PANGIUM SP. LEAF EXTRACT AS BIOPESTICIDE ON BRASSICA OLERACEA PLANT IN NORTH SULAWESI PROVINCE, INDONESIA

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PANGIUM SP. LEAF EXTRACT AS BIOPESTICIDE ON *BRASSICA OLERACEA* PLANT IN NORTH SULAWESI PROVINCE, INDONESIA

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Abstract

Pangium sp. has the potential to be developed as a biopesticide because it has the ability to inhibit the activity of several types of insect pests. In this study, pangium leaf extract and pesticide were applied to Brassica oleraceae cabbage farms; to determine the type and population of pests and their natural enemies. Each carried out on an area of 500m², with 1,250 cabbage plants. Observation and sampling of insects and natural enemies at the larval stage, were carried out seven times every seven days starting on 14 DAP (days after planting); diagonally, where there are five sampling spots, by sweeping using insect nets five times; then collected and identified. Results indicated on the treatment area of pangium leaf extract found seven types of pests: Plutella xylostella, Crocidolomia pavonana, Aphis sp., Liriomyza brassicae, Spodoptera sp., Chrysodeixis calcites, Grylotalpa sp., and Parmarion sp.; dominated by P. xylostella and C. pavonana. The natural enemies found were six types of predators: Coenagrionidae, Asilidae, Mantidae, Sphecidae, Libellula sp., Menoxhilus sexmaculata and one parasitoid Diadegma semiclausum. In the pesticide treatment, four types of pests: P. xylostella, C. pavonana, Aphis sp; L. brassicae; and four types of natural enemies/predators: Coenagrionidae, Asilidae, Mantidae, Sphecidae and one parasitoid D. semiclausum. The average population in the pangium leaf extract treatment area, pests 8.91 individuals, natural enemies/predators 2.35 individuals and parasitoids 6.13 individuals. In the pesticide treatment area: pests 3.05 individuals, natural enemies/predators 1.2 individuals and parasitoids 0.51 individuals.

Key words: *leaf extraction, cabbage, natural enemies, pests, parasitoid*

INTRODUCTION

Cabbage belongs to the order *Brassicales*, family *Brassicaceae*, genus *Brassica*. *Brassica oleracea* is a species of plants such as cabbage, broccoli, cauliflower, from the wild cabbage plant before cultivation, which is native to Western Europe. Now *B. oleracea* is selected by farmers with various shapes/appearances and traded under several names. The part of the plant that is used is either a swollen stem base, separate leaves, shoots with tightly growing leaves or flowers that grow close together, usually not easy to grow in the tropics. *B. oleracea* is relatively thick green in color with a slight white tinge due to the surface covered with fine hairs. In some varieties the leaves are arranged in a dense rosette and sit on the stem. In the lowlands, the size of the crop is reduced and the plant is very susceptible to Plutella leaf-eating caterpillars [22, 5]. Because the selling price of cabbage is determined by its appearance, farmers often spray cabbage plants with insecticides in excessive quantities so that the cabbage does not have holes in its leaves due to being eaten by caterpillars.

The green revolution that occurred in the past few decades was marked by the use of superior varieties, chemical fertilizers and pesticides to produce phenomenal growth in agricultural productivity, resulting in high production yields and impressive profits, but on the other hand, undesirable consequences such as pollution emerged environment due to the uncontrolled use of chemicals, resulting in

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damage to the agricultural environment. The pesticide residues found in soil, air, and water as well as on agricultural products produced; consequently, they can endanger human health and the environment. This is in accordance with the opinion of Kumar (2012)[12], that the indiscriminate use of chemical fertilizers and pesticides in the agricultural industry causes contamination of water and food sources and the development of insect populations that are resistant to insecticides.

The increasing concern about the adverse impact on the environment associated with the use of synthetic chemical products has prompted efforts to search for technologies and natural products based on biological processes to control pests. In developing a control strategy against plant pests, it is necessary to pay attention to the risks that occur, both to humans and the environment [26]. Therefore, a control strategy that is safe for farmers is needed in order to protect their crops, but not harmful to humans and the environment. According to *Lindsey et al.* (2020) [13], there are several methods that have been applied in pest management so far, both traditional methods, chemical methods and biological methods.

The use of biopesticides can be applied as an alternative to plant pest control because it is proven to be effective for pest control and produces sustainable agricultural products [18]. Biopesticides are organic compounds and antagonistic microbes that inhibit or kill plant pests and diseases [23]. Several factors indicate that bio-pesticides are an excellent alternative to synthetic pesticides, namely they are very effective, have specific targets and have less environmental risks [6]. Biopesticides are a good alternative in an effort to increase crop production, the use of which will increase in the coming years [17], which further states that this biological control can reduce greenhouse gas emissions compared to chemical pesticides [7].

