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Feeding Activity of *Heliotis armigera* Hubner Larvae on Food Formulated with Ethanol Extracts of Bitter Melon Leaves (*Momordica charantia* L.), Galangal Leaves (*Lactuna indica* L.) and Adjuvant Agrestic

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ABSTRACT

The research on the Feeding Activity of *Heliotis armigera* Hubner larvae on food formulated with ethanol extracts of bitter melon leaves (*Momordica charantia* L.), galangal leaves (*Lactuna indica* L.) and adjuvant agrestic has been conducted. This study used the ratio formulation of bitter melon and galangal (1:1, 1:2, 2:1), 1% adtjuvan agristik. The feeding activity was observed using the feeding method with several concentrations (0.00, 0.58, 1.16, 1.74, 2.32, 2.92) and 15 larvae for iterations using a completely randomized design (CRD). The data from the observations were analyzed using variance; if there were differences, it would proceed to the Duncan test of 5%. Insect feeding activity is influenced by food containing concentrations of 1.16% - 2.92% of a formulation (1:1, 1:2, 2:1) of bitter melon leaf extract, galangal leaf extract, and 1% agrestic adjuvant, leading to a decrease in insect growth rate (RGR). The insect's feeding ability (RCR), ability to convert consumed food into usable nutrients (ECI), and ability to digest food and utilize it (ECD) are also reduced. Conversely, the ability to digest insect food (AD) is increased. The best formulation and concentration are (2:1) and (1.74%).

Keyword: Feeding Activity, *Momordica charantia* L, *Lactuna indica* L., Heliothis armigera.

ABSTRAK

Penelitian ini bertujuan untuk mengetahui Aktivitas Makan Larva *Heliotis armigera Hubner* pada makanan yang diformulasi dengan ekstrak etanol daun pare (*Momordica charantia* L.), daun lengkuas (*Lactuna indica* L.) dan adjuvant agrestic. Penelitian ini menggunakan formulasi perbandingan pare dan lengkuas (1:1, 1:2, 2:1), adtjuvan agristik 1%. Aktivitas pemberian pakan diamati menggunakan metode pemberian pakan dengan beberapa konsentrasi (0,00, 0,58, 1,16, 1,74, 2,32, 2,92) dan 15 larva untuk iterasi menggunakan rancangan acak lengkap (RAL). Data hasil observasi dianalisis menggunakan varians; apabila terdapat perbedaan maka dilanjutkan ke uji Duncan 5%. Aktivitas makan serangga dipengaruhi oleh makanan yang mengandung konsentrasi 1,16% - 2,92% formulasi (1:1, 1:2, 2:1) ekstrak daun pare, ekstrak daun lengkuas, dan bahan pembantu agrestik 1%, sehingga menyebabkan penurunan laju pertumbuhan serangga (RGR). Kemampuan serangga untuk mencari makan (RCR), kemampuan mengubah makanan yang dikonsumsi menjadi nutrisi yang dapat digunakan (ECI), dan kemampuan mencerna makanan dan memanfaatkannya (ECD) juga berkurang. Sebaliknya, kemampuan mencerna makanan serangga (AD) meningkat. Formulasi dan konsentrasi terbaik adalah (2:1) dan (1,74%)..

Keyword: Aktivitas Makan, *Momordica charantia* L, *Lactuna indica* L., Heliothis armigera.

1. Introduction

The use of botanical insecticides at the level of farmers is used in a very simple way, i.e. immersing the formulation of all plants into one solution without knowing its concentration, so that no reference is obtained in its use. This, of course, cannot measure how great the level of success is. Therefore, no botanical insecticide raw formulation is available on the field or in the market. This condition is one that causes at least farmers to strive in organic farming. Of the 17 districts in Tanah Karo as the center of horticulture producers in the province of North Sumatra, only 4 have organic agrestic land with an area of more than 10% [1]. For this, it is necessary to solve the use of plants as botanical insecticides in organic farming.

