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Effects of *Piper aduncum* Extract on Snail Mortality in Moringa Cultivation

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Abstract. Synthetic pest control has negatively impacted the environment. Piper aduncum (forest betel) is a wild plant with potential as a botanical pesticide. Snails often attack 1-3 month-old moringa seedlings, and forest betel has pesticidal properties that can eliminate the snails attack. This research objective was identify effective part of forest betel to control snail. This research was conduct on the Forest Fiber Technology Research and Development Center (BP2TSTH)'s nursery on Kuok, Kampar, Riau. This research used Completely Randomized Design (CRD) with three treatments and five replications. Extract from forest betel fruit, twigs, and leaves were applied to snails on moringa seedlings, and the effects were observed for initial death, lethal time 50 (LT50), and daily mortality. Result indicated that botanical pesticides extracted from the fruit, twigs, and leaves of forest betel have similar abilities to control snails on moringa. However, each extract showed low efficacy, affecting only 40–60% of the snails, with initial death times ranging from 6.4 to 8.8 hours after application and LT50 values of 21 to 46.4 hours.

1. Introduction

Excessive use of synthetic chemical pesticides over a long period of time has indirectly caused negative impacts on the environment. The use of synthetic chemical pesticides is intended to increase crop yields by suppressing the population of major plant pests. The impact of synthetic chemical pest control is a decrease in crop yields, contamination of hazardous chemicals, health problems, pest resistance, the emergence of new pests, and ecosystem damage. On a wider scale, the use of synthetic chemical pesticides is believed to cause ecosystem damage and climate change. Alternative pest control by considering environmental factors needs to be prioritized.

The magnitude of the impact of damage to the environment has prompted people to seek alternative pest control methods, such as botanical pest control. This approach utilizes natural ingredients to create botanical pesticides. Indonesia is rich in flora that can be used as raw materials for botanical pesticides [1]. In fact, plants that produce botanical pesticides in Indonesia belong to 235 families and include about 2,400 species [2] cit [3]. Lestari (2020) noted that sembung leaves and gadung tubers show great potential as botanical pesticides for controlling snail pests [4]. Likewise, Harahap (2018) indicated that betel nut extract has the potential as a molluscicide, achieving a 100% mortality rate in golden snails by the third day [5]. However, selecting plant species for botanical pesticide must their availability in nature to prevent over-exploitation.

Forest betel (Piper aduncum L.) is a wild plant with potential as a botanical pesticide due to its secondary metabolites, which are effective for pest control. The chemical diversity of

compounds produced by P. aduncum lends itself to broad biological applicability, particularly in fungicidal and insecticidal activities [6]. The secondary metabolites piperamides and dilapiol containing in *P. aduncum* are able to kill pests. *P aduncum* also contains secondary metabolites such as hexane and essential oils, contributing to its effectiveness as a botanical pesticides [6]. Idris and Nurmansyah (2020) reported that oil extracted from forest betel demonstrates molluscicidal properties against golden apple snails [7]. Similarly, Irawan (2018) showed the flour of *P. aduncum* extract cause early death of larva on 12 hours after application and total mortality reached 92% [8].

Snail infestation are common agricultural problem, especially in tropical and subtropical region causes significant damage to crops, reducing yield and quality. One of the crops affected by snail infestations is Moringa oleifera, a highly nutritious plant valued for its medicinal and agricultural benefits. While chemical pesticides have been widely used for pest control, there is a growing interest in natural, plant-based biocides due to environmental and health concerns. Snails typically target 1- to 3-month-old moringa seedlings, with an attack intensity of 30-40% [9]. Additionally, Rahmanto in Lestari (2020) reported that the percentage of snail attacks in Banjarbaru nurseries reached 51.5%, with an attack intensity of 45.8% [4]. The issue of snail pests is quite serious and has the potential to cause plant failure, necessitating immediate action.

Controlling snail pests using botanical pesticides is an important area of study. The use of botanical pesticides derived from forest betel can prevent environmental damage and is often more cost-effective than synthetic chemical pesticides. It is essential to test various parts of the betel forest plant—such as the fruit, stems, and leaves—to determine their effectiveness in controlling snail pests. This study aims to explore which extracts from different part of forest betel (*Piper aduncum* L.)—specifically fruit, twigs, and leaves—are most effective in managing snail infestations.

