

The repellent action of stored pest rice (*Sitophilus oryzae*) using home ingredients

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Abstract

The rice (*Oryza sativa* L.) is the second most important crop in the world after wheat. It is a staple food in India, and is continually infested by several insect pests during the period of storage. Pest is an insect or animal that destroys plants, food etc and the pest of rice is known as rice weevils. The scientific name of rice weevil is termed as *Sitophilus oryzae*. Chemical pesticides are extensively used in pest management. Using these pesticides increasingly from year to year, thus leading to environmental pollution. Insects gain resistance against these chemical pesticides, & lead to turn pesticides to be not efficient. Hence in this research study some of the home ingredients such as Turmeric, Garlic, Ginger and Bay leaf are used as home ingredients to control the loss of rice weevil. Thus, the objectives of the study are that natural methods can be a more environmentally friendly alternative to synthetic pesticides.

Keywords: *Sitophilus oryzae*, turmeric, ginger, garlic, bayleaf, *Oryza sativa*

Introduction

The rice weevil could be the major primary pest in storage products. (Champ & Dyte, 1976). Stored products are vulnerable to various deteriorative factors that lead to substantial economic losses & pose health risks. (Adam, 1976). One of the most destructive pests of stored cereal grain globally is the rice weevil (Coleoptera, Curculionidae). The different stages (egg, larvae, and pupae) feed and develop concealed within the seed kernels, causing huge losses. (Dobie, 1974)

Storage grain losses of major cereal crops can be attributed primarily to attack by rice insect pests, diseases, and rodents (Rana and K.C.1977). It is generally believed that half of the storage losses are usually caused by insects (FAO, 1968). *Sitophilus oryzae* L. is the most cosmopolitan in nature, and causes severe losses in rice, maize, barley, wheat, and other crops (Bhatia *et. al.*, 1975; Singh, *et.al.*, 1980; Neupane, 1995). While the hot, humid climate of Southeast Asia is quite suitable for rice cultivation, it is equally suitable for rapid stored-product insect development which can result in explosive outbreaks, potentially causing devastating post-harvest rice grain.

In fact, most grain storage systems used for long- or short-term use are rudimentary and poor at best. The majority of farmers and organizations tend to concentrate their efforts on the production aspect. While focusing on production, farmers tend to ignore the need for post-harvest loss minimization. Additionally, little applicable extension work has been organized to encourage adoption of improved practices, including modern technologies such as advanced storage systems, use of effective eco-friendly pesticides, or even resistant varieties. Increasing global agricultural demand continues to necessitate the research and development of more efficient and ecologically sound agriculture.

Rice weevils (*Sitophilus oryzae*) have caused significant damage and losses in rice storage. It is a staple food for about half of the world's population. Therefore, it is important to search for solutions that minimize losses and production costs for producers and ensure food quality and safety for consumers.

Improved methods for the detection and monitoring of hidden infestations are useful for adopting these infestation control measures; chemical methods are used to prevent rice losses due to infestations; changing to prevent rice losses due to infestations; however, is of the utmost importance, as it harms the environment and human health.

The management of infestation by controlled storage conditions, namely temperature and atmosphere composition, and the use of current fossil-based packaging with modified atmospheres, is well recognized (Campos *et al.*, 2013). The use of chemicals in the agriculture industry is rapidly increasing from year to year, leading to environmental pollution problems. Even though synthetic pesticides are reliable against pest damage, unfortunately, they will harm the environment, humans, and living organisms, 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 non-target organisms. Naturally, plants, herbs, spices are alternative sources of pest control because they contain a range of bioactive chemicals. One product that is environmentally friendly and does not poison consumers is the use of plant-based materials known as bio pesticides that come from plant-based materials.

The aim of this research is to determine the most effective way to treat rice weevils using ginger, garlic, turmeric, and bay leaves either singly or in combination. (Eko Aprilianto & Anum Asrianto, 2023) Bay leaves, ginger, garlic, and turmeric can be effective against rice weevils due to their repellent and insecticidal properties. Bay leaves are particularly known for their strong repellent properties. Ginger and turmeric are less effective than bay leaves but garlic, ginger and turmeric act as repellents which can be used directly on stored grains or as part of a larger pest control strategy.

