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The Effectiveness of *Piper caninum* (Von. Blume) Leaf Extract As a Botanical Insecticide for *Plutella xylostella* L. on Pakcoy Plants (*Brassica rapa* L.)

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ABSTRACT

The concept *back to nature* makes vegetable insecticides an option in pest control. *Plutella xylostella* L. are one of the pests that are often found in pakcoy plants. The purpose of this study was to determine the effectiveness of leaf extract of *Piper caninum* on pest mortality by knowing the LC50 and LT50 values and the effect of the extract on pakcoy plants. The research method used was an experiment with a completely randomized design (CRD) and a randomized block design (RBD). The study used 5 levels of extract concentration, namely negative control (0%), 0.5%, 1%, 1.5% and 2%. The data analysis technique used is an *analysis of variance* (ANOVA) further tested with Duncan's test of 5%. The results showed that the LC50 value of the extract was 1.6% with an interval of 0.2% to a concentration of 1.8%. The LT50 value of the extract was 0.7 hours. *P. caninum* extract gave a significant difference in the wet weight of pakcoy, but did not give a significant difference in the height and number of pakcoy leaves

1. Introduction

Fluctuations in pakcoy production can not be separated from various factors that influence the cultivation process, one of which is the presence of plant-disturbing organisms. Suswando *et al*., (2019) stated that there is a *Plutella xylostella* L. that is often encountered and can be categorized as a pest organism for pakcoy plants. Sambel (2010) reported that these pests eat pakcoy leaves which then leave holes in the leaves. This pest is also a factor in severe damage to plants, which can reduce production yields by up to 85% and crop failure (Suswando *et al*., 2019).

The use of synthetic insecticides is still used because the method of use is easy, practical, cheap, and easily available in the market. However, according to Winarti (2015), synthetic insecticides also have a negative impact because they will cause resistance to insect pests and will leave residues on plants and the surrounding environment. Sambel (2010) also added that insecticide residues left on plants will have a bad impact if they are directly consumed by humans because they can cause chronic poisoning if consumed in large quantities. Muaddibah (2016) in his research also said that synthetic insecticides affect ecological factors because they will cause environmental pollution.

Various efforts have also been made to suppress the use of synthetic insecticides. Salaki *et al*., (2012) stated that one of the businesses that have the opportunity to be developed is the use of plant materials as vegetable insecticides. The use of vegetable insecticides as a substitute for synthetic insecticides is because it has environmentally friendly properties and has minimal adverse effects. Vegetable insecticides also have a short level of action and are not worried about leaving residues on plants, in addition, Sambel (2010) also added that vegetable insecticides can work in a compatible manner with biological control.

Vegetable insecticides commonly used are biological agents obtained from plant parts which are then processed into extracts (Kumari *and* Shanmugam, 2020). Semangun (2006) said that plant extracts can be used as vegetable insecticides because they contain bioactive substances such as flavonoids, polyphenols, alkaloids, saponins, and tannins. Sogawa and Sakamura (1987)

also explained that alkaloid is one of the compounds that can work as poison and disrupt insect hormones. Meanwhile, tannin is a compound that has good insecticidal properties against insect caterpillars (Dhaelmi and Hutagol, 1994).

Piper caninum von. Blume is one of the plants that have several bioactive compounds that are known to act as antioxidants, antimicrobials, antifungals, antityrosinase, anticholinesterase, anti-inflammatory, antileishmanial, and insecticides (Salleh *et al*., 2016). This makes researchers interested in raising the above problems by using *P. caninum* extract as a vegetable insecticide for leaf worm pests on pakcoy plants.

2. Literature Review

3. Methodology

The research will be conducted from December 2021 to February 2022. The research was conducted at the Pest and Disease Observation Laboratory of the UPTD for Food Crop Protection and Horticulture, Gianyar. The manufacture of *P. caninum* extract was carried out at the Biopesticide Laboratory of Udayana University. The forest chili leaves used as extracts were taken directly from Senganan Village, Penebel District, Tabanan Regency, Bali. The leaves taken were washed, cut into small pieces, and dried for 3 days (Harborne, 1987). The dry and clean forest chili leaves were then crushed and macerated with methanol in a ratio of 1:10 for 48 hours in the dark and at room temperature. The extract was then filtered and evaporated at 40°C with *a rotary evaporator*.

The concentration of the extract used consisted of 5 levels, namely 0% (negative control), 0.5%, 1%, 1.5% and 2%. Each treatment was repeated 5 times so that there were 25 experimental units from each design. *Plutella xylostella* were cultivated independently to obtain second-generation, second-instar larvae. The study used a completely randomized design (CRD) conducted in the laboratory and a randomized block design (RBD) conducted in a *greenhouse*. In research in the laboratory, pakcoy leaves were cut in sizes 3 cm x 3 cm which was then sprayed with 10 ml of each extract concentration. The second instar *Plutella xylostella* is then deliberately invested in the leaves. Observations were made for 24, 48, 72, and 96 HAP (hours after application). Research in the *greenhouse* by seeding and planting pakcoy.

