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**REVIEW: CONTROL OF STRAWBERRY APHIDS  
(*Chaetosiphon fragaefolii*; Aphididae) THROUGH  
SUSTAINABLE NATURAL MATERIALS IN STRAWBERRY  
(*Fragaria x ananassa*) CULTIVATION**

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**ABSTRACT**  
Leaf aphid (*Chaetosiphon fragaefolii*; Aphididae) is one of the pests that attack Strawberry plants (*Fragaria x ananassa*) which can transmit infective viruses to Strawberry plants (*Fragaria x ananassa*). Symptoms caused by leaf aphids (*Chaetosiphon fragaefolii*) include sooty mold, dwarfed growth, twisted stems, curling, and yellowing. Farmers will suffer losses caused by the symptoms of leaf aphids (*Chaetosiphon fragaefolii*) such as significant decreases in Strawberry (*Fragaria x ananassa*) harvest yields. The methodology used in this article review is by conducting literature studies from various platforms such as Google Scholar, Science Direct, Bing AI, Publish or Perish, and SINTA from the Ministry of Education and Culture. The literature obtained consists of 60 journals discussing leaf aphids (*Chaetosiphon fragaefolii*) attacking Strawberry plants (*Fragaria x ananassa*), symptoms caused by leaf aphids (*Chaetosiphon fragaefolii*), and leaf aphid (*Chaetosiphon fragaefolii*) control methods. Then the literature obtained is summarized and organized using Mendeley. The aim of this literature study is to examine ways to control leaf aphids (*Chaetosiphon fragaefolii*) attacking Strawberry plants (*Fragaria x ananassa*) using natural materials. The results for controlling leaf aphids (*Chaetosiphon fragaefolii*) through natural materials are as follows: Entomopathogenic fungi: *Beauveria bassiana* and *Metarhizium* sp. Parasitoids: *Apanteles vargas*, Predators: Syrphidae family, Asilidae family, *Crius eximiosus*, *Cycloptera sanguinea*, *Eriopsis connexa*, and *Coleomegilla quadrijasciata*. Organic pesticides: neem leaves with a concentration of 35 (g/l of water) and mortality of 8.76 individuals, while papaya leaves using a concentration of 30 ml/liter of water.

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**KEYWORDS** – Aphididae; Control; Strawberry

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### ABSTRACT

Leaf aphid (*Chaetosiphon fragaefolii*; *Aphididae*) is one of the pests that attack Strawberry plants (*Fragaria x ananassa*) which can transmit infective viruses to Strawberry plants (*Fragaria x ananassa*). Symptoms caused by leaf aphids (*Chaetosiphon fragaefolii*) include sooty mold, dwarfed growth, twisted stems, curling, and yellowing. Farmers will suffer losses caused by the symptoms of leaf aphids (*Chaetosiphon fragaefolii*) such as significant decreases in Strawberry (*Fragaria x ananassa*) harvest yields. The methodology used in this article review is by conducting literature studies from various platforms such as Google Scholar, Science Direct, Bing AI, Publish or Perish, and SINTA from the Ministry of Education and Culture. The literature obtained consists of 60 journals discussing leaf aphids (*Chaetosiphon fragaefolii*) attacking Strawberry plants (*Fragaria x ananassa*), symptoms caused by leaf aphids (*Chaetosiphon fragaefolii*), and leaf aphid (*Chaetosiphon fragaefolii*) control methods. Then the literature obtained is summarized and organized using Mendeley. The aim of this literature study is to examine ways to control leaf aphids (*Chaetosiphon fragaefolii*) attacking Strawberry plants (*Fragaria x ananassa*) using natural materials. The results for controlling leaf aphids (*Chaetosiphon fragaefolii*) through natural materials are as follows: Entomopathogenic fungi: *Beauveria bassiana* and *Metarhizium* sp. Parasitoids: *Aphehinus varipes*, Predators: *Syrphidae* family, *Asilidae* family, *Orius insidiosus*, *Cycloneda sanguinea*, *Eriopis connexa*, and *Coleomegilla quadrifasciata*. Organic pesticides: neem leaves with a concentration of 35 (g/l of water) and mortality of 8.76 individuals, while papaya leaves using a concentration of 30 ml/liter of water.

