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# Evaluation of Medicinal Plant Powders for Control of *Sitophilus oryzae* in Rice (*Oryza sativa)*

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Author SS collected all the samples, performed monitoring of experiment, find values, noted out and tabulate the data. Author SA sat the laboratory experiment, monitored and fulfilled the required lab conditions, carried out statistical analysis and provided data for tables and graphs. Both authors read and approved the final manuscript.*

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## ABSTRACT

Cereals, specially rice is vital dietary staples, supplying crucial nutrients like carbohydrates for energy, dietary fiber for good digestion, proteins, vitamins for metabolism, and minerals like iron and magnesium. They serve as key sources of energy for billions globally, underpinning food security and economic stability. The rice weevil (*Sitophilus oryzae*) is a destructive pest that infests stored rice, causing extensive damage and posing threats to food availability and economic conditions. *Asparagus racemosus*, or Shatavari, exhibits strong pest control due to its rich phytochemical composition, including saponins, flavonoids, and alkaloids. Cassia occidentalis, or *kasundhi* or coffee senna, also offers pest control through its bioactive compounds such as anthraquinones, flavonoids, and tannins. In a study, *Asparagus racemosus* at 5 g, 10 g, and 15 g doses showed 15%, 30%, and 70% contact toxicity and 10%, 25%, and 70% repellency against *Sitophilus oryzae*

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in rice grains. *Cassia occidentalis* demonstrated 25%, 45%, and 75% contact toxicity and 25%, 35%, and 65% repellency at the same doses. Untreated grains saw a 21.36% weight loss due to pests, while a 15 g dose of *Asparagus racemosus* reduced weight loss to 5.26% and *Cassia occidentalis* to 6.99%. These findings highlight both plant's effectiveness in minimizing pest-induced grain damage.

*Keywords: Rice; Oryza sativa; basmati; Sitophilus oryzae; Asparagus racemosus; Cassia occidentalis; plant protectants.*

## 1. INTRODUCTION

Rice (*Oryza sativa*) is a vital staple food, especially in Asia, and belongs to the Poaceae family. It exists in two main subspecies: *Oryza sativa indica*, grown in tropical regions, and *Oryza sativa japonica*, grown in temperate areas. Rice plants are monocots with hollow stems, slender leaves, and panicles that bear grains. Cultivation demands warm climates and plentiful water, often involving flooded fields. Nutritionally, rice is a rich source of carbohydrates, providing essential energy, and contains moderate amounts of protein, vitamins such as B1 (thiamine), and minerals like iron and magnesium, making it a crucial component of diets worldwide [1,2]. Rice is integral to the Indian economy, serving as both a staple food for the majority of the population and a critical agricultural commodity. It is a primary source of livelihood for millions of farmers, particularly in rural areas, and occupies a significant portion of the country's arable land [3]. India is one of the largest producers and exporters of rice, contributing 10 per cent of the agricultural GDP and foreign exchange earnings [4]. The rice industry supports numerous ancillary sectors, including milling, transportation, and retail, thus playing a vital role in food security, employment, and economic stability. *Sitophilus oryzae*, commonly known as the rice weevil, is a significant pest affecting stored grains worldwide, including rice, wheat, and maize [5-7]. This small beetle, about 2-3 mm long, features an elongated snout and reddish-brown to black coloration with distinct spots on its wing covers. The weevil's lifecycle comprises egg, larval, pupal, and adult stages, with larvae developing inside grains, causing substantial damage by consuming the grain from within. This infestation leads to considerable economic losses by reducing both the nutritional and market value of the grains. *S. oryzae's* ability to thrive in various climates makes it a pervasive threat to global food security [8-11]. Botanical protectants play a crucial role in sustainable agriculture by providing an eco-friendly alternative to synthetic pesticides [12]. Derived from plants, these natural compounds help manage pests and diseases while minimizing environmental impact and reducing health risks to humans and wildlife [13]. *Asparagus racemosus*, also known as Shatavari, is effective in pest control due to its diverse phytochemicals, including saponins, flavonoids, and alkaloids, which have insecticidal and repellent properties [14-17]. Its antimicrobial qualities help it fend off infections that could attract pests. Additionally, the plant releases volatile compounds that naturally repel many pests, making it less likely for them to target the plant. Research has shown that extracts from *Asparagus racemosus* can inhibit the growth and development of certain insect pests, disrupting their life cycles and reducing their populations. These attributes collectively contribute to its efficacy as a natural pest control agent [18-20]. *Cassia occidentalis*, commonly known as kasundhi or coffee senna, has pest control effects due to its bioactive compounds such as anthraquinones, flavonoids, and tannins, which possess insecticidal and repellent properties [21,22]. These compounds can disrupt the growth and development of various pests, acting as natural deterrents. Additionally, the plant's antimicrobial properties help prevent infections that could attract pests, while its strong odor can repel certain insects, making *Cassia occidentalis* an effective natural pest control agent [23]. They often target specific pests, reducing the likelihood of resistance development and preserving beneficial organisms. Additionally, botanical protectants are biodegradable, promoting healthier ecosystems and supporting organic farming practices [24]. Their use is essential in integrated pest management (IPM) strategies, contributing to safer food production and environmental conservation [23].

