ISSN: 2053-406X(Print)
ISSN: 2053-4078(Online)

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# European Journal of Biology and Medical Science Research

Vol 5, Issue 5, August 2017

editor.ejbmsr@ea-journals.org

European - American Journals

# CONTACTS:

Tel : +44(0)1634 560711
Fax : +44 (0)1582 515277

**Email:**
info@ea-journals.org
ecrtdresearch.team@ea-journals.org

**Address 1:**

European Centre for Research, Training and Development (ECRTD)
# 3 BAKER Street
Luton, Beds
LU1 #PX
United Kingdom

**Address 2:**

#13 Duncan Rd
Gillingham, Kent
ME7 4LA
United Kingdom

**ISSN: ISSN 2053-4019(Print)**
**ISSN: ISSN 2053-4027(Online)**

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European Journal of Biology and Medical Science Research
Vol.5, No.5, pp.38-45, October 2017
Published by European Centre for Research Training and Development UK (www.eajournals.org)

# THE RESEARCH OF COFFEE QUALITY DUE TO THE ATTACK OF COFFEE BORER PESTS BANANA HAMPEI TO GET A BIG PROFIT IN MANDAILING NATAL, INDONESIA

**Ika Rosenta Purba**

Biology Department, FKIP Faculty, Simalungun University (USI), Siantar, Indonesia

**ABSTRACT**: *The use of entomopathogen as a controlling agent is one way to avoid the negative impact of chemicals on the environment. In Indonesia in the 19th century the use of entomopathogenic fungi which is one of the important elements in biological control began to grow rapidly, especially on plantation crops. The combination of chemical compounds contained in coffee beans greatly affect the taste of coffee while the H. hampei attack can cause the defective coffee beans and also negatively affect the composition of chemical compounds contained in coffee beans, especially in caffeine and reducing sugar.*

**KEYWORDS**: Coffee Quality, Pest, Big Profit, Fungi

## INTRODUCTION

Today, the farmers still use insecticides to overcome the decrease in productivity and quality of coffee, so the killing of natural enemies such as *Heterospilus coffeicola* and *Cephalonomia stephanoderis Betr* that live in the same ecosystem as *H. hampei* and the use of insecticides can leave residues on the product (Barerra et al. , 1990). Then thre will be pest resistance, environmental pollution, and the rejection of agricultural products due to the pesticide residues that exceed the tolerance threshold (Junianto & Sulistyowati, 2000). Deciyanto & Igaa (2007) also explain that pest control with chemical insecticides creates many environmental problems, especially low insect sensitivity to insecticides, the emergence of more harmful secondary pests, contamination of soil and water, and the danger of human poisoning in direct contact with insecticides chemistry.

The controls that are considered potential to overcome PBKo pest one of them is by using biological agents that have high effectiveness in controlling such as *Beauveria bassiana* (Wiryadiputra et al., 2008). Biological agents include predatory organisms, parasites, parasitoids, and pathogens. Some organisms that can act as biological agents include vertebrate animals, insects, nematodes, bacteria, viruses and fungi (Prawirosukarto et al., 2003).

The use of entomopathogen as a controlling agent is one way to avoid the negative impact of chemicals on the environment. In Indonesia in the 19th century the use of entomopathogenic fungi which is one of the important elements in biological control began to grow rapidly, especially on plantation crops (Junianto, 2000). If it is developed specifically through exploration and testing at the laboratory scale then the use of the fungus will be better (Haris and Kukuh, 2012).

Bioinsecticides that can be used to control pests are among others entomopathogenic fungi that are known to be effective as important plant pest control such as *Beauveria bassiana, Metarhizium anisopliae, Nomuraea rileyi, Paecilomyces fumosoroseus, Aspergillus parasiticus,* and *Verticillium lecanii.* But the lack of knowledge of farmers about the benefits



Print ISSN: ISSN 2053-406X, Online ISSN: ISSN 2053-4078

and efforts to maintain the viability and effectiveness of fungi in pest control, including the way of propagation, preparation and its application becomes a constraint in the utilization of various types of fungi (Prayogo, 2006).

**Theoretical framework**

Coffee belongs to a group of shrubs with the genus *Coffea*. Coffee belongs to the family *Rubiaceae*, subfamily *Ixoroideae*, and the Coffeae tribe (Penggabean, 2011). Based on the classification and botanical plant, the coffee plant is included in:

Kingdom : Plantae

Subkingdom : Tracheobiophyta

Sub Division : Magnolioppsida

Division : Spermatophyta

Class : Magnoliopsida

Subclass : Asteridae

Order : Rubiales

Family : Rubiaceae

Genus : Coffea

Species : Coffea arabica L.