The combination of different spices like ginger, garlic, bay leaves, and turmeric can enhance their effectiveness. (Emily Gaylord, 2023). Ginger (*Zingiber officinale*) can be used to control rice weevils by repelling them and potentially causing mortality. Ginger extract, particularly when used in

higher concentrations, has been shown to be effective in killing rice weevils. Additionally, ginger can deter weevils from infesting stored rice grains. Ginger can be a natural and potentially safer alternative to synthetic chemical pesticides for controlling rice weevils.

Studies have shown that ginger extract can cause significant mortality rates in rice weevils, with some concentrations achieving high mortality within 48 hours. The insecticidal and repellent properties of ginger are likely due to the presence of various phytochemicals in the extract, such as saponins, alkaloids, and flavonoids. (Ampong-Nyarko, 1993).

Garlic (*Allium sativum*) can be an effective natural deterrent for rice weevil control due to its strong odour and insecticidal properties. Garlic can repel weevils and even cause mortality, especially when used in combination with other methods, such as diatomaceous earth. Rice weevils are sensitive to strong smells, and garlic's pungent odour acts as a repellent, discouraging them from infesting stored rice.

Garlic contains compounds (like allicin), which are toxic to insects. It can be shown that contact, fumigant, and repellent toxicity against rice weevils, with increasing effectiveness over time. Garlic-based products, when applied as a fumigant or through contact and fumigation, can reduce the rate at which weevils lay eggs and hatch. It can create a more potent and long-lasting control method against rice weevils. (Chaudhry, 2020)

Turmeric (*Curcuma longa*) exhibits pesticidal and repellent properties against rice weevils, effectively reducing populations and damage to stored rice. Turmeric's compounds interfere with the weevil's behaviour and act as a natural pesticide. Turmeric's bioactive components, like curcumin, kill rice weevils by inhibiting their growth and development. It can make rice grains less appealing to weevils,

reducing their feeding and damage. One study found that a turmeric nano emulsion at 20 kg achieved 100% adult mortality after two weeks and completely inhibited progeny emergence over nine months. Turmeric's effectiveness can be enhanced when combined with other natural compounds like piperonyl butoxide.

Bay leaves (*Laurus nobilis*) containing their strong aromatic compounds, play as a natural repellent, preventing rice weevils from infesting or residing in stored rice. The scent is believed to be unpleasant to weevils, discouraging them from infesting or residing in stored rice. It contains essential oils like eucalyptol and terpenes, which contribute to its weevil-repellent properties. These compounds are thought to be responsible for the repellent effect. To maintain their effectiveness, it is recommended to avoid areas where bay leaves are stored, as their scent diminishes over time. Bay leaves can repel rice weevils for a few months, and their effect can be noticeable within a few hours. Increasing repellency over time (Braana laf kelleen, 2024).

Material and Methods

The adult stage of *Sitophilus oryzae* (Rice weevil) was obtained from naturally infested rice grains. Subsequent culturing was done in a controlled laboratory setting. Sex differentiation was achieved through the type examination of external morphological characteristics, notably the rostrum. Males were distinguished by slender thick and broad rostrum, whereas females exhibited a thin and sharp rostrum. The adults are maintained in plastic containers with three replicates conducted on 250g of rice samples. Adult weevils were introduced into the containers at varying sex ratios of (16:3:3:2) and 3:2:1. The experiments were conducted at controlled temperature. Thermocol Ice boxes were utilized, with cotton swabs as the bedding material and a thermometer attached for continuous monitoring.



