect of yam seed extract (*P. erosus*) on the feeding activity and attack intensity of armyworms (*S. litura*) on mustard leaves (*B. juncea*) and also to workout effective concentration against feeding activity and attack intensity (*S. litura*). This quantitative study used an experimental method with a completely randomized design with 11 treatments and 4 replications, so 44 experimental units were obtained consisting of P0 to P10. Based on the ANOVA test, the results showed that the F_{value} was greater than F_{table} which means that yam seed extract had a significant effect on the feeding activity and attack intensity of *S. litura*. Further, the concentration of 5% (P10) was most effective in reducing the feeding activity and attack intensity of *S. litura*. Thus, yam seed extract has a potential and is expected to be used as an environmentally friendly plant-based insecticide.

Key words : Armyworms (*Spodoptera litura* F.), attack intensity, feeding activity, mustard leaves (*Brancia juncea* L.), yam seed extract (*Pachyrhizus erosus* U.).

INTRODUCTION

Armyworms are pests that attack many vegetable crops in Indonesia, such as mustard greens, cabbages, chilis, shallots, and beans. Armyworms attack in swarms in large numbers at night. The life behavior of these armyworms can cause plants to be hollow, less fertile, and even dead (Kalshoven, 1981). According to Department of Food Crops Agriculture (2010), the attack of the armyworms *S. litura* in Jambi City can reach up to 40%. The attack of armyworms *S. litura* on susceptible varieties has caused a significant loss, as the plant leaves are attacked which finally decrease the plant's productivity and even crop failure. One of the vegetable crops in Indonesia suspected to have decreased its productivity and even failed to harvest due to the armyworms *S. litura* is mustard.

Farmers control the intensity of attacks by using synthetic insecticides unwisely. As a result, they can damage the environment and disrupt the health of humans who consume the vegetables (Johari *et al*., 2018a; Johari *et al*., 2018b; Elijonnahdi *et al*., 2021). The use of synthetic insecticides can result in resistance, pest resurgence, killing of natural enemies, increased residues in yields, environmental pollution, and health problems for consumers (Johari *et al*., 2017; Johari *et al*., 2020a). To control the use of synthetic insecticides periodically, it is necessary to find other alternatives which do not damage the environment. One of them is the use of plant-based insecticides that are more environmentally friendly and harmless to humans. One of the plants with the potential as a plant-based insecticide is yam seeds (Johari *et al*., 2019b). Yam seed extract has a significant effect on the widespread phenomenon of thrips attack on chili leaves. Concentrations of 1.5% and 2% are highly effective in suppressing the extent of thrips attack on chili leaves (Johari *et al*., 2020b). This is because yam seed extract contains a *pachyrhizid* compound which is toxic to insects (Johari *et al*., 2020b). This study revealed the effectiveness of yam seed extract against the feeding activity and attack intensity of armyworms *S. litura* on mustard leaves, which is useful for the development of plant-based insecticides in the biological control.

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MATERIALS AND METHODS

The research was carried out at the Laboratory of Plant Pests and Diseases and the Laboratory of Animal Husbandry, Jambi University from August to October 2021. This research is a quantitative study using an experimental method with a Completely Randomized Design. There were 11 treatments and 4 replications, so 44 experimental units were obtained consisting of P0 (0%), P1 (0.5%), P2 (1%), P3 (1.5%), P4 (2 %), P5 (2.5%), P6 (3%), P7 (3.5%), P8 (4%), P9 (4.5%), P10 (5%).

The preparation of armyworms *S. litura* as the test animal obtained from the exploration in the field. The adult was collected from vegetable crops that had not been sprayed with any synthetic pesticides. The adult *S. litura* obtained from this exploration was reared using 10% of honey feed until F1 offspring was obtained. *S. litura* to be treated was instar III. The steps of extracting yam seeds used the steps carried out by Johari *et al.,* (2020b).