**Coffee Fruit Bores (PBKo/Coffee Fruit Powder)**

In African countries, coffee ferment pests Coffee with the scientific name *Hypothenemus hampei* of the Order (Coleoptera: Curculionidae) is an endemic insect that is very damaging to coffee plants. Female insects make a hole in the coffee fruit to put and store the eggs. After hatching, the coffee beans will be fed by the larvae of the *H. hampei* insects, so that it decreases the yield and quality of coffee. Coffee fruit borer pests are found in Kona District on Hawaiian Island in August 2010 (Burbano et al., 2010).

The female *H. hampei* beetle attacks the young coffee fruit by groping into the coffee beans and laying around 30-50 eggs, the eggs hatching into a caterpillar. The factors affecting the development of pests are planting below 1,200 dpl height then the continuous fruit supply allows the continuous development of coffee fruit growers of the generation of generation and the wide of the shade which resulted in high humidity, this condition is an environment that is very suitable for the development of PBKo pest (Manurung et al., 2012).

The adult insects (beetles) are brownish-black, small, long for 2 mm female and 1.3 mm for male. This pest development system is throuh the adult insects lay eggs in the fruit that has hardened, the age of the stage of eggs is 5-9 days. The newly hatched larvae are clear white, and then turn into dirty white. The larva has no legs, and the larval stage is completed for 10-26 days. The prepupa period is 2 days and the pupa stadiuim is aged 4-9 days. The period of insect development from eggs is placed until the adult insect takes 25-35 days. This period of development is strongly influenced by temperatures which is generally associated with altitude.


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The higher the place, the lower is the temperature, the longer is the development of insects. The length of life of female insects is average 156 days while for male insects are maximum of 103 days (Santoso, 1993). The *H. hampei* insects enter into the coffee fruit by making a hole on the tip of the fruit around the disc, causing the fruit to break and fall. The severe attacks occurred in Java in 1929, resulting in a 40% reduction in yield. H. hampei insects can breed and live normally only in coffee beans. Arabica coffee (*C. arabica*) is the most susceptible to the attack of coffee pest, followed by Robusta coffee (*C. canephora)*, while Coffee Ekselsa (*C. excelsa*) and Liberica coffee (*C. liberica*) are the most resistant (Prayogo, 2006).

**Entomopathogenic Fungi**

Entomopathogenic fungi are the first microorganisms used in the control of biological insect pests. From the number of species that have been identified in association with insects, only 10 species have been used as bioinsecticides for pest control (Indrayani, 2011). Entomopathogenic fungi are heterotrophic microorganisms that live as insect parasites (Hawksworth et al., 1983), which is one bioinsecticide types that can be used to control plant pests (Prayogo, 2006). Entomopathogenic fungi belong to six groups of microorganisms that can be used as bioinsecticides that is fungi, bacteria, viruses, nematodes, protozoa and ricketsia (Santoso, 1993).

Several types of entomopathogenic fungi are also known to attack insects and have been used to control the plant pests. The fungi include: *Metarhizium anisopliae, Beauveria bassiana, Paecilomyces sp., Verticillium sp.,* and *Spicaria sp* (Widayat & Rayati, 1993).Entomopathogenic fungi are one of the potential biological agents to control various types of pests such as soybean pest (Prayogo, 2006) cabbage pests (Trizelia, 2005) and banana cob borer germ (Hashim et al., 2005). The use of entomopathogenic fungi is a good process usage that already exists in the local ecosystem as well as by introduction from outside through inoculation technique (Lacey, 1997). Gillespie (1988), describes one of the most potent entomopathogenic fungi in the control of several species of insect pests is Beauveria bassiana. These fungi are reported as biological agents that are very effective in controlling several insect pest species including termites, white lice, and some beetles.

In Indonesia, the results of the B. bassiana study have also been widely published, especially from food crops to control soybean insect pests (*Riptortus linearis* and *Spodoptera litura*), rice ear bug (*Leptocorisa acuta*) (Prayogo, 2006), Plutella xylostella in vegetables (Hardiyanti, 2006).

## METHODOLOGY

**Place and time of research**

The research is conducted in Biology Laboratory, Faculty of Biology, University of Medan Area, (UMA), Medan, Indonesia and farmed coffee farm in Pakantan Village, Mandailing Natal in July 2016 until May 2017.

