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Response of *Caryedon serratus* (Oliver) (Bruchidae: Coleoptera) towards Various Botanicals and Hosts

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Studies on repellence effect of few botanicals on *Caryedon serratus* (Olivier) in stored groundnut were carried out at Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during the year 2013-2014. The results revealed that out of seven treatments *viz.* chilli powder, garlic powder, dhatura powder, custard apple leaf powder, ginger powder, black pepper powder and mint leaf powder @ 5 g/ 50 seeds the treatment of black pepper powder (90.35, 88.95, 87.09, 86.75 and 85.46 per cent repellence at 15 min, 30 min, 1 h, 2 h and 24 h, respectively) was greater and at par with treatment custard apple leaf powder and garlic powder@ 5 g per 50 g seeds of groundnut compared to datura leaf powder and mint leaf powder. Groundnut seed treated with *Tamarindus indica* (Ambali), *Arachis hypogaea* (Groundnut), *Acacia nilotica* (Babul) and *Cassia fistula* (Garmalo) were found to be preferred for oviposition by *Caryedon serratus* as compared to *Prosopis juliflora* (Gandobaval).

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Keywords: Bruchid; Caryedon serratus; hosts; botanicals; repellent.

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.), is an annual prostrate herbaceous legume native to South America [1] which belongs to the plant family Fabaceae. It is the third largest oilseed produced in the world. Groundnut is grown in tropical and sub-tropical regions and in the continental part of temperate countries. In Gujarat, the region of Saurashtra is considered to be the groundnut oil bowl of the country [2]. The average area under groundnut cultivation in Gujarat during 2014-15 stood at 13.96 lakh hectares with a production of 27.25 lakh tonnes and productivity of 1951 kg ha^{-1} [3]. More than 1000 species of insects are capable of infesting stored groundnuts especially on pods [4,5,6]. Among several pests attacking groundnut during storage, the seed beetle *Caryedon serratus* (Oliver) is of major importance causing about 20% damage [7] and gradually emerging as the major storage pest in Gujarat. Estimated losses due to this pest in India are about 19 to 60 per cent when, stored for more than 5 months, increase in level of free fatty acids in the oil thereby lowering the quality [8]. As scanty of work on management of *C. serratus* in stored groundnut with few botanicals has been done, and very little information pertaining to its response towards different food and its extracts is known, the present study on repellent effect of various botanicals on *C. serratus* in stored groundnut was carried out at Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2013-2014.

2. METHODOLOGY

2.1 Repellence of Various Botanicals on *C. serratus*

2.1.1 Rearing techniques of test insect

The initial culture of the test insect was maintained on uninfested groundnut seeds at 30° ± 1°C and 75 ± 5 per cent relative humidity in BOD incubator. A pair of *C. serratus* was obtained from this stock culture maintained at the Department of Entomology, College of Agriculture, Junagadh and mass multiplied. From this, 25 pairs of one or two days old adults were released in wide mouth cylindrical glass jar measuring 20 cm x 15 cm containing (15 g) unshelled seeds of groundnut. The jar was covered with muslin cloth and fastened with rubber band. Subsequently the adult emerged from this culture were used for further mass multiplication. In order to get continuous fresh supply of *C. serratus* adults, need based dated culture was obtained at regular time interval using this rearing technique. All the necessary care was taken while handling the insect.

2.1.2 Separation of Sex

The sexes were separated on the basis of secondary sexual characters in adult bruchid. In males, pygidium or sixth visible tergite projects downward and concealed by elytra. Fifth visible sternite is deeply incurved interiorly, so that the seventh tergite is often seen projecting between it and the pygidium. Whereas, in females, the pygidium was seen projecting beyond the elytra in dorsal view. The fifth sternite is fully extended so that the ventral surface is more or less flat. The seventh tergite is absent [9].

2.1.3 Repellence effect of various botanicals on *C. serratus*

Laboratory experiment was conducted for the evaluation of repellence effect of various botanicals on *C. serratus* at Department of Entomology, College of Agriculture, JAU, Junagadh during the year 2013-14 in CRD design constituted of 4 replications of 7 treatments details of treatments are mentioned below.

