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The efficacy of *Piper nigrum* and *Curcuma longa* powders for the management of the *Callosobruchus maculatus* (Chrysomellidae: Coleoptera) on the Pigeon pea

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Abstract
The implication of agricultural products, pigeon pea, *Cajanus cajan* (L.) is a basic legume crop known for its important role in attractive dietary variety and supporting the social and economic well-being of human. Pulses play an important role in the diet of the Indian people. Undoubtedly, pulses are an important protein source for the vegetarians and it is also measured as poor man's meat for the under privileged people who cannot afford animal proteins. The vulnerability of pigeon pea to invasion by the pulse beetle, scientifically referred to as *Callosobruchus maculatus*, shows an important challenge, demanding an immediate essential for complete thoughtful and real control plans. Pigeon pea, a tough competitor to pulse yields, has appeared as a significant risk, subsequent in vital protein content fatalities inside pigeon pea. The plant powders used in the study were *Piper nigrum* and *Curcuma longa* powders. The objectives of the present study were to learn the effect of diverse concentrations of medicinal powders of *Piper nigrum* -Pepper and *Curcuma longa* – Turmeric on the pulse beetle *Callosobruchus maculatus* (Coleoptera: Bruchidae); To evaluate the mortality rate of *Callosobruchus maculatus* by the effect of *Piper nigrum* and *Curcuma longa* powders; To assess the properties of the powders on the superiority of *Cajanus cajan*-Pigeon pea; To find out the FTIR analysis of the two powders.

Keywords: Pigeon pea, *Cajanus cajan* (L.), Pulse beetle *Callosobruchus maculatus* and botanicals *Piper nigrum* and *Curcuma longa* powders).

Introduction
The pulse seeds suffer a great injury during packing due to insect occurrence, (Sherma,1989) [11]. Moreover, pulses stored exactly for feeding purpose should not be preserved with toxic chemicals since the remains of the chemicals may carriage serious risk on human health. On the other hand, certain plant measures and old methods are much safer than chemical insecticides, Weaver and Subramanyam, (2000) [14]. The alternate methods as the use of ash, edible oils and plant products that could be simply used by farmers need to be considered, reported by Isman, (2008) [4]. Lale, (1992) [6] reported that plant materials and local old methods are much harmless than insecticides and proposed that their use needed abuse. Effective use of plant extracts, ash, vegetable oils and plant leaf powders in insect pest regulator has been reported by many workers Bakkali *et al.*, Chiasson *et al.*, 2004 [2] and Isman and Machial, (2006) [5]. Pigeon pea (*Cajanus cajan* (L.) Millsp.), also known as red gram, is an important food legume crop in semi-arid tropical and subtropical farming systems (Shanower *et al.*, 1999) [10]. The crop is harvested only once each year, which means that storage is an important component of the pigeon pea postharvest system. Bruchids of the genus *Callosobruchus* (Coleoptera: Bruchidae) including *C. chinensis* (L.), *C. maculatus* (F.) and *C. analis* (F.) are major causes of losses in stored pigeon peas (Singh and Jambunathan, 1990) [12]. Outcome of safe alternatives to synthetic insecticides to guard stored grains and grain products from insect invasions are highly needed. Plant powder insecticides have yields accomplished synthetic insecticides. Recently, care have been given to the probable use of plant products or plant derived mixtures as promising substitute to synthetic insecticides in directing insect pests of stored products (Rajapakse *et al.*, 2002) [8].

Materials and Methods
The materials and procedures, used for the current study are defined under the following headings:

Rearing of Test Insect - *Callosobruchus maculatus*
Adults of the *Callosobruchus maculatus* - pulse beetles were collected from household. 10 Insects of *C. maculatus* were introduced into separate container which is containing pigeon pea *Cajanus cajan.* The pulse beetle, systematically known as *C. maculatus*, was cultured in a measured laboratory setting using pigeon pea as their food. The lab settings were maintained at a steady temperature of 27±1°C and a humidity level of 70±1% RH. To start the rearing process, we placed adult beetles from infested grains into flexible containers with disinfected pigeon pea. Once the adult beetles laid their eggs, we took them out of the containers. The fresh hatched beetles were then free onto fresh pigeon pea for mating and laying more eggs. This whole cycle was repeated every 15 days to confirm, we always had different stages of the insects offered for our research.

