The Efficacy of the Leaf Powders of *Justicia Adhatoda L.* and *Leucas Aspera* on the Management of the Pulse Beetle *Callosobruchus Chinensis L.* (Coleoptera: Bruchidae), in *Cicer Arietinum L.* (Chickpea)

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Abstract

Insects are a problem in stored grains throughout the world. In India, there are about 200 species of pest insects which cause damage to stored grains and grain products in storage. The stored chickpea seeds are affected by bruchids. The pulse beetle Callosobruchus chinensis is the most widespread and destructive insect pest of economically important leguminous chickpea. The pest control of C. chinensis is very important to protect the loss of nutritive and economic value of chickpea. The present study aimed to protect the stored chickpea seeds from C. chinensis infestation using leaf powders of Justicia adhatoda L. and Leucas aspera by analyzing the effect of these two leaf powders on the mortality rate. Through this study, it has been found that J. adhatoda showed more efficacy against C. chinensis and it can be considered as a safer alternative for synthetic chemical insecticides. The study was to investigate the phytochemicals, physico chemical parameters, FTIR spectrum, seed germination percentage and vigour index for their safety and efficacy. The use of natural medicinal plants like J. adhatoda and L. aspera develop a cheap, safe and easy method for the protection of stored grains against the insect pest C. chinensis.

Keywords: **Callosobruchus chinensis, Biopesticide, *Justicia adhatoda, Leucas aspera,* Insecticides**

1. INTRODUCTION

In India there are about 200 species of pest insects which cause damage to stored grains and grain products in storage [12]. Among these, the pulse beetles Callosobruchus spp. are the major pests in stored pulse [2] and [5]. Pulse beetle causes not only quantitative but also qualitative losses like nutritive loss and germination loss. Chickpea, (*Cicer arietinum*) is a good source of energy, protein, minerals, vitamins, fiber, and also contains potentially health beneficial phytochemicals [20]. Among the pulses, chickpea is preferred to food legumes [16] in some regions because of its multiple uses. The stored chickpea is affected by bruchids. The pulse beetle, *Callosobruchus chinensis* is the most widespread and destructive insect pest of economically important leguminous chickpea.

The pest control of *C. chinensis* is very important to protect the loss of nutritive and economic value of chickpea. Due to short life cycle and high degree of reproductive capacity, losses caused by this beetle to the pulses have been estimated to the tune of 30-40 per cent in storage. It is a primary and most destructive pest of stored pulses. The bruchid infestation also affects seed quality, market value and can reduce chickpea seed viability to 2% after months of storage [6]. The traditional method of controlling storage pests by sun-drying is safer to human health and environment. But this method is laborious, time consuming, often expensive and requires suitable drying yard, when large volume of stored grain is involved. Moreover, it depends on favorable weather conditions. Recently, the use of different plants and their derivatives has appeared as an effective alternative to synthetized insecticides in the control of various insect pests of food grains. In contrast, biopesticides are cheaper, more readily biodegradable, some of them being less toxic to mammals, more selective in action, and less subjected to pest resistance.

Adhatoda leaves have been used extensively in ayurvedic medicine for over 2,000 years primarily for respiratory disorders [8]. The leaf extract is safe for human consumption and the oil has

low mammalian toxicity. *Leucas aspera* commonly known as 'Thumbai' is distributed throughout India from the Himalayas down to Ceylon. The plant is used traditionally as an antipyretic and insecticide. Medicinally, it has been proven to possess various pharmacological activities like antifungal, antioxidant, antimicrobial, antinociceptive and cytotoxic activity. The powders of certain plant parts i.e., leaves, bark, seeds as well as oil extracts suppressed the oviposition and adult emergence and increased mortality rate of bruchids and maintained the seed quality as well, when mixed with stored grains [18],[1],[14],[4],[15]. Botanical powders are safe and interesting alternatives of chemicals insecticides especially in developing tropical countries where plants are abundantly present throughout the year [10]. The present study aimed to protect stored chickpea seeds from *C. chinensis* infestation under laboratory conditions using leaf powders of *Justicia adhatoda L.* and *Leucas aspera.*