The treatment used an active extract of yam seeds on mustard leaves as feed for armyworms as the test animal, and without using any active extract in the control. The initial weight of mustard leaves for each treatment was 2 grams. Then, the mustard leaves were weighed again after the treatment. The final weight of the mustard leaves for each treatment unit was recorded and then calculated using the feeding activity formula. The intensity of attacks was determined by measuring the initial area of the leaves before and after the treatment. The effect of yam seed extract on the feeding activity of the armyworms *S. litura* was calculated by analysis of variance at a significant level (α) of 0.05. If there were a difference, it would be continued with the Duncan Multiple Range Test at a significant level (α) 0.05 to determine the level of influence of each treatment.

RESULTS AND DISCUSSION

The results of the study on the feeding activity of armyworms were obtained after the treatment. The average data of the armyworms' feeding activity is shown in Table 1 and Fig. 1.

Based on Table 1 and Fig. 1, it can be seen that there is a decrease in the feeding activity with an increase in the given concentration. This is due to effect of the active yam seed extract which can inhibit metabolism, nervous system, and *antifeedant* of armyworms *S. litura*. Yam seed extract contains *rotenone* which can inhibit the cellular respiration, which has an impact on nerve tissues and muscle cells, and finally causes insects to stop eating (Novizan, 2002).

Treatment P0 (Control) and P1 (0.5%) showed the average percentage of decrease in feeding activity of *S. litura* that was not significantly different and significantly different from other treatments. For treatment P2 (1%), P3 (1.5%), and P4 (2%) were not significantly different and significantly different from other treatments. Treatment P5 (2.5%) and P6 (3%) were not significantly different and significantly different from other treatments. This illustrates that the extract with the concentrations of 2.5% and 3% had the same level of ability in reducing the feeding activity of the armyworms *S. litura* and was more influential than the concentrations of 1%, 1.5%, and 2%. The percentage decrease in feeding activity of *S. litura* in treatments P7, P8 and P9 was not significantly different, but significantly different from other treatments. The percentage decrease in feeding activity of *S. litura* with treatment P7 (3.5%) was 59.875%, while for P8 (4%), it was 59% and P9 (4, 5%) that was equal to 58,250%.

Table 1. Average feeding activity of armyworm (*Spodoptera litura* F.) in each treatment.

S. No.	Treatment concentration	Average feeding activity
1.	0.0	87.12
2.	0.5	85.37
3.	1.0	79.75
4.	1.5	79.25
5.	2.0	77.75
6.	2.5	70.87
7.	3.0	68.50
8.	3.5	59.87
9.	4.0	59.00
10.	4.5	58.62
11.	5.0	53.62

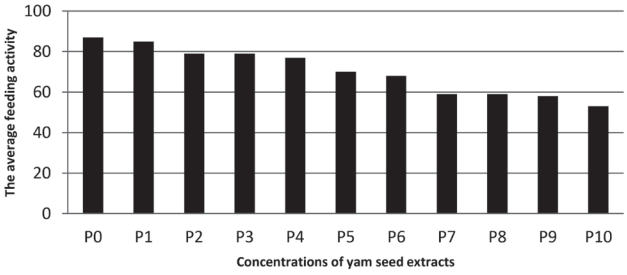

Fig. 1. Graph of the average feeding activity of armyworms *S. litura* on mustard plants with each treatment P0 to P10

Table 2. Average attack intensity of *S. litura* in each treatment.

S. No.	Treatment concentration	Average attack intensity
1.	0.0	84.99
2.	0.5	83.72
3.	1.0	75.48
4.	1.5	74.30
5.	2.0	72.54
6.	2.5	68.42
7.	3.0	67.74
8.	3.5	62.02
9.	4.0	61.56
10.	4.5	60.88
11.	5.0	55.97