**Objective of Study:** To conduct an analytical comparative study on efficacy of leaf powder of Shatavri (*Asparagus racemosus*) and Casundhi (*Cassia occidentalis*) against *Sitophilus oryzae* in stored rice.

## 2. MATERIALS AND METHODS

### 2.1 Site of Experiment

The study was carried out in the Department of Zoology, A.N.D.N.N.M. MAHAVIDYALAYA, KANPUR [UP, INDIA]. Kanpur is situated in central plains of Ganga-Yamuna at the latitude 26º27 ′ 29 ″ North and longitude 80º20 ′ 00 ″ East.

### 2.2 Protectants Collection and Preparation

*Asparagus racemosus* roots and *Cassia occidentalis* seeds were collected and then identified. After the identification, the roots and seeds were properly washed and dried in air under the room temperature. After it, the dried roots and leaves were ground and the powder was made ready to use.

### 2.3 Rice Grains Collection and Preparation

**Variety taken-** *Oryza sativa var. Basmati.*

Whole and un-infested rice grains were collected from the cereal market, Kanpur. After the collection the grains were heat sterilized to kill any hidden infesting stage and disinfected seeds were weighed using digital balance and then stored in cool and dried place for further work.

### 2.4 Assessment of Physical Characters of *Oryza sativa var. Basmati*

Before being stored in airtight jars, the grains were sun-dried to prevent mold growth caused by environmental moisture or humidity. For the experiment, only fully intact and uninfected grains were chosen.

#### 2.4.1 Grain moisture content and its removal

The Silva method was employed to measure the grain's moisture content. The grains were placed in pre-weighed crucibles and then dried in a hot air oven at 105°C until a constant weight was achieved. The moisture content was determined by calculating the difference between the initial weight and the dried weight.

#### 2.4.2 Grain weight

Initially, 100 grams of fresh grains were weigh measured and recorded. This measurement was repeated every 7 days over the period of experiment.

#### 2.4.3 Removal of hidden infestation

Infestation by fungi, insects, and other organisms was eliminated by heat sterilizing the grain at 60-70°C for 15-20 minutes.

### 2.5 Insect Rearing

Mass rearing was conducted under controlled laboratory conditions with a temperature of 30±2°C and relative humidity of 65±5%. For the experiment, 250 grams of sterilized, healthy rice grains were placed in a 500 ml glass container. 50 adult pairs (male to female ratio 1:1) were introduced. The container was covered with muslin cloth secured with a rubber band to ensure proper aeration. The culture was periodically examined with care throughout the study. Newly emerged insects were considered the new generation for further research.

### 2.6 Treatments

T1- *Asparagus racemosus*
T2- *Cassia occidentalis*
T3- Control

### 2.7 Assessment of Contact Toxicity and Repellency

**Contact Toxicity:** In an experiment, 100 grams of uninfested rice were placed in separate glass petri dishes. Three different dosages of protectant powder (5 g, 10 g, and 15 g) were mixed with the rice in these dishes, along with a control treatment that received no powder. Ten pairs of *Sitophilus oryzae* insects were introduced into each petri dish, which were then covered to prevent the insects from escaping. After 48 hours, adult insect mortality was recorded and the percentage of mortality was calculated.

**Repellency:** To assess the repellency of plant powder against *Sitophilus oryzae* in rice grains, an experiment was conducted using equal quantities of uninfested rice, each mixed with varying concentrations of plant powder (5 g, 10 g, 15 g) and a control with no powder. Ten pairs of *Sitophilus oryzae* were introduced into each jar, which were not covered to test repellency. After a set period, the distribution of insects was observed.

