THE TESTING OF GINGER, TURMERIC AND GALANGAL POWDER ON THE MORTALITY OF THE RICE WEEVIL (*Sitophilus oryzae*)

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Abstract

One product that is environmentally friendly and does not poison consumers is the use of plant-based materials known as biopesticides that come from plant-based materials. The aim of this research is to determine the mortality rate of rice weevil treated with ginger, turmeric and galangal powder either singly or in combination. The research was carried out at the Banjarnegara Polytechnic Integrated Laboratory. A total of 20 rice weevil imagoes resulting from breeding were infested in a jar containing 100 g of rice. The research used a completely randomized design with 7 treatments in the form of A0: control; A1: ginger powder 15 g; A2: turmeric powder 15 g; A3: galangal powder 15 g; A4: ginger powder 7.5 g and turmeric powder 7.5 g; A5: ginger powder 7.5 g and galangal powder 7.5 g; A6: turmeric powder 7.5 g and galangal powder 7.5 g. Each treatment used 4 replications so there were 28 research units. The data obtained for each parameter was analyzed using the F test, if significantly different, continued with the Duncan test at the 5% level. The use of ginger, turmeric and galangal powder, whether applied singly or in combination on rice weevil, was not able to increase the mortality rate in all treatments at 1, 2, 3 and 4 weeks after treatment. The percentage of yield loss shows that in treatments A0, A1, A2, A3, A4, A5, and A6 respectively, namely 0%; 3.75%; 3.75%; 10.00%; 11.25%; 5.00%; and 16.25%. The percentage of damaged rice weight shown in treatments A0, A1, A2, A3, A4, A5, and A6 respectively was 5.00%; 10.00%; 8.75%; 15.00%; 23.75%; 8.75%; and 25.00%.

Keywords: *galangal, ginger, mortality, rice weevil, turmeric.*

A. Introduction

The quality of rice can be determined from the integrity of its shape and appearance. Rice that has no physical defects, no dirt, no disturbing organisms can be called good quality. Efforts to improve the quality of rice in storage continue to be made, one of which is through research. Lihawa & Toana, (2017) stated that there was damage to rice and a decrease in rice quality, one of which was caused by pest attacks. In fact, damage to rice by warehouse pests can reach 10-20% of stored rice. Hendrival & Muetia, (2016) also stated that the rice storage period will affect the loss of rice weight and an increase in the number of holes in rice due to Sitophilus oryzae attacks.

Rice stored on a household scale often does not apply good agricultural product storage standards. The problem that exists if product storage does not comply with storage standards can result in several losses. If rice products are stored in poor containers, they can be more easily infested by insect pests. Insect pests that cause damage to the quality and quantity of rice easily reduce the quality of rice. The use of synthetic chemical insecticides is inappropriate if used on post-harvest products, because the products will be consumed immediately. Other alternatives are needed to control pests in storage. One product that is environmentally friendly and does not poison consumers is the use of plant-based materials known as biopesticides that are sourced from plant-based materials.

The success of using plant-based ingredients to control warehouse pests on a household scale can be further applied on an industrial scale. Warehouse pest control on an industrial scale currently still uses synthetic chemicals. Arum and Hasjim, (2020), fumigation in grain product storage warehouses generally uses phosphine gas (PH_3). In fact, to be able to exceed 100% mortality of a test pest insect pupa, 404 ppm phosphine is needed at a dose of 1 g per m3. There needs to be alternative efforts to control warehouse pests that are environmentally friendly and safe for consumers.

Previous research by Apriliyanto & Sarno, (2022) stated that the use of several vegetable ingredients in the form of pandan leaf simplicia, bay leaves, and lemongrass at 7 days after treatment (HSP) showed a percentage of rice weevil mortality of 59.29%, 39.29% respectively. %, and 50.00%. Studies are still needed on the potential of other plant materials which are thought to influence rice weevil mortality. Information about the influence of some plant materials on rice weevil mortality is still limited. Therefore, it is necessary to test ginger powder (Zingiber Officinale), turmeric (Curcuma longa), and galangal (Alpinia galanga) on rice weevil (Sitophilus oryzae) mortality. The aim of this research is to determine the mortality rate of rice weevils treated with ginger, turmeric and galangal powder either singly or in combination. It is hoped that the results of this research can be applied in society, especially in the field of agro-industrial product management in rice storage.