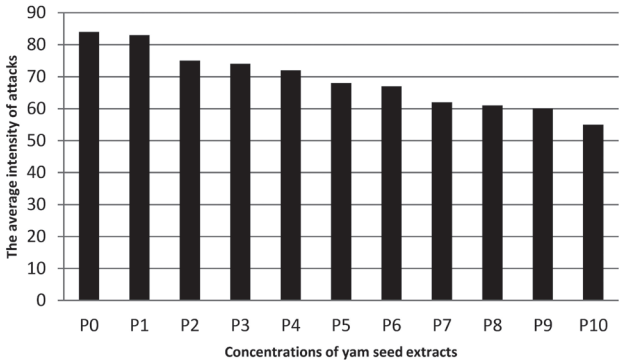

Fig. 2. Graph of the average intensity of attacks by armyworms *S. litura* on mustard plants with each treatment P0 to P10.

Treatment P10 (5%) showed a significantly different feeding activity from other treatments. The percentage decrease in feeding activity in P10 (5%) was 53.625% in the active category (Johari, 2010). This indicates that the 5% of extract concentration is effective in reducing the feeding activity compared to other treatments. This is in accordance with Haryuningtyas *et al*. (2011) that 5% of yam seed extract is the most effective compared to concentrations of 1 and 2.5%. This concentration is able to kill mites faster than the concentrations of 1 and 2.5%. The higher the extract concentration is given, the lower the feeding activity of *S. litura* larva (Kartina and Shulkipli, 2019).

The decrease in feeding activity in the treatment with yam seed extract was due to the active compound contained in yam seeds, namely *rotenon*. *Rotenon* functions as an antifeedant that can inhibit insect eating activity but does not kill it directly. *Rotenon* functions as a respiratory inhibitor, as an antifeedant that causes insects to stop eating, and as an insect growth regulator that inhibits the insect development (Johari *et al*., 2019a; Hutabarat *et al*., 2015).

Rotenone is a strong inhibitor of electron transport between NAD+ and coenzyme Q, succinate oxidation and cytochrome oxidase in mitochondria so that ATP is not formed. If ATP is not formed, the organism will lack energy to carry out life activities. In fact, the ATP produced and processed is the largest ATP production for cellular respiration, so if most of the ATP production is not generated, the organism will lack energy and result in death (Geraldin *et al*., 2020). The results of the study on the intensity of attacks by the armyworms *S. litura* were obtained after 3 days of observation. The area of mustard leaves before and after treatments was measured. From the area of the affected mustard leaves, the intensity of attacks by *S. litura* is shown in Table 2 and Fig. 2.

Based on Table 2 and Fig. 2, it can be seen that the average percentage of attack intensity by armyworms *S. litura* decreased in the treatment with yam seed extract. The intensity of *S. litura* attacks in the control treatment (P0) was not significantly different from the 0.5% extract (P1) and was significantly different from other treatments.

The 1% extract treatment (P2) was not significantly different from the 1.5% extract (P3) and the 2% extract (P4), but was significantly different from other treatments. The percentage of attack intensity of 1% extract treatment (P2) was 75.485%, the percentage of attack intensity of 1.5% extract treatment was 74.307%, and the percentage of 2% extract treatment was 72.545%. Both belong to the category of heavily damaged. It indicates that the reaction of armyworms *S. litura* to the active compounds present in the yam seed extract depends on the concentration. It occurs because the insect's reaction to allelochemicals contained in the leaves depends on the dose, so at a certain concentration it can act as a food inhibitor (Gaol *et al*., 2019).

The percentage of 2.5% extract (P5) and 3% extract (P6) treatments was not significantly different and significantly different from other treatments. The percentage of 2.5% extract treatment was 68, 427% while the percentage of 3% extract was 67, 740%. The percentage of attack intensity in treatments with 3.5% extract (P7), 4% extract (P8) and 4.5% extract (P9) was not significantly different, but significantly different from other treatments. Increasing

the concentration of 3.5% extract (P7), 4% extract (P8) and 4.5% extract (P9) had the same ability to reduce the percentage of attack intensity. Plant-based pesticides generally cannot kill the sprayed pests directly, but these pesticides function as: (1) *repellent*, compounds that repel the presence of insects due to their pungent smell, prevent insects from laying eggs, and stop the egg hatching process (2) *antifeedant*, compounds that prevent insects from eating plants that have been sprayed mainly because of their bitter taste (3) *neurotoxins* and (4) *attractants*, compounds that can attract the presence of insects that can be used in insect traps (Geraldin *et al*., 2020; Boadu *et al*., 2011).