The planting medium was made with the formulation carried out by Safitri *et al*., (2020) with a ratio of 40% soil, 40% compost, and 20% husk charcoal. Planting media that is ready to be put into *polybags* measuring 20 cm x 20 cm. Pakcoy seeds are sown in a *seedling test* for 14 days and then transferred to *polybags*. Pakcoy plants aged 21 days after planting (DAT) were invested with 5 instars II *Plutella xylostella* for one *polybag*. Extract spraying was carried out after 24 hours of *Plutella xylostella* infestation, and repeated spraying was carried out up to 3 times with spraying intervals of 7 days until harvest (Malvin and Reni, 2019). The extract was sprayed with a *hand sprayer* of 50 ml/*polybag* (Nalu et al., 2021). Observations on leaf damage, plant height, and the number of leaves were carried out when the pakcoy was harvested.

4. Results and Discussion

4.1. Test the effectiveness of *Piper caninum* extract against *Plutella xylostella* in the laboratory

Based on the results obtained in Figure 4.1 that *P. caninum* extract sprayed on pakcoy leaves that have been invested in caterpillars can kill caterpillars so that it shows mortality in caterpillars after 96 HAA (hours after application). Through Duncan's test analysis, there was a significant difference in the treatment given to the mortality of *P. xylostella* for 96 hours of observation; the death of caterpillars had begun to be seen in 24 HAA with the highest average mortality with the extract concentration treatment of 1% (Table 1). The *P. xylotella* mortality occurred because the extract used had active compounds such as saponins, tannins, alkaloids, and flavonoids (Sa'diyah *et al*., 2013). Research by Chan *and* Siu (2014) also said that forest chili leaves can act as a stomach poison for caterpillars. The role of the *antifeedant* extract on *P. xylostella* causes to have a dislike for pakcoy leaves that have been treated with extracts so that the caterpillars do not eat and die (Anggoroningtyas *et al*., 2021). This is in line with the research results obtained, that not all leaves are touched and damaged due to caterpillar eating activities.

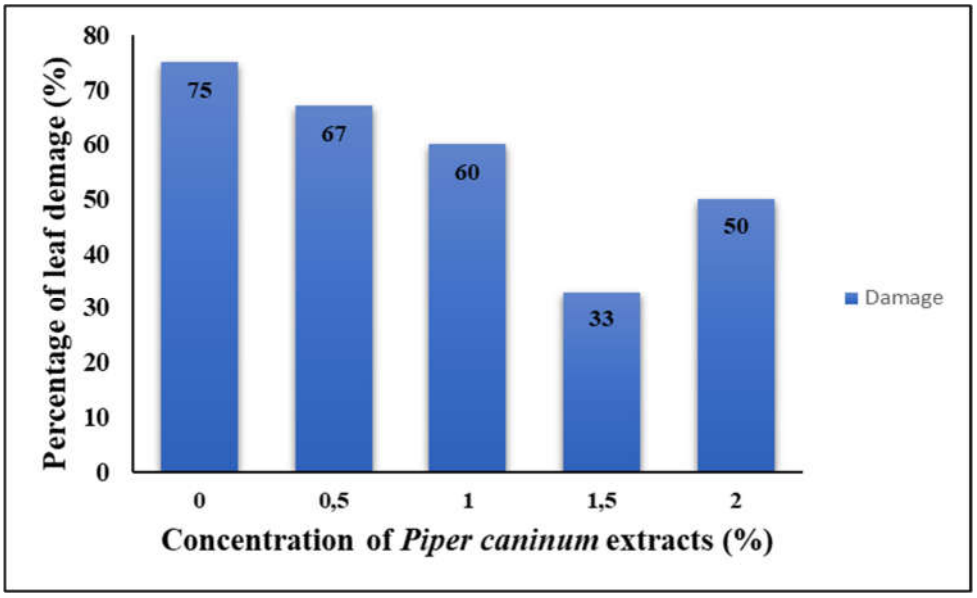

Figure 1. Percentage of test results of *P. caninum* extract on *P. xylostella* mortality at all times of observation. The test results showed that the negative control treatment could not cause mortality in *P. xylostella*, while all extracts with various concentrations caused mortality in leaf caterpillars.