Medicinal plant powders
The plant powders *Piper nigrum* - Black Pepper, family Piperaceae and *Curcuma longa* -Turmeric, family Zingiberaceae were collected and used against the pests of Pigeon pea *Cajanus cajan.*

Experimental Design
Two replications from each concentration and untreated control maintained simultaneously. From the residue, desired concentration 1gm, 2gms, 3 gms, 4 gms and 5 gms concentration of plant powders were prepared. 25 grams of infected pigeon pea was taken in a container in which

different doses of plant powders was added. The containers were mixed well and dried. All the treatment and control were replicated two times. The newly developed adults 10 were released into the container and were firmly closed with lid.

Observation

The mortality of insects were observed and recorded for each experiment and control at every 24 hours interval for 7 days. The lifeless insects were removed from the pigeon pea at the time of counting.

FTIR Spectrum Analysis

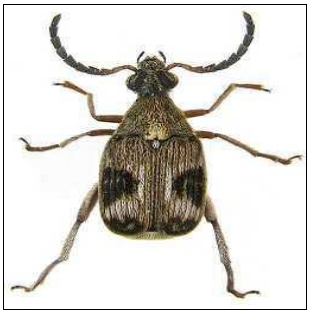
(Bobby *et al.*, 2012) Fourier Transform Infrared Spectrophotometer (FTIR) is the most powerful tools for finding the types of chemical bonds present in mixtures. For FTIR analysis, dried powders of aqueous solvent extracts of the plant materials were used. 10 mg of the dried extract powder was condensed in 100 mg of KBr pellet, in order to prepare luminous sample disc. The powdered sample of each plant powder was loaded in FTIR Spectroscope, with a scan range from 500 - 3500 cm-1 with a resolution of 4 cm^{-1}. The bands were obtained in contrast with the reference chart.

Statistical Analysis

The Mean values, Standard deviations, Linear Multiple Regression and Correlation Coefficient of the two plant powders on the pulse beetle *Callosobruchus maculatus* were analysed using the SPSS package -version-17.0 and STATISTICA-98 version.

Insect Photos

Callosobruchus maculatus-Pulse Beetle



Result and Discussion

From the experiments, the following results were obtained:

In the first trial of *Piper nigrum* powder on *Callosobruchus maculatus*, the mortality rate was higher in 5 grams concentration (21) and lower in 4 grams (15), 11 in 3 and 2 grams and lowest in 1 gram (9). The analysis of Mean and Standard deviation was higher in 5 grams concentration that is 3.00 and 0.81 respectively and lowest in 1 gram concentration that is 1.28 and 0.48 respectively. The Beta value for 5 grams was 0.51 and the t-value is more in 4 grams that is 0.91. The Correlation-coefficient 1 indicates a perfect linear association among the concentrations and the mortality rates. (Table-1, 1a, b &c).

In the second trial of *Piper nigrum* powder on *C. maculatus*, the mortality rate was higher in 5 grams concentration (24) and lower in 4 grams (20), 16 in 3 and 13 in 2 grams and lowest in 1 gram (9). The analysis of Mean and Standard deviation was higher in 5 grams concentration that is 3.42 and 1.27 respectively and lowest in 1 gram concentration that is 1.28 and 0.37 in 2 grams respectively. The Beta value for 5 grams was 0.40 and the t-value is more in 3grams that is 0.93. The Correlation-coefficient of 1 indicates a perfect linear association among the concentrations and the mortality rates. **(**Table-2, 2a, b &c).

