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Beauveria bassiana FUNGUS AS A BIOLOGICAL ALTERNATIVE FOR THE CONTROL OF *Bactrocera carambolae* ON CHILI PLANTS

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Abstract

Chili plants are an important horticultural crop for the Indonesian population. Still, in the context of pest control, the use of insecticides to manage the OPT is proving to be increasingly problematic for the environment and human health as a result of their ability to decimate microscopic organisms present in the soil so that as decomposers or decomposer microorganisms and earthworms perish, the soil would ultimately become more barren. Therefore, it needs to be overcome by finding other alternatives that are more environmentally friendly and reduce the negative impact of pesticides. This study aimed to determine an environmentally friendly alternative biological control using the Beauveria bassiana fungus. This study used an experimental method with five treatments and three replicates, notably spore concentration using B. bassiana 6g, 7g, 8g, 9g, and control. The use of this fungus is simple and does not incur significant costs. From the results of data collection, the Beauveria bassiana fungus is effective in killing carambolae with a fast mortality rate at a concentration of 9 g/500 ml of water (86.7%), and the slowest concentration is at 6 g/500 ml of water (63.4%).

Keywords: *Beauveria bassiana,* Control, *Bactrocera carambolae*

INTRODUCTION

The annual cayenne pepper plant (*Capsicum frutescens L*) is a species of the eggplant family. Both lowland and highland locations may successfully cultivate this shrub. This plant has a spicy flavor because it contains the key compound capsaicin, which, when combined with other spices like ginger and lemongrass, may produce a spicy flavor and a warming sensation (Abidin *et al.,* 2021). Besides serving as a food spice, chili peppers' main purpose is to include vitamin B6, folic acid, and potassium, which can protect us from heart disease. Chili plants are one of the vegetable commodities that are highly significant for the people of Indonesia. The function of cayenne pepper is to keep blood pressure in the body stable so that the heart can work optimally.

Around 800,000 tons per year, or 66,000 tons per month, are needed to meet the demand for chili in major cities with a population of one million or more. Over the past five years, around 6 tons/hectare of

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chili have been produced nationally. The chili harvest area needs roughly 11,000 ha per month to satisfy the monthly needs of metropolitan residents (Anwarudin *et al.*, 2015). The intrusion of pests and diseases on chili plants, such as fruit flies, is one of the factors that influence production; however, farmers' efforts as the primary producers to increase crop production to meet market demand are typically hindered and even experience a drastic decline because it is influenced by several factors (Bactrocera carambolae).

B. carambolae and B. dorsalis, two species of fruit flies, prey on chili plants (Sahetapy *et al.*, 2019). *B. neocoknata* belongs to the *B. dorsalis* group and has an inbred body that is somewhat similar to but not identical to the *B. carambolae* and *B. papaya* species (Wangi, 2017). *Bactrocera carambolae,* or fruit fly, is a genus of the insect class of the anthropod phylum, which is part of the kingdom of Animalia and lacks a spine, also known as an invertebrate (Nurfahrida, 2017). Five categories make up the classification of fruit flies, including *Bactricera carambola*, which includes a black band along the costal and anal lines, and the tip of the wing is curved like a fishing rod. Black-colored lines form a distinct T-shaped pattern on the abdomen. *Bactrocera albistrigata* has wings with a blackish-brown band running between the r-m and dmcu and a very narrow costa band up to the apex. A large black pattern is on the lateral side of the abdomen. *Bactrocera umbrosa,* three bands that extend from the coastal margin to the underside of its wings, make up its wings. Abdomen The color is brownish yellow without a T pattern. *Bactrocera papaya* has exceptionally transparent wings with black stripes on the costal and anal lines—transverse lines in the triple tergites and the abdomen. *Bactrocera cucurbitae* has clear wings, a brown stripe from the coastal line to the apex, and a rounded costa on the back.

One of the main pests of chili plants is the fruit fly or *Bactrocera carambolae*. It is believed that it primarily targets more than 100 different kinds of horticulture crops. Attack vigor can reach 100% in densely populated areas. The fruit fly thus draws interest in programmatic control. Fruit flies typically prey on fruit during the wet season and target newly calved fruit. Fruit flies will land on the target and then oviposit into the fruit flesh to lay their eggs. Fruit that has recently been pierced will be challenging to control as it only bears tiny black specks as markings (Sahetapy *et al.,* 2019). Biological control is an activity that farmers can do in controlling plant pest organisms (OPT) by utilizing microorganisms or natural enemies that are around us.

Applying microorganisms to manage plant pest organisms is known as biological control (OPT). Using biological agents, such as *Beauveria bassiana,* is one of the things that can be done. *B. bassiana,* a fungus among insect pests, can cause white muscardine and produce white mycelium and conidia (spores). *Beauveria bassiana* is one of the entomopathogenic fungi that comprise PHT's natural adversaries. Numerous research studies have thoroughly established *B. bassiana's* efficiency in controlling some insect pests.