Plants are widely known to produce various secondary metabolites/compounds such as flavonoids, terpenoids, alkaloids, saponins and others that are useful as a means of self-defense [2]. The search for plants that can produce biopesticides, such as antifeedant to control insect pests, is of great interest to researchers around the world. This is because in plant protection, antifeedant compounds do not kill, repel or trap insect pests, but only inhibit the appetite of these insects, so that food crops or commodity crops can be protected. An antifeedant compound is a compound that, if tested on insects, will temporarily or permanently stop appetite. Insect pest control using compounds that inhibit feeding activity provides several advantages such as not causing resistance, high selectivity, easy to degrade, and relatively non-toxic to humans [14].

One of the plants that has the potential as a bio-pesticide is *Pangium* sp., where the leaves of this pangium plant contain at least 11 compounds and 8 compounds have been successfully identified, namely: pinene; trimethylbenzene; triflorotetradecylacetic acid; nonadekene; 13-hexyloxacyclotridec-10-en-2-on; phytol; 3 eicosene; and diisooctylbenzendicarboxylic acid [16}. While the Pangium fruit, in addition to containing cyanide acid, also contains vitamin C, iron ions, beta-carotene, hidnocarpat acid, khaulmograt acid, glorat acid, and tannins [21]. Pangium leaf extract was able to inhibit the feeding activity of *Plutella xylostella* larvae [20, 16]. The lethal concentration 50 (LC 50) of pangium leaf extract against *Crocidolomia pavonana* larvae at a concentration of 1,360 ppm [1].

This study used pangium leaf extract which was sprayed on cabbage farms. The aim is to determine the types and populations of pests and their natural enemies, which are applied with pangium leaf extract and then compare them with the types and populations of pests and their natural enemies found in cabbage plants that are sprayed with pesticides. This study is expected to provide data and information on the use of pangium leaf extract in cabbage cultivation activities, especially in plant pest control.

MATERIALS AND METHODS

The research was conducted from April to July 2021, starting with the preparation of pangium leaf extract as biopesticides, then continued with sampling and insect observations. The method, does not use a special design because it is carried out based on primary data, namely direct observation data at the research location, on an area of 500m^2, a length of 25 meters and width of 20 meters; there are 10 beds in the observation area; with observation were carried out seven times, with intervals every seven days , starting on days 14, 21, 28, 35, 42, 49, and 56 DAP (days after planting); diagonally, where there are five sampling spots, and the number of plants observed is 1,250 plants/0.05 ha (equivalent to 25,000 plants/ha).In this study, observations were made on the types and populations of pests and natural enemies on cabbage farms, which were sprayed with pangium leaf extract as biopesticides, compared to those sprayed with pesticides. Each pest and natural enemies sampling spot at the larval stage, there were 25 cabbage plants, by sweeping using insect nets five times; then collected and identified.

Preparation of pangium leaf extract

The collected pangium leaves are washed with running water and then dried. As much as 2 kg of pangium leaves, thinly sliced and pounded until smooth and then blended. Next, 60 grams of detergent was added as an adhesive and mixed with 20 liters of water and shaken until homogeneous, and allowed to stand for 24 hours. After 24 hours, the solution was filtered using gauze, so that the extract was obtained and the extraction solution was ready for use [25, 9]. For application in the field, for an area of 500 m^2, two liters of extract solution can be used; and the use of extracts was carried out once a week for one growing season (between 65 – 75 days after planting).

Sampling and pest observation

Sampling on plants was carried out directly by taking the insect larvae found. Sampling was carried out using the diagonal slice method, so that there were five sampling spots on agricultural land, and each spot was determined to be taken as many as 25 plants as shown in Figure 1.

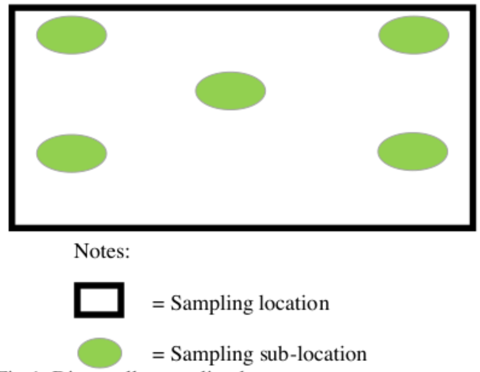

Fig.1. Diagonally sampling layout
Source: Own design.