Fig 1: Damaged Rice Containing Rice Weevils

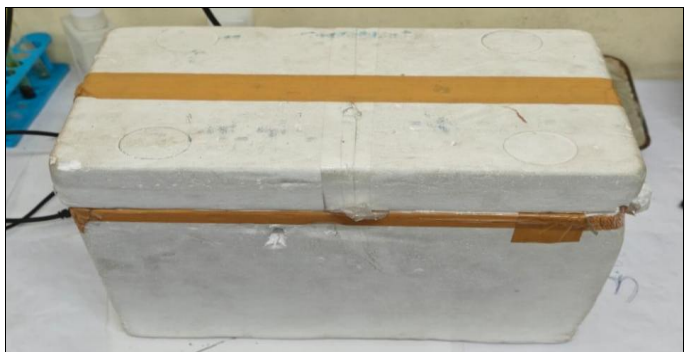


Fig 2: Thermocol Ice Box



Fig 3: Ice Box containing experimental Boxes



Fig 4: Experimental boxes containing different spices with concentration (0.75gms)



Fig 5: Larvae of Rice Weevil



Fig 6: *Sitophilus oryzae* Under Stereo Microscope



Fig 7: Rice Weevils Macroscopic Image

Experimental Preparation

The experimental preparation involved sourcing selected spices from local nuts and spices shop in the vicinity of Bangalore. Also, some spices were procured from a local vegetable vendor for the purpose of the study.

In the experimental setup, varying concentration of the spices were employed to ascertain the lethal dosage. Specifically, 10, 20, and 30% of the spices were mixed with 20g of rice. Notably, the 10% concentration resulted in a 50% mortality rate among the pests, thereby establishing it as a reference point for the lethal dose.

Experimental Setup

Table 1: List of Botanical (Species) Tested for Insecticidal activity against *Sitophilus oryzae*

SI No.	Family	Botanical spices	Common name	Plant part used	Location
1	Zingiberaceae	<i>Zingiber officinale</i>	Ginger	Underground Stem	Grocery Shop
2	Amaryllidaceae	<i>Allium sativum</i>	Garlic	Bulb	Grocery Shop
3	Cucurbitaceae	<i>Curcuma longa</i>	Turmeric	Underground Stem	Grocery Shop
4	Lamiaceae	<i>Laurus nobilis</i>	Bay leaf	The leaf	Grocery Shop



Fig 1: *Zingiber officinale*



Fig 2: *Allium sativum*



Fig 3: *Curcuma longa*



Fig 4: *Laurus nobilis*

Methodology

The study utilized adult weevils aged between 7 to 14 days, sourced from a controlled culture. The experimental design

comprised four distinct concentrations of spices: 0.25, 0.50, 0.75, and 1 gram. The spices were securely wrapped in layered muslin cloth and introduced into plastic containers

containing 20 grams of rice. The containers were sealed with muslin cloth, secured using a rubber band to ensure adequate ventilation.

The weevils were categorized into a mixed group comprising both males and females (n = 3 males and n = 3 females) for each spice concentration. Three replicates (R1, R2 & R3) were prepared for each experimental condition - 9 in all.

The experiment was conducted at regular intervals over a period of 3 months (First 3 weeks of every month i.e., 21days) and observations recorded on days 1, 2, 3, 4, 5 & subsequent days. The study monitored the mortality rate of weevils exposed to different spice concentrations until the desired outcome was achieved.

Results

A brief introduction explains that the experiment evaluated the contact mortality of *Sitophilus oryzae* male and female adults over varying exposure periods (1-21 days) when treated with different concentrations (0.25g, 0.50g, 0.75g, and 1g) of various spices.

Experimental Findings

The results are presented in a series of bullet points, detailing the mortality rates observed at different concentrations of spices.

At a concentration of 0.25g, *Zingiber officinale* showed 2% mortality on day 1 but reached 100% by day 21 for both male and female adults.

Allium sativum demonstrated 100% mortality by day 21.

In contrast, *curcuma longa* showed mortality below 90% until day 15.

Laurus nobilis displayed 100% mortality by day within 6-7 hrs.

At a concentration of 0.50g, *Zingiber officinale*, *Allium sativum*,

Curcuma longa as showed 100% mortality by day 20.

Laurus nobilis showed 100% mortality by day 20.

At a concentration of 0.75g, *zingiber officinale*, *Allium sativum*, *curcuma longa*, and *Laurus nobilis* showed 100% mortality by day 15.