The different repellent materials *viz*., chilli powder, garlic powder, dhatura leaf powder, custard apple leaf powder, ginger powder, black pepper powder and mint leaf powder were prepared using dried leaves of each botanical and powdered in electric grinder. This fine powder was used for the experiment. The large Petri dish was put in the central and seven small Petri dishes were attached to the central Petri dish around its circumference and a small hole was made to allow free passage between each small Petri dish and the large central dish.

Fifty groundnut seeds were thoroughly mixed with 5 g of each plant powder. Each experiment test was replicated 4 times. For each replicate 25 pair of *C. serratus* adults were released in to the large dish (35 cm x 11 cm). The direction of movement of beetles was recorded after 15 min, 30 min, 1 h, 2 h and 24 h with occasional changing of direction to prevent any positional biasness.

Table 1. Details of various botanicals used for experiment

Sr. no.	Repellent materials	Scientific name	Doses
1	Chilli powder	*Capsicum annum* (L.)	5 g/50 seeds
2	Garlic powder	*Allium sativum* (L.)	5 g/50 seeds
3	Dhatura leaf powder	*Datura stramonium* (L.)	5 g/50 seeds
4	Custard apple leaf powder	*Annona squamosa* (L.)	5 g/50 seeds
5	Ginger powder	*Zinziber officinalis* (Rosc.)	5 g/50 seeds
6	Black pepper powder	*Piper nigrum* (L.)	5 g/50 seeds
7	Mint leaf powder	*Mentha spicata* (L.)	5 g/50 seeds

2.2 Ovipositional Preference of *C. serratus* on Host Foods

Laboratory experiment was conducted for the evaluation of ovipositional preference of *C. serratus* on host foods in complete randomized design (CRD) with five treatments and four replications at Department of Entomology, College of Agriculture, JAU, Junagadh during 2013-14.

2.2.1 Food-*in situ* test

The pods of the respective foods approx. 100 seeds were filled in the Petri dish (15 cm x 1.5 cm) and each such Petri dish was arranged at the equal distance inside the rearing cage (30 cm x 30 cm x 30 cm). The five foods mentioned in Table 2 were tested for studying the ovipositional preference. Hundred adults (50 female and 50 male) of *C. serratus* confined in a jar and kept in centre of cage were allowed to emerge for free choice of oviposition. Number of eggs laid on each food pods were counted at 24 h of insect exposure. Such test was repeated with fresh 100 adults for four days duration.

2.2.2 Food-extract test

Water extract of each five foods, were prepared by macerating the respective food by taking 100 g of food and 200 ml water, keeping the crude suspension for 24 h and then filtered using muslin cloth and flask. Hundred kernel of groundnut were dressed with each respective food extract and allowed to dry under fan for 15 minutes. The Petri dish containing 100 kernels with respective extract were arranged inside the rearing cage and then 100 insect adults (50 males and 50 females) confined in a jar were allowed to emerge for oviposition. Numbers of eggs laid by the test insects were counted after 24 h of the insect exposure. The test was repeated with the fresh 100 adults for four days means four times.

3. RESULTS AND DISCUSSION

3.1 Repellence of Various Botanicals on *C. serratus*

3.1.1 Repellence effect after 15 minutes

The data presented in Table 3 and depicted in Fig. 1 on repellence effect of various botanicals *C. serratus* adults recorded after 15 minutes revealed that the treatment of black pepper powder 5 g per 50 g seeds of groundnut caused higher repellence effect of 90.35 per cent and it was at par with custard apple leaf powder (86.53) and garlic powder (84.50) per cent repellence effect of *C. serratus* adults, respectively.

3.1.2 Repellence effect after 30 minutes

The percent repellence effect to *C. serratus* after 30 minutes with various botanicals under laboratory study recorded in stored groundnut seeds have been presented in Table 3 and depicted in Fig. 1. Results revealed that black pepper powder 5 g caused maximum repellence effect of 88.95 per cent, which was at par with custard apple leaves powder and garlic powder with 86.21 and 83.67 per cent repellence effect, respectively.