In the first trial of *Curcuma longa* powder on *C. maculatus*, the mortality rate was higher in 5 grams concentration (25) and lower in 4 grams (19), 14 in 3 and 12 in 2 grams and lowest in 1 gram (8). The analysis of Mean and Standard deviation was higher in 5 grams concentration that is 3.57 and 1.51 respectively and lowest in 1 gram concentration that is 1.14 and 0.48 in 2 grams respectively. The Beta value for 5 grams was 0.31 and the t-value is more in 5 grams that is 0.94 respectively. The Correlation-coefficient 1 indicates a perfect linear association among the concentrations and the mortality rates. (Table-3, 3a, b &c).

In the second trial of *Curcuma longa* powder on *C. maculatus*, the mortalityd rate was higher in 5 grams concentration (26) and lower in 4 grams (22), 15 in 3 and 12 in 2 grams and lowest in 1 gram (9). The analysis of Mean and Standard deviation was higher in 5 grams concentration that is 3.71 and 1.60 respectively and lowest in 1 gram concentration that is 1.28 and 0.48 in 1 and 2 grams respectively. The Beta value for 5 grams was 0.34 and the t-value is more in 5 grams that is 0.89 respectively. The Correlation-coefficient 1 indicates a perfect linear association among the concentrations and the mortality rates. (Table-4, 4a, b &c).

The rate of mortality was noted in the treatment of neem leaf powder (35.63%) at all three doses but minimum was reported from black pepper powder treatment (10.25%). Treatments like, T1 (Tulsi leaf powder), T4 (Sweet flag rhizome powder), T5 (Dry chilli powder) and T7 (Tobacco leaf powder) were at par. These results are in conformism with the findings of Sunil Kumar (2003) [13], who reported that, sweet flag rhizome powder and custard apple seed powder recorded suggestively minimum damage to seeds with 17.20 and 20.00 per cent, correspondingly against *S. oryzae* in sorghum at 180 days after storage. The rate of adult mortality of *C. chinensis* in seeds treated with grain protectants clearly showed the greater performance of chemical treatments over vegetable oils. Among the oils karanj oil caused extreme mortality (82.67%) at 24 hours after treatment by recording a total mortality of 91.33% after 7 days of treatment indicating that chemical protectants were more toxic to the adults than the oils. These findings derive support from Patil *et al.*, (1994) [7] who found that deltamethrin (12.5 ppm) was the most active treatment by recording high mortality. Sadat and Asghar (2006) [9] also reported 75 to 100% mortality of adult pulse beetles in spinosad treated seeds. Huang *et al.*, (2007) [3] observed the similar results.

Tables

Table 1: First trial of *Piper nigrum* powder on *Callosobruchus maculatus*

Trial	Concentrations				
	1gram	2 grams	3 grams	4 grams	5 grams
Day 1	1	1	1	2	2
Day 2	1	2	1	2	3
Day 3	2	1	2	1	2
Day 4	1	1	2	2	3
Day 5	1	2	2	3	4
Day 6	1	2	2	3	3
Day 7	2	2	1	2	4

Table 1a): Analysis of Mean and Standard deviation of first trial of *Piper nigrum* powder on *Callosobruchus maculatus*

Concentration	Mean	Standard deviation
1 gm	1.28	.48
2gm	1.57	.53
3gm	1.57	.53
4gm	2.14	.69
5gm	3.00	.81

Table 1b): Linear Multiple Regression summary for First trial of *Piper nigrum* powder on *Callosobruchus maculatus*

Concentration	Beta value (Co-efficient)	Std Error	t-value
1gm	.17	.08	.11
2gm	.18	.08	.11
3gm	.16	.05	.00
4gm	.45	.11	.91
5gm	.51	.07	.45

Table 1c): Correlation Co-efficient for First trial of *Piper nigrum* powder on *Callosobruchus maculatus*