The purpose of the study was to determine the signs of Bactrocera carambolae on chili plants brought on by *Beauveria bassiana*, as well as the impact of the fruit fly-transmitted *Beauveria bassiana* fungus on chili plants (*Bactrocera carambolae*).

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RESEARCH METHODS

This research will be conducted in the neighborhood of Jl. Tonsaru, Tondano District, Minahasa Regency, North Sulawesi Province. The research will be conducted in September-October 2022. The materials used in this study are Beauveria bassiana stater, 75% alcohol, chili plants, rice, and water. The tools used include jars, tablespoons, pots, knives, cloth, stapler, scissors, machetes, cameras, clear plastic, raffia rope, measuring cups, aluminum foil, label paper, a hand sprayer, and writing instruments. This research will be conducted in several stages. These stages are described as follows:

Propagation of Beauveria bassiana fungus. After being cleaned, the rice was soaked in water for around 24 hours before drying. Clean, dry rice is placed in plastic bags containing 100 grams of rice per bag and sanitized by steaming it in a steamer for less than two to three hours. It is sterilized, cooled, and then placed in a jar already cleaned with alcohol. One tablespoon of B. bassiana Stater should be placed into the plastic-filled rice solid medium before being sealed up firmly with a funnel to prevent contamination. It was then moved nearer to the candle/bunsen lamp. The fungus's name and the date of its propagation were written on the bag's label (Wowiling *et al.*, 2015). Furthermore, the plastic is shaken to evenly distribute the fungal spores on the rice media, and it is then kept at room temperature for about two weeks until mycelium forms on the surface of the rice (Siluh *et al.*, 2012). Moreover, it was then catching fruit flies using fruit fly traps.

Stages of insecticide manufacturing. The weights of *B. bassiana* grown on rice media are 6g, 7g, 8g, and 9g. Then, 500 cc of water is added to each weighed media, combined with a stirring rod, and filtered to separate the rice from the water before being deposited in a hand sprayer. Biological insecticides are prepared for use as plant sprays (Wowiling *et al.*, 2015).

Application of Beauveria bassiana on chili fruit. Direct application is made by spraying all plant parts, particularly the leaves, and fruit. Observation under a Microscope. Infected fruit flies were observed under a microscope because the size of fruit flies and hyphae is very small with four times magnification. Data were collected by observing chili fruit plants; observations began after application to see fruit fly mortality. The percentage of fruit fly mortality is calculated using the formula:

$$P = \frac{n}{N} X\ 100\%$$

Such that:

P = percentage of mortality

n = number of insects that died

N = number of insects observed

The data obtained were then analyzed using Anova (Analysis of Variance) and then continued with the BNT test to see any differences between treatments.

RESULTS AND DISCUSSION

The results of B. carambolae mortality data caused by B. bassiana can be seen in Table 1. below.

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Table 1. Mortality of Bactrocera carambolae

Treatment	Repeat			Total
	U1 500ml	U2 500ml	U3 500ml	
Control	0	0	0	0
P1 6g	6	7	6	19
P2 7g	8	6	7	21
P3 8g	7	8	8	23
P4 9g	8	9	9	26
Total	29	30	30	**89**

These results show that B. bassiana effectively kills B. carambolae with mortality in each treatment. The highest mortality occurs at a concentration of 9g/500 ml of water (86.7%), then followed by a concentration of 8g/500 ml of water (76.7%) and a concentration of 7g/500 ml of water (70%). The slowest mortality occurs at a concentration of 6g/500ml of water (63.4%), while in the control treatment, no mortality occurs. Furthermore, this mortality was tested to see the real difference in the effect of B. bassiana on B. carambolae. The real difference was 6g/500 ml (63.4%) and 9g/500 ml (86.7%). The B. carambolae analysis test results can be seen in the ANOVA table below.

Table 2. Variance Tests of the Effect of Giving *Beauveria bassiana Against Bactrocera carambolae*

Source of diversity	Free Degree (DB)	Sum of Squares (JK)	Center Square (KT)	F Calculate 0,05	F table
Treatment	t – 1 4	JKP 193	KTP = $\frac{JKP}{DBP}$ 123,25	$\frac{KTG}{KTP}$ 397,52	3,48
Error	t (r – 1) 10	JKG 490.380	KTG = $\frac{JKG}{DBG}$ 49.038		
Total	tr – 1 14	JKT 490.873			

Description:

F calculate > F table

Ho is rejected and the effect is significantly different

Furthermore, further tests were carried out using the BNT test to see any differences between treatments. After getting the BNT value, the next step is to provide BNT notation which can be seen in Table 3. below.

Table 3. BNT notation

Treatment	Average	Notation BNT
6 g	7	a
7 g	7	a
8 g	7,67	a
9 g	8,67	a

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The application of B. bassiana at various concentrations substantially impacts fruit fly mortality, based on the ANOVA test (B. carambolae). This is because fewer spores that infect fruit flies' bodies result from lower spore densities caused by lower B. bassiana doses. Because of the tiny poison generated and poor germination power caused by low spore density, B. bassiana takes longer to kill fruit flies.