**List 1. Protectants used and doses**

| S.N. | Protectant | Common name | Parts used | Sources from | Dose | Process of use |
|---|---|---|---|---|---|---|
| 1 | ***Asparagus racemosus*** | Shatavari | Root | Shatavari plant | 5 g/100 g<br>10 g/100 g<br>15 g/100 g | Thoroughly mixed with grains. |
| 2 | ***Cassia occidentalis*** | Kasundhi | Seeds | Kasundhi plant | 5 g/100 g<br>10 g/100 g<br>15 g/100 g<br>10 g/100 g<br>15 g/100 g | Thoroughly mixed with grains. |

## 2.8 Observation of Damage

In an experiment, 150 grams of uninfested rice were placed in separate glass jars. Three different dosages of protectant powder (5 g, 10 g, and 15 g) were mixed with the rice, along with a control treatment that received no powder. After 60 days, each container's rice was weighted and the extent of weight loss was calculated up to 60 days from the release of *S. oryzae* into container. Grains of every containers were independently weighed by electronic balance machine. Percent of grain weight loss was calculated from the difference of un-infested grain weight and the weight of the grain after the infestation of *S. oryzae.* Percentage of grain damage was assessed using the following formula:

$$\text{Weight loss (\%)} = (\text{weight loss of grains} / \text{total weight of grains}) \times 100$$

## 2.9 Statistical Analysis

Data collected from the laboratory experiments were statistically analyzed. Statistical design was Complete Randomized Design (CRD). Tabulated data was transformed into percentages (%) and analyzed. Final tables and graph were prepared using Microsoft Office Excel.

## 3. EXPERIMENTAL FINDINGS

**Table 1. Contact toxicity and repellency of *Asparagus racemosus and Cassia occidentalis* against *Sitophilus oryzae* in *Oryza sativa* var. Basmati**

| S.N. | Protectant | Doses | Contact Toxicity | Repellency |
|---|---|---|---|---|
| 1 | ***Asparagus racemosus*** | 5 gm. | 15 % | 10 % |
| | | 10 gm. | 30 % | 25 % |
| | | 15 gm. | 70 % | 70 % |
| 2 | ***Cassia occidentalis*** | 5 gm. | 25 % | 25 % |
| | | 10 gm. | 45 % | 35 % |
| | | 15 gm. | 75 % | 65 % |
| 3 | **Control** | 00 | 00 | 00 |

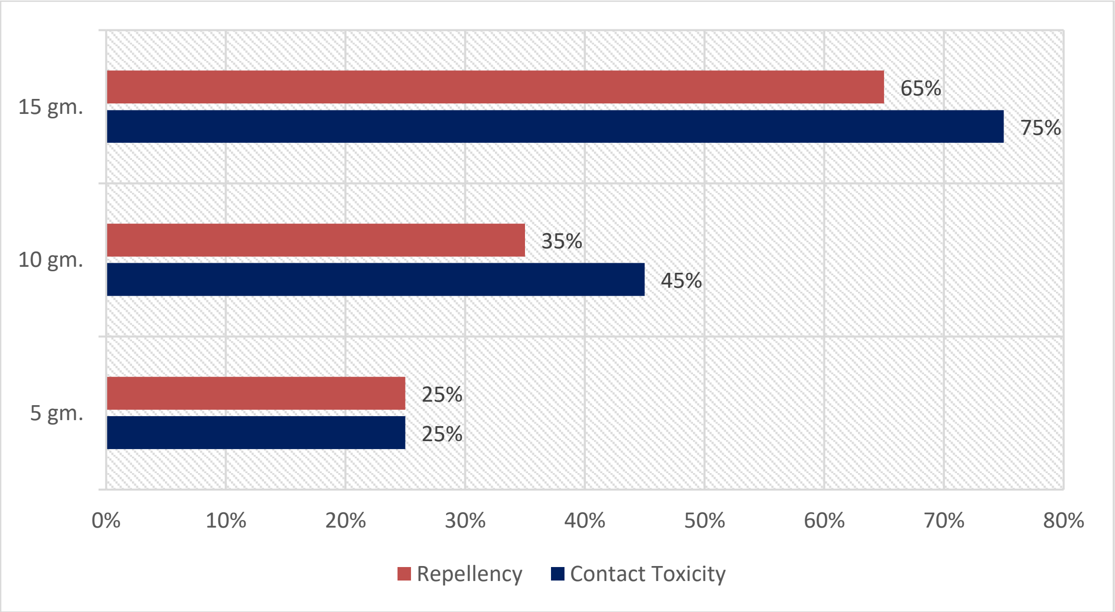


**Fig. 1. Contact toxicity and repellency of *Cassis occidentalis* against *Sitophilus oryzae* in *Oryza sativa var. Basmati***

