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Entomopathogen Bacteria as Biocontrol Agents of Pest Insect

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ABSTRACT

Insects are animals that have the potential to become pests. One way to control environmentally friendly insect pests is by using entomopathogenic bacteria. Bacteria are one of the biocontrol agents found in various places and have mass production faster than other microorganisms. This study aims to explain the types of entomopathogenic bacteria that act as insect pest controllers for agriculture. The type of research used in this study is Systematic Literature Review. The data was obtained from analyzing 80 articles related to issue 2014-2022. The article is collected by searching the databases Google Scholar and ERIC. The results showed that there were several types of pathogenic bacteria against insects, including Bacillus thuringiensis against cockroaches, Serratia entomophila against stem planthoppers, Serratia proteamaculans against the Coconut Beetle, and Serratia wilting against the Coconut Beetle
Keywords: Entomopathogenic Bacteria, Bacillus thuringiensis, Serratia entomophila, Serratia proteamaculans, dan Serratia marcescens.

ABSTRAK

Serangga merupakan hewan yang berpotensi menjadi hama. Salah satu cara pengendalian serangga hama yang ramah lingkungan yaitu dengan menggunakan bakteri entomopatogen. Bakteri merupakan salah satu agen biokontrol yang terdapat di berbagai tempat dan memiliki produksi massa yang lebih cepat dibandingkan mikroorganisme lain. Penelitian ini bertujuan untuk menjelaskan jenis bakteri entomopatogen yang berperan sebagai pengendali serangga hama pertanian. Jenis penelitian yang digunakan pada penelitian ini adalah Systematic Literature Review. Data yang digunakan diperoleh dari hasil analisis 80 artikel terkait terbitan 2014-2022. Artikel yang digunakan dikumpulkan dengan mencari pada database Google Scholar dan ERIC. Hasil penelitian menunjukkan bahwa terdapat beberapa jenis bakteri patogen terhadap serangga, diantaranya Bacillus thuringiensis terhadap Kecoa, Serratia entomophila terhadap Wereng Batang, Serratia proteamaculans terhadap Kumbang Kelapa, dan Serratia marcescens terhadap Kumbang Kelapa.
Keyword: Bakteri Entomopatogen, Bacillus thuringiensis, Serratia entomophila, Serratia proteamaculans, dan Serratia marcescens

1. INTRODUCTION

Insects are living things with the most species on earth, green plants are the largest part of all terrestrial biomass. Most of the many species of insects that exist, eat plants. Thus, more than 400,000 species of plant-eating insects live from about 300,000 species of vascular plants. Pests are herbivores/phytophages that attack plants. Attacks vary, such as insects that eat plants directly or lay eggs on plant parts and become plant pathogens/vectors. Also there is damage that causes losses such as broken (Amrullah, 2019).

Efforts to increase crop production experienced problems due to weather conditions, plant pests (PTP), and fluctuating price fluctuations. Pest disturbances in particular can cause yield losses, for example, Hypothenemus hampei (coffee berry borer) on coffee trees causes crop losses of up to 25%. Conopomorpha cramerella Snellen (cocoa pod borer) reaches 90% and cocoa pod borer can reduce palm oil production by up to 40% (Behrens et al., 2014).

The indiscriminate use of chemical pesticides will have a negative impact on the economy, ecology and health. In addition, broad-spectrum insecticides can kill predators and parasites. This condition can cause serious problems, including the emergence and death of the Diadegma semiclausum parasite, which is the main component of cabbage IPM (Rahardjo et al., 2014). To overcome this resistance, alternative control efforts are needed, especially by using natural enemies such as insect pathogens (Virgianti, 2021).

Biological control is pest control using living organisms. Microorganisms can be used as biological agents, for example bacteria that cause insect diseases. The use of microorganisms (microbes) as biological control agents is limited, namely limiting the strains/types of bacteria that cause insect disease, bacterial strains that are applied to areas that have not been explored often fail because they are not adapted. (Sihombing et al., 2014). The use of bacteria from one location as a biological agent has the advantage of being more adapted to the environment than bacteria from another region. In addition, it is necessary to test the efficacy of each isolate after exploration before it is developed and used widely as a control agent or growth agent for insect pathogens. (Zulfiana et al., 2017).(Mailissa et al., 2017)

Bacteria are a group of organisms found in plant parts and soil in agricultural areas. Insectivorous bacteria have specific effects on target insects. Bacteria as biological control agents have several advantages, including their ability to spread widely in various locations, mass production is faster and easier than other microorganisms. Some bacteria cause disease in insects (Suhartono et al., 2022). Pathogenic bacteria can enter the body of insects through food or through transit of sick insects. Therefore, bacteria capable of biological control of larvae can be obtained from infected dead insects (S. Kahar et al., 2019).