Increasing demand for organic agrestic products will increase the use of botanical insecticides. Tanah Karo, as the center area of organic vegetable producers, take such opportunities through organic cultivation using botanical insecticides to control pests. This is in connection with the nature of environmentally-friendly botanic insecticides [2] and also due to the increasing level of education, knowledge, and awareness of the public about the many plants that can be used as botanical insecticides, among others: bitter gourd leaves (*M. charantia*), galangal leaves (*L. indica*). According to [3] this plant is potentially a botanical insecticide. For this, it is necessary to solve the use of plants as botanical insecticides in organic farming.

Research on plants as insecticides is directed at producing various secondary compounds with toxic properties by looking at their killing power. This toxic concentration still enables the killing other valuable insects and increased resistance to pests [4], [5]. Therefore, the use of botanical insecticides by farmers must be evaluated to find the contents of secondary metabolites, concentration, and formulation (composition) with the ratio of concentration (1:1, 1:2, 2:1) ethanol extracts from plant leafy plants with the addition of agrestic adjuvants that can affect the physiology (growth) of pests by observing the parameters of mortality and insect feed activity; adding insect growth (RGR). The ability to eat. (RCR). The ability to transform the food eaten into food consumed by the body (ECI). The ability to transform digested food into food that the body can consume. (ECD). The ability to feed food by insects (AD) [6]. thus, obtaining the formulation ratio (1:1, 1:2, 2:1) and the best concentration of ethanol extracts of steam leaves and lengthy leaves.

2. Material and Methods

2.1 Preparation and maintenance of experimental animals [6].

In the laboratory, larvae from the field were reared on their natural food. After reaching adulthood, they were transferred to breeding cages in a 2:1 ratio and provided with a food source consisting of honey and sugar solution, along with cloth placed on three sides of the cage for egg deposition. The hatched larvae were placed in plastic cups and provided with the formulated food. They were reared until they reached the fifth instar larvae stage, ready to be used as test organisms.

2.2 Production of artificial food [7].

Mix 50 g of cornmeal, 50 g of soybean extract, and 30 g of wheat germ in a blender with distilled water. Add 100 cc of water, 20 g of rice flour, 50 g of cornstarch, and 50 g of granulated sugar. Incorporate 12 g of vitamin, 2 g of sorbic acid, 6 g of ascorbic acid, and 2.5 g of nipagin, and stir until it becomes a paste. Add 10 cc of corn oil. Combine all the ingredients into a heated agar solution with 800 ml of distilled water at a temperature of 70°C. Then, add 15 g of yeast and 10 ml of formalin. Allow it to cool down until it becomes ready-to-use food. Cut the food into pieces and place them in plastic cups for larval rearing. For treatment purposes, add ethanol extracts of bitter melon and galangal leaves according to their respective concentrations and formulations.

2.3 Research Design

Using a Completely Randomized Design (CRD), there were 15 replications (15 fifth instar larvae). The experiment included six treatment concentrations (0.00, 0.58, 1.16, 1.74, 2.32, 2.92) with formulations (1:1, 1:2, 2:1) of bitter melon leaf extract, galangal leaf extract, and 1% agrestic adjuvant. The data were analyzed using the SPSS 22 computer program.

2.4 Procurement of ethanol extracts from bitter melon leaves and galangal leaves [8].

Bitter melon leaf powder and galangal leaf powder were soaked in ethanol for 3 times, each time lasting 24 hours until the ethanol extract became clear. The extract was then evaporated using a rotavapor at 40°C, resulting in concentrated ethanol extracts of bitter melon leaves (*M. charantia*) and galangal leaves (*L. indica*).