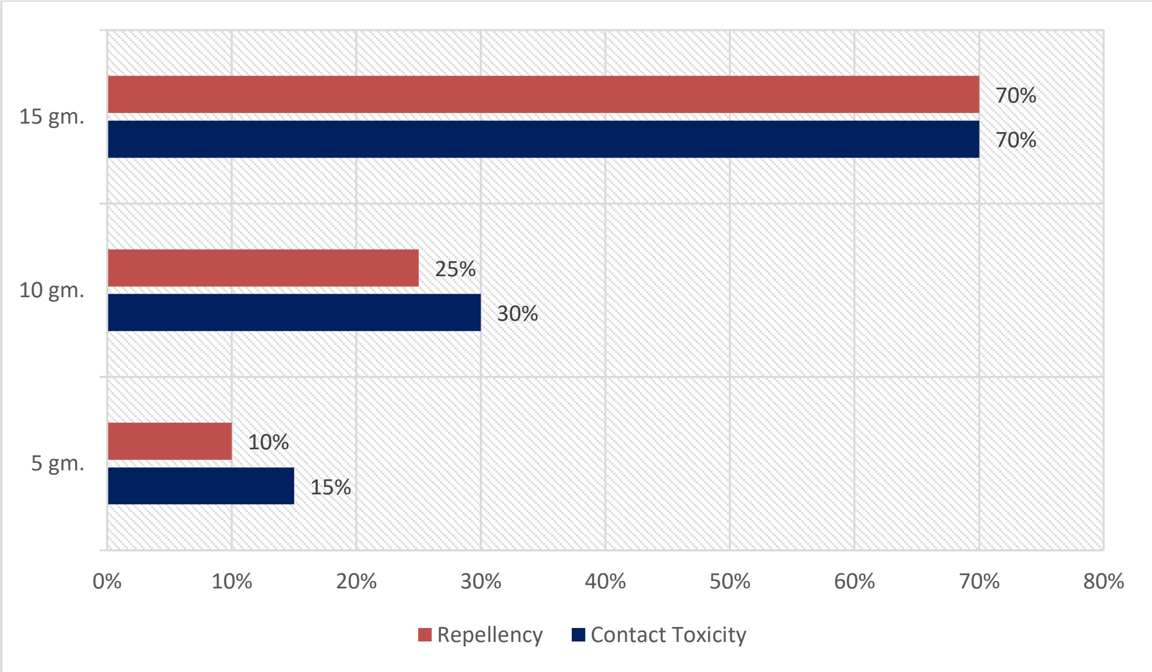


**Fig. 2. Contact toxicity and repellency of *Asparagus racemosus* against *Sitophilus oryzae* in *Oryza sativa var. Basmati***

**Table 2. Effect of *Asparagus racemosus and Cassia occidentalis* on weight loss in *Oryza sativa* var. Basmati due to infestation of *Sitophilus oryzae***

| S.N. | Protectants | Doses | Weight of grains before infestation [in gm.] | Weight of grains after infestation | Loss of weight in grains [in gm.] | % Age loss of weight in grains |
|---|---|---|---|---|---|---|
| T1. | ***Asparagus racemosus*** | 5 gm. | 150 | 121.32 | 28.68 | 19.12 |
| | | 10 gm. | 150 | 131.43 | 18.57 | 12.38 |
| | | 15 gm. | 150 | 142.11 | 7.89 | 5.26 |
| T2. | ***Cassia occidentalis*** | 5 gm. | 150 | 118.33 | 31.67 | 21.113 |
| | | 10 gm. | 150 | 129.36 | 20.64 | 13.76 |
| | | 15 gm. | 150 | 139.51 | 10.49 | 6.993 |
| T3. | **Control** | 00 | 150 | 117.96 | 32.04 | 21.36 |

