BIOMA
p-ISSN: 0126-3552
e-ISSN: 2580-9032

DOI: 10.21009/bioma.v20i2.49336 Research article

Insecticidal effects of the pandanus (*Pandanus amaryllifolius* Roxb. ex Lindl.; Pandanaceae) leaf powder against rice weevil (*Sitophilus oryzae* Linnaeus 1753; Curculionidae)

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ABSTRAK

*Penurunan kuantitas dan kualitas bahan pangan dapat terjadi selama penyimpanan di gudang yang disebabkan oleh serangan hama kutu beras (*Sitophilus oryzae*). Perlu adanya pengendalian terhadap hama kutu beras yang bersifat ramah lingkungan seperti penggunaan insektisida nabati serbuk daun pandan wangi. Penelitian ini bertujuan untuk mengetahui efek insektisida serbuk daun pandan wangi terhadap hama kutu beras. Rancangan penelitian yang digunakan adalah rancangan acak lengkap non faktorial dengan menggunakan 4 taraf dosis, yaitu 15, 30, 45, dan 60 g. Hasil penelitian menunjukkan bahwa dosis menunjukkan pengaruh yang berbeda nyata terhadap mortalitas kutu beras dengan persentase mortalitas tertinggi ditemukan pada pengaplikasian dosis 60 g, yaitu 43,50%. Implikasi hasil temuan menunjukkan bahwa meskipun dosis bubuk daun pandan wangi yang lebih tinggi (60 g) secara signifikan meningkatkan kematian kumbang beras dan juga menyebabkan penurunan berat beras, namun perlu pemberian dosis bio-insektisida yang seimbang untuk menghindari kerusakan berlebihan pada beras. Selain itu, hasil uji organoleptik menunjukkan bahwa dosis yang lebih rendah (15 g dan 30 g) lebih disukai oleh konsumen untuk warna, rasa, dan aroma, yang menyiratkan bahwa kontrol dosis yang cermat sangat penting untuk efektivitas pengendalian hama dan mempertahankan penerimaan konsumen.*

Kata kunci: Efektivitas, Insektisida, Kutu Beras, Nabati, Pandan Wangi

ABSTRACT

The reduction in the quantity and quality of food can occur during storage in warehouses due to the infestation of rice weevils (Sitophilus oryzae). Environmentally friendly control methods for rice weevil pests are needed, such as using botanical insecticides made from fragrant pandan leaf powder. This research aimed to determine the effects of fragrant pandan leaf powder insecticide on rice weevil pests. The research design used was a non-factorial Completely Randomized Design (CRD) utilizing four dosage levels: 15, 30, 45, and 60 g. The results showed that the dosages had a significant effect on rice weevil mortality, with the highest mortality rate found at the 60 g dosage, reaching 43.50%. The implications of the findings indicated that while higher doses of fragrant pandan leaf powder (60 g) significantly increase rice weevil mortality and also lead to rice weight loss, a balanced dose of bio-insecticide is needed to avoid excessive damage to the rice. Additionally, the organoleptic test results indicate that lower doses (15 g and 30 g) are more preferred by consumers for color, taste, and aroma, which implies that careful

dosage control is crucial for both pest control effectiveness and maintaining consumer acceptance.

Keywords: *Effectiveness, Insecticide, Rice Weevil, Botanical, Fragrant Pandan*

INTRODUCTION

Rice weevils (*Sitophilus oryzae)* are one of the most widespread primary pests and cause significant damage to stored grain products such as rice, sorghum, wheat, and corn (Cao et al., 2024). These rice weevils are common pests in storage facilities, often responsible for rice damage. They create small holes in rice grains, making them easily crumble into powder, which negatively impacts rice quality, rendering it tasteless and musty. Thus, it is essential to control rice weevils properly to maintain the quality and quantity of stored rice (Rizal et al., 2019).

The control of rice weevils often relies on chemical insecticides, which can have negative consequences such as environmental pollution and a decline in rice quality. Therefore, alternative solutions, such as plant-based insecticides, are needed. These bio-insecticides, made from natural materials, do not leave harmful residues on crops or the environment and can be produced using simple equipment and ingredients. One plant with potential as a bio-insecticide is fragrant pandan leaves (*Pandanus amaryllifolius*), which contain alkaloids, saponins, flavonoids, tannins, and polyphenols (Wardani et al., 2020).