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## INTRODUCTION

Strawberry (*Fragaria x ananassa*) is one of the favorite fruits in Indonesia. Although strawberries are not native to Indonesia, people often consume them in both raw and processed forms. Processed products derived from strawberries, such as syrup, jam, dodol, and strawberry juice, are popular (Amri, 2022). Strawberry plants originate from the American continent. According to Soviet botanist Nikolai Ivanovich Vavilov, who traveled through Asia, Africa, Europe, and America from 1887 to 1942, strawberries are believed to have originated from Chile. The first variety or seed of strawberries found in Chile is *Fragaria chiloensis* (L), known as Duchene or Chili strawberries (Sinaga & Laia, 2020). Therefore, considering the origin of strawberries (*Fragaria x ananassa*), these plants require a cool and humid environment. The suitable growing conditions include an average temperature ranging from 17–20°C, humidity of 80–90%, 8-10 hours of sunlight per day, and annual rainfall of around 600mm–700mm (Mahardika et al., 2023).

In Indonesia, the main areas for strawberry (*Fragaria x ananassa*) cultivation are Lembang, Ciwidey in Bandung, Cipanas in Cianjur, Tawangmangu in Karanganyar, Batu in Malang, Bedugul in Bali, Karangmulya in Garut, and Sawangan in Magelang (Hutajulu et al., 2018). The production of strawberries in Indonesia fluctuated from 2008 to 2017, showing a declining trend. It contributed to 73.32% of the total domestic strawberry production (Silaban & Trimo, 2021). In 2014, the harvest yielded 58,884 tons, while in 2020, strawberry production only reached 8,350 tons (Oktavia et al., 2022).

The decrease in strawberry production is influenced by Plant Pests (*Pest Organisms*) (Offayana et al., 2016). Pest attacks on strawberry plants (*Fragaria x ananassa*) can be observed in changes to leaves, roots, stems, and fruit (Efrilla et al., 2020). Identifying pests in strawberry plants is crucial to detect diseases early for early prevention before these pests spread. Failure to promptly identify and control strawberry pests can lead to losses for farmers (Dong et al., 2021). One of the pests in strawberry cultivation (*Fragaria x ananassa*) is the aphid, which belongs to the Aphididae family (Indira & Trimo, 2021).

Currently, the trend in pest control involves the use of synthetic pesticides, but the results obtained are often ineffective and even detrimental to humans and the agroecosystem environment (Sopialena et al., 2020). This is evident in the absence of natural enemies, leading to an increase in the number of pest insects, diseases, and even weeds tolerant to pesticides, as well as a reduction in natural enemies in cultivation habitats. Broad-spectrum chemical pesticides can have negative impacts on the environment, non-target insects, and human health due to resistance factors (Baroffio et al., 2018). Resistance to insecticides has been reported in 500 species of insects, 100 species of pathogens, 50 species of weeds, 5 species of rodents, and 2 species of nematodes. This number increases every year (Robika et al., 2019). The use of broad-spectrum chemical insecticides can result in the accumulation of pesticide residues in the soil, making them difficult to degrade. If consumed, fruits containing residues can cause various degenerative diseases such as cancer due to their toxic nature. Accumulated pesticides in the soil can lead to resistance in pests and soil damage (Patmawati et al., 2020). Therefore, sustainable alternatives for insect pest control are increasing, including biological control using

26 parasitoids, predators, and entomopathogenic fungi (Bischoff et al., 2023). The use of botanical pesticides provides an environmentally friendly alternative for controlling plant pests in strawberry cultivation (Hutapea et al., 2020).

## RESEARCH METHOD

15 The methodology used in this article review involves conducting a literature study from various platforms such as Google Scholar, ScienceDirect, Bing AI, Publish or Perish, and SINTA from the Ministry of Education and Culture. A total of 60 journals discussing the strawberry aphid (*Chaetosiphon fragaefolii*) attacking strawberry plants (*Fragaria x ananassa*), the symptoms of aphid infestation caused by *Chaetosiphon fragaefolii*, and the control of *Chaetosiphon fragaefolii* were obtained. The obtained literature was then summarized and organized using Mendeley.