Concentration	1gram	2 grams	3 grams	4 grams	5 grams	Total
1 gram	1.00	-.09	-.09	-.63	-.00	.14
2 grams	-.09	1.00	-.16	.64	.76	.82
3 grams	-.09	-.16	1.00	.19	.00	.26
4 grams	-.00	.76	.19	1.00	.59	.79
5 grams	-.00	.76	.00	.59	1.00	.92
Total	-.14	.82	.20	.79	.92	1.00

Table 2: Second trial of *Piper nigrum* powder on *Callosobruchus maculatus*

Trial	Concentrations				
	1gram	2 grams	3 grams	4 grams	5 grams
Day 1	1	1	2	2	2
Day 2	1	2	1	2	3
Day 3	1	2	3	3	2
Day 4	1	2	2	3	3
Day 5	2	2	2	3	4
Day 6	2	2	3	3	5
Day 7	1	2	3	4	5

Table 2a): Analysis of mean and standard deviation second trial of *Piper nigrum* powder on *Callosobruchus maculatus*

Concentration	Mean	Standard deviation
1 gm	1.28	.48
2gm	1.85	.37
3gm	2.28	.75
4gm	2.85	.69
5gm	3.42	1.27

Table 2b): Linear Multiple Regression summary for second of *Piper nigrum* powder on *Callosobruchus maculatus*

Concentration	Beta value (Co-efficient)	Std Error	t-value
1gm	.19	.23	.82
2gm	.13	.23	.60
3gm	.24	.26	.93
4gm	.27	.34	.80
5gm	.40	.28	.43

Table 2c): Correlation Co-efficient for second trial of *Piper nigrum* powder on *Callosobruchus maculatus*

Concentration	1gram	2 grams	3 grams	4 grams	5 grams	Total
1gm	1.00	.25	.19	.14	.57	.56
2gm	.25	1.00	.16	.54	.49	.59
3gm	.19	.16	1.00	.73	.37	.68
4gm	.14	.54	.73	1.00	.65	.85
5gm	.57	.49	.37	.65	1.00	.89
Total	.56	.59	.68	.85	.89	1.00

Table 3: First trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Trial	Concentrations				
	1gram	2 grams	3 grams	4 grams	5 grams
Day 1	0	1	1	1	2
Day 2	1	1	2	2	2
Day 3	1	2	2	2	3
Day 4	2	2	1	3	3
Day 5	1	2	2	3	4
Day 6	1	2	3	4	5
Day 7	2	2	3	4	6

Table 3a): Analysis of mean and standard deviation first trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Concentration	Mean	Standard deviation
1 gm	1.14	.69
2gm	1.71	.48
3gm	2.00	.81
4gm	2.71	1.11
5gm	3.57	1.51

Table 3b): Linear Multiple Regression summary for First trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Concentration	Beta value (Co-efficient)	Std Error	t-value
1gm	.16	.22	.74
2gm	.14	.23	.61
3gm	.22	.25	.86
4gm	.27	.34	.78
5gm	.31	.32	.94

Table 3c): Correlation Co-efficient for First trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Concentration	1gm	2gm	3gm	4gm	5gm	Total
1gm	1.00	.63	.29	.71	.54	.70
2gm	.63	1.00	.41	.74	.71	.78
3gm	.29	.41	1.00	.73	.81	.80
4gm	.71	.74	.73	1.00	.90	.96
5gm	.54	.71	.81	.90	1.00	.96
Total	.70	.78	.80	.96	.96	1.00

Table 4: Second trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Trial	Concentrations				
	1gram	2 grams	3 grams	4 grams	5 grams
Day 1	1	1	2	2	2
Day 2	1	2	1	2	2
Day 3	1	1	2	3	3
Day 4	1	2	2	3	3
Day 5	2	2	1	3	5
Day 6	2	2	3	4	5
Day 7	1	2	4	5	6

Table 4a): Analysis of mean and standard deviation First trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Concentration	Mean	Standard deviation
1 gm	1.28	.48
2gm	1.71	.48
3gm	2.14	1.06
4gm	3.14	1.06
5gm	3.71	1.60