B. Literature Review and Hypothesis Development

High rice productivity must be accompanied by managing the quality of the results by avoiding attacks by rice weevils. The use of vegetable insecticides and appropriate storage media is a solution to this problem (Gunadi, Yulinda & Sari, 2022). The rice weevil (Sitophylus oryzae

L.), is a post-harvest pest that can damage rice in storage. This rice weevil causes rice grains to become small holes, break easily and crumble like flour which makes the quality low. It even makes cooked rice taste unpleasant and smells musty. The presence of rice weevils requires appropriate control efforts. One way to control rice weevils is to use plant material as a botanical insecticide. This method is considered safe and cheap, when compared to the use of synthetic insecticides (Isnaini, Pane & Wiridianti, 2015).

Symptoms of damage caused by rice weevil on several varieties of rice show differences in symptoms of damage. Mekongga, Ciherang and Inpari 21 rice showed signs of damage in the form of rice grains starting to turn white, then irregular white lines as a result of the larvae's grinding activity in the rice grains. Symptoms of rice weevil damage on the Cimelati and IR 64 rice types have not been seen as on the other three varieties (Booroto, Goo & Noya, 2017).

In the application treatment of ginger rhizome extract, the mortality of Aphis sp. The highest is 26% different from other treatments. Turmeric vegetable pesticide can be used as an alternative to synthetic or chemical pesticides (Tasnia, Ibnusina & Alfikri, 2022). In observations during 6 and 9 days (hours after application) mortality of Aphis sp. increased with the application of botanical pesticides. In the 9th day observation, the mortality of Aphis sp. The application treatment of turmeric, ginger and betel leaf extracts was significantly different from the control. In the turmeric extract application treatment, mortality of Aphis sp. namely 12% and application of betel leaf extract, namely 20% (Wibowo et al., 2022). The results of this research show that the mode of action of the substances contained in galangal functions to repel (repellent) and kill (pesticidal) insects (Hastuti, Rusmana & Hasan, 2015). The success of a plant material in reducing insect populations or increasing insect mortality is thought to be applicable to other types of target insects.

The development of mortality of S. oryzae imago after application of a mixture of babandotan (Ageratum conyzoides) leaf powder with turmeric (Curcuma longa) and ginger (Zingiber officinale) rhizome powder showed a similar pattern with mortality reaching > 95% until the end of the observation. Mortality of S. oryzae imago after application of a mixture of A. conyzoides leaf powder with C. longa and Z. officinale rhizome powder occurred frequently in observations 2–9 hsa (days after application). The increase in mortality of S. oryzae imago is related to the increase in the concentration of a mixture of A. conyzoides leaf powder with C. longa and Z. officinale rhizome powder so that it is known that the insecticidal activity of this mixture is quantitatively active (Hendrival et al., 2017). Several vegetable ingredients have

compounds that are most effective in controlling the pest S. oryzae, so this results in the death of the pest, the level of attack on rice does not occur optimally, as a result the percentage of weight loss becomes lower and controlled (Mulyani & Widyawati , 2016).

C. Research Method

Rice weevil propagation aims to provide a number of weevil adults that meet needs with a uniform size. Rice weevil breeding is carried out at the Banjarnegara Polytechnic Integrated Laboratory. Rice weevil breeding is carried out in long box containers containing 2 kg of rice, then infested with rice weevils that have been bred previously. 100 g of rice is placed in a long rectangular jar, transparent color, top size 17.5 x 12 cm, bottom size 14.5 cm x 9 cm, height 5.5 cm, volume capacity 750 mL made from original food grade PP polypropylene. The lid of the jar is cut to a size of 10 cm x 5 cm and the part is covered again with gauze.

Ginger, turmeric and galangal powders are obtained by purchasing them ready to use. 15 g of ginger, turmeric and galangal powder for each treatment was put into a tea bag container, then put into a box filled with 100 g of rice in each research unit.