Fragrant pandan plant has potential as a bio-insecticide due to its secondary metabolite compounds such as alkaloids, saponins, flavonoids, tannins, and polyphenols, which act as natural defence mechanisms produced by plants. These compounds are toxic to insects and help protect plants from pest attacks. Alkaloids act as stomach poisons to insects, inhibiting acetylcholinesterase enzymes, which disrupt the central nervous system and damage insect egg membranes. Flavonoids act as insecticides, causing paralysis in vital insect organs such as the respiratory system, leading to death. Saponins also have entomotoxic effects, damaging insect eggs, disrupting reproduction, and reducing insect fertility (Indriyani et al., 2019). The application of 40 g of fragrant pandan leaf powder has been shown to cause a 76.67% mortality rate in rice weevils after 21 days (Lisa et al., 2024). Therefore, this research was conducted to evaluate the effectiveness of fragrant pandan leaf powder bio-insecticide against rice weevils after 7 days of bio-insecticide application. Additionally, this research examined the organoleptic properties of rice following the application of powdered bio-insecticide of fragrant pandan.

METHODOLOGY

Research site and experimental design

This research was conducted at the Plant Protection Laboratory of the Faculty of Agriculture, Teuku Umar University, and the Organoleptic Laboratory of the Department of Agricultural Product Technology (THP). The experimental design used was a Completely Randomized Design (CRD) with four levels of bio-insecticide doses: 15, 30, 45, and 60 g, which the doses were modified from the research of (Lisa et al., 2023).

DOI: 10.21009/bioma.v20i2.49336

Research procedures

Rice weevil rearing

Before the experiment, 200 rice weevils were collected from a rice warehouse and placed in a sack for reproduction. These weevils were then infested in a container filled with rice for two weeks and used as samples for the experiment.

Bioinsecticide preparation

The fragrant pandan leaves used were dark green leaves (approximately 8 weeks after planting). Older leaves contain higher levels of secondary metabolites compared to younger leaves, as the increasing age of the leaves influences the quantity of secondary metabolites and bioactive compounds produced (Malik et al., 2022). A total of 2 kg of fresh leaves were harvested and washed with running water, then dried for 3-5 days to reduce moisture content. Afterward, the fragrant pandan leaves were ground into powder using a powder grinder with a capacity of 200 g. The powder was sieved using a 40 mm sieve to obtain fine powder, resulting in a final amount of 1.5 kg.

Bioinsecticide application

The bio-insecticide powder was applied by mixing it into jars containing 200 g of rice at doses of 15, 30, 45, and 60 g. Each jar was shaken to ensure even distribution of the powder. Referring to research conducted by Lisa et al. (2024), twenty rice weevils were added to each jar, and the jars were covered with gauze and tied with rubber bands. The bio-insecticide treatment was observed for 7 days.

Weevil mortality was recorded daily, starting 24 hours after the bio-insecticide application, and continued for 7 days. The rice weevil mortality was calculated using the following formula (Abbot, 1925 in Putri et al., 2018):

$$Po = \frac{r}{n} \times 100\%$$

Information:

M : Insect mortality percentage

a : Number of dead insects

b : Total number of insects used in the treatment

Rice weight loss

Indirect damage because of the weevil consumption was observed on the 7th day using the formula (Pramono *et al*., 2024):

$$\%\, weight\ loss = \frac{W1 - W2}{W1} \times 100\%$$

Information :

W_1 = Initial weight

W_2 = Final weight

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Organoleptic testing

Organoleptic testing was performed on rice mixed with fragrant pandan leaf powder, evaluating the color, taste, and aroma. Eighteen panelists, both male and female adults, participated in the organoleptic test. Panelists were provided with a questionnaire to evaluate the color, aroma, taste, and texture on a scale where 8-10 indicated "most like," 5-7 "like," 3-4 "dislike," and 0-2 "most dislike." The scoring on this scale referred to the hedonic test scale (Ismanto, 2023).

Data analysis

The data were analyzed using One-Way ANOVA. If significant differences were found, a Duncan's Multiple Range Test (DMRT) test at a 5% significance level was conducted for further analysis.

RESULTS AND DISCUSSION

Rice weevil mortality

One-Way ANOVA results showed that dose levels had a significant effect on rice weevil mortality. Further analysis revealed that the highest dose of fragrant pandan leaf powder (60 g) significantly differed from the 15 g and 45 g doses (**Table 1**).

TABLE 1. Rice weevil mortality after application of bio-insecticide powder

Type of Bioinsecticide	Dose	Average Rice Weevil Mortality (%) (Mean ± SD)
Fragrant Pandan	15 g	$31{,}50^{a} \pm 2{,}12$
	30 g	$37{,}50^{ab} \pm 2{,}12$
	45 g	$30{,}00^{a} \pm 4{,}24$
	60 g	$43{,}50^{b} \pm 2{,}12$

These results indicated that fragrant pandan, used as a bio-insecticide, induced rice weevil mortality with the highest percentage (43.50%) at a dose of 60 g after 7 days of application. This is in accordance with Pramono et al. (2024), where a 13 g dose of a combination of fragrant pandan and kaffir lime leaves bio-insecticide caused an 89% mortality rate in rice weevils 21 days post-application compared to only 15% at an 11 g dose. Meanwhile, in the study by Fara et al. (2016), the use of fragrant pandan botanical pesticide at the highest dose of 10 g resulted in the highest mortality of rice weevils, with 48 individuals killed, compared to 31 individuals at an 8 g dose.