At a concentration of 1g, *zingiber officinale*, *Allium sativum*, *curcuma longa* and *Laurus nobilis* spices showed 100% mortality effects, day 12

The synergistic effect of combining *Zingiber officinale* and *Allium sativum* resulted in a notable efficacy on day 5, demonstrating a significant impact on the target variable.

The concomitant administration of turmeric and bay leaves exhibited a pronounced efficacy within a short timeframe, with notable effects observed as early as day 1 or 2.

This finding indicates that the synergistic interaction between these two botanicals may yield rapid and significant outcomes, suggesting potential utility in various applications.

Statistical Analysis

The analysis of variance (ANOVA) revealed that spice concentration, species, and exposure duration significantly impacted mortality, as indicated by F-values and p-values at varying days. Generally, higher spice concentrations led to faster and higher mortality rates across the spices tested.

In summary, the document presents the results of an experiment evaluating the contact mortality of *Sitophilus oryzae* male and female adults when exposed to various spice powders at different concentrations. The findings indicate that higher concentrations of spice powders result in higher mortality rates, with some spices showing 100% mortality at certain concentrations. The statistical analysis supports these findings, highlighting the significance of spice concentration, species, and exposure duration on mortality rates.

Table 2: The mortality of *Sitophilus oryzae* adult male and female exposed 1-21days on rice treated with spices concentration for (0.25gms)

Spices (0.25gms)	Number of Days				
	1	5	10	15	21
<i>Zingiber officinale</i>	0	50	58.35	60.3	98
<i>Allium sativum</i>	10	70.2	79.4	89.40	100
<i>Curcuma longa</i>	0	49.7	49.8	74.9	100
<i>Laurus nobilis</i>	21.3	33.4	94.4	96.70	100
<i>Zingiber officinale</i> + <i>Allium sativum</i>	9.3	22.6	49.9	89.7	100
<i>Curcuma longa</i> + <i>Laurus nobilis</i>	62.3	79.2	95.2	100	100

ANOVA Single Factor

Summary						
Groups	Count	Sum	Average	Variance		
1	6	102.9	17.15	551.347		
5	6	305.1	50.85	456.551		
10	6	427.05	71.175	451.6497		
15	6	511	85.166	223.0547		
21	6	598	99.666	0.666667		
ANOVA						
Source of Variation	SS	D f	MS	F	P-value	F crit
Between Groups	24817.5	4	6204.37	18.42955	3.62E-07	2.75871
Within Groups	8416.34	25	336.653			
Total	33233.8	29				

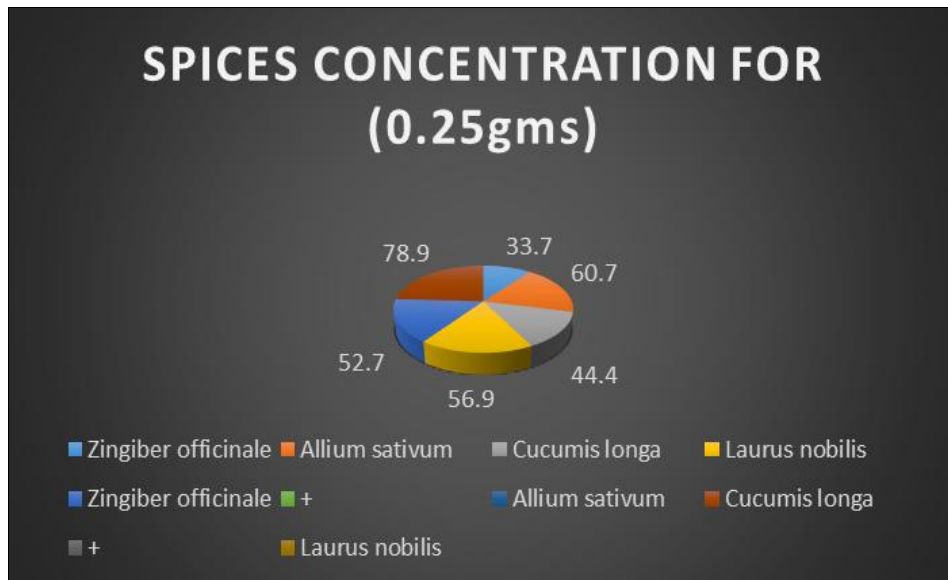


Table 3: Spices Concentration for (0.50gms)