2. MATERIALS AND METHODS

Collection and Culture of insects: The pulse beetle, *Callosobruchus chinensis L.* adults were obtained from naturally infested chickpea (*Cicer arietinum*) seeds from a local market in Kozhikode, Kerala. It was found out that the 500g package of chickpea seeds bought from the market was having a considerable amount of infested *C. chinensis L.* in it. This package was kept under room temperature and assured relative humidity. After 48 hours some amount of infested chickpea seeds along with the insect pest were transferred into a closed glass jar. This jar also kept in room temperature in relative humidity and ventilation (once in a day - by opening the jar). After 48 hours, the adults were removed and the jar was left for 25 days to obtain adult beetles for the experiment.
Collection of plants: The fresh leaves of *Justicia adhatoda L.* and *Leucas aspera* (Table 1) were collected from Kozhikode district and used against pest of pulses (*Callosobruchus chinensis L.*).

Table:1 - Medicinal Plants

Botanical Name	Common Name	Vernacular Name	Family Name
Justicia adhatoda	Vasaka	Aadalodakam	Acanthaceae
Leucas aspera	Thumbai	Dronapushpi	Lamiaceae

Preparation of leaf powders: The fresh leaves of selected plants were collected, and afterward they were washed in running water. Then they were shade dried for a period of 2-3 weeks. And the dried leaves were ground into fine powder using an electric grinder, and it was passed through a sieve and retained in separate containers.

A. Experimental Design

The fine leaf powders were added separately to 5 containers each which has infested chickpea seeds in it. Control consisted of infested pulses only; without the leaf powders. In to the 5 containers each, exactly 10 number of *Callosobruchus chinensis L.* adults were introduced. The experiment was replicated thrice. Duration of each trial was set to 24 hours. In the 5 containers, plant powders were added in a gradually increasing concentration such as 1g, 2g up to 5g. After 7 days the dead adults were removed and the percentage of mortality of insects were recorded. Phytochemical analysis and FTIR analysis of the leaf powders were also conducted. Seed vigour index is also calculated by multiplying germination (%) and seedling length (mm). All experiments were performed in 3 replicates and data are the mean, ±SD and Correlation Coefficient. Data were subjected to Regression estimation also.

3. RESULT

The efficacy of the leaf powders of *Justicia adhatoda L.* and *Leucas aspera* on the management of the pulse beetle *Callosobruchus chinensis L.* in Chickpea were done in laboratory conditions. All

experiments were performed in 3 replicates and data are the mean, ±SD, Correlation Coefficient and Linear Multiple Regression.

There were three trials had been carried out to find the more efficacy of pest control using *L. aspera*. It is found that 3rd and 4th gram slats had more efficacy to control pest which evidence that the three trials mean value almost greater than one. The value also indicates that both 4th and 5th gram slats had a sufficient efficacy to control pest by using *L. aspera* (Table 2).

There were three trials had been carried out to find the more efficacy of pest control using *J. adhatoda*. It is found that 3rd and 4th gram slats had recorded more efficacy to control pest which evidence that the three trials mean value almost greater than one. The value also indicates that both 4th and 5th gram slats had a sufficient efficacy to control pest by using *J. adhatoda*. (Table 3).

Comparative analysis of the mean values of *Leucas aspera* and *Justicia adhatoda* were studied, from the observations of 3 trials of each plant powders, *J. adhatoda* leaf powder influences more on the mortality rate of *Callosobruchus chinensis* in chickpea when compared to the *L. aspera* leaf powder.

The dried and powdered leaf powders of *Leucas aspera* and *J. adhatoda* were subjected to Physicochemical analysis. In this, pH, Turbidity, Electrical conductivity and temperature were analyzed. In this, it shows pH 6.7 (acidic in nature), Electrical conductivity 0.01 MS, Turbidity 3.2 NTU and Temperature 23.8^{0}C for *L. aspera* and for *J. adhatoda* pH is 7.9 (basic in nature), Electrical conductivity is 0.02 MS, Turbidity is 1.4 NTU and temperature at 26.9^{0}C (Table 4).

The FTIR spectrum of leaf extracts of *L. aspera* and *J. adhatoda* were analyzed and the result of FTIR spectrum profile is depicted in Table 5a and 5b and Fig 1a and 1b respectively.