## RESULT AND DISCUSSION

### BACKGROUND OF APHIDS

13 Aphids (Aphididae) are one of the pests that attack strawberry plants (*Fragaria x ananassa*) (Indira & Trimo, 2021). Aphids (Aphididae) are pests classified under the order Hemiptera (Puspita et al., 2022). They are considered one of the most destructive groups of pests worldwide. Approximately 450 out of more than 5,000 plant species have been documented, with about 100 belonging to the Aphidinae subfamily and are considered economically significant. Most aphid species feed on one or more plant species, but only 18 species are considered truly polyphagous (Bass & Nauen, 2023). Polyphagous aphids are more likely to transmit plant diseases (Maharani et al., 2018).

8 In the Aphididae family, a common pest found on strawberry plants (*Fragaria x ananassa*) is *Chaetosiphon fragaefolii*. This species can transmit viruses that infect strawberry plants. The transmitted viruses include yellow edge virus (*Potexvirus; Alphaflexiviridae*), streak virus (*Secoviridae*), Strawberry Crinkle Virus (*Fragaria x ananassa*) (*Cytorhabdovirus; Rhabdoviridae*), and Strawberry Vein Banding Virus (*Fragaria x ananassa*) (*Caulimovirus; Caulimoviridae*) (Bonneau et al., 2019).

### MORPHOLOGY



Figure 1. Alata type



Figure 2. Aptera type

3 Review: Control of Strawberry Aphids (*Chaetosiphon Fragaefolii*; *Aphididae*) Through Sustainable Natural Materials In Strawberry (*Fragaria X Ananassa*) Cultivation

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***Chaetosiphon fragaefolii***

According to the study by (Rondon & Cantliffe, 2004), the morphology of the aphid *Chaetosiphon fragaefolii* reveals that its eggs are whitish to yellowish. The nymph is small, measuring around 0.8–1.1 mm, making it similar in appearance to the adult *Chaetosiphon fragaefolii*. The nymph's color varies from light green to pale yellow. Adult *Chaetosiphon fragaefolii* has a length of 1.3–1.5 mm, with a pale to yellowish-green color and short setae (hairs) covering its entire body. The antenna is of the same length as its body or longer. Cornicles are approximately 1/4 of the body length, pale in color, slender, and the legs are pale green and almost transparent. Adult *Chaetosiphon fragaefolii* without wings are small, ranging from 0.9-1.3 mm, while winged ones are medium-sized, ranging from 1.3–1.5 cm, elongated, transparent, and either whitish-yellow or pale green.

***Life Cycle***

Aphids have two types of life cycles: sexual and asexual. Asexual reproduction in aphids occurs only through parthenogenesis, where aphids can reproduce without mating. Aphids live attached to a host throughout the year and undergo sexual morph reproduction to produce genetically recombined eggs on the host plant in the fall. In cold temperatures, aphids reproduce parthenogenetically without wings (fundatrix) giving birth to viviparous nymphs (Bhatt et al., 2018). There are two types of aphids in the life cycle: alate types with wings (sexual) and aptera types without wings (asexual) (Manuhutu et al., 2020). A wingless female can give birth to an average of 68.2 nymphs, while a winged female gives birth to 49 nymphs. Aphids have four instars, and the nymphal stage lasts for 16 days at 15°C, nine days at 20°C, five days at 30°C, and adults can live for about 4-12 days. Adult aphids are more active at warm temperatures ranging from 17°C to 27°C (Sari et al., 2020).