SPICES(0.50gms)	Number of Days				
	1	5	10	15	21
<i>Zingiber officinale</i>	0	63	70	78	100
<i>Allium sativum</i>	21	80.9	90.4	99.6	100
<i>Curcuma longa</i>	0	41	49.7	83.5	100
<i>Laurus nobilis</i>	33.69	59.7	95.6	99.9	100
<i>Zingiber officinale + Allium sativum</i>	26.8	33.9	59.4	92.7	100
<i>Curcuma longa + Laurus nobilis</i>	80	89	99.5	100	100

Anova Single Factor

Summary					
Groups	Count	Sum	Average	Variance	
1	6	161.49	26.915	869.5506	
5	6	367.5	61.25	463.947	
10	6	464.6	77.43333	426.9387	
15	6	553.7	92.28333	90.48567	
21	6	600	100	0	
ANOVA					
Source of Variation	SS	df	MS	F	F crit
Between Groups	20233.54	4	5058.385	13.6645	2.75871
Within Groups	9254.609	25	370.1844		
Total	29488.15	29			

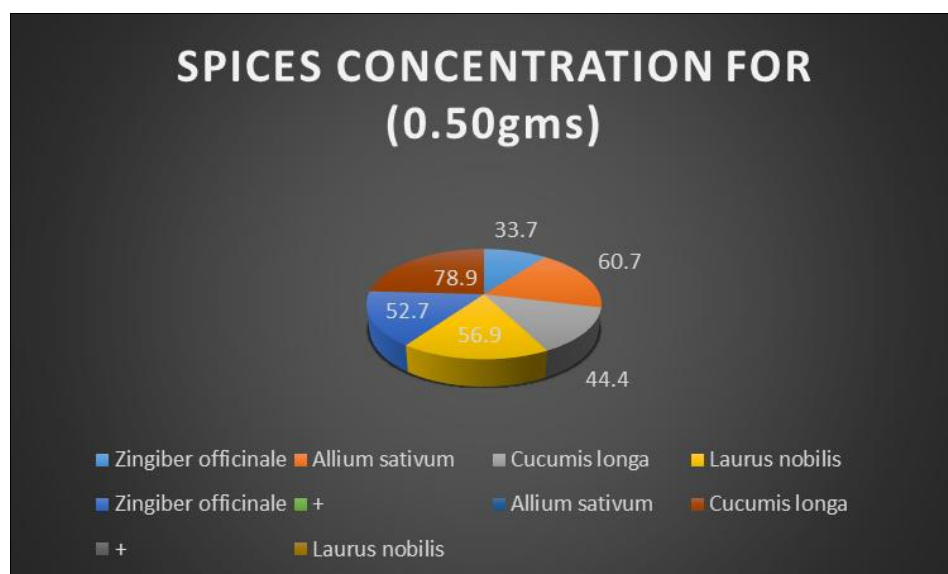
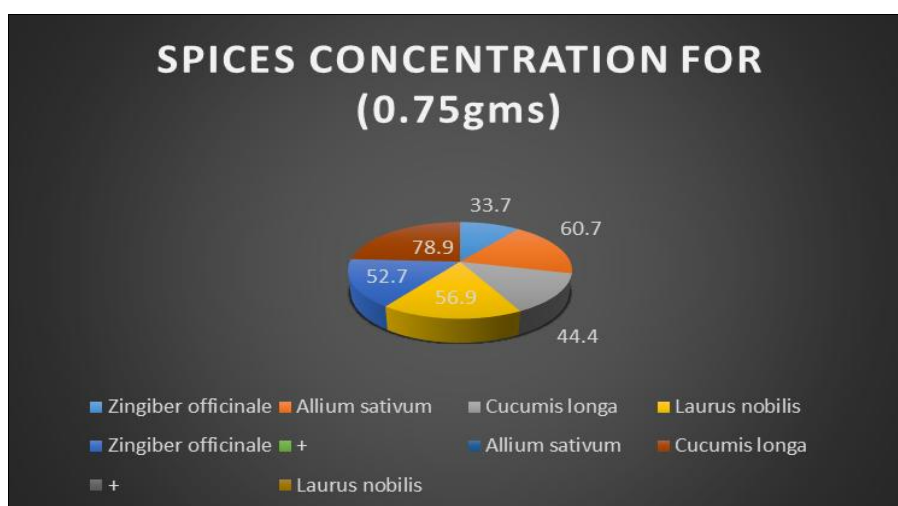