2. Research Methods

This research was conducted from September 2023 to May 2024 at the nursery of the Forest Fiber Technology Research and Development Center (BP2TSTH) in Kuok, Kampar, Riau. This study used Completely Randomized Design (CRD) with three treatments and five replications. Botanical extracts were prepared from parts of *P. aduncum*, including fruits, twigs, and leaves. These materials were powdered and dissolved in sterile water to achieve concentration 100 g/L. The extract applied to moringa seedlings infested with six snails. Data were analyzed using the ANOVA test at a 5% level of significance.

2.1 Observations parameter

2.1.1 Initial Death

Initial death refers to the time it takes for the extract of forest betel plant parts to kill the treated snails in each treatment. This was observed every three hours following the application of the extract.

2.1.2 Lethal Time 50

Lethal time 50 (LT50) defined as time require for each treatment to kill 50% of snails population. Observations were conducted every three hours after application until 50% of the snail population in each experimental unit had died.

2.1.3 Daily mortality

Daily mortality is defined as the number of pests that die each day following the application. The percentage was calculate by the Natawigena's formula (1993) [10] as below:

$$DM = \frac{a - b}{a} \times 100\%$$

Information:
DM : daily mortality
a : number of treated snails
b : number of live snails

2.1.4 Total Mortality

Total mortality is defined as the percentage of total treated snails that died in the end of observation. The percentage was calculate with Natawigena's formula (1993)[10] as below:

$$TM = \frac{N}{n} \times 100\%$$

Information:
TM : total mortality
N : number of deadly snails
n : number of treated snails

3. Results and Discussion

3.1 Initial Death and Lethal Time 50

Botanical pesticide's application made from extract of the fruit, twig, and leaves of forest betel showed no significant difference in initial mortality rates for the snails, with a time range of 6,4 to 8,8 hours (Table 1). This suggests that the different parts of the forest betel may have similar efficacy in inducing snail mortality. A similar result is also obtained for the lethal time 50 observation (Table 2). Botanical pesticides from the fruit, twigs, and leaves of the forest betel gave no significant difference to the lethal time of 50 snails in the range of 21-46 hours after application. Forest betel contains active compounds from the piperamidine group, including piperine, pipericide, piperlonguminin, and guininsin. Forest betel contained essential oils, as shown on several research, primarily consists of two major group: phenylpropanoid and monoterpene [6]. The bioactive constituents have been identified in the essential oils of forest betel including flavonoid, dillapiole, myristicin, carpacin, apiole, safrole, sarisan, and 1,8-cineole [11]. Rali (2007) noted that, in addition to containing 43,3% dillapiole, forest betel's leaves also include compounds such as 8,2% β-caryophyllene, 6,7% piperitone, and 5,1% α-humulene, along with other compounds each less than 5%. The fruit of forest betel primarily contains dilapiol, with an abundance of 68,8% [12].

Table 1. Initial death of snail to forest betel extract

No	Plant Part	Initial Death (hour)
1	Fruit	8,8 a
2	Twig	7,2 a
3	Leaves	6,4 a

* similar letter indicates that it is non-significant at LSD test (p ≤ 0,05)

Table 2. Initial death of snail to forest betel extract

No	Plant Part	Lethal Time 50 (hour)
1	Fruit	46,0 a
2	Twig	21,0 a
3	Leaves	24,6 a

* similar letter indicates that it is non-significant at LSD test (p ≤ 0,05)

3.2 Daily Mortality

The efficacy of botanical pesticides derived from the fruits, twigs, and leaves of forest betel to kill snails decreases from the first to the third day (Figure 1). On the first day after application, snail mortality ranged from 35% to 45%. By the second day, efficacy dropped to 5% to 20%, and by the third day, no snails died, resulting in 0% mortality. This decrease is attributed to the reduction of forest betel extract due to evaporation. Dadang and Prijono (2008) noted that one limitation of plant insecticides is their low persistence, necessitating repeated applications, especially when pest populations are high [13]. Therefore, effective pest control requires regular

applications at specific intervals. The highest snail mortality was observed with twig extracts (45%), followed by leaf extracts (40%) and fruit extracts (35%). This suggests that twig extracts may contain a higher concentration of secondary metabolites, which can poison snails through both contact and stomach toxicity.

