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Bio efficacy of Pongamia pinnata and Lantana camara Medicinal Plant Extracts Against the Storage Pest *Callosobruchus maculatus* (Coleoptera: Chrysomelidae) Infesting Stored Cowpea

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ABSTRACT

Stored grain and pulse losses caused by insect pests represent a major challenge to global food security, particularly in developing countries where post-harvest management practices are often inadequate. Pulses such as cowpea are highly susceptible to infestation by storage insect pests, resulting in significant quantitative and qualitative losses during storage. Infestation not only reduces seed weight and nutritional value but also lowers market quality and seed viability. Conventional management of storage pests mainly depends on synthetic insecticides and fumigants; however, their indiscriminate use has led to several adverse consequences, including environmental pollution, toxic residues in food products, development of insect resistance, destruction of beneficial organisms, and health hazards to humans and animals. In recent years, increasing attention has been directed toward the use of botanical pesticides as safer and eco-friendly alternatives to chemical insecticides. India is recognized as one of the world's richest centers of medicinal and aromatic plants, with more than 2,500 plant species reported to possess medicinal and pesticidal properties. Many of these plants produce biologically active secondary metabolites such as alkaloids, flavonoids, tannins, terpenoids, phenols, saponins, and essential oils, which play a vital role in plant defense mechanisms against herbivorous insects and microbial pathogens. Insect pests can be managed with the use of synthetic insecticides, but in storage, any intervention with insecticides leads to closest application for consumption which is totally unsafe. This study contributes to the development of eco-friendly botanical insecticides derived from medicinal plants. The evaluation of Pongamia pinnata and Lantana camara may provide valuable information regarding their insecticidal potential and phytochemical composition. Identification of bioactive compounds responsible for pest control can support future research on plant-based formulations for storage pest management.

Keywords: *Stored Grain Pest, Alkaloids, Mortality, Infestation, Botanical Extract, Callosobruchus maculatus .*

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INTRODUCTION

Pulses constitute an important component of the human diet and serve as a major source of proteins, carbohydrates, fats, sugars, vitamins, and essential minerals, particularly in developing countries [1]. Among pulses, cowpea is an economically important leguminous crop widely cultivated for its nutritional value and adaptability to diverse agro-climatic conditions. However, substantial post-harvest losses occur during storage due to infestation by insect pests. Among these, *Callosobruchus maculatus* (Coleoptera: Bruchidae) is recognized as one of the most destructive storage pests of pulses in tropical and subtropical regions [2].

Infestation by this bruchid pest causes severe damage to stored grains, resulting in weight loss, reduction in nutritional quality, decreased seed viability, and economic losses. The management of storage insect pests has traditionally relied on synthetic insecticides and fumigants. Although these chemicals provide rapid control, their continuous and indiscriminate application has created several ecological and health-related concerns, including environmental contamination, toxic residues in food materials, harmful effects on non-target organisms, and the development of insect resistance [3]. Consequently, there is an increasing need to explore environmentally safe, biodegradable, and sustainable alternatives for pest management.

Botanical insecticides derived from medicinal plants have emerged as promising alternatives due to their bioactive phytochemical constituents possessing insecticidal, repellent, antifeedant, and growth-inhibitory properties.

