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The Effectiveness of Natural Plant Powder in Controlling Rice Weevils (*Sitophilus oryzae*)

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Abstract. The rice industry today, very depends on synthetic pesticides to protect against losses. However, synthetic pesticides pose toxicity and give a negative effect on humans, animals, and the environment. Thus, this study aims to observe the effectiveness of natural powders such as neem (*Azadirachta indica*) and black pepper (*Piper nigrum*) in controlling rice weevil (*Sitophilus oryzae*) during rice storage. Treatments included in this experiment comprised control where no plant powder was applied (T0), black pepper powder (T1), neem leaves powder (T2), and a combination of neem with black pepper (T3). All treatments were conducted on different types of rice, Malaysia (local) and Thailand rice. 30 g of dosage for all treatments were applied to 100 g of rice with 20 weevils introduced. The experiment was laid out in a completely randomized design (CRD) with 32 samples. The finding shows natural plant powder was significant ($P=0.000$) in controlling rice weevil. Meanwhile, neem leaves powder (T2) was more effective in controlling rice weevils during storage due to the lowest survival rate (Local: 78.75%, Thailand: 55%) and the highest mortality rate (Local: 21.25%, Thailand: 45%) of rice weevils for both types of rice. Besides, neem leaves powder also showed the lowest rice damage data (Local: 20.75%, Thailand: 20.35%) compared to other treatments. Study findings can help to meet current health, environment, and safety standards.

1. Introduction

Rice or known as *Oryza Sativa L.* is the second most important crop in the world after wheat. It is a valuable food and known as a staple food in Malaysia and continually infested by several insect pests during the period of storage. The common insect pests on rice are *Sitophilus oryzae* (rice weevil), *Oryzaephilus surinamensis* (saw-toothed grain beetle), *Tribolium castaneum* (Red Flour Beetle), and *Plodiainter punctella* (Indian Meal Moth). The combination of primary and secondary pests in one commodity enhances the rice infestation. *Sitophilus oryzae* could be the major primary pest in storage products with the ability to eat on the whole grain [1]. The way to protect stored products against these pests is crucial in many countries, especially those that do not have adequate storage facilities. Currently, pest and disease control are relying on synthetic pesticides. The use of chemicals in the agriculture industry is rapidly increasing from year to year that leading to environmental pollution problems [2]. Even though synthetic pesticides are reliable against pest damage, unfortunately, they will harm the environment, humans, and living organisms [3]. The same goes for pest controlling in rice storage relies on the application of many types of synthetic pesticide and fumigant which is normally used to control pest in the storage stage. Although the fumigation method has been widely used in the grain storage



industry, nevertheless these practices lead to very serious problems for example pesticide residue in grain, environmental pollution, pesticide resistance, and toxicity to the non-target organism [4]. Naturally, plants, herbs, and spices are alternative sources of pest control because contain a range of bioactive chemicals [5; 6]. The neem tree or known as *Azadirachta indica* is one of the promising plant species utilized for biopesticides [7]. Neem leaves contain alkaloid compounds, nimbidine, tannins, resins, azadiractin [8] that are suitably used as plant pesticides [9]. Black pepper is a spice that has bioactive compounds that are normally contained in commercial insecticides, fungicides, and bactericides [10]. Moreover, black pepper is significant as a plant pesticide especially for killing insects [11; 12;13]. Therefore, this study aims to determine the effectiveness of this natural powders such as neem and black pepper in controlling rice weevils (*Sitophilus oryzae*).

2. Methodology

The research was conducted at the laboratory of the Universiti Malaysia Kelantan Jeli Campus, Kelantan. The average temperature and relative humidity during the experiment period were 32°C (ranging from 29°C to 35°C) and 70 ± 5%, respectively.

2.1. Sampling of rice

Two types of rice manufactured in Malaysia (local) and Thailand have been chosen to test the effectiveness of natural plant powder in controlling rice weevils due to a report that mentions Thailand's high chemicals during the fumigation process compared to Malaysia [14]. To ensure that rice is uninfestation, both types of rice were kept in a deep freezer for 72 h to kill pests at all life stages because eggs are particularly very sensitive to cold [15]. The container was shaken to make sure rice and treatment powders were mixed thoroughly.