Entomopathogens are a new solution for farmers because they are considered as insect pathogens that are effective in controlling a number of important crop pests. Primarily as a horticultural product. This study aims to identify insect pathogenic bacteria as biological control agents against insect pests.

2. METHOD

This study uses the Systematic Literature Review method. Systematic Literature Review is a method of examining data by summarizing the main research findings which present more complete and balanced facts. The document review process is carried out in a structured manner through the stages of data collection, data reduction, analysis, and drawing conclusions.

This research is reviewed from various previous research articles that have been published nationally in accredited scientific journals. Article criteria used to obtain data were collected by searching for articles in the Google Scholar and ERIC databases using the keywords Entomopathogenic bacteria and entomopathogenic bacteria against insect pests. The article consists of 80 national and international articles published in 2014-2022. The research results are then used as discussed in this article.

3. RESULTS AND DISCUSSION

Based on the results of the literature review, it shows that the articles analyzed in the 2014-2022 publications regarding entomopathogenic bacteria against insect pests. The analysis of the article is used by the researcher to display the data and is presented in table 1 below:

Table 1. Entomopathogenic Bacteria against Insect Pests

No.	Entomopathogenic Bacteria	Pest Insects
1.	*Bacillus thuringiensis*	Cockroach (*Periplaneta Americana* and *Blatella germanica*)
2.	*Serratia entomophila*	Brown Planthopper (*Nilaparvata lugens*)
3.	*Serratia proteamaculans*	Coconut Beetle (*Brontispa longissima*)
4.	*Serratia marcescens*	Coconut Beetle (*Brontispa longissima*)

Bacillus thuringiensis is a gram positive bacterium which has purple cells, rods and oval endospores. Bacillus thuringiensis is a commonly used control agent because it is non-toxic to non-target organisms (Wibowo, 2017). Bacillus thuringiensis has the potential to be a biological control agent for controlling B. germanica and P. americana. This user fulfills the requirements as a microbial biocontroller against pests and plant vectors for the rapid spread of the use of this biopesticide. Indeed, in B. thuringiensis, several genes encode proteins that are resistant to several pests (Saraswati et al., 2019).

B. thuringiensis is an example of a bacterium that can act as a biopesticide in pest control. This biological agent is toxic to the stomach, so if it enters the digestive tract it will cause damage. These bacteria can produce protein crystals that have toxic content (Pujiastuti, 2018). B.thuringiensis as a true biological agent is used in many studies and proven effective. This has been proven in a study by Adam et al (2014), stating that B. thuringiensis biopesticides can damage the digestive tract and interfere with insect appetite, causing insects to die and smell bad. Prototoxins produced by bacteria can injure the intestinal wall of insects (Sutriono & Zahar, 2022).

B. thuringensis is a stomach poison, the bacteria must enter the stomach of the larvae, namely the pest must eat the fiber coated with B. thuringiensis bacteria (Candra et al., 2018). Bacterial infection larvae are characterized by dark brown color and intestinal paralysis, other signs observed are reduced or even stopped larvae feeding activity, larvae weaken, less sensitive to touch. The larvae that cause infection in B. thuringiensis do not kill the larvae immediately, these larvae can still survive and become pupae until they become adults. Infected insects are often small, have a shorter lifespan, are deformed, and are sterile (Wibowo, 2017).

Cockroaches are disease-carrying insects that have a negative impact on health. Pest control using too much pesticide can cause residues in the environment and pest resistance. Characteristics of death due to the toxic effects of the stomach caused by B. thuringiensis isolates cause damage to the cockroach's middle stomach so that it can disrupt the pest's metabolism. The death process experienced by the test insects causes the insects to consume protein crystals belonging to insect pathogenic bacteria, B. thuringiensis, where the protein crystals dissolve in the insect's digestive system and the insect's protease enzymes will help break down these crystals. During the test period, the bacterial spores will germinate and will damage the test insect's intestinal membrane (Rini et al., 2016).

Serratia is a Gram-negative bacterium in the Enterobateriaceae family that has flagella, making it move. Serratia entomophila is the causative agent of amber disease and is used as a biopesticide in exotic pastures to control endemic pest larvae. Serratia proteaculans is associated with a specific chronic infection caused by the larvae, which can take 2-3 months after ingesting the bacteria before the larvae die. Due to weakening of the host's gut over time, bacteria eventually enter the haemocoel causing septic death (Vaughan et al., 2022).

The white or brown planthopper (Nilaparvata lugens Stal.) (Hemiptera: Delpachidae) is a dangerous insect that attacks most rice varieties causing mild to severe damage, even crop failure. Leafhoppers can be dangerous because they are flexible and can adapt to the environment, as well as being carriers of viruses for a number of diseases. Planthoppers damage by sucking the liquid in the stems so that the rice withers. Planthopper attacks are marked by rice leaves that turn green and then turn yellow-brown (Sianipar et al., 2017).