Observation of pest population density is done by collecting and counting the number of pests found, were made 7 times when the plants were 14, 21, 28, 35, 42, 49 and 56 DAP (day after planting). The following formula was used to calculate the population density:

$$P = \frac{n}{N}$$

Notes: P = average population density
n = number of pests found
N = number of observations

Natural enemy sampling and observation

Sampling of natural enemies using insect nets was carried out by sweeping with five double swings on the surface of cabbage plantations. Observations of parasitoids were carried out by collecting pests at the larval stage and then rearing and observing the appearance of parasitoids. The larvae of these pests are usually hosts for parasitoids. The parasitoid imago that came out of the pupa was collected and then identified. The population density of natural enemies, both predators and parasitoids, was calculated using the same formula as the calculation of the pest population density. The collected samples were then identified according to Kalshoven (1981) [11] and [3].

RESULTS AND DISCUSSIONS

Pest type and population density

From the observations, it was found that there were seven types of pests, namely *Plutella*

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xylostella, Crocidolomia pavonana, Spodoptera sp., *Chrysodeixis chalcites, Liriomyza brassicae, Aphis* sp., *Parmarion* sp. The most dominant pests found were *P. xylostella* and *C. pavonana*.

P. xylostella had an average population density of 19.31 individuals and was mostly found at plant ages of 21 DAP to 35 DAP and decreased in population at 42 DAP. Young larvae of *P. xylostella* feed on cabbage leaves by leaving the epidermal tissue to form transparent spots that are visible as white patches. The attack of the adult larvae causes the cabbage leaves to have holes and if the population is high enough, the attack will be more severe so that only the bones and veins are left behind and the plant does not form a crop or a crop can be formed but in abnormal conditions. Adult larvae when disturbed squirm and quickly fall through the threads that are released. With this thread the larvae can climb again to the leaf surface. Rainfall conditions in the early weeks were relatively low, presumably causing the relatively high population of *P. xylostella*. Rainfall can affect the development of insect populations in nature, because high rainfall will cause damage or death of egg and larval/nymph stages, especially small ones. In humid conditions and high rainfall intensity insect development will be suppressed, on the contrary in relatively long summer conditions will support its development so that the population in nature will be high [11, 4]. The average pest population density is given in Table 1.

Table 1. Average Pest Population Density in Treatment of Pangium Leaf Extract and Chemical Pesticides

Pest type	Observation time (days after planting = DAP)							Mean
	14	21	28	35	42	49	56	
	(individual)							
C. pavonana	0	0	2.3	14.6	37.7	40.1	22.7	16.77
P. xylostella	5.1	31.7	33.6	37.9	15.7	5.9	5.3	19.31
Spodoptera sp.	0	2.2	3.2	0	0	1.8	0.6	1.11
L. brassicae	3.3	2.5	4.4	3.5	2.8	8.5	3.2	4.03
C. chalcites	0	0.4	1.5	0	0	1.8	0.9	0.66
Aphis sp.	0	0.7	3.1	2.7	4.3	5.5	5.3	3.09
Pharmarion sp.	0	0	0	0	3.7	5.5	4.3	1.93

Source: Own calculation on the basis of data.

Another dominant pest found was *C. Pavonana*. This pest was mostly found at the age of plants above 49 DAP where the average population density was 16.77 individuals. Baideng *et al*. (2020) [1] reported that 3% pangium leaf extract could cause larval mortality of 76.67% at 120 HAA (hours after application). Meanwhile, Manoppo *et al*., (2019) [15] reported 86.3% mortality of *C. pavonana* using 50 ppm Pangium leaf extract. *C. pavonana* will be seen in abundance, when the plant begins to form a crop. These larvae are clustered on the leaf surface and as the plant grows larger, the larvae are spread all over the plant, especially on the young leaves. Other pests such as *Aphis* sp., *Spodoptera* sp., *L. brassicae, C. chalcites* and *Pharmarion* sp., the average population density is only slightly less than five individuals. On land treated with pangium leaf extract, the average pest population was 8.91 individuals, while on land treated with pesticides, the number was 3.05 individuals (Table 2).

This amount is still below the threshold, because it does not affect crop damage that can harm farmers.

In cabbage with pesticide treatment, only 4 types of pests were found, namely *C. pavonana, P. xylostella, L. brassicae* and *Aphis* sp. The use of high-intensity pesticides is thought to cause inhibition of the development of other pests. However, the excessive use of pesticides, apart from causing environmental pollution, can also lead to pest resistance, the emergence of secondary pests and pest resurgence [19, 12].