2.2 Preparation of natural powder and rice weevil (*Sitophilus oryzae*)

The neem leaves and black paper used as a natural powder in the experiment were purchased at the shop in Kota Bharu, Kelantan. 5 kg neem leaves and black paper were dried under shade conditions to avoid photodegradation of active compounds by ultra-violet ray [16], then grounded using a grinding machine and sieved with a 10 mm sieve. Neem leaves, black paper, and a combination of neem plant powders were weighted with 30 g for each treatment using a digital balance. The control treatment was not treated with any powder. The stocks of rice weevils were collected from local paddy farmers in Kelantan and purchased at an insect shop in Kota Bharu, Kelantan. The rice weevils were identified as the *Sitophilus oryzae* in the laboratory.

2.3 Data collection

100 g of rice were treated with different natural powders extract with a dosage of 30 g for each treatment in a small container. All treatments included control (no treated with any material) (T₀), black pepper powder (T₁), neem leave power (T₂), and a combination of neem leave and black pepper powder (T₃). 20 rice weevils were introduced into each container and stored for 8 weeks, where observations were done weekly. The parameters of this study involve survival rate, mortality rate, and grain damage rate. The numbers of alive rice weevils were counted and recorded to measure the survival rate while the numbers of dead weevils for the mortality rate. Data for both parameters were recorded by observing and counting weevils across the 8 weeks, expressed in a percentage. Grain damage was assessed at the end of the storage period. The weight of grains with holes was counted as damaged through weevil feeding. Grain damage was calculated as the proportion of grain weights using the formula below:

$$\text{Grain damage (\%)} = \frac{\text{Weight of treated grains with holes}}{\text{Total weight of grains}} \times 100$$

2.4 Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and significant differences existed; treatment means were compared at a 0.05 significant level.

3. Result and discussion

3.1 Effect of the Natural plant powder on Survival and Mortality of Rice Weevil

Figure 1 shows the finding for rice weevil survival and mortality for local and Thai rice. The result shows that there is a significant difference ($P=0.000$) in the rice weevil survival and mortality rate when applied to all the treatments (Table 1). Results for the survival of rice weevils stated that neem leaves powder was found as the best treatment to repel rice weevils for both rice (Local: 78.75%, Thailand: 55%) with the lowest survival rate. Followed by the combination of neem leave and black pepper powder (Local: 87.5%, Thailand: 63.75%), black pepper powder (Local: 88.75%, Thailand: 67.5%), and control (Local: 95.0%, Thailand: 92.5%). Finding for the mortality rate of rice weevil also shown that the neem leaves powder is the best treatment with a higher mortality rate for both types of rice (Local: 21.25%, Thailand: 45%). Next is the combination of neem leave and black pepper powder (Local: 12.5%, Thailand: 36.25%), black pepper powder (Local: 11.25%, Thailand: 32.5%), and control (Local: 5.0%, Thailand: 7.5%). Closely to a previous study, neem can cause mortality for rice weevils [17;18]. Active ingredients in neem tree that make the leaves bitter [19] and Azadirachtin bioactive ingredients in neem is useful for insect repellent role. Supported by a previous study that showed biologically active components in neem have insecticidal activity [20]. Therefore, can be concluded that the two natural plant powder that was used for the study contained active substances that were effective in killing the weevils, thereby decreasing their population throughout storage. Based on this study, there is a different effect on all treatments to local and Thailand rice, where the survival rate for rice weevil in Thailand rice is more lowers compare to local rice. Thailand has used a high amount of chemicals to control losses that normally happen during the storage stage [21] and it affects influenced the research finding due to the treatment undergone by both rice during their storage before market. Based on Ahmed et al. [14], Thailand has used 90% of the chemical during the fumigation process to control grain pests during storage compared to Malaysia only used 20%.

3.2 Effect of the Natural plant powder on Grain Damage

Based on Table 1, this study shows that there is a significant difference ($P=0.032$) in grain damage for local and Thailand rice when applied with all the treatments. Among all treatments, neem leaves powder is the best treatment to control grain damage due to very low rice damage for both rice (Local: 20.75%, Thailand: 20.35%), which was followed by a combination of neem leave and black pepper powder (Local: 25.25%, Thailand: 24.75%), black pepper powder (Local: 30.9%, Thailand: 30.9%) and control (Local: 37.75%, Thailand: 38.5%). Agreed by Rojasara et al. [17], that mention neem is an effective treatment against rice damage from rice weevils. Neem contains antifeedant properties that repel rice weevil and reduce rice damage [22].