**Materials and Tools**

The material used is the soil samples obtained from around the community coffee plantation in Pakantan Village, Mandailing Natal, medium PDA (Potato Dextrose Agar), sterile aquades,


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spirtus, cotton, 70% alcohol, paper disc, tissue. The tools used in this research are laminar flow cabinet, autoclave, petri dish, bunsen, glass stirrer, tweezers, filter paper, incubator, microscope, glass cover, object glass, measuring cup, test tube, volume pipette, erlenmeyer, fugation centrals, razors, and plastic wrap.

**Implementation of Research**

This research is conducted in two phases, namely, exploration phase and testing phase in the field.

**Research Phase I: Exploration of Entomopathogenic Fungi**

The first stage of the research was conducted by exploring entomopathogenic fungi from coffee plantation land in Pakantan Village, Mandailing Natal. The experimental design used is vitro testing which is a completely randomized design (RAL) with 5 replications.

The soil samples are taken from the coffee plantation area in Pakantan Village, Mandailing Natal by digging at a depth of 5 - 10 cm around the roots of the plants along with the remnants of the plants, and then mixed until homogeneous, the samples taken into the plastic bag which are then taken to the laboratory to be isolated. The soil sample which is weighed 1 g then dissolved with 9 ml of water in the test tube. Soil solution is taken 1 ml with micro pipette, and then made series of dilution in storey tube reaction until 10-4. From each dilution series 1 ml is taken which is previously shaken by using a vortex for 30 seconds, then put in a sterile petri dish filled with 10 ml of PDA media to grow the pathogen (Haris & Hernowo, 2012). After the fungal colonies are formed (7 HSI) microscopic observations are conducted and the fungi are identified based on their morphological characteristics. The coffee fruit borer that will be used for laboratory testing is reproduced by collecting the coffee fruit borer contained in the coffee fruit by passing coffee fruit and taking H. hampei pest that has been collected from the field which is kept in a clean, ventilated plastic jar screen. Borer Pests are kept in the laboratory with a given coffee fruit.

**In Vitro Testing**

From the isolation results, it cannot be ascertained that the fungus is an entomopathogenic fungus. Therefore, to determine the entomopathogenic fungus, the isolated fungus needs to be inoculated on healthy *H. hampei* insects from the result of laboratory maintenance. A total of 10 test insects were immersed in the suspension of the isolated fungus of the same age, and then the insect is released back into a gauze-vented mask jar. After obtaining the isolated entomopathogenic fungi which resulted in the death of the H. hampei fruit coffee borer, the spore density testing is conducted to find the correct dose used in the field. The selected isolated entomopathogenic fungi are diluted with 107/mL, 108/mL, and 109/mL and 1010/mL density and then tested insects are put into the suspension solution of local isolated entomopatogen fungi and subsequently the insect is released back into a gauze vented mask. The observations are conducted 3 times starting from the time of 7 HSAs.

**In Vitro Observation**

The observations are conducted every 24 hours starting from the time of inoculation until 2 weeks. The dead insects are examined under a microscope, to ascertain the cause of insect mortality due to the isolated fungi or other causes. The percentage of larval mortality is calculated by using the following formula:


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$$M = A / B \times 100\ \%$$

Note

M = Percentage of mortality

A = Number of dead insects infected by fungi

B = Number of tested insects

The percentage of mortality obtained is then corrected by using the following formula (Abbott's, 1925):

$$P = \frac{P_0 - P_c}{100 - P_c} \times 100\ \%$$

Note

P = Percentage of tested insects that died after being corrected

P0 = Percentage of tested insects that died at the treatment

Pc = Percentage of dead insects in control.

**Research Phase II: Effectiveness Test of Entomopathogenic Fungi on Coffee Plant**

The second phase of research is testing the effectiveness of entomopathogenic fungi found from the isolation results in the laboratory and which has the potential as a controlling agent of coffee fruit pest borer. The experimental design used is a randomized block design (RAK) with 5 replications. The composition of the treatment combinations can be seen in the following table.

**Table. 1: Composition of Entomopathogenic Fungi Treatments**

| No | Treatement | Description |
|---|---|---|
| 1 | J | Entomopatogen Fungus |
| 2 | K | Control |

**Preparation of Sample Crops**

The determination of crop samples by using purposive random sampling method, plant samples selected from plantation community aged ± 3 years, plant samples used as many as 10 plants/treatments.