In New Zealand, non-spore-forming pathogenic insects from the genus Serratia, one of which is S. entomophila, has been successfully developed as an effective biopesticide to control grass moth (Costelytra zealandica). Non-spore-forming bacteria that are not actively invading invade the casing when the insect is stressed or injured. The virulence factor of S. entomophila is contained in its 150 kb plasmid. The S. entomophila plasmid carries 4 genes that code for highly virulent insect venom. Some of these genes can be a source for the development of leukocyte-resistant rice with a molecular approach (Priyatno et al., 2011).

Serratia proteaculans is a faculative anaerobic Gram-negative rod-shaped bacterium. S. proteaculans was also found to cause amber disease. S. proteamaculans resides in the S. liquefaciens complex. It is non-pigmented and produces DNA, gelatinase and lipase. These are lysine decarboxylase and ornithine decarboxylase positive. Serratia proteaculans is indole, urease, and arginine dihydrolase negative. Serratia proteaculans strain 94 which is called protealysin. This protein is encoded by 341 amino acids and is shown to have high homology with thermolysin-like proteinases. . Serratia proteaculans is able to be a biocontrol for insect pests.

Serratia proteaculans acts as an insect pathogen to control coconut pests Brontispa longissima Serratia sp. infection. The silkworm, Bombyx mori inhibits coagulation, especially in the wound area, and reduces resistance by reducing the adhesion of insect immune cells. Likewise with Gallaria mellonella larvae can cause the larvae to turn purple in color, move slowly and eventually die(Rahma et al., 2019).

Serratia marcescens, or red bacteria (BM), is a gram-negative insect pathogenic bacterial species in the Enterobacteriaceae family. S. marcescens isolated from brown tuber (WBC) was characterized by the presence of convex colonies and the production of red pigment. The red pigment produced by S. marcescens is a secondary metabolite and is called prodigiosin from the tripyrrole family (Manzila et al., 2016). Colonies of S. marcescens have a convex shape and are red in color due to the production of the pigment prodigiosin. Bacteria with corresponding colonies by Gram stain method (Devina et al., 2020).

This bacterium is mobile because it has peri-rich flagella (Wicaksono et al., 2017). (Wicaksono et al., 2017). S. marcescens is commonly found in soil, leaves, water, and the bodies of insects and humans. Because it can live in extreme temperatures between 50 and 40 °C and a pH between 5 and 9, this bacterium is facultative anaerobe. These bacteria are able to degrade various enzymes and have various biological activities such as antibacterial, anticancer, biosurfactant, and pharmaceutical ingredients. .

Possibility to create a new biopesticide based on S. marcescens with high activity against lepidoptera pests. However, the preparations had no harmful effects on non-target organisms, so we examined the cytotoxic activity of the isolate against mammalian epithelial cells, determining siderophore production, antimicrobial susceptibility, and presence of integrons in the S. marcescens genome. Several hydrolytic enzymes and secondary compounds produced by these bacteria make these bacteria a pathogen for insects. The existence of different species is thought to be responsible for the death of the larvae. S. marcescens bacteria are capable of releasing secondary compounds such as serralysin and prodigiosin. Other hydrolytic enzymes produced by S. marcescens are chitinase, protease and carbohydrase (S. Kahar et al., 2019).

Brontispa longissima is a pest on coconut plants which can cause leaf damage and economic loss of coconut yields. One of the most important pests that attack coconuts is Brontispa longissima, or sometimes known as 'dry beetle'. They will attack almost every stage of plant life, particularly those that have already started to produce. This is because every month new coconut leaves are produced morphologically in Brontispa's food source.

Symptoms of Brontispa longissima attack, prolonged movement characterized by brown staining observed on young leaves. Brontispa longissima larvae tend to be found indirectly on leaves that are still closed, which encourages the growth and development of Brontispa longissima larvae to the imago stage. The growth and development of Brontispa longissima larvae lasts for 52-60 days, resulting in destructive activity within a certain time. The active phase of the coconut tree attack is the imago. Therefore, it is necessary to anticipate so that the life cycle of Brotispa longissima in the larval stage can be reduced and the negative impact on the environment can be minimized to avoid attack and its spread. Environmentally friendly control of Brontispa longissima can be achieved through the use of biopesticides from the bacterial species Serratia entomophila and Serratia mascesce.

4. CONCLUSION

Based on the results of the literature review, it was concluded that entomopathogenic bacteria can be used as biocontrol agents against agricultural insect pests. The results showed that there were several types of pathogenic bacteria against agricultural insect pests, including bacillus thuringiensis against cockroaches, serratia entomophila against stem planthoppers, serratia proteamaculans against coconut beetles, and serratia marcescens against coconut beetle

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