Table 1. ANOVA table for result effects of treatments for all parameters.

		Sum of Squares	df	Mean Square	F	Sig.
Survival rate	Between Groups	3104.688	3	1034.896	13.517	.000
	Within Groups	918.750	12	76.563		
	Total	4023.438	15			
Mortality rate	Between Groups	3104.688	3	1034.896	13.517	.000
	Within Groups	918.750	12	76.563		
	Total	4023.438	15			
Grain damage	Between Groups	744.730	3	248.243	4.105	.032
	Within Groups	725.740	12	60.478		
	Total	1470.470	15			

* Significant at the 0.05 level.

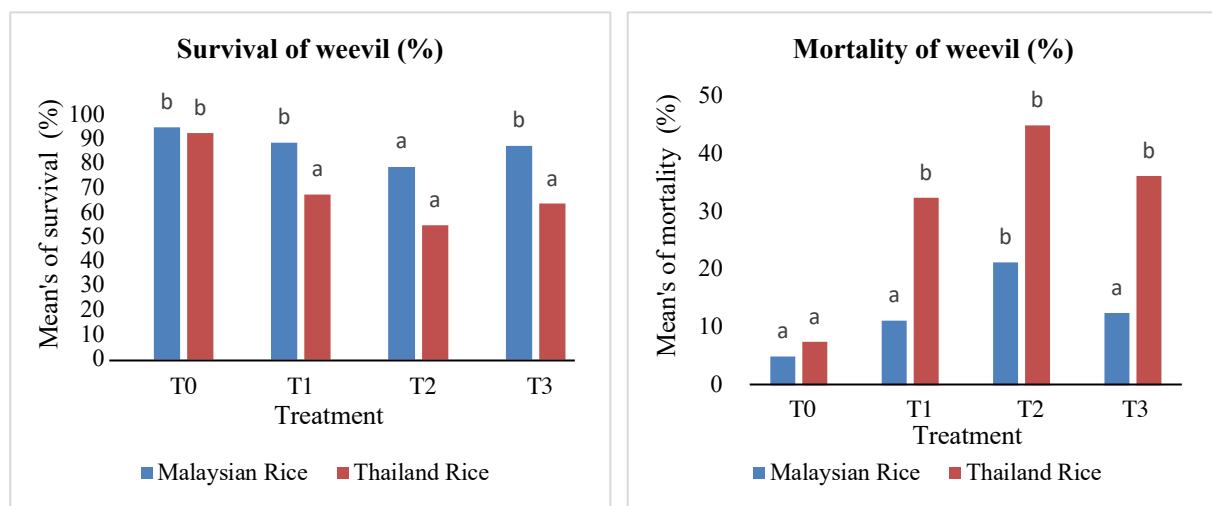


Figure 1. Survival and mortality rate on rice weevil for local and Thailand rice after application of natural plant powder.

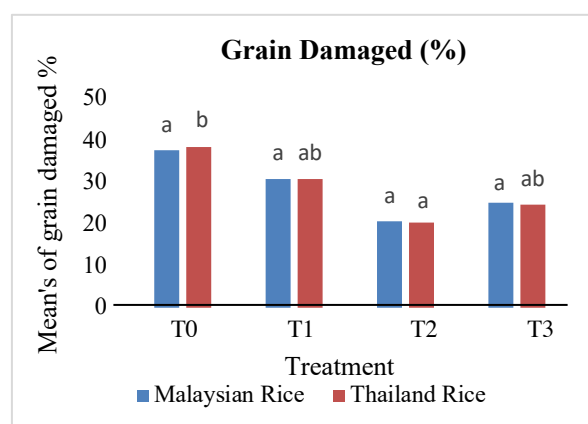


Figure 2. Grain damage after treated local and Thailand rice with natural plant powder.

4. Conclusion

The main objective of this study was to identify the effectiveness of natural plant powder in controlling rice weevils (*Sitophilus oryzae*). Among, all natural plant powders, neem leaves powder is the best treatment for controlling rice weevils. Nonetheless, the combination of neem leaves and black pepper powder, and black pepper powder is also significant in controlling rice weevils. This study is one alternative to help reduce the risk of rice damage caused by rice weevils, as well as to reduce chemical applications in the rice industry that can be dangerous to human health and the environment.

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