4. TABLES

Table 2: Comparative analysis of three trial of Pest control using *Leucas aspera*

Concentration	1 Trial		2 Trial		3 Trial	
	Mean	β-value	Mean	β-value	Mean	β-value
1 gram	0.71	.19	0.71	.24	0.71	.19
2 grams	0.85	.19	0.71	.24	0.85	.19
3 grams	1	.23	0.85	.22	1	.23
4 grams	1.14	.21	1	.27	1.14	.21
5 grams	1.28	.25	1	.26	1.28	.25

Table 3: Comparative analysis of three trial of Pest control using *Justicia adhatoda*

Concentration	1 Trial		2 Trial		3 Trial	
	Mean	β-value	Mean	β-value	Mean	β-value
1 gram	1	.21	1.14	.23	0.85	.21
2 grams	1.14	.21	1	.19	1.14	.20
3 grams	1.14	.19	1.14	.26	1.14	.20
4 grams	1.42	.24	1.42	.25	1.28	.27
5 grams	1.42	.29	1.42	.23	1.42	.23

Table 4: -Physicochemical analysis of *Leucas aspera* and *Justicia adhatoda*

Plant	pH	EC (MS)	Turbidity (NTU)	Temperature (^{0}C)
Leucas aspera	6.7	0.01	3.2	23.8
Justicia adhatoda	7.9	0.02	1.4	26.9

Table 5a: - FTIR Absorption frequencies (cm^{-1}) of *Leucas aspera*

Frequency (cm^{-1})	Functional Groups	Phyto compounds
3248.13	O-H Stretch, H-bonded	Alcohols, Phenols
1635.64	N-H bend	1^0 amines
1234.44	C-N Stretch	Aliphatic amines
1087.85	C-O Stretch	Alcohols, carboxylic acids, esters,
694.37	C-H “oop”	Aromatics
671.23	N-H wag	1^0, 2^0 amines
601.79	C-Cl Stretch	Alkyl halides
509.21	C-I Stretch	Halo compound

Table 5b: - FTIR Absorption frequencies (cm-1) of *Justicia adhatoda*

Frequency (cm^{-1})	Functional Groups	Phyto compounds
3286.70	O-H Stretch, H-bonded	Alcohols, Phenols
1635.64	N-H bend	1^0 amines
1257.59	C-N Stretch	Aromatic amines
686.66	C-H “oop”	Aromatics
601.79	C-Cl Stretch	Alkyl halides
563.21	C-Br Stretch	Alkyl halides