Table 2. Details of various host food used for experiment

Sr. no.	Host foods	Scientific name	Dose
1	Groundnut	*Arachis Hypogea* (L.)	100 seeds/25 pairs
2	Babul	*Acacia Nilotica* (L.)	-do-
3	Garmalo	*Cassia fistula* (L.)	-do-
4	Velvet mesquite/Gando Baval	*Prosopis juliflora* (Sw.)	-do-
5	Amli	*Tamarindus indica* (L.)	-do-

Table 3. Repellence effect of various botanicals on *C. serratus* over intervals

T.N.	Botanicals	Repellence (%) after period of time				
		15 Min	30 Min	1 h	2 h	24 h
T_1	Chilli powder (*Capsicum annum* (L.) @ 5 g/50 g of groundnut seeds	62.96* (79.31)	62.73* (78.98)	62.01* (77.84)	60.95* (76.25)	58.65* (72.90)
T_2	Garlic powder (*Allium sativum* (L.) @ 5 g/50 g of groundnut seeds	66.83 (84.51)	66.28 (83.67)	65.13 (82.25)	64.35 (81.25)	62.33 (78.33)
T_3	Datura leaf powder(*Datura stramonium* (L.) @ 5 g/50 g of groundnut seeds	52.41 (62.78)	52.34 (62.64)	52.29 (62.54)	51.96 (62.00)	49.85 (58.43)
T_4	Custard apple leaf powder (*Annona squamosa* (L.) @ 5 g/50 g of groundnut seeds	68.79 (86.53)	68.26 (86.21)	66.48 (84.00)	65.67 (83.00)	63.42 (79.75)
T_5	Ginger powder (*Zingiber officinalis* (Rosc.) @ 5 g/50 g of groundnut seeds	64.55 (81.30)	61.85 (77.36)	61.20 (76.70)	61.06 (76.50)	59.54 (74.29)
T_6	Black pepper powder (*Piper nigrum* (L.) @ 5 g/50 g of groundnut seeds	72.21 (90.35)	70.62 (88.95)	69.05 (87.09)	68.78 (86.75)	67.81 (85.46)
T_7	Mint leaf powder (*Mentha spicata* (L.) @ 5 g/50 g of groundnut seeds	60.12 (75.15)	57.79 (71.57)	57.00 (70.28)	56.50 (69.50)	54.45 (66.17)
S.Em.±		1.87	2.00	1.91	1.79	1.91
C.D. at 5%		5.49	5.87	5.62	5.26	5.60
C.V. %		4.67	5.09	4.95	4.67	5.18