2.5 *Observation Of Test Parameters*

2.5.1. Feeding activity (Nutrition Index) of insects

The food, which was weighed and consisted of 6 concentrations (0.00, 0.58, 1.16, 1.74, 2.32, 2.92) with formulation ratios (1:1, 1:2, 2:1) of bitter melon leaf ethanol extract (M. *charantina*), galangal leaf extract (*L. indica*), and 1% agrestic adjuvant, was provided to 15 fifth instar larvae placed in 15 plastic bottles with a diameter of 5 cm and a height of 8 cm. Observations were conducted for 4 days. The remaining food, feces, and larvae were dried in an oven and weighed. Feeding activity was calculated using the formula for the Nutritional Index parameters [6], which are as follows:

Growth rate (RGR) = G/T.A
Feeding ability (RCR) = F/T.A
Ability to digest food and utilize it (ECD) = (G/F-E) x 100%
Ability to convert consumed food into usable nutrients (ECI) = (G/F) x 100%
Ability to digest food (AD) = (F-E)/F x 100%

Note:
G = Difference in larval weight during the treatment (initial larval weight - final larval weight)
F = Amount of food consumed
E = Weight of dried feces
T = Duration of treatment
A = Average larval weight during the treatment (initial larval weight + final larval weight)/2

2.6 Statistic analysis

The feeding activity parameter was subjected to an analysis of variance (ANOVA) test, specifically Duncan's post hoc test at a significance level of 5%, using SPSS release 22. This analysis helped determine the optimal formulation ratio and concentration of bitter melon leaf ethanol extract, galangal leaf extract, and 1% agrestic adjuvant.

3. Result and Discussion

The mortality of insects treated with different concentrations of ethanol extracts from bitter melon leaves and galangal leaves, as well as the feeding activity with various concentrations and formulations of these extracts along with 1% agrestic adjuvant, yielded the following results:

3.1 Feeding activity (Nutritional Index) of insects

3.1.1. Feeding rate (RCR) and Growth rate (RGR)

Feeding activity (nutritional index) of insects: The feeding rate (RCR) and growth rate (RGR) decreased after treatment with all formulations and concentrations of ethanol extracts from bitter melon leaves, galangal leaves, and agrestic adjuvant (Figure 1).

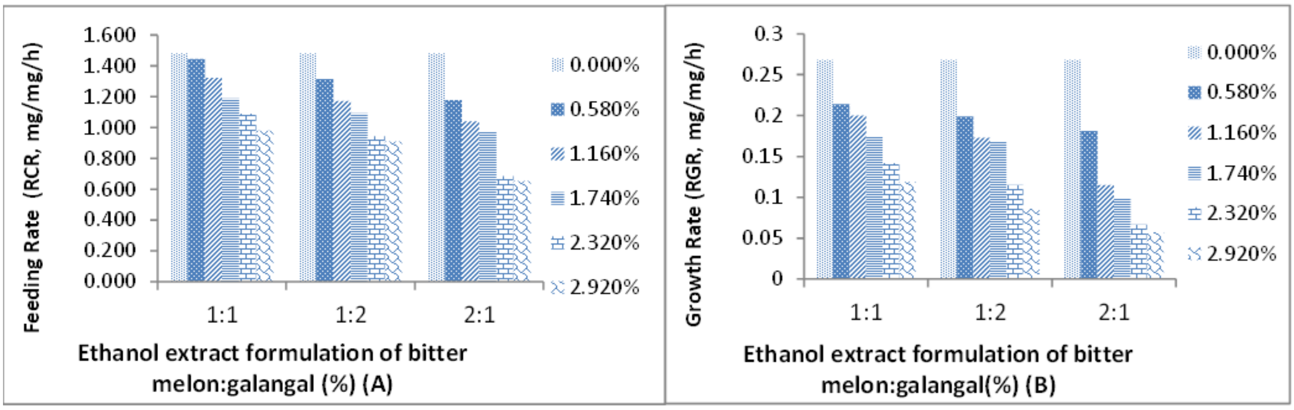

Figure 1. A. Feeding rate (RCR) and B. Growth rate (RGR) of insects in response to treatment with formulations and concentrations of ethanol extracts from bitter melon leaves, galangal leaves, and agrestic adjuvant.