Ferron (1980) in Rosmiati (2018) state that the successful use of B. bassiana in pest control is partly determined by the density of spores and the number of those that germinate on the insect's body, so the chances of B. bassiana killing insects will also be faster, but if on the contrary the lower the density and germination, the chances of B. bassiana killing will also be slower.

P = n/N X100%

P = 89/120X100%

= 1,35%

Symptoms of *Beauveria bassiana* fungus attack on *Bactrocera carambolae*

Observations of the symptoms of *B. bassiana* fungus attack on B. carambolae showed that the sample of test insects had a change in body color in fruit flies, from a yellowish color (Suharsono & Nuryadin, 2019) to a dark brown color with a stiff body.

The poison produced typically causes damage to the tissue as a whole, which results in insect death. *Beauvericin* is a toxin produced by the fungus B. bassiana (Soetopo & Indrayani, 2007). The host insects' epidermis, digestive system, and spiracle apertures are all entry points for this fungus. Fruit flies with the B. bassiana fungal infection, and those that naturally perish differ (picture 1).

Picture 1. *Bactrocera carambolae*

The preponderance of the infected fruit flies in this investigation was discovered to have no fungal mycelium growing outside the afflicted body. According to Kumendong (1995), which cited Bell (1977), pathogenic fungi can kill insects through various processes, including the creation of toxins.

Toxin production has been studied in B. bassiana, where this toxin compound can weaken the host after attacking the body organs and then damaging the hemolymph to inhibit metabolic processes in the insect body. By attacking the body organs and hemolymph, the activities of infected insects will usually stop eating, so they become weak and further accelerate the death process.

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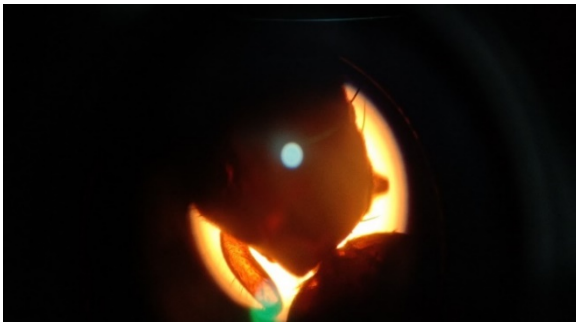
When the pathogenic fungus B. bassiana infects an insect, it can kill it. However, the formation of spores on the insect's body is not always present (Soetopo & Indrayani, 2007). A 4x magnification microscope will then study the infected fruit flies. White fungal mycelium can be seen growing on the body of B. carambolae (Picture 2).

Picture 2. Infected *Bactrocera carambolae*



Picture 3. Non-infected *Bactrocera carambolae*

Effect of *Beauveria bassiana* Fungus on Mortality of *Bactrocera carambolae*

The mortality of *B. carambolae* is affected by the application of *B. bassiana* fungus in various concentrations. The typical percentage of bauh fly mortality begins on day four following treatment and does not manifest itself until days 1–2 after application, as seen in Table 1.

On the fourth day following application, fruit fly mortality started to show overall. This occurs because the pathogenic fungus kills slowly, causing the insect's activity to decline and its movement to slow. Additionally, Poinar and Thomas (1984) in Komendong (1995) stated that the initial symptoms of pathogen infection in infected insects are insects that look weak, have decreased endurance, and move inactively. Compared to the control treatment, where fruit flies continued to behave normally after 24 hours of application, this drop in fruit fly activity started to show.

Steinhauss (1949) in Wowiling *et al.* (2015) claimed that B. bassiana's infection process against insects is more effective with conidia than hyphae. The test insects, however, may potentially perish due to the hyphae. The four main routes by which a fungal infection occurs are through the integument, trachea, wound, and digestive tract. The most precise method involves the infection process in A. craccivora and direct access to the integument. Generally speaking, the procuticle and epicuticle are the

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two layers of integument through which the process of fungus infection of the body wall must pass.

The *B. bassiana* fungus penetrates its host's body, reproduces in one or more host tissues, and then contacts and infects a new host. This is how it infects the body of the insect. Moreover, a fungal inoculum linked to the host insect's body can sprout, grow into a sprout tube, and pierce the insect's cuticle. Enzymes or poisons are secreted to perform mechanical or chemical penetration. Beauveria poisons released by the fungus will harm the insect's bodily tissues. The insect will pass away in just a few days. The fungus's mycelia will spread throughout the entire insect's body.

CONCLUSION

Symptoms of B. bassiana fungus attack on B. carambolae showed that the test attack sample changed skin color with a stiff and hardened body and overgrown with white mycelium on the body surface. The effect of Beauveria bassiana fungus on Bacrocera carambolae showed killing effectiveness with a fast mortality rate at a concentration of 9g/500 ml of water (86.7%).

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