**Arcsine percentage transformation*
Figures in parenthesis are retransformed values

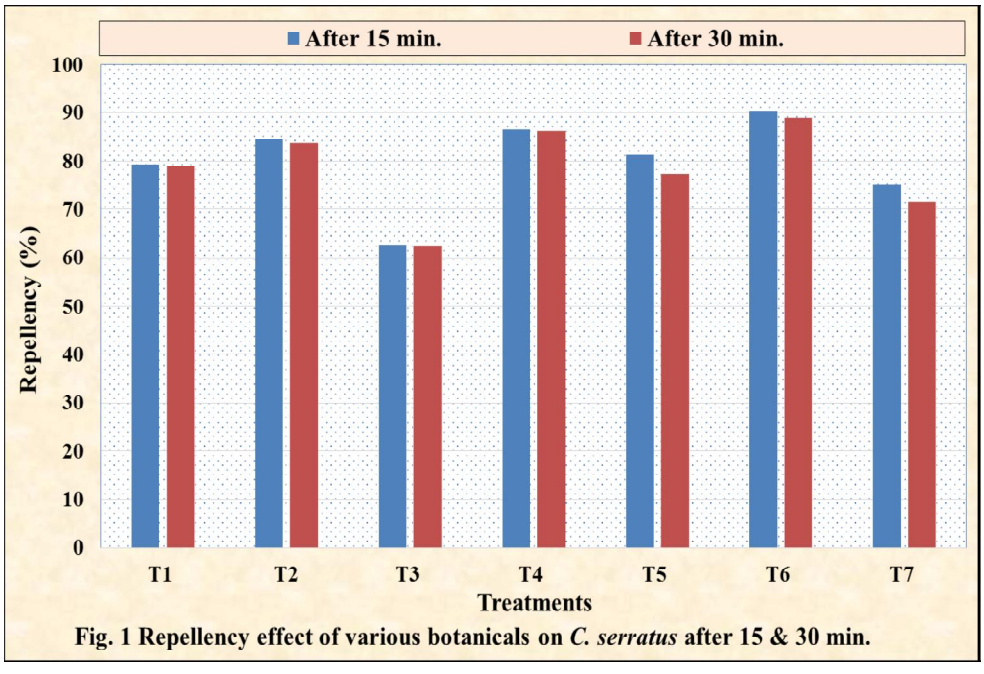

Fig. 1 Repellency effect of various botanicals on *C. serratus* after 15 & 30 min.

The minimum repellence effect of *C. serratus* adults recorded 62.64 per cent was caused by datura leaf powder followed by mint leaf powder in which, 71.57 per cent repellence effect of *C. serratus*.

3.1.3 Repellence effect after 1 h

The data shown in Table 3 and depicted in Fig. 2 revealed that the black pepper powder was found better than rest of the treatments as it gave 87.09

per cent repellence effect of *C. serratus* adults, and was at par with custard apple leaves powder (84.08) and garlic (82.03) per cent repellence effect of *C. serratus* adults.

The lowest repellence effect of *C. serratus* adults recorded in datura leaf powder with 62.54 per cent repellence effect of *C. serratus* (Oliver), which was at par with mint leaf powder with 70.28 per cent repellence effect of *Caryedon serratus* adults.

3.1.4 Repellence effect after 2 h

The data on repellence effect *C. serratus* adults (Table 3 and depicted in Fig. 2) recorded after 2 h revealed that the treatment of 5 g black pepper powder caused maximum repellence effect of 86.75 per cent and it was at par with the repellence of (83.00% and 81.25%) caused by custard apple leaf powder and garlic leaf powder, respectively.

The minimum repellence effect of 62.00 per cent was caused by datura leaf powder which was at par with mint leaf powder with 69.50 per cent repellence effect of *C. serratus* adults.

3.1.5 Repellence effect after 24 h

Data presented in Table 3 and Fig. 2 found that the treatment black pepper leaf powder proved to be significantly superior over rest of the treatments as it gave 85.46 per cent repellence effect of *C. serratus* adults, which was at par with the application of 5 g of custard apple leaves powder and garlic powder were in the next effective group of treatments caused 79.75 and 78.33 per cent repellence effect of *C. serratus* adults, respectively.

The minimum repellence effect of *C. serratus* recorded in datura leaf powder 58.43 per cent repellence effect of *C. serratus* adults. Repellence effect of various botanicals on *C. serratus* over period of time presented in Table 3 reveals that black pepper powder treatment offers consistent and superior repellence of 90.35, 88.95, 87.09, 86.75 and 85.46 per cent at 15 min, 30 min, 1 h, 2 h and 24 h, respectively towards *C. serratus* and is at par with garlic powder and custard apple leaf powder treatment.

A study on the various plant powders for the protection of the pea seeds against *Callosobruchus chinensis* (L.) reported that the black pepper was the most effective as it resulted in minimum seed damage and weight loss and maximum germination, while ginger was the least effective [10]. This result was found in favour of the present investigation.

Furthermore, the effectiveness of various botanicals against *C. serratus* (Oliver) has been reported by various scientists [11,12,13,14,15, 16]. Thus, the results obtained in the present investigation are in close agreement with the findings of the earlier workers.