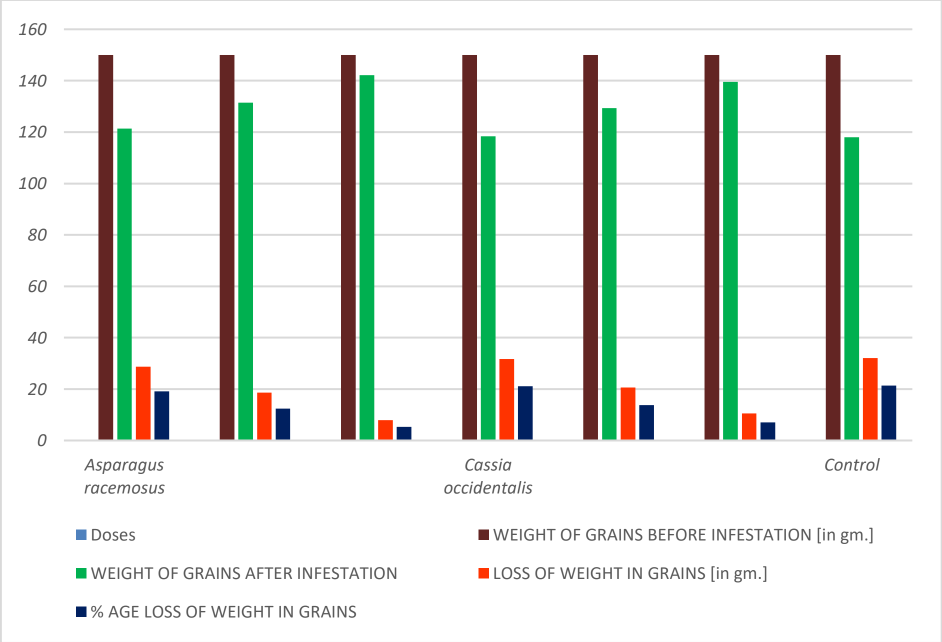


**Fig. 3. Effect of *Asparagus racemosus* and *Cassia occidentalis* on weight loss in *Oryza sativa var. Basmati* due to infestation of *Sitophilus oryzae***

## 4. RESULTS AND DISCUSSION

*Asparagus racemosus*, commonly known as Shatavari, exhibits strong pest control effects due to its rich phytochemical composition, including saponins, flavonoids, and alkaloids, which possess insecticidal and deterrent properties. Additionally, its antimicrobial properties help prevent fungal and bacterial infections that often attract pests. The plant produces volatile compounds that act as natural repellents, making it less attractive to pests. Furthermore, extracts from *Asparagus racemosus* have been shown to inhibit the growth and development of certain insect pests, disrupting their life cycles and reducing their populations. These combined factors make Asparagus racemosus an effective natural pest control agent. *Cassia occidentalis*, known as kasundhi or coffee senna, has pest control effects due to its bioactive compounds like anthraquinones, flavonoids, and tannins, which have insecticidal and repellent properties. These compounds interfere with the growth and development of pests and act as natural deterrents. Additionally, its antimicrobial properties prevent infections that might attract pests, and its strong odor repels certain insects, making *Cassia occidentalis* an effective natural pest control agent. In the study, different doses of *Asparagus racemosus* and *Cassia occidentalis* were evaluated for their effectiveness in pest control. *Asparagus racemosus* at doses of 5 g, 10 g, and 15 g exhibited 15%, 30%, and 70% contact toxicity, respectively, and provided 10%, 25%, and 70% repellency. In comparison, *Cassia occidentalis* at the same doses demonstrated higher contact toxicity rates of 25%, 45%, and 75%, and provided 25%, 35%, and 65% repellency, respectively [Table 1, Figs. 1 and 2]. Further observations focused on grain weight loss due to pest infestation. The control group, which did not receive any treatment, experienced a significant weight loss of 21.36%. However, treatments with *Asparagus racemosus* and *Cassia occidentalis* substantially mitigated this loss. The most effective treatment was with 15 g of *Asparagus racemosus*, which reduced grain weight loss to only 5.26%. Similarly, a 15 g dose of *Cassia occidentalis* also proved effective, reducing grain weight loss to 6.99%. [Table 2, Fig. 3] These results indicate that both plants, particularly at higher doses, are highly effective in reducing pest-induced damage to stored grains.

## 5. CONCLUSION

Research has shown that extracts from *Asparagus racemosus* can inhibit the growth and development of certain insect pests, disrupting their life cycles and reducing their populations. These attributes collectively contribute to its efficacy as a natural pest control agent. *Cassia occidentalis*, commonly known as kasundhi or coffee senna, has pest control effects due to its bioactive compounds such as anthraquinones, flavonoids, and tannins, which possess insecticidal and repellent properties.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

We, Shraddha Srivastava and Sangeeta Awasthi hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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## CODE AVAILABILITY

Application Software – MS Word, MS Excel and SPSS.

## DELCLARATION

I Shraddha Srivastava, declare that the submitted research paper is my original work and no part of it has been published anywhere else in the past. I take full responsibility, that if in future, the paper is found invalid according to basic rules, the last decision will be of the authorities concerned.

## CONFLICTS OF INTEREST

First author is a research scholar in a state university and second author is Professor as well as supervisor of the first author. Both the authors receive no compensation as a researcher or professor from any of the board or agency.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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