Pongamia pinnata (L.), commonly known as Karanja, belongs to the family Fabaceae and is widely distributed in tropical and subtropical regions. It is a medium-sized glabrous tree traditionally valued for its medicinal and pesticidal properties. Different parts of the plant are used in traditional medicine for the treatment of skin diseases, rheumatism, bronchitis, hypertension, and other ailments [4,5]. The leaves and seeds of the plant contain several biologically active compounds, including flavonoids, alkaloids, tannins, and karanjin, which are known to exhibit insecticidal and antimicrobial activities. Similarly, Lantana camara (Verbenaceae), commonly known as wild sage or red sage, is an important medicinal plant widely distributed throughout tropical regions. Although regarded as an invasive weed in many areas, the plant possesses several pharmacological and biological properties due to the presence of pentacyclic triterpenoids known as lantadenes and other secondary metabolites [6]. Extracts of the plant have been reported to exhibit antimicrobial, antifungal, insecticidal, and repellent activities against a variety of insect pests. In view of the increasing demand for eco-friendly pest management strategies, the present study was undertaken to evaluate the biocontrol potential of leaf extracts of *Pongamia pinnata* and *Lantana camara* against *Callosobruchus maculatus* infesting stored cowpea seeds. The study also includes phytochemical analysis of the selected plants in order to identify the bioactive constituents responsible for their insecticidal activity. The findings may contribute to the development of effective plant-based bioinsecticides for sustainable management of storage pests.The present study aims to investigate a biocontrol method using *Pongamia pinnata* and *Lantana camara* leaf extract as a bio insecticide against *Callosobruchus maculates* in economically important pulse crop cowpea. The Phytochemical components of the plants were also analyzed.

MATERIALS AND METHODS

Rearing of test insects

Adults of *Callosobruchus* species were collected from households, and they were identified under Stereo Binocular Microscope (Karl Zeiss Stemi DV4) using the keys of [7,8]. Ten pairs of test insects, *C. maculatus* were collected from the stock and released into separate jars containing cow pea seeds.

Preparation of plant powders

The fresh leaves of selected plants were collected, washed and shade dried. The dried leaves were ground into fine powder in an electric pulverizer, passed through a sieve and retained in packets.

Experimental design

The laboratory experiment was laid in a Completely Randomized Design (CRD). Two replications from each concentration and an untreated control were maintained simultaneously. From the residue, desired concentrations, i.e., 0.5%, 1%, 1.5%, 2% and 2.5% concentrations of leaf powder were prepared. 25g of disinfected cowpea seeds were taken in a container in which different doses of leaf powder were added. The containers were shaken well. All the treatments and the control were replicated two times. 5 pairs of newly emerged adults were released into each packet. The containers were tightly closed with lids. The various criteria considered to screen the insecticidal effect of selected plant powders are given below.

Observations

a) Percentage mortality of *C. maculatus*

Observations of mortality of insects were recorded for each treatment and control at every 24 hours interval for six days. The dead and moribund insects which were taken as dead were removed from the grains at the time of counting. Percentage mortality of each day was calculated using the following formula:

$$\text{Percentage mortality of insects} = \frac{\text{Dead insects}}{\text{Insects introduced}} \times 100$$

Percentage weight loss of the cowpea

To calculate the weight loss of grain, the control and treated grains were sieved to remove all the dust insects using a grain sieve (3 mm diameter). The weights of the remaining grains were taken at electronic balance . The per cent weight loss was calculated using the formula.

$$\text{Percentage weight loss} = \frac{OW - CW}{OW} \times 100$$

Where,

OW = Original weight on dry weight basis; CW = Current weight on dry weight basis.

Phytochemical Analysis

The phytochemicals such as Resin, Saffonins, Flavonoids, Steroids, Tannins, Glycosites, Antraquinine, Terpenes, Saponins test, Reducing Sugar and Phlobotannis analysis were carried out by standard method.

Statistical Analysis

The data of percentage mortality, percentage weight loss, and germination obtained from the bioassay studies were transformed into ARC sine values before subjecting to ANOVA. Mean difference of each variable was further analyzed using Least Significant Difference (LSD) test. To find out the significance of the comparative efficacy of different leaf extracts on adult mortality, adult emergence, percentage weight loss of cowpea, germination percentage, and vigour index, one-way analysis of variance was used and the mean values thus obtained were grouped using LSD using SPSS Package.

Fig.1: C. maculatus infesting grains of cow pea

RESULT AND DISCUSSION

The Bioassay studies using leaf powder on adult mortality of *C. maculatus*, weight loss, and germination percentage and vigour index of cowpea are described below. The statistical analysis of the data revealed highly significant difference between the control and different treatment.