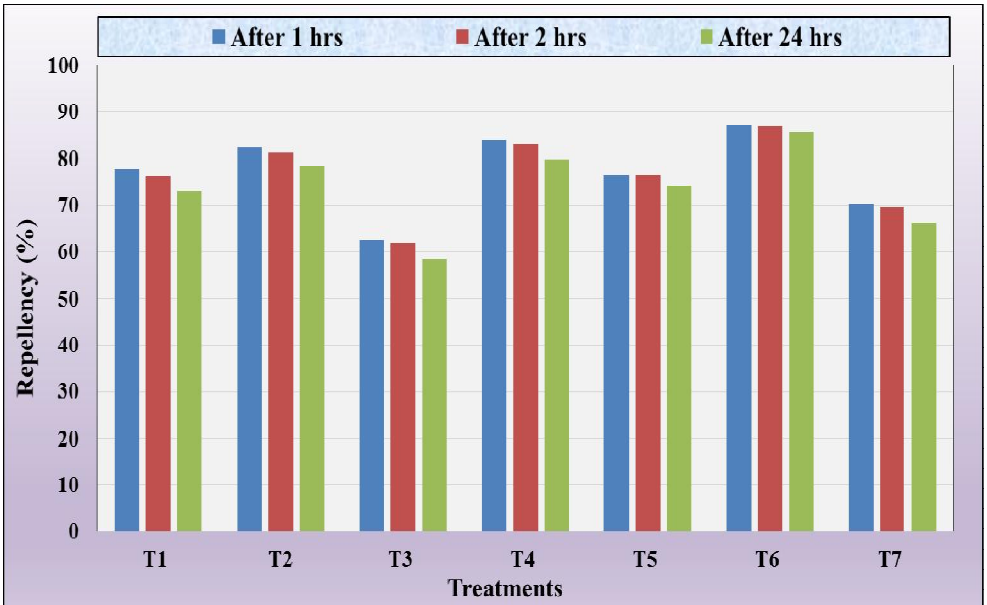

Fig. 2 Repellency effect of various botanicals on *C. serratus* after 1, 2 & 24 hrs.

3.2 Ovipositional Preference of *C. serratus* on Different Hosts Food-*in situ* Test

3.2.1 Total number of eggs laid by female

The results presented in Table 4 and Fig. 3 revealed that the number of egg laid by female varied significantly among the different hosts. The mean number of eggs laid on the hosts ranged from 29.60 to 201.00 eggs per 100 seeds. The maximum number of eggs was observed in *T. indica* while, minimum on *P. juliflora*. The most preferred host *T. indica* was significantly differing from remaining hosts. Ambali recorded the highest oviposition of 201.00 eggs laid by female which was statistically at par with groundnut (167.80), babul (85.40) and garmalo (66.20). Significantly less oviposition was noticed in case of gando baval (29.60 eggs).

Earlier, a study indicated that the highest number of eggs per 5 pairs (98) was recorded on tamarind (ambali) pods, followed by *Acacia nilotica* (87.6), while eggs were not recorded on *Cassia tora* seeds [17]. The percentage of oviposition by *Caryedon serratus* was found to be the lowest in *Acacia nilotica* [18].

3.2.2 Eggs with seed

Perusal of data presented in Table 4 depicted in Fig. 3 shows that the highest per cent eggs with seed was found in *Tamarindus indica* (Ambali) (95.13%), though the other host foods were also found to be preferred for oviposition by *C. serratus.*

Table 4. Ovipositional preference of *C. serratus* on different host

T.N.	Host	Total no. of eggs laid by female	Eggs with seed (%)
T_1	Groundnut (*Acacia hypogea*)	12.95* (167.80)	67.62** (85.31)
T_2	Ambali (*Tamarindus indica*)	14.18 (201.00)	77.48 (95.13)
T_3	Garmalo (*Cassia fistula*)	8.14 (66.20)	58.43 (72.48)
T_4	Babul (*Acacia nilotica*)	9.23 (85.40)	67.04 (84.58)
T_5	Gando Baval (*Prosopis juliflora*)	5.44 (29.60)	30.00 (25.00)
S.Em.±		2.27	1.61
C.D. at 5%		6.70	4.74
C.V. %		4.62	4.95