The fragrant pandan leaves contain secondary metabolites such as steroids, terpenoids, saponins, flavonoids, phenolics, and tannins. Flavonoid, tannin, saponin, and steroid compounds can exert a mortality effect on the rice weevil (Lisa et al., 2023).

The data suggest that higher doses of bio-insecticides result in greater insect mortality. The lowest dose (15 g) killed 31.50% of rice weevils, while the highest dose (60 g) killed 43.50%. Similar trends were reported by Yudiawati (2019), where the highest concentration (18%) of lime peel extract killed 70% of *Spodoptera exigua* larvae. It is hypothesized that higher bio-insecticide concentrations increase the amount of toxins exposed to insect bodies, causing higher mortality rates.

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Rice weight loss

Rice weight loss was observed on day 7 after the treatment, with varying levels across the different bio-insecticide doses (**Table 2**).

TABLE 2. Average rice damage at different bio-insecticide doses

Bioinsecticide of fragrant pandan leaf powder (g)	Rice damage (%)
15 g	0,98
30 g	0,81
45 g	0,76
60 g	1,24

The percentage of rice damage after the application of botanical insecticide powder showed a decrease in the weight loss of rice obtained within the dosage range of 15 g to 45 g. The lowest percentage of rice damage at the concentration of botanical insecticide treatment could be due to the high number of mortalities of rice weevil imagoes. However, a different result was found when using pandan powder at a dosage of 60 g, where the obtained result was the highest percentage of rice weight loss (1.24%). This high value of rice weight loss could be influenced by the life cycle of the rice weevil inside the rice. The number of surviving weevil imagoes affects the intensity of rice damage. According to Wicaksono *et al*. (2018), the higher the concentration of botanical insecticide used, the more toxic secondary metabolite compounds are consumed by the rice weevil pest, inhibiting the rice weevil from consuming large amounts of rice. Additionally, the population of weevil imagoes affects the intensity of rice damage.

Organoleptic test results

The organoleptic test is based on a sensory evaluation involving sight, taste, smell, and touch, i.e. the hedonic test (preference) according to Makmur *et al*. (2022). This test is conducted to determine consumer acceptance using a hedonic scale. The organoleptic test results for color showed changes in rice mixed with fragrant pandan powder (**Figure 1**). The higher the dose of powder used, the greener the rice becomes, resulting in a greener color when cooked.

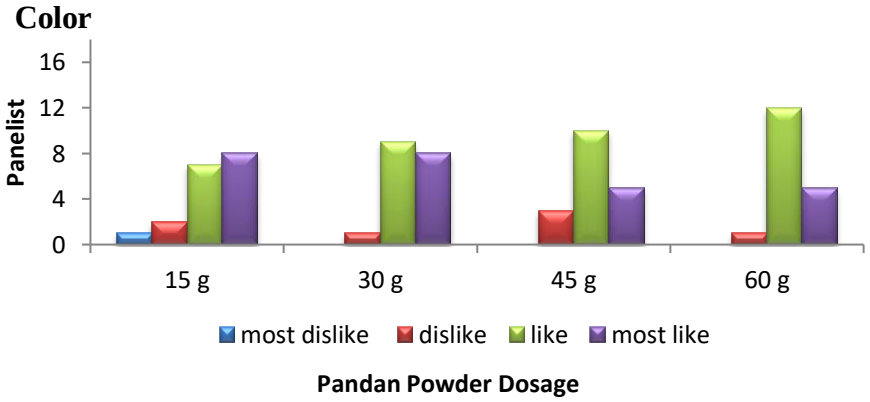

Figure 1. Panelist test results on the produced color of rice

DOI: 10.21009/bioma.v20i2.49336

The panelists' highest preference score for the color of pandan-flavored rice was at the lower doses of 15 g and 30 g. However, the preference score decreased as the highest dose of 60 g was used. This could be influenced by the panelists' habit of consuming white rice, where color changes in the rice lead to a decrease in consumer interest.