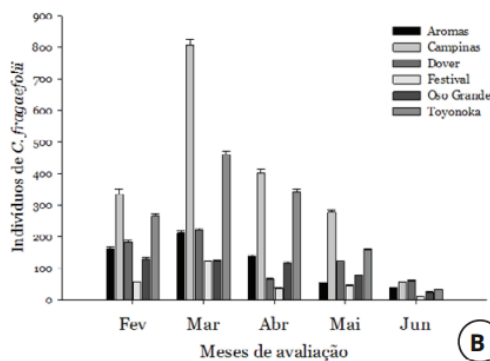


Table 1. Population density of *Chaetosiphon fragaefolii* (Guimarães et al., 2018)

Meses	Temperatura média (°C)	Umidade (% b.u.)
jan	20,33	77,94
fev	21,09	70,18
mar	22,02	60,85
abr	19,18	77,90
mai	16,47	81,42
jun	16,95	67,00

Table 2. Average temperature and humidity during the experiment (Guimarães et al., 2018)

Based on research conducted (Guimarães et al., 2018) of the 6 varieties tested the highest population density in aphids (*Chaetosiphon fragaefolii*) occurred in March which was caused by the air temperature in the study environment reached 22.02 °C, while in April, May and June began to experience a decrease in population which was also caused by the temperature dropping. This is because at high temperatures or dry seasons, pests can experience population spikes (Taylo & Magdalita, 2021). While pest populations at the lowest temperatures, will experience slow growth (Wardani, 2015).

**Symptoms**



Figure 3. Symptoms of *Chaetosiphon fragaefolii* infestation (source: personal documentation)

This pest damages plants directly by extracting their nutrients and excreting honeydew, leading to the growth of sooty mold (*Capnodium* sp.) on the leaf surfaces (Foda et al., 2021). The honeydew can attract ants that use it as a food source (Maharani et al., 2020). As a result, photosynthesis and respiration in strawberry plants (*Fragaria x ananassa*) are hindered. Aphids also indirectly harm plants by transmitting viruses to them (Marianah, 2020). Symptoms of the infestation are more clearly visible on younger plants. In severe infestations, the growth becomes stunted, and the stems may twist, curl, and sometimes turn yellow (Kessek et al., 2015).

**CONTROL**

Control of aphids (*Chaetosiphon fragaefolii*) on strawberry plants (*Fragaria x ananassa*) can be achieved using four natural substances: Entomopathogenic fungus, Parasitoid, Predator, and Organic Pesticide.

**Entomopathogenic Fungus**

Review: Control of Strawberry Aphids (*Chaetosiphon Fragaefolii*; *Aphididae*) Through Sustainable Natural Materials In Strawberry (*Fragaria X Ananassa*) Cultivation

The entomopathogenic fungi that can control aphids (*Chaetosiphon fragaefolii*) are *Beauveria bassiana* and *Metarhizium sp.*

#### ***Beauveria bassiana***

*Beauveria bassiana* is an entomopathogenic fungus that can control aphids. This fungus can produce various extracellular enzymes such as chitinase, lipase, and protease, which function to break down the insect cuticle and release toxins. The produced toxins include bassianin, bassiacridin, beauvericin, bassianolide, beauverolides, tenellin, isoralit, oosporein, and oxalic acid, which can increase blood pH, blood clotting, and stop blood circulation. The toxins from *Beauveria bassiana* also cause damage to tissues in muscles, the digestive system, the respiratory system, and the nervous system (Fadhilah & Asri, 2019). *Beauveria bassiana* can effectively control pests with a mortality rate of 90% at a concentration of 0.4 grams/L of water (Arsensi et al., 2022). The attack mechanism of *Beauveria bassiana* involves spores entering the body of the host insect through the skin, digestive tract, spiracles, and other openings. Additionally, fungal inoculum attached to the body of the host insect can germinate and develop into germ tubes, then penetrate the insect's cuticle. The penetration is done mechanically and/or chemically by releasing enzymes or toxins. The fungus then releases the toxin beauverin, causing damage to the insect's body tissues. Within days, the insect will die. Subsequently, the fungal mycelium will grow throughout the insect's body. The infected insect will die with its body hardening like a mummy and covered by white hyphal threads (Sopialena et al., 2021).