Table 4: Spices Concentration for (0.75gms)

SPICES(0.75gms)	Number of Days				
	1	5	10	15	21
<i>Zingiber officinale</i>	0	79.5	82.5	99.7	100
<i>Allium sativum</i>	30.7	89.6	99.5	100	100
<i>Curcuma longa</i>	0	36.8	59.5	80.4	100
<i>Laurus nobilis</i>	49.7	60.3	99.3	100	100
<i>Zingiber officinale</i> + <i>Allium sativum</i>	40.4	62.3	79.5	84.5	100
<i>Curcuma longa</i> + <i>Laurus nobilis</i>	93.5	97	99.9	100	100

ANOVA Single Factor

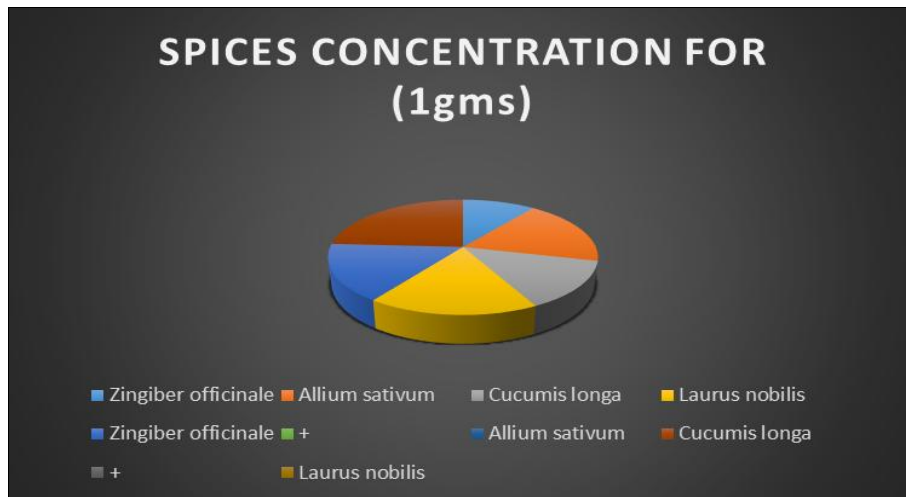
Summary						
Groups	Count	Sum	Average	Variance		
1	6	214.3	35.71667	1226.582		
5	6	425.5	70.91667	490.7977		
10	6	520.2	86.7	261.232		
15	6	564.6	94.1	83.128		
21	6	600	100	0		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	15933.82	4	3983.455	9.660422	7.27E-05	2.75871
Within Groups	10308.7	25	412.3479			
Total	26242.51	29				

**Table 5:** Spices Concentration for (1gms)

SPICES(1gms)	Number of Days				
	1	5	10	15	21
<i>Zingiber officinale</i>	33.7	9.5	90.4	99	100
<i>Allium sativum</i>	60.7	79.9	99.4	100	100
<i>Curcuma longa</i>	44.4	70.9	80.9	91	100
<i>Laurus nobilis</i>	56.9	70.4	81.5	92.4	100
<i>Zingiber officinale</i> + <i>Allium sativum</i>	52.7	77.4	89.7	93.5	100
<i>Curcuma longa</i> + <i>Laurus nobilis</i>	78.9	90.9	99.5	100	100

ANOVA Single Factor

Summary						
Groups	Count	Sum	Average	Variance		
1	6	327.3	54.55	235.487		
5	6	399	66.5	835.46		
10	6	541.4	90.23333	66.71867		
15	6	575.9	95.98333	17.04167		
21	6	600	100	0		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	9477.478	4	2369.37	10.25961	4.67E-05	2.75871
Within Groups	5773.537	25	230.9415			
Total	15251.01	29				



Discussion

Rice weevil repellents can be broadly categorized into natural and synthetic options, with various approaches including plant-based repellents, physical barriers, and controlled storage conditions. Neem, ginger, garlic, laurus bay leaf, cinnamon, and clove have shown promise as natural repellents.