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Table 2. Average Pest Population Density in Treatment of Pangium Leaf Extract and Chemical Pesticides

Type of pest	Treatment	
	Pangium leaf extract	Pesticide
	(individual)	
C. pavonana	16.77	7.93
P. xylostella	19.31	10.77
Spodoptera sp.	1.11	0
L. brassicae	4.03	1.33
C. chalcites	0.66	0
Aphis sp.	3.09	1.37
Pharmarion sp.	1.93	0
Mean	**8.91**	**3.05**

Source: Own calculation on the basis of data.

Natural enemy type and population density

The types of predators found were 6 species, namely *Coenagrionidae*, *Sphecidae*, *Labilulla*, *Asilidae*, *Menochilus sexmaculatus*, and *Mantidae*. While in pesticide treatment, only 4 types of predators were found, namely *Coenagrionidae*, *Sphecidae*, *Labilulla* and *Asilidae*, because excessive use of pesticides can cause the death of natural enemies [19]. The presence of natural enemies is important to maintain the biological balance in the agricultural ecosystem because it can suppress the development of pests [24]. Minimizing the use of chemical insecticides is a form of conservation of natural enemies in nature [8]. Conservation is one of the techniques in biological control that functions to preserve natural enemy species in nature [10].

The predator population found means was 2.35 individuals, while on land that was sprayed with pesticides there were 1.2 individuals (Table 3).

Predatory movement activity is thought to be the cause of the reduced number of individuals that can be netted in the sampling process, but the varied types of predators found can be assumed that a predation process occurs which can cause a decrease in certain pest populations. To sustain life and generation, predators will actively seek and find their hosts [10].

Table 3. Average Predator Population Density in Treatment of Pangium Leaf Extract and Chemical Pesticides

Type of pest	Treatment	
	Pangium leaf extract	Pesticide
	(individual)	
Coenagrionidae	5.3	2.7
Libelulla sp.	1.5	1.1
Sphecidae	3.3	2.4
Asilidae	1.3	1
Menochilus sexmaculatus	1.8	0
Mantidae	0.9	0
Mean	**2.35**	**1.2**

Source: Own calculation on the basis of data.

The parasitoid found was *Diadegma semiclausum* and found in its host insect, *P. xyostela*. The average percentage of parasitization of *D. semiclausum* in the Pangium leaf extract treatment was 6.13%, while in the pesticide treatment it was 0.51% (Table 4). The small percentage of parasitization indicates that the presence of natural enemies of *D. semiclausum* on agricultural land is not yet well established. This is thought to be the cause of the high population of *P. xylostella*.

Table 4. Average Percentage of Parasitization of *D. semiclausum* to *P. xylostella* in Cabbage Plant

Treatment	Sampling (days after planting = DAP)							Mean
	14	21	28	35	42	49	56	
	(individual)							
Pangium leaf extract	0	3.3	7.5	9.7	8.1	8.8	5.5	6.13
Pesticide	0	0	0.7	1.4	0.5	0.3	0.7	0.51

Source: Own calculation on the basis of data.

D. semicalisum is a solitary parasitoid that is endo-parasitic because in one host pupa, only one individual parasitoid is found. These parasitoids belong to the Order *Hymenoptera*, Family *Ichneumonidae*, and Genus *Diadegma* [3, 8]. Parasitoid *D. semiclausum* was found in the host *P. xylostella* both in the treatment of pangium leaf extract and pesticides.

CONCLUSIONS

There were seven types of pests on cabbage plantations that were applied with pangium leaf extract, namely *P. xylostella, C. pavonana, Spodoptera* sp., *C. chalcites, L. brassicae, Aphis* sp., *Parmarion* sp, with an average pest population of relatively small, namely 8.91, while in pesticide treatment land only four types of pests were found, namely *C. pavonana, P. xylostella, L. brassicae* and *Aphis* sp., and the pest population was 3.05 individuals on average. The dominant pests whose populations were found in observations were *P. xylostella* and *C. pavonana*. The natural enemies found in the pangium leaf extract treatment area were six types of predators (Coenagrionidae, Sphecidae, Labilulla, Asilidae, *M. sexmaculatus*, and Mantidae) and one parasitoid (*D. semiclausum*). In the pesticide treatment area, there were fewer predators, namely four types of predators (Coenagrionidae, Sphecidae, Labilulla and Asilidae) and one parasitoid (*D. semiclausum*). The population of natural enemies in the pangium leaf extract treatment area averaged 2.35 individuals (predators) and 6.13 individuals (parasitoids). Meanwhile, in the pesticide treatment area, the population of predators is 1.2 individuals and parasitoids are 0.51 individuals. Based on the data obtained, it shows that the use of pangium leaf extract as a bio-pesticide is better for use on cabbage plantations. This is based on the type and population of pests and natural enemies found, although they are almost the same as those found in pesticide treatment areas, but in greater numbers.

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