Table 4b): Linear Multiple Regression summary for First trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Concentration	Beta value (Co-efficient)	Std Error	t-value
1gm	.13	.23	.58
2gm	.12	.20	.61
3gm	.25	.31	.81
4gm	.32	.42	.75
5gm	.34	.38	.89

Table 4c): Correlation Co-efficient for First trial of *Curcuma longa* powder on *Callosobruchus maculatus*

Concentration	1gm	2gm	3gm	4gm	5gm	Total
1gm	1.00	.40	-.09	.22	.54	.44
2gm	.40	1.00	.09	.41	.51	.52
3gm	-.09	.09	1.00	.85	.61	.76
4gm	.22	.41	.85	1.00	.90	.96
5gm	.54	.51	.61	.90	1.00	.96
Total	.44	.52	.76	.96	.96	1.00

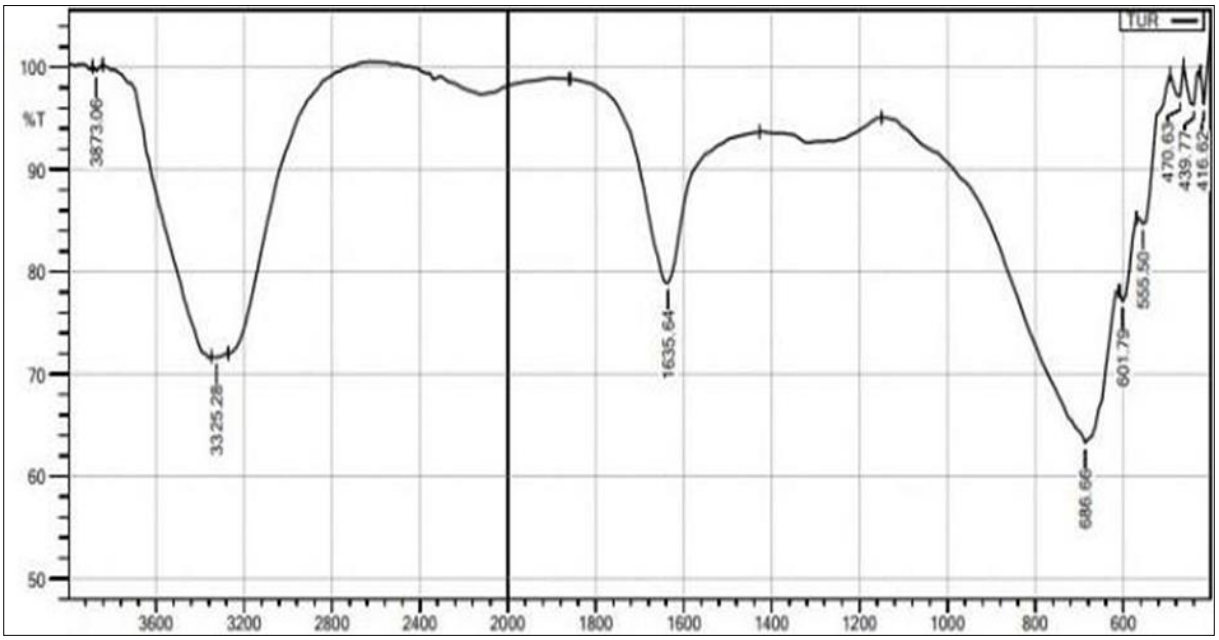


Fig 1: FTIR analysis- sample-turmeric

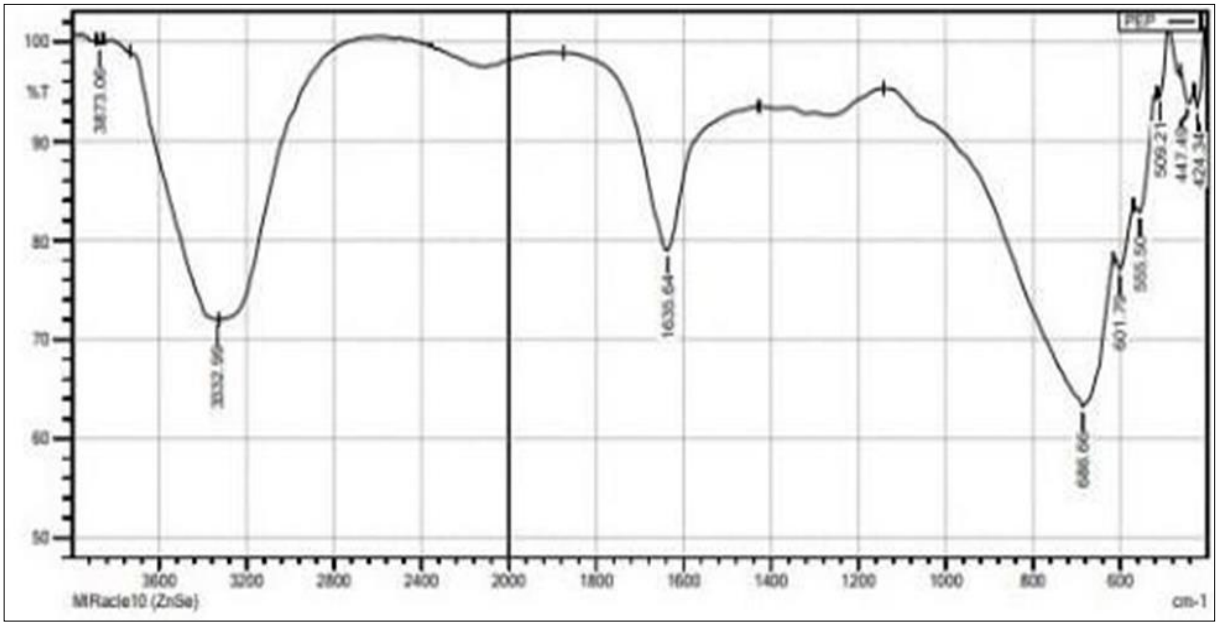


Fig 2: FTIR analysis- sample-pepper

Summary and Conclusion

The study was carried out in the off-test site environment to assess the insecticidal effectiveness of *Piper nigrum* and *Curcuma longa* powders in the storage grain pigeon pea *Cajanus cajan* pest *Callosobruchus maculatus.*

The detailed summary of the study is enlisted below:

- Selected botanical powders of *Piper nigrum* and *Curcuma longa* were taken and used for the treatment of pigeon pea *Cajanus cajan.*
- 250 grams of *C. cajan*, was weighted and they are kept in the room temperature for 48 hours.
- After 48 hours some quantity of infested *Piper nigrum* and *Curcuma longa* powders along with the insects were moved into a closed glass jar.
- Exactly 10 numbers of storage grain pest *Callosobruchus maculatus* was introduced into each container along with the additional powders of *P. nigrum* and *C. longa* in the concentration of 1-5 grams in each container.
- Regular observation was taken at every 24 hours intervals for 7 days on adult mortality of *C. maculatus.* The study was examined the assets of medicinal plant components, for their protection and effectiveness.
- An unreal insecticide is either not easily offered to most farmers or they cannot afford them. The use of natural medicinal plant powders like of *P. nigrum* and *C. longa* which can be simply grown by such farmers and thus should be encouraged.
- An adequate range of mortality rate was noticed in *P. nigrum* and *C. longa* powders of all concentrations.
- When compared to the mortality rate between the two powders, the *C. longa* 5 grams concentration was recorded higher percentage of mortality rate of *C. maculatus.*
- From the present study it shows the possibility of using medicinal plant powders as insecticides to regulate the storage grain pest *Callosobruchus maculatus.*
- The study showed that the powders of *C. longa* when compared to *P. nigrum* were effective on controlling the storage grain pest *Callosobruchus maculatus.*
- The FTIR spectrum were also analyzed for the two samples.

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