From Figure 1, it can be observed that at treatment concentrations of (1.16%-2.92%) and formulations (1:1, 1:2, 2:1), there was a statistically significant decrease in RCR by (10.856%-33.917%; 20.971%-38.570%; 29.804%-43.628%), respectively, compared to the control RCR value. This decrease in RCR led to a decline in larval RGR by (25.373%-55.597%; 35.447%-67.910%; 57.089%-78.731%), respectively, and the decrease became more pronounced with increasing treatment concentrations. The best formulation and concentration were found to be 2:1 and 1.74%, respectively.

This effect could be attributed to the presence of secondary metabolites in the ethanol extracts of bitter melon leaves (*M. charantia*), galangal leaves (*L. indica*), and agrestic adjuvant, which have toxic properties towards the larvae. As explained by [9] and [10]. The presence of secondary metabolites in plants serves as a self-protective mechanism against insect attacks, and [11] and [12], some studies have shown that botanical insecticides can impact insect growth [13]. Demonstrated that ethanol extracts from a mixture of four plants with the addition of the miracle adjuvant can influence the growth of *H. armigera* larvae [14].

3.1.2. Ability to digest food and utilize it (ECD), ability to convert consumed food into usable nutrients (ECI), and ability to digest food (AD).

The test results as shown in Figure 3 indicate that all treatment concentrations and formulations of ethanol extracts from bitter melon leaves, galangal leaves, and agrestic adjuvant can influence the feeding activity of the pest insect, fifth instar larvae of *H. armigera*. This is evident in the form of a decrease in the efficiency of converting ingested food into usable nutrients (ECD), the efficiency of converting digested food into usable nutrients (ECI), and the ability to digest food (AD).