#### ***Metarhizium sp.***

*Metarhizium sp.* is an entomopathogenic fungus that can control pests in the Aphididae family (Wathi et al., 2015). This fungus can penetrate the body of the host insect through two methods: mechanical pressure and the assistance of toxins produced by the entomopathogenic fungus (Hasyim et al., 2016). The attack of the fungus on insects is characterized by the insect's body becoming stiff and hard, resembling a mummy, and hyphae emerging from the insect's body attacked by the fungus. However, for *Metarhizium sp.*, over time, the infected larvae will change color from white hyphae to green (Arsi et al., 2020). The application of *Metarhizium sp.* is done once during the vegetative phase of the plants. The application is carried out in the evening with a concentration of 20 g per liter of water, with a spraying volume of 70 m per plant cluster. This application is effective in infecting and causing death to aphids, reducing the population of aphids (*Chaetosiphon fragaefolii*) (Hasibuan et al., 2014).

#### **Parasitoid**

Parasitoids that can control aphids (*Chaetosiphon fragaefolii*) are *Aphelinus varipes* (Lahiri et al., 2022).

#### ***Aphelinus varipes***

*Aphelinus varipes* is a species of parasitoid wasp found attacking aphids. *Aphelinus* species are small in size (about 1 mm long) and are weak fliers. In search of hosts and mates *Aphelinus varipes* often performs walking. *Aphelinus* females

in parasitizing aphids prefer instar 2 to 4th instar to lay eggs, but can also lay eggs at all stages (Hopper et al., 2019). The parasitoid mechanism of *Aphelinus varipes* is carried out by the mother who lays eggs in the host's skin or inserts directly into the host's body through its ovipositor. After hatching, parasite larvae suck body fluids from the host or feed on body parts (Hopper et al., 2017). There is a temperature of 20°C, wasps develop from eggs to pupae in about 14 days; third instar wasps kill their host, leaving the host intact, the external skeleton of the tick host; (exoskeleton) hardened and black, in a process called mummification. Adult *Aphelinus varipes* appears about one week after pupation by chewing a hole through the host's exoskeleton (Stewart, 2021).

### Predator

The order Diptera includes two families that can act as natural controllers of aphids (*Chaetosiphon fragaefolii*). The two families are Syrphidae and Asilidae. Syrphidae is one of the important predators that control the presence of aphids (*Chaetosiphon fragaefolii*). Syrphidae populations reach their maximum at a food density of 100 aphids per day at 22°C. This makes Syrphidae a potential predator that responds positively to the presence of aphids (*Chaetosiphon fragaefolii*) (Rizal et al., 2018). In the family Asilidae also called robber flies or grass flies, have predatory properties and attack various insects, can even attack animals larger than their bodies. Most of the Asilidae family catches flying prey, but *Leptogastinae* usually attack resting or perching insects (Solikhatin et al., 2021). The natural predator of aphids (*Chaetosiphon fragaefolii*) is also present in the order Hemiptera and order Coleoptera. In the order Hemiptera there is *Orius insidiosus*, while the order Coleoptera there are 3 predatory insects, namely *Cycloneda sanguinea*, *Eriopis connexa* and *Coleomegilla quadrifasciata* (Francesena et al., 2019). Generalist predators of the genus *Orius* (small pirate insects) feed on various types of prey. They are voracious predators at all stages of their active life, which means they can be released at different stages of development. *Orius insidiosus* attacks many soft-bodied arthropods such as aphids (*Chaetosiphon fragaefolii*) (Johnson & Hooks, 2021). Predatory insects from the Order of Coleoptera known as coccinellid beetles can control aphids (*Chaetosiphon fragaefolii*) by preying on 20-90 pests per day, so that the effectiveness ability is very high both imago and larvae (Efendi et al., 2018).