A total of 20 rice weevil imagoes resulting from breeding were infested in a jar containing 100 g of rice. Tests with 15 g of vegetable material were based on research (Isnaini, Pane & Wiridianti, 2015), that using this weight of vegetable material was able to kill rice weevils. Rice that has been infested with rice weevils is stored for 4 weeks under laboratory conditions. The research used a completely randomized design with 7 treatments in the form of A0: control; A1: ginger powder 15 g; A2: turmeric powder 15 g; A3: galangal powder 15 g; A4: ginger powder 7.5 g and turmeric powder 7.5 g; A5: ginger powder 7.5 g and galangal powder 7.5 g; A6: turmeric powder 7.5 g and galangal powder 7.5 g.

Each treatment used 4 replications so there were 28 research units. The parameters observed according to Hendrival & Muetia, (2016) are the percentage of powder fraction with the following formula:

The calculation of rice weight loss was carried out on a 20 g rice sample. The rice in the container is stirred until the whole rice and hollow rice are evenly distributed, then the weight loss percentage is calculated.

$$Persentage\ of\ weight\ loss\ = \frac{(U\ x\ Nd) - (D\ x\ Nu)}{(U\ x\ N)} x\ 100\%$$

Information:

U: weight of whole rice fraction (g); D: weight of the hollow rice fraction (g); Nu: number of whole rice fractions; Nd: number of rice fractions with holes; N : number of sample rice.

Calculation of the percentage of rice with holes in a 20 g rice sample.

$$Persentage\ of\ rice\ with\ holes = \frac{Nd}{N}\ x\ 100\%$$

Information:

Nd: number of rice fractions with holes; N : number of sample rice; Observations on the percentage of mortality of rice weevils were carried out at 7 days after treatment (DAT), 14 DAT, 21 DAT, and 28 DAT. Observations were made on the number of deaths of rice weevil imago.

$$P = \frac{a}{b}\ x\ 100\%$$

Information :

P : Mortality percentage

a : Number of dead imago

b : Number of living imago.

The data obtained for each parameter was analyzed using the F test, if significantly different, continued with the Duncan test at the 5% level.

D. Discussion

The results of observations on the rice weevil pest S. oryzae which attacked the test rice showed that the rice weevil was active in the rice boxes. Symptoms of rice attacked by rice weevils include the surface of the rice having eating marks and the surface of the rice grains being uneven. Weevils also often enter the rice to eat from the rice, until powder remains from their meal. Weevils are often found in the middle or bottom layer of rice, rarely found in the top layer of rice. If they are at the top, the weevils are sometimes found between the bags of the powdered vegetable material being tested. Udo, (2019) several secondary metabolites can act as insecticides and antifeedants which influence insect movement, oviposition, feeding behavior, developmental and physiological processes and insect behavior patterns.

The results of observations of rice weevil mortality at 1 WAT (week after treatment) showed that there was no significant difference in all treatments (Table 1). Observations at 1 WAT showed that all treatments tried in the form of ginger, turmeric and galangal powder, either singly or in combination, could kill rice weevils. The control (without the addition of vegetable matter) showed that no rice weevils died. Rice weevils in the treatment box are often in the middle of the

rice, and sometimes they also enter the rice grains. Narharirao & Yadav, (2023) in their research, the use of several vegetable ingredients can be toxic and antifeedant against rice weevils. Furthermore (Fadila et al., 2020) stated that plants from the Zingiberaceae group are poisonous and can kill insects with their active ingredients.

Observation results at 2 WAT also showed that there was an increase in the percentage of rice weevil mortality. Even though there was no significant difference between treatments, all vegetable ingredients were able to kill rice weevils. As for 3 WAT and 4 WAT, it also shows that all treatments are not significantly different. There is an increase in the mortality rate with each observation. Weekly observations showed that there was an increase in the mortality rate of rice weevils in all treatments, although in all treatments there was no significant difference in the mortality rate of rice weevils. It is suspected that the type of formulation also influences the mortality rate of rice weevils. In the research conducted, all treatments used powder formulations. Pakeerathan et al., (2021) in their research used leaf, flower and seed preparations in both fresh and dry form, the use of dry seed preparations as a botanical insecticide was more effective in the percentage of rice weevil mortality.

Table 1. Mortality of rice weevils with several plant material treatments.