**Application of Entomopathogenic Fungi**

Entomopathogenic fungi that have a good influence on the decrease of the coffee fruit borer which has been tested in the laboratory in vitro is used as entomopathogenic fungus to be tested in vivo. The enhanced entomopathogenic fungi are multiplied on PDA media, the colonies formed subsequently suspended in sterile water at dilution 109, to obtain a suspension of the fungus which was then used for the application. The fungi applied to the coffee plants, each individual plant is given 200 mL of fungal suspension. The application of entomopathogenic fungus is conducted 3 times.



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**Disposal**

After application of entomopathogenic fungi, next the coffee plant is lid by using a translucent hood and has fine holes, at the bottom of the hood is tied by using a rapali rope.

**Observation**

**Coffee fruit attacked**

The observation is conducted 3 times, that is by counting the coffee fruit attacked before the application as comparison, then the attacked fruits are recalculated every 7 HIS to see the increase of attack.

## DISCUSSION

The isolation results of soil samples in PDA medium are obtained 10 isolated entomopathogenic fungi. For the result of isolated entomopathogenic fungus which are successfully grown on PDA media can be seen in figure1.

**Figure 1: Growth of Entomopathogenic Fungal Colonies Isolated from Soil on PDA Medium**

**a = hyphae and myceliac arises, b = soil samples**

Figure 1 above shows, the appearance of entomopathogenic fungi from soil that have been incubated in PDA media proves that entomopathogenic fungi are found on the soil. The virulent entomopathogenic fungi can be obtained from the target pests or from rhizosphere in the plant ecosystem where the pest is present, because the soil is a natural reservoir for entomopathogenic fungi (Nuraida & Hasyim, 2009). Deciyanto & Igaa (2008), state that epizootic fungus B. bassiana is easy to develop in all soil types because the soil is the main habitat, its application not only can be done through the surface of the plant but also through the irrigation system together with irrigation water.

As an insect pathogen, B. bassiana can be isolated naturally from plantation or from soil. Its epizootical in nature is strongly influenced by climatic conditions, especially requires a humid and warm environment. In some countries, this fungus has been used as a biological agent controlling a number of insect pests ranging from food crops, ornamental, fruits, vegetables, beans, horticulture, plantations, forestry to desert plants (Sabbahi, 2006).



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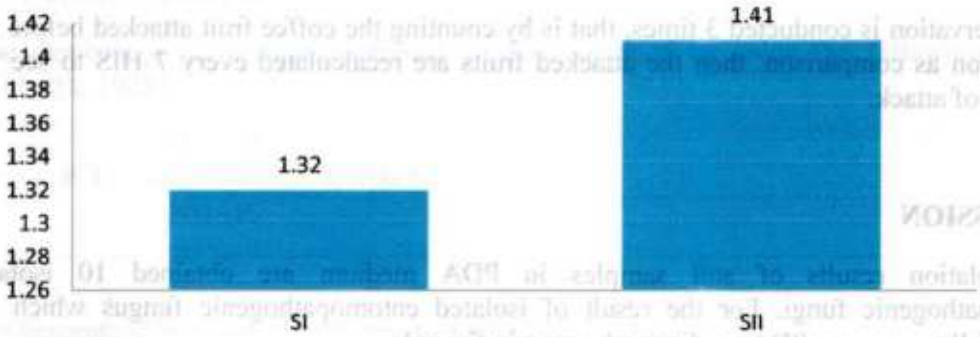
**a. Caffeine levels**

Based on the percentage analysis of caffeine content of the coffee beans, it shows that the attack of *H. hampei* pest can cause the increase level of caffeine in the coffee beans. The average percentage of caffeine content of the coffee beans after tested can be seen in figure 2.

**Figure 2: The Percentage of Caffeine Content of Coffee Beans**




The figure above shows that, the caffeine content of coffee beans attacked by H. hampei (S II) is higher than the caffeine content of coffee beans that are not attacked by *H. hampei* (SI). The combination of chemical compounds contained in coffee beans greatly affect the taste of coffee while the *H. hampei* attack can cause the defective coffee beans and also negatively affect the composition of chemical compounds contained in coffee beans, especially in caffeine and reducing sugar (Tobing et al., 2006). *H.hampei* is one of the main causes of declining production and quality of coffee in Indonesia, even in all coffee-producing countries. The resulting damage to the fruit becomes undeveloped, it turns reddish yellow and eventually falls that cause a decrease in the number and quality of the results (Hayata, 2016).

## CONCLUSIONS

There is a decrease in coffee quality due to H. hampei attack. The combination of chemical compounds contained in coffee beans greatly affect the taste of coffee while the *H. hampei* attack can cause the defective coffee beans and also negatively affect the composition of chemical compounds contained in coffee beans, especially in caffeine and reducing sugar

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