Table 1. Mortality of leaf caterpillars for 96 hours after application of the extract

Extract concentration (%)	Observation			
	24 JSA	48 JSA	72 JSA	96 JSA
0	0±0.00^{a}	0±0.00^{a}	0±00^{a}	0±0.00^{a}
0.5	2±0.70^{b}	1±0.00^{b}	1.2±0.84^{b}	0.8±0.84^{a}
1	2.8±0.44^{b}	1.2±84^{b}	1±0.70^{b}	0±0.00^{a}
1,5	2.6±1.52^{b}	1.4±0.55^{b}	1±1.00^{b}	0±0.00^{a}
2	1.6±0.90^{b}	2.4±0.90^{c}	1±0.00^{b}	0±0.00^{b}

Note: the same letter behind the mean value indicates no significant difference at the 5% Duncan test level

4.2. The effectiveness test of *P. caninum* against *P. xylostella* L.

The results of the effectiveness test of *P. caninum* extract against *P. xylostella* in the field were carried out by looking at the level of leaf damage that occurred. Pakcoy leaf damage due to *P. xylostella* began to be seen at 24 DAP or 2 days after *P. xylostella* investment. The percentage of leaf damage was observed at 35 DAA (harvest). The results of Figure 2 show that pakcoy plants that were given negative control treatment (without extract concentration) experienced quite high damage, namely 75%, and the lowest percentage of damage was found in pakcoy plants with extract treatment at 1.5% concentration, which was only 33%. The low leaf damage that occurred in pakcoy plants after being given treatment in the form of *P. caninum* extract, because the extract worked as an effective botanical insecticide in suppressing the *P. xylostella*'s eating refusal, so the leaf damage that occurred was relatively low (Widawati *and* Randi, 2015).

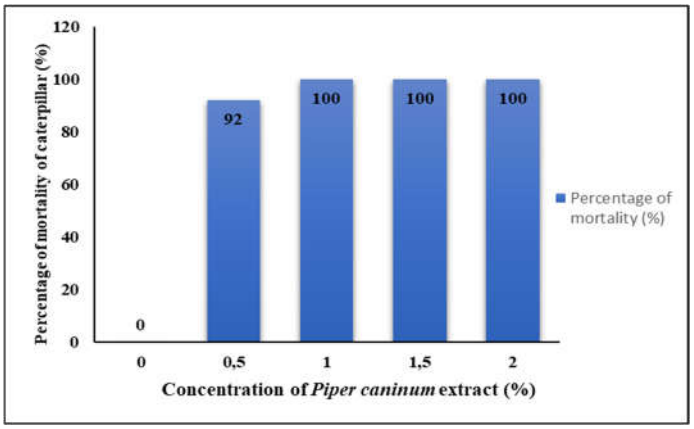

Figure 2. Percentage of damage to pakcoy leaves by caterpillars after administration of *P. caninum* extract at 35 DAP (harvest).

4.3. Test value LC_{50} (*Lethal concentration 50*) and value LC_{50} (*Lethal time 50*).

The value test was carried out to determine the concentration of extract required to kill 50% of the population of the test *P. xylostella* in the experiment. The value test in this study was carried out during observations in the laboratory. The values obtained are presented in Table 2. Based on Table 2, it was found that the values obtained in the observation of 24 HAA required an extract with a concentration of 0.5%, in the observation of 48 HAA required an extract with a concentration of 1.3%, in the observation of 72 HAA required an extract with a concentration of by 0.80%, and at 96 HAA observations, it can be estimated that new *P. xylostella* can die without extract.

Table 2. Value LC_{50} of *P. caninum* extract

Time (JSA)	*P. caninum* extract (%)
24	0,5
48	1,3
72	0,80
96	0

The results obtained from the value test mean that the longer the observations are done, the value will be lower, meaning that the lower the concentration, the longer it will take to kill 50% of the population of the test *P. xylostella*.
A value of *Lethal Time of 50%* is also needed in a study to determine the effectiveness of an insecticide in killing test animals. Value is the time required for a compound to kill 50% of the test animal population. The values are presented in Table 3. The results showed that the negative control treatment (0%) did not know the time needed to kill 50% of the larvae, the treatment with a concentration of 0.5% took 0.7 hours, a concentration of 1% took 1.2 hours, the 1.5% concentration took 1.1 hours and the 2% concentration took 0.8 hours. The observations (Table 3.) are in line with Aminah (1995) who states that the higher the concentration given, the lower the value or the time required to turn off 50% the faster.