Treatment	Rice weevil mortality (%)			
	1 weeks after treatment ^{ns}	2 weeks after treatment ^{ns}	3 weeks after treatment ^{ns}	4 weeks after treatment ^{ns}
A0	0	5,00	11,25	16,25
A1	3,75	10,00	20,00	26,25
A2	3,75	8,75	12,50	27,50
A3	10,00	15,00	20,00	23,75
A4	11,25	23,75	30,00	45,00
A5	5,00	8,75	11,25	12,50
A6	16,25	25,00	30,00	32,50

Note: Data were transformed using arcsin (√%), then analyzed using the F test at the 5% level, if significantly different, continue with the Duncan test at the 5% level. ns: not significantly different. A0: control; A1: ginger powder 15 g; A2: turmeric powder 15 g; A3: galangal powder 15 g; A4: ginger powder 7.5 g and turmeric powder 7.5 g; A5: ginger powder 7.5 g and galangal powder 7.5 g; A6: : turmeric powder 7.5 g and galangal powder 7.5 g. WAT: weeks after treatment.

The use of ginger, turmeric and galangal powder, whether applied singly or in combination on rice weevils, was not able to increase the mortality rate in all treatments at 1 WAT, 2 WAT, 3 WAT and 4 WAT. The volatile compounds present in all the materials tested are thought to have the same or equivalent effect on rice weevils. The same effect in all treatments with the same level of mortality is thought to contain toxic compounds in ginger, turmeric and galangal at equivalent

levels in influencing the development and mortality of rice weevils. Ainane et al., (2019) stated that volatile extracts contain high levels of deadly compounds against insect pests.

Observation results in the form of the percentage of yield loss in rice infested with rice weevils showed that there was no significant difference in all treatments (Table 2.). The percentage of yield loss shows that in treatments A0, A1, A2, A3, A4, A5, and A6 respectively, namely 0%; .75%; 3.75%; 10.00%; 11.25%; 5.00%; and 16.25%. Yield loss for all rice showed the same percentage level. All treatments suspected rice weevil activity in damaging rice grains with the same level of greed. The presence of volatile compounds in each material tested is thought to have no effect on the damaging mechanism or eating speed of the rice weevil. Pal et al., (2022) the use of ginger powder on rice can affect weight loss and rice weevil populations during storage. Risnawati, (2020) the form of formulation of vegetable ingredients also influences the level of toxicity to target insects.

Table 2. Percentage of yield loss and weight of damaged rice

Treatment	Yield loss percentage (%)^{ns}	Percentage of damaged rice weight (%)^{ns}
A0	0	5,00
A1	3,75	10,00
A2	3,75	8,75
A3	10,00	15,00
A4	11,25	23,75
A5	5,00	8,75
A6	16,25	25,00

Note: Data were transformed using arcsin (√%), then analyzed using the F test at the 5% level, if significantly different, continue with the Duncan test at the 5% level. ns: not significantly different. A0: control; A1: ginger powder 15 g; A2: turmeric powder 15 g; A3: galangal powder 15 g; A4: ginger powder 7.5 g and turmeric powder 7.5 g; A5: ginger powder 7.5 g and galangal powder 7.5 g; A6: : turmeric powder 7.5 g and galangal powder 7.5 g. wat: weeks after treatment.

The results of observing the percentage of damaged rice weight showed that each treatment was not significantly different (Table 2). The percentage of damaged rice weight shown in treatments A0, A1, A2, A3, A4, A5, and A6 respectively was 5.00%; 10.00%; 8.75%; 15.00%; 23.75%; 8.75%; and 25.00%. The percentage of damaged rice weight along with the results of the analysis of the percentage of yield loss were not significantly different across treatments. Damage to rice is in the form of part of the grain being eaten, leaving the damaged part in the form of an uneven surface of the grain because there are traces of rice weevil eating. Apart from

that, it can also make whole grains into powder, even though the volume of rice powder is still very low.

E. Conclusion

The use of ginger, turmeric and galangal powder, whether applied singly or in combination on rice weevils, was not able to increase the mortality rate in all treatments at 1 WAT, 2 WAT, 3 WAT and 4 WAT. The percentage of yield loss shows that in treatments A0, A1, A2, A3, A4, A5, and A6 respectively, namely 0%; .75%; 3.75%; 10.00%; 11.25%; 5.00%; and 16.25%. The percentage of damaged rice weight shown in treatments A0, A1, A2, A3, A4, A5, and A6 respectively was 5.00%; 10.00%; 8.75%; 15.00%; 23.75%; 8.75%; and 25.00%.

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