The highest percentage decrease in the attack intensity by *S. litura* was 55, 975% with 5% extract (P10). At a concentration of 5% (P10), it was effective in reducing the intensity of attacks by armyworms *S. litura* compared to other treatments. Reddy (2015) stated that at a concentration of 5%, it was able to reduce the intensity of attacks by armyworms *S. litura* up to 12.46%, so the yam seed extract *P. erosus* at a concentration of 5% was effective in reducing the intensity of attacks by armyworms *S. litura* compared to the 2% concentration which was only able to reduce 15.17%.

The characteristic of attacks by armyworms *S. litura* is that they will damage the leaves by leaving remnants of the upper epidermis until the leaves are so transparent that they become hollow. If it is a severe attack by *S. litura*, the leaves will run out and only bone leaves remain. Palit (2016) stated that the symptom of attacks caused by *S. litura* was by eating the leaves which caused the leaves to have holes, and in severe attacks only leaf veins were left. Generally, they will move together from plants that their leaves have been eaten to new plants. For symptoms of armyworms' attacks on leaves, the edge of the leaf to the center of the leaf are damaged, even the entire leaf can be eaten by armyworms *S. litura* (Kalshoven, 1981).

Compounds contained in yam seed extract are toxic, one of which is *rotenon*. *Rotenon* that enters the insect's body is first initiated by a contact with dermal poison, and then, the poison will diffuse into the cell. It causes a functional damage to plasma which results in loss of cell energy which can interfere with the respiration and metabolism of insects (Gupta, 2014).

In addition to containing rotenone, yam seeds also contain *pachyrhizid*, *pachyrhizine*, *saponins*, and some others that work synergistically as insecticides and acaricides. Yam seeds, especially the old ones, contain toxins such as *rotenone* and *rotenoids* which are effectively used as insecticides derived from plants. In addition, yam seeds also contain *saponine* which plays a role in producing a waxy layer of insect pests, so these insects are easily eradicated (Jaiswal *et al*., 2022; Adawiyah and Pakki, 2018).

Yam seeds also contain *Pachyrhizid*, an active substance of chemical poison that can enter and seep into insects' body tissues and kill them. *Pachyrhizid* acts slowly as a poison that inhibits metabolism and the nervous system. The mechanism of *Pachyrhizid* action is through the cuticle entering the insect's body because the insect's body size is relatively smaller, so the outer surface area of the body is relatively larger than the body size of mammals. Further, it will damage and disrupt the mechanism of the nervous system by inhibiting glutamate oxidase which results in nerve conduction failure. This will make the insects die slowly (Hudayya, 2012).

The results of this study concluded that Yam seed extract has a significant effect in reducing the feeding activity of armyworms (*S. litura*) on mustard leaves (*B. juncea*); Yam seed extract has a significant effect in reducing the intensity of attacks by armyworms (*S. litura*) on mustard leaves (*B. juncea*); Yam seed extract concentration of 5% is effective in reducing the feeding activity of armyworms; Yam seed extract concentration of 5% is effective in reducing the intensity of attacks by armyworms. From the description above, it can be emphasized that yam seed extract has the potential as an active material in the development of environmentally friendly plant-based insecticides in biological control efforts.

AUTHORS' CONTRIBUTION

Research starting from preparation, implementation, data collection and analysis and editing paper (AJ), Data collection and analysis, editing paper (RA), Field research performers and data collectors (ZMM), Data collection and analysis, editing paper (M); Data collection and analysis, editing paper (IL).

DECLARATION

The authors declare that they have no conflict of interests.

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