Table 3 Value LT_{50} of *P. caninum* extract

Extract concentration (%)	Hours
0	-
0,5	0,7
1	1,2
1,5	1,1
2	0,8

4.4. Effect of concentration of *P. caninum* on the productivity of pakcoy.

P. caninum extract with various concentrations showed significant differences in the wet weight of pakcoy. This can be seen from the results of the Duncan test analysis carried out, that there is an interaction between the concentration of the extract given, thus affecting the wet weight of the pakcoy plant. The results of the wet weight observations obtained are presented in Table 4. That the difference in wet weight produced began to be seen in pakcoy plants with 1% extract concentration treatment. It is suspected that the extract that works at this concentration acts as a vegetable insecticide that can suppress the growth of *P. xylostella* and inhibit the appetite of caterpillars, so that the resulting leaves do not have high damage, and have optimal wet weight at harvest. (Hardyati et al., 2019).

Table 4. Effect of concentration of *P. caninum* extract on pakcoy wet weight (gr)

Extract concentration (%)	Observation of wet weight (gr)
0	58,80±14,23a
0,5	34,00±20,03a
1	56,00±24,64ab
1,5	69,80±36,56b
2	47,40±30,33ab

Note : the numbers followed by the same letter are not significantly different based on Duncan's test of 5%.

The effect of *P. caninum* extract on plant height, based on Duncan's test, did not show any significant difference. The results are presented in Table 5, that there is no real effect of the given extract on plant height, this indicates that the content of compounds contained in the extract does not work as nutrients that can be utilized by plants as metabolism in increasing growth (Malik, 2014).

Table 5 Effect of *P. caninum* extract concentration on pakcoy plant height (cm)

Extract concentration (%)	Observation	
	28 HST	35 HST
0	18,30±3,42[a]	20,80±3,03[a]
0,5	16,40±5,41[a]	18,40±3,13[a]
1	19,70±2,11[a]	19,80±3,27[a]
1,5	18,70±1,56[a]	21,00±3,87[a]
2	15,60±3,15[a]	19,60±1,94[a]

Note: the numbers followed by the same letter are not significantly different based on Duncan's 5% test.

The observations obtained on the productivity variables of the pakcoy plant (plant height, number of leaves, and wet weight) after being given treatment in the form of negative control (0%) and *P. caninum* extract, showed that the yield of pakcoy with the need for negative control (0%) had a value of which is quite high and does not show a significant difference with the yield of pakcoy after being given various concentrations of *P. caninum* extract. The results of the analysis of the effect of the extract on the number of leaves are presented in Table 6. The results obtained show that the higher the extract does not give a good value to the growth of the number of leaves on the pakcoy plant.

Table 6 Effect of *P. caninum* extract concentration on the number of pakcoy leaves (strands)

Extract concentration (%)	Observation of leaf number	
	28 HST	35 HST
0	11,80±0,83[a]	17,80±1,78[a]
0,5	10,00±3,74[a]	14,80±1,64[a]
1	12,20±1,92[a]	16,60±4,09[a]
1,5	12,80±1,64[a]	19,20±5,31[a]
2	10,20±2,58[a]	15,40±4,50[a]

Note: the numbers followed by the same letter are not significantly different based on Duncan's 5% test.

It is suspected that *P. caninum* extract with a high concentration, exceeding the given optimum limit, can suppress and inhibit plant growth and development. Einhelling (1995) said that this event could occur due to changes in the structural modification of plant membrane channels, to the loss of the function of the ATP enzyme in plants which affects the absorption and concentration of ions and water which then affects the process of photosynthesis and stomata opening. Bioactive compounds contained in *P. caninum* extract include polyphenolic compounds, which are thought to inhibit the growth enzymes of Indole acetate (IAA) and gibberellins (GA) which play a role in stimulating growth, so that if these enzymes are inhibited, growth will also be inhibited (Sastroutomo, 1990). The results of this study are also by Suriani *et al*., (2020) who said that there was a decrease in the number of leaves in the treatment of forest chili extract with a concentration of 2% in their study. This is caused by the toxic effects of high concentrations of preparations, which affect plant resistance.

5. Conclusion

P. caninum extract can affect the mortality rate of leaf caterpillars, as for the *Lethal concentration* 50 value (extract, namely the observation 24 HAA requires extract with a concentration of 0.5%, in the observation 48 JSA requires an extract with a concentration of 1.3%, in the observation 48 HAA requires extract with a concentration of 0.80% and on observations of 96 HAA it can be estimated that the caterpillars die without extract treatment. While the *Lethal time is* 50 (that is, in the negative control treatment (0%) it is not known how long it takes to kill 50% of the *P. xylostella*, the treatment with a concentration of 0.5% takes 0.7 hours, a concentration of 1% takes 1.2% hours, a concentration of 1.5% takes 1.1 hours and a concentration of 2% takes 0.8 hours. *P. caninum* with a concentration of 1.5% can have an effect and show a significant difference in the wet weight of pakcoy plants but does not affect the growth of plant height and number of leaves. carry out further testing regarding the processing of vegetable insecticides from *P. caninum* extract which is more practical to be applied by farmers in the field.

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