5. FIGURES

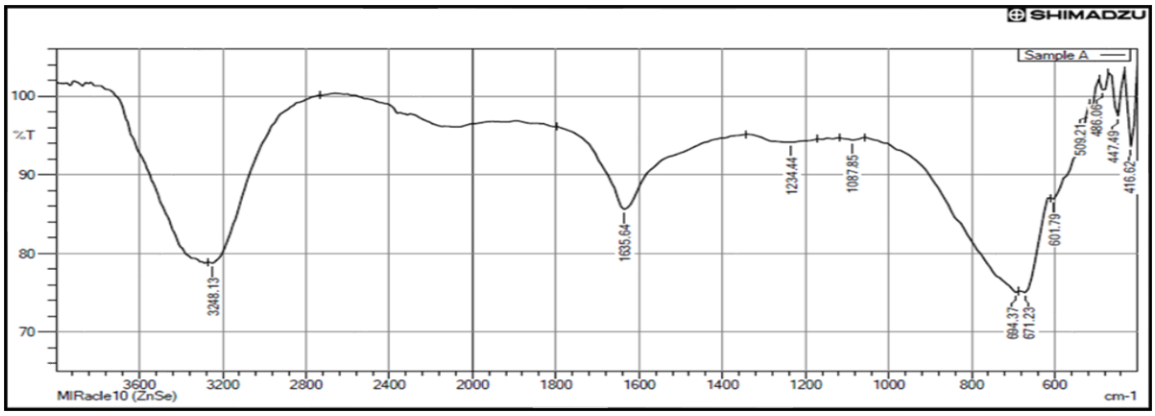

Figure-1 a: - FTIR Spectrum of *Leucas aspera*

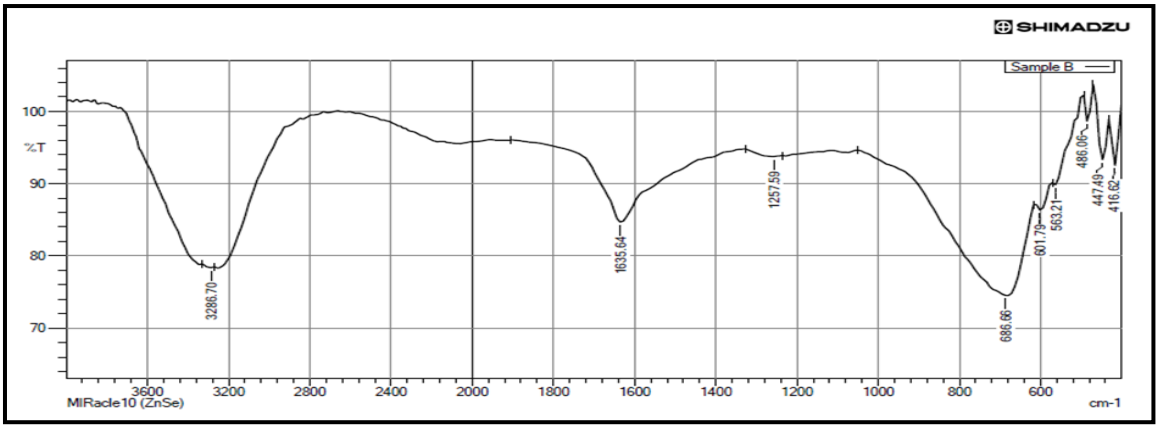

Figure-1 b: - FTIR Spectrum of *Justicia adhatoda*

6. DISCUSSION

Callosobruchus chinensis L. is a major pest of chickpea as it does more than 10% damage to chickpea and renders the grain unfit for human consumption due to bad odour of insect excrements in the grains, [13]. Single larvae of *Callosobruchus chinensis L.* can destroy several mature seeds [7],[16]. The grains lose their germination capacity and become unfit for human consumption due to heavy infestation of grains by *Callosobruchus chinensis*.

Severe infestation leads to 100% damage thus leaving the seed coat. In addition to quantitative losses, the *Callosobruchus chinensis* also causes qualitative losses to the grains [11]. In grub stage, the beetles lives inside the grains and fills the burrows with their excrement and dead bodies [3]. The pulses are susceptible to the attack of insect before and after harvest, the extend of infestation has been reported as high as 70%.

As far as botanicals are concerned many researchers have reported the insecticidal activities of the plant derivatives against different types of storage insect pests that may be used in the control of storage insect pests. [18] reported that *M. ferruginea* seed powder against *C. chinensis* provides complete protection of stored chickpea for six months in the laboratory.

The powders play important role in killing insects by occlusion of spiracles, by causing tracheal resistance in respiration and by obstructing movement of insects, eventually causing death [15]. To the best of our knowledge, the dried leaf powders of *M. charantia*, *E. globulus* and *P. nigrum* are tested for the first time for the control of *C. chinensis* in chickpea seeds.

According to [9], green gram, chickpea, cowpea, and pea could be protected from damage by the *Callosobruchus* species for 8-11months by mixing powdered neem kernel with grain sat 1 or 2 to 100 parts.

7. CONCLUSION

This investigation was carried out in the laboratory to evaluate the insecticidal studies of leaf powders against the notorious pulse beetle, *Callosobruchus chinensis* in Chickpea. Present study was to investigate the properties of medicinal plant components, for their safety and efficacy. A synthetic insecticide is either not easily available to subsistence farmers or they cannot afford them, the use of natural medicinal plant leaves like *L. aspera* and *J. adhatoda* which can be easily grown by such farmers. Among the *L. aspera*, higher percentage of mortality rate of *C. chinensis* was recorded in 5g. Among the *J. adhatoda*, higher percentage of mortality rate *of C. chinensis* was recorded in 5g. But on a comparative analysis between the leaf powders of *L. aspera* and *J. adhatoda*, *J. adhatoda* brought the higher mortality rate of *C. chinensis* than *L. aspera*. The above results indicated that the leaf powders of *J. adhatoda* is very effective in controlling *Callosobruchus chinensis*.

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