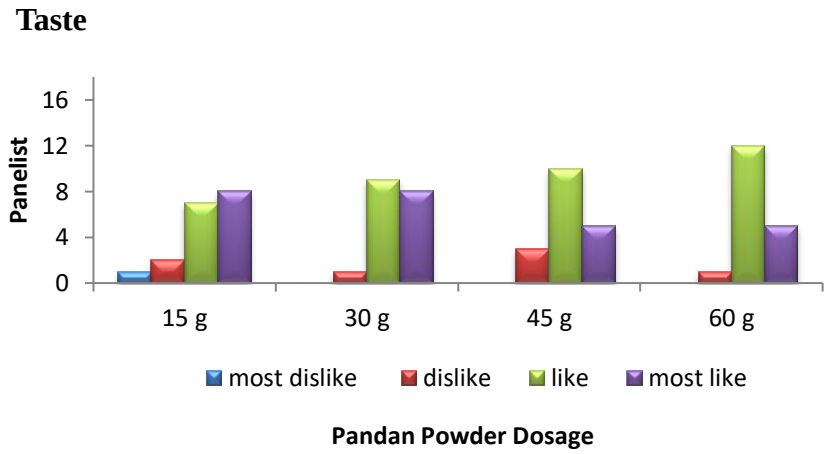

FIGURE 2. Panelist test results on the taste produced of rice

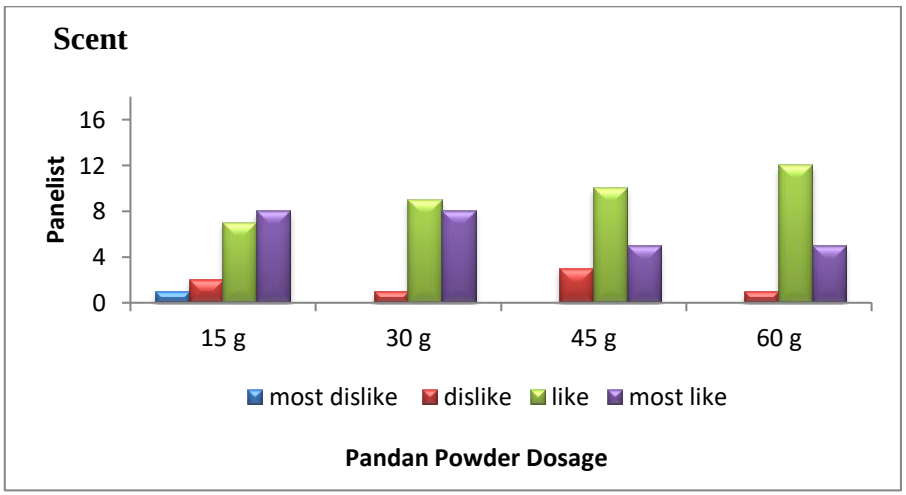

FIGURE 3. Panelist test results on the aroma produced of rice

Based on the organoleptic test results for taste and aroma, it was also shown that the higher the dose used, i.e., 60 g, the higher the panelists' dislike score. However, for the 15 g and 30 g doses, consumer preference scores remained high compared to the dislike scores. This is because fragrant pandan is a plant commonly used by the public as a flavor and aroma enhancer in food, making consumers familiar with the taste and aroma changes. The carotenoid compounds in fragrant pandan provide a strong aroma to food, which is why it is often used as a natural food coloring agent (Irwansyah *et al.*, 2023).

CONCLUSIONS

The fragrant pandan leaf powder as bio-insecticide, significantly impacted rice weevil mortality, with the highest mortality (43.50%) observed at a 60 g dose. This finding aligns with previous studies, suggesting that higher concentrations of bio-

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insecticides lead to increased weevil mortality due to a higher exposure to toxic secondary metabolites. Despite the higher mortality at the 60 g dose, rice damage was relatively low across all doses, with the lowest damage observed at 45 g. The increase in rice damage at the highest dose (60 g) could be attributed to the balance between weevil mortality and the remaining live population's impact on rice consumption. The organoleptic test results revealed that consumer preferences for rice color, taste, and aroma were highest at the lower doses (15 g and 30 g), with a decrease in preference at the 60 g dose. This suggests that while higher doses of fragrant pandan are effective in controlling rice weevils, they may not be as well-received by consumers due to changes in quality of the rice.

AUTHOR CONTRIBUTIONS

O.L contributed to the overall research design, and data analysis. S.F.L., P.M.S., & M.M contributed to finalising the concept and manuscript. Z.W. contributed to fieldwork, lab work, and data collection.

ACKNOWLEDGEMENT

We are grateful to all those who helped with this research.

CONFLICTS OF INTEREST STATEMENT

There are no conflicts to declare.

DISCLOSURES AND ETHICS

As a requirement of publication author(s) have provided to the publisher signed confirmation of compliance with legal and ethical obligations including but not limited to the following: authorship and contributorship, conflicts of interest, privacy and confidentiality and (where applicable) protection of human and animal research subjects.

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