Impact of application of leaf powder on weight loss

Pongamia pinnata

Highly significant variation between the treatments and control were noticed (Table:1). Although *P. pinnata* extracts recorded a gradual increase in percentage of mortality, when compared to the *L. camera*, which showed a maximum mortality on 48 and 72 hours of observation, (Table 2 & 3). In this case, the extreme reduction in weight loss was observed for *P. pinnata* leaf extract. All the five concentrations of *Pongamia* recorded minimum weight loss of cow pea ranging in 1% and maximum into 2.5%. In control, 1.00 weight loss only. It is common experience to observe that maximum damage to stored grain is caused by insect pests. The pesticide contamination of pulses found to be above 40% in India.

Lantana camara

In comparison with *Pongamia*, reduction in the weight loss was noticed in *Lantana* (Table:1). Among the treatments, highest reduction in the weight loss was observed. Minimum weight loss of cow pea was recorded in 2.5% and maximum was in 1.8%. A complementary approach for the safe management of pulse beetle, five leaf extracts and powders belonging to the family, Solanaceae, Labiatae, Malvaceae, Verbenaceae and Fabaceae were selected to evaluate their pesticidal effectiveness on pulse beetle and mycobial pests of cowpea.

Impact of *Pongamia pinnata* and *Lantana camara* leaf powder on adult mortality

The higher percentage of mortality was recorded in 1, 1.5, 2, 2.5% concentration of all leaf extracts than 0.5% concentration. Significant increase in the percentage of mortality was recorded from 48, 72, 96, and 120 and 144 hours.

Table 1: Impact of selected Leaf powders on Percentage weight loss of cowpea

TREATMENTS	0.5	1	1.5	2	2.5
CONTROL	1.00 (5.44) d	1.00 (5.44) d	1.00 (5.44) d	1.00 (5.44) d	1.00 (5.44) d
L.C	4.20 (11.66) bc	4.00 (11.52) bc	6.80 (15.01) ab	6.40 (14.64) ab	2.40 (8.78) cd
P.P	5.40 (13.03) bc	4.24 (11.86) bc	6.20 (14.41) ab	7.00 (15.34) ab	11.00 (19.36) a
Treat (T)	Grand mean 5.331	SED 321.07	CD Value **		

Figures in parenthesis are ARC SINE transformed before ANOVA.
Means with same letter in each column are not significantly different.
SED – standard error deviation. CD – critical difference.
*** Significant at 1% level. * Significant at 5% level. NS = Not significant.*

Table 2: Mortality of Callosobruchus maculatus after 48 hours

TREATMENTS	0.5	1	1.5	2	2.5
CONTROL	0.005 (0.28) c	0.005 (0.28) c	0.005 (0.28) c	0.005 (0.28) c	0.005 (0.28) c
L.C	0.005 (0.28) c	0.005 (0.28) c	0.005 (0.28) c	0.005 (0.28) c	0.005 (0.28) c
P.P	25.00 (28.83) b	69.99 (64.32) a	45.00 (42.11) ab	45.00 (42.11) ab	45.00 (41.98) ab
Treat (T)	13.27	13337.36	CD value **		

Figures in parenthesis are ARC SINE transformed before ANOVA.
Means with same letter in each column are not significantly different.
*SED – standard error deviation. CD – critical difference. ** Significant at 1% level.*
** Significant at 5% level. NS = Not significant.*

Table 3: Mortality of Callosobruchus maculatus after 72 hours

TREATMENTS	0.5	1	1.5	2	2.5
CONTROL	10.00 (13.28) a	10.00 (13.28) a	10.00 (13.28) a	10.00 (13.28) a	10.00 (13.28) a
L.C	35.00 (36.22) a	35.00 (36.22) a	10.00 (13.28) a	9.99 (18.43) a	15.00 (16.60) a
P.P	25.00 (22.50) a	20.00 (19.61) a	39.99 (39.22) a	34.99 (36.21) a	29.99 (33.20) a
Treat (T)	Grand mean 24.8	SED 5217.98	CD Value Not Significant		

Figures in parenthesis are ARC SINE transformed before ANOVA.
Means with same letter in each column are not significantly different.
SED – standard error deviation. CD – critical difference.
*** Significant at 1% level. * Significant at 5% level. NS = Not significant.*