To deter rice weevils using common household items

By placing - Bay leaf, ginger, or garlic inside or around rice container for existing infestations, consider freezing the rice or using diatomaceous earth around storage areas (Rakta Kiran, Kanishalatha, Onkar Shama, Vidya Bharti (2024). Freezing infested rice for at least 72 hours can kill both adult weevils and their eggs, making it a good option for eliminating existing infestations accordingly.

The investigation undertaken herein demonstrates that the mortality rate of *Sitophilus oryzae* adults, encompassing both male and female specimens, is profoundly influenced by the type of spice employed, the concentration thereof, and the duration of exposure via an indirect method of application. Among the diverse array of spices subjected to scrutiny, *Zingiber officinale* and *Allium sativum* exhibited the most pronounced insecticidal efficacy, achieving rapid and comprehensive mortality at relatively lower concentrations (0.25g and 0.50g) and abbreviated exposure periods. *Laurus nobilis* consistently demonstrated elevated efficacy, attaining 100% mortality by day 7 or earlier across all concentrations, whereas *Curcuma longa* showed achieved 100% mortality by day 20 at 0.25g and at an accelerated rate at higher concentrations. (Mumtaz Akhtar, Muhammad Arshad, Abu Bakkar 2013) ^[3]

In contradistinction, *Zingiber officinale* displayed moderate efficacy, necessitating protracted exposure periods and elevated concentrations (0.75g and 1g) to attain 100% mortality. *Curcuma longa* was less efficacious than the other species, particularly at lower concentrations, only achieving 100% mortality at higher doses subsequent to extended exposure periods, thereby indicating a slower and weaker insecticidal property.

In summation, this research suggests that *Laurus nobilis* and *Allium sativum* could be efficacious for the control of *S. oryzae* in stored grains, offering potent and rapid-acting insecticidal properties, even at lower concentrations. These findings underscore the potential of natural spices as viable alternatives to synthetic insecticides for pest management in grain storage facilities. (Akash Rohidas Bhargade 2020)

Summary and Conclusion

This study demonstrates that the contact mortality of *Sitophilus oryzae* (*S. oryzae*) adults, both male and female, is strongly influenced by the type of spice, concentration, and exposure time in an in-direct method of application. Among the spices tested, *Zingiber officinale* and *Allium sativum* exhibited the most potent insecticidal effects, achieving rapid and complete mortality of lower concentrations (0.25g and 0.5g) and short exposure periods. *Zingiber officinale* consistently demonstrated high efficiency, reaching 100% mortality by day 15 at all concentrations, while *Zingiber officinale* in the combinations of *Zingiber officinale* & *Allium sativum* achieved 100% mortality by day 15 at 0.25 g and faster at higher concentrations.

In Contrast *Curcuma longa* and *Laurus nobilis* showed moderate efficacy, requiring longer exposure periods of higher concentrations (0.75g and 1g) to achieve 100% mortality.

Curcuma longa was less effective than other species, particularly at lower concentrations, only reaching 100% mortality at higher doses after extended exposure periods, indicating weaker insecticidal properties.

Overall In the combinations of both *Zingiber officinale* and *Allium sativum*, *Curcuma longa* and *Laurus nobilis* (0.75g to 1g) showed faster results while the combination of *Curcuma longa* and *Laurus nobilis* showed faster efficacy than any other spices.

This research suggests that *Zingiber officinale*, *Allium sativum*, and combinations of *Curcuma longa* and *Laurus nobilis* could be useful for the control of *S. oryzae* in stored grains, offering potent insecticidal properties and last-acting insecticidal properties, even at lower concentrations. These findings emphasize the potential of natural spices as effective alternatives to synthetic insecticides for pest management in grain storage.

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