### Organic Pesticides

Organic pesticides that effectively control aphids (*Chaetosiphon fragaefolii*) are neem leaves (*Azadirachta indica*) and papaya leaves (*Carica papaya*)

#### *Azadirachta indica*

Neem leaves (*Azadirachta indica*) are biopesticides that can affect the phylum of Arthropods which include the Aphididae family, *Chaetosiphon fragaefolii* (Pramita & Murlistyarini, 2020). Neem leaf extract contains the active ingredient azadirachtin. Azadirachtin is toxic although this extract compound does not directly

Review: Control of Strawberry Aphids (*Chaetosiphon Fragaefolii*; Aphididae) Through Sustainable Natural Materials In Strawberry (*Fragaria X Ananassa*) Cultivation

kill insects, but affects activities such as reducing appetite, inhibiting growth, and inhibiting egg reproduction and hatching (Sidauruk et al., 2019). Azadirachtin active compounds enter the nymph's body through three pathways, namely the respiratory tract, toxic compounds, physical contact, and digestive tract (Rajab et al., 2018). The concentration of neem leaf insecticide (*Azadirachta indica* A.Juss.) that had the most effect on aphid death was 35 (g/l water), and the number of dead aphids was 8.76 (Javandira et al., 2022).

### **Papaya leaves (*Carica papaya*)**

Papaya leaves (*Carica papaya*) is an alternative vegetable pesticide that can control aphids (*Chaetosiphon fragaefolii*) which belongs to the family of Aphididae. This is in agreement with (Setiawan & Oka, 2015) that papaya leaves can control aphids (*Chaetosiphon fragaefolii*) because they contain toxic compounds such as papain, alkaloids, flavonoids and saponins. The content of papaya leaves, namely papain, also works actively as a stomach poison that enters the body or responds to aphids, thereby reducing the feeding activity of aphids. The working system of papain as a stomach poison in the body of aphids is absorbed by the walls in the digestive organs of aphids then will be delivered to the nerve center of aphids so that it will potentially provide pressure and reduce the metabolic process of internal organs and inhibit the eating activities of aphids so as to cause aphids to die (Vandalisna et al., 2021). The use of papaya leaf extract as a vegetable pesticide will certainly have a positive influence on plant growth because it contains flavonoid compounds that work as neurotoxins and have residues that can cause pests to decrease activity and even stop (Nanda et al., 2022). Alkaloids are secondary metabolites that act as stomach poisons in pests (Fauzana & Faradila, 2018). If alkaloid and flavonoid compounds enter the stomach of insects, it will block the digestive process and can be toxic (toxin) for insects. This compound can also cause taste receptors in insects to be inhibited so that insects are unable to identify their food (Bumulo et al., 2021). Saponin substances can affect the digestive system of pests by making different bonds with some digestive enzymes. Due to strong binding with certain enzymes, saponins damage the mucosal lining of some cells in the digestive system. So that aphids can lose appetite which causes aphids to become lethargic and die due to saponin toxicity (Qasim et al., 2020). To use papaya leaf vegetable pesticides to effectively control aphids, papaya leaf extract with a concentration of 30 ml / liter of water is needed (Yudiawati & Hapis, 2016). Spray 3 times a week in the morning or evening when the air temperature is lower and the humidity is higher (Jujaningsih et al., 2021).

## **CONCLUSION**

Strawberry plant nuisance organisms (*Fragaria x ananassa*) are aphids with the species *Chaetosiphon fragaefolii*. This species can transmit viruses that infect strawberry plants (*Fragaria x ananassa*). Viruses carried include yellow edge virus (*Potexvirus; Alphaflexiviridae*), striped virus (*Secoviridae*), Strawberry wrinkle virus (*Cytorhabdovirus; Rhabdoviridae*), and Strawberry vein band virus

(*Caulimovirus; Caulimoviridae*). To control *Chaetosiphon fragaefolii* there are 4 ways, namely: 1. Fungus entomopathogen : *Beauveria bassiana* and *Metarizium* sp. 2. Parasitoid : *Aphelinus varipes*. 3. predator : family Syrphidae, family Asilidae, *Orius insidiosus*, *Cycloneda sanguinea*, *Eriopis connexa* dan *Coleomegilla quadrifasciata*. 4. Organic pesticides: neem leaves (*Azadirachta indica*) with a concentration of 35 (g / l water) and mortality of 8.76 heads, while papaya leaves (*Carica papaya*) use a concentration of 30 ml / liter of water.

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