The present investigation demonstrated that leaf powders of *Pongamia pinnata* and *Lantana camara* possess significant bioactive potential against Callosobruchus maculatus infesting stored cowpea seeds. Phytochemical analysis of *P. pinnata* revealed the presence of important secondary metabolites such as tannins, flavonoids, terpenoids, glycosides, and anthraquinones. These compounds are known to exhibit insecticidal, repellent, antifeedant, and growth-regulating activities against a wide range of insect pests [9]. The presence of karanjin and pongamol in *P. pinnata* has been particularly associated with neurotoxic and feeding deterrent effects on storage insects and mites, thereby reducing feeding activity, reproduction, and survival [10]. The superior inhibitory effect of *P. pinnata* leaf powder observed in the present study may be attributed to its rich phytochemical composition and synergistic action of multiple bioactive compounds. Previous investigations have also reported that powdered leaves and seed extracts of *P. pinnata* are effective against several stored grain insect pests due to their strong antifeedant and toxic properties [11]. Botanical insecticides derived from *P. pinnata* are considered environmentally safe because they degrade rapidly and leave minimal toxic residues in stored food products.

Similarly, Lantana camara possesses diverse biological activities owing to the presence of pentacyclic triterpenoids known as lantadenes, along with alkaloids, flavonoids, and essential oils. Earlier studies have reported that *L. camara* exhibits antibacterial, antifungal, insecticidal, nematocidal, and antimicrobial activities [12]. The moderate insecticidal activity recorded in the present study against *Callosobruchus maculatus* may be associated with these phytochemicals, which interfere with insect metabolism and physiological functions.

An important observation of the present study was that both plant leaf powders exhibited considerable inhibitory effects on the insect pest while causing minimal adverse effects on cowpea seeds. This indicates their potential suitability as eco-friendly grain protectants for stored pulses. In contrast to synthetic insecticides, botanical products are biodegradable, comparatively safer to non-target organisms, and less likely to induce resistance in insect populations [13]. The use of plant-based biopesticides can therefore contribute significantly toward sustainable storage pest management and reduction of post-harvest losses. The present study revealed that leaf powders of Pongamia pinnata and Lantana camara exhibited considerable insecticidal activity against Callosobruchus maculatus in stored cowpea seeds. The phytochemical screening of *P. pinnata* confirmed the presence of biologically active compounds such as flavonoids, tannins, glycosides, and terpenoids, which may contribute to its insecticidal and antifeedant properties. Similar findings were reported by [14], who identified several bioactive constituents from the stem bark of *P. pinnata* with significant biological activities.

The strong inhibitory effect of *P. pinnata* leaf powder observed in the present investigation supports earlier studies demonstrating the effectiveness of plant-derived products against storage pests. Botanical leaf powders significantly reduced infestation and reproductive potential of *Callosobruchus maculatus*, indicating the importance of medicinal plants in stored grain protection [15]. Likewise, [16] observed that seed extracts of medicinal plants adversely affected fecundity and fertility of stored grain insect pests. Both plant powders caused minimal adverse effects on cowpea seeds while effectively suppressing insect infestation. The results therefore suggest that these medicinal plants may serve as safe, eco-friendly, and cost-effective alternatives to synthetic insecticides for the management of storage pests. Such plant-based pest control strategies may also help reduce post-harvest grain losses, which are a major concern in stored food commodities.

The findings of the present investigation support the growing scientific evidence that medicinal plants can serve as effective alternatives to synthetic chemical pesticides. The utilization of locally available plants such as Pongamia pinnata and Lantana camara may provide farmers with an economical, environmentally compatible, and sustainable method for protecting stored grains against insect infestation and microbial contamination. Further studies on formulation development, dosage optimization, and field-level application are recommended to enhance their practical utility in integrated pest management programs.

Credit authorship contribution statement

Author 1: Conceptualization, Methodology, Investigation, Writing – Original Draft. **Author 2:** Data Curation, Formal Analysis, Visualization. **Author 3:** Supervision, Project Administration, Writing – Review & Editing All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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