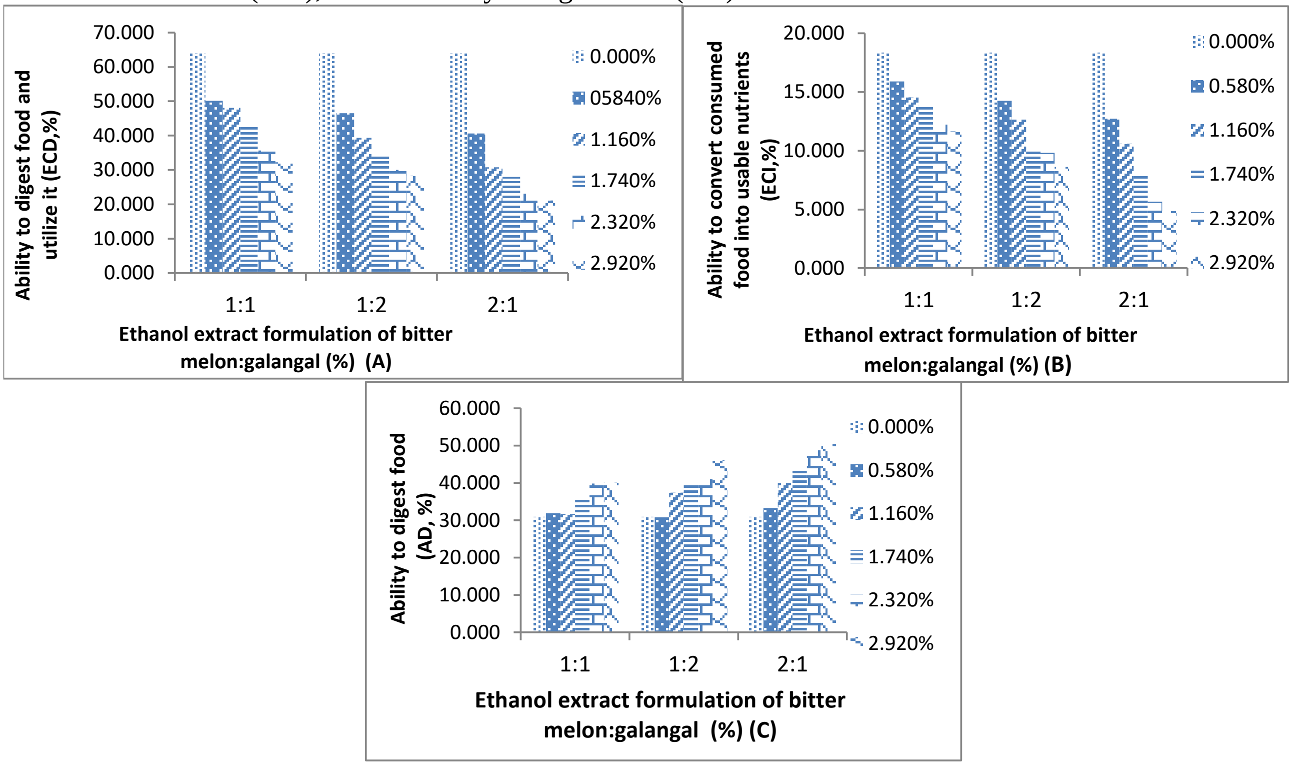

Figure 2. (A) Ability to digest food and utilize it (ECD), (B) ability to convert consumed food into usable nutrients (ECI), and (C) ability to digest insect food (AD) of fifth instar larvae of *H. armigera* on food treated with formulation ratios (1:1, 1:2, 2:1) of ethanol extracts from bitter melon leaves, galangal leaves, and agrestic adjuvant.

The decrease in ECD and ECI occurred within the concentration range of 1.16% - 2.92% with formulations (1:1, 1:2, 2:1), with values of (24.805%-49.581%; 38.436%-55.773%; 51.890%-66.919%) for ECD and (20.857%-36.540%; 32.609%-58.493%; 42.329%-73.517%) for ECI, respectively. On the other hand, the value of AD increased by (2.425%-22.835%; 17.345% -32.809%; 22.567%-36.156%) with the best formulation and concentration being (2:1) and (1.74%), respectively, which affected the feeding activity of the insects.

At concentrations ranging from 1.16% to 2.92%, all formulations (1:1, 1:2, 2:1) significantly reduced the values of ECD and ECI while increasing the value of AD. This effect became more pronounced with the increasing concentration of the treatment, demonstrating that the given treatment concentrations were effective in influencing the feeding activity of the larvae, as indicated by the reduced RGR of the larvae. The decline in RGR of the larvae correlated with the decrease in ECD and ECI. In response to toxic compounds in their food, insects will exhibit compensatory responses, as explained by Simpson and Simpson (1990) [14]. Among these responses, insects may increase their AD value. Furthermore, as described by [10] and [15], various studies on nutritional index parameters have shown that botanical insecticides can affect insect feeding activity.

The disturbance in insect feeding activity is likely due to the botanical insecticides from bitter melon leaves and galangal leaves affecting the insect's digestive enzymes and detoxification mechanisms. [15] explained that secondary metabolites from Brassicaceae induce the activity of detoxifying enzymes in several Lepidopteran species such as Heliothis virescens Fabricius, Trichoplusia Hubner, and Anticarsia gemmatalis Hubner. Some other plants can also induce the activity of detoxifying enzymes, such as *Azadirachta indica, Curcuma longa, Acorus calamus* [16], *Azadirachta indica, Quassia amara, Cuorophia guianensis* [17], *mahogany, neem, tobacco* [18], and plants like *Nigella sativa, Aristolochia, Jatropha curcas* [19]

4. Conclusion

From this study, it can be concluded that the feeding activity of the insect is influenced by the treatment concentrations and formulations of ethanol extracts from bitter melon leaves (*M. charantia*), galangal leaves (*L. indica*), and agrestic adjuvant, resulting in a decrease in feeding rate (RCR) and growth rate (RGR). Additionally, the ability to digest food and utilize it (ECD) and the ability to convert consumed food into usable nutrients (ECI) decrease, while the ability to digest food (AD) increases with effective formulations and concentrations in the treatment of (2:1), (1.74%).

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