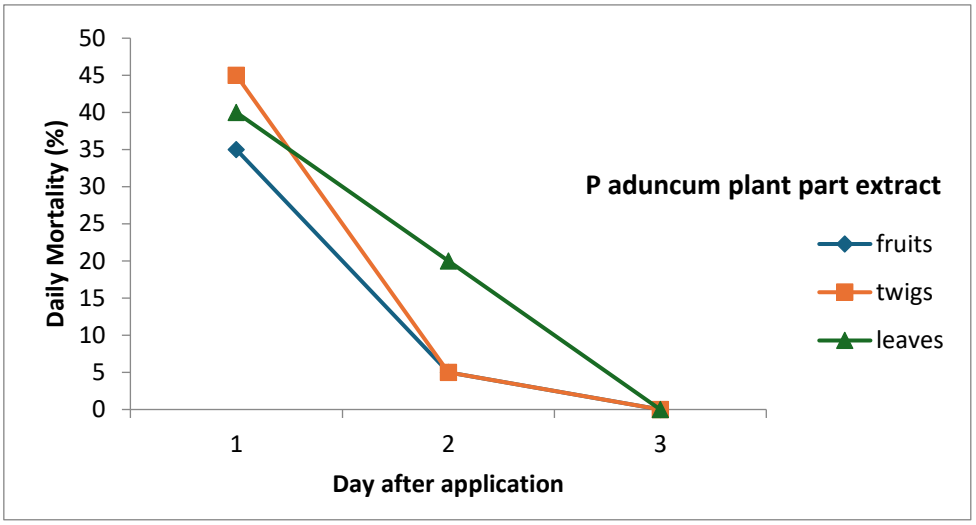

Figure 1. Daily snails mortality following the extract application

3.3 Total Mortality

Treatment of botanical pesticides extract of the fruit, twigs and leaves of the forest betel showed no significant difference in total snail mortality until the third day following the extract application, with a range of 40-60%. The similar effect of the forest betel extract application to the snails is probably the no difference of piperamide content among those forest betel parts. The forest betel plant contains piperamide and dillapiole compounds which are insecticidal. The active compound piperamide in various types of Piper plants works as a nerve poison and causes knockdown and rapid death of insects [14]. It functions as both contact poison and stomach poison in snails. Contact poison entered snail body through the snail's head and abdominal legs, while stomach poison is ingested through the mouth and digestive tract. Piperamidine enters as a stomach poison through the feeding mechanism in pests. This compound enters through the mouth gap (rima oris) and the digestive tract. The piperamidine compound works by damaging the nervous system [4]. Once inside the body, piperamide disrupts the nervous system by inhibiting nerve impulses, leading to irregular movements and seizures, which can ultimately result in death [15]. Dillapiole also contributes to insecticidal activity by inhibiting the polysubstrate monooxygenase (PSMO) enzyme, which normally detoxifies harmful compounds in insects [16], [14]. However, the total mortality of snails observed with forest betel extract remains below the effective pesticide threshold of 80% (Dadang and Prijono, 2002), indicating that this extract is less effective for controlling snails [13].

Table 3. Total Mortality of snail to forest betel extract

No	Plant Part	Total Mortality (%)
1	Fruit	40 a
2	Twig	50 a
3	Leaves	60 a

* similar letter indicates that it is non-significant at LSD test (p ≤ 0,05)

4. Conclusions

The fruit, twigs, and leaves of the forest betel plant demonstrate similar efficacy as botanical pesticides against snail pests in moringa nurseries. However, among these extracts, the leaf extract shows the highest efficacy as a molluscicide. It caused early mortality at 6,4 hour after

application, Lethal Time 50 (LT50) at 24,6 hour after application, and total mortality in 60%. This makes leaf extract a promising natural pesticide for snail control. Additionally, forest betel leaves are abundant and easier to collect than the fruit or twigs.

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