**Square root transformation*
***Arcsine percentage transformation*
Figures in parenthesis are retransformed values

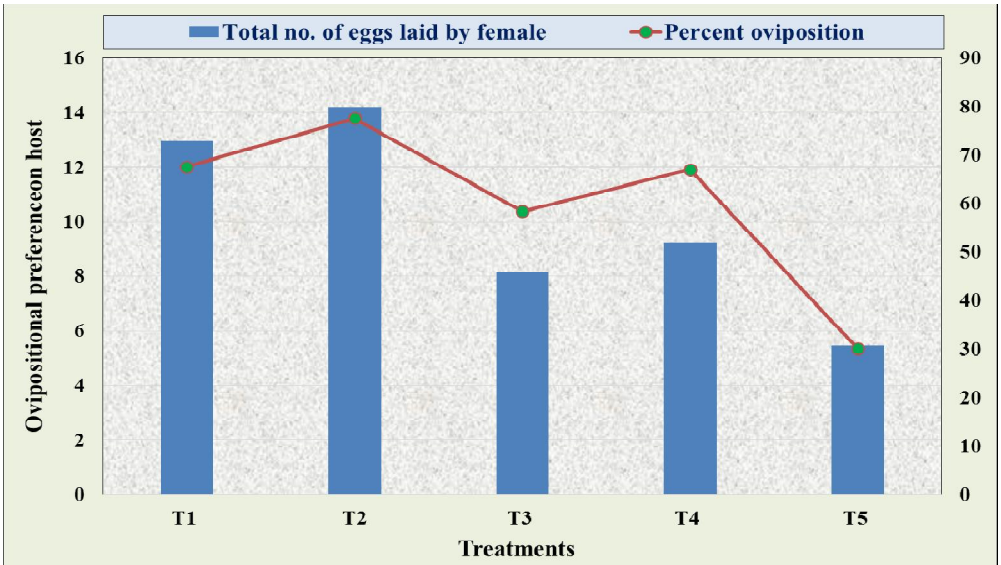

Fig. 3 Ovipositional preference of *C. serratus* on different host

Significantly the lowest percentage of eggs with seed was recorded in *Prosopis juliflora* (gando baval) (57.11%). Remaining various host foods in intermediate group in which numbers of eggs with seeds 72.48 to 85.31 eggs with seeds. Thus, it can be concluded that *T. indica* is most preferred host while *P. juliflora* a forest tree is least preferred tree host for oviposition by *C. serratus.* These finding are in close agreement with earlier workers [19]. Female of *C. serratus* laid 80 per cent of their eggs on *T. indica* [20].

3.3 Ovipositional Preference of *C. serratus* on Different Food Extracts

3.3.1 Total number of eggs laid by female

The data on oviposition presented in Table 5 revealed that there was significant effect on different host food extracts for egg laying by female *C. serratus.* The mean number of eggs laid on the hosts ranged from 14.60 to 147.80 eggs per 100 seeds. Significantly maximum number of eggs was found in groundnut (124.60), which was at par with the ambali (124.60), babul (68.80) and garmalo (45.60). Significantly less oviposition was noticed in case of gando baval (14.60 eggs).

3.3.2 Eggs with seed

Data summarized in Table 5 and depicted in Fig. 4 showed that the maximum number of eggs with seed was found in *Arachis hypogaea* (Groundnut) (86.92%), which was closely followed by ambali food extract (79.29%). Though the other host food extracts were also found to be preferred for oviposition by *C. serratus.* The lowest percentage of eggs with seed was recorded in *Prosopis juliflora* (gando baval) (16.60%). Garmalo and babul having 37.00 and 59.80, eggs with seeds respectively.

According to the observation, the texture of the seed coat appears to play a major role in the selection of oviposition sites by the beetles. The female preferred seeds with a smooth coat to a rough coat. Odour of seeds may also provide a stimulus for oviposition which could come from the chemical composition of the seed [21]. A combination of several factors such as seed texture, seed size and shape, weight and volume of the seed and the seed colour has been suggested to be responsible for the ovipositional preference of bruchid to different crops [22].

A study reported that cowpea lines with smooth surface were more preferred for oviposition by *C. chinensis* than cowpea line having rough surface [23]. Yet another investigation reported that seed having large size and dark seed coat were more preferred for oviposition than seeds having small and convex-shinny surface [24,25]. Other findings also revealed that seed colour and morphological characters affect the oviposition [26]. It is difficult to assign cause for variation but it may be attributed to texture, other physical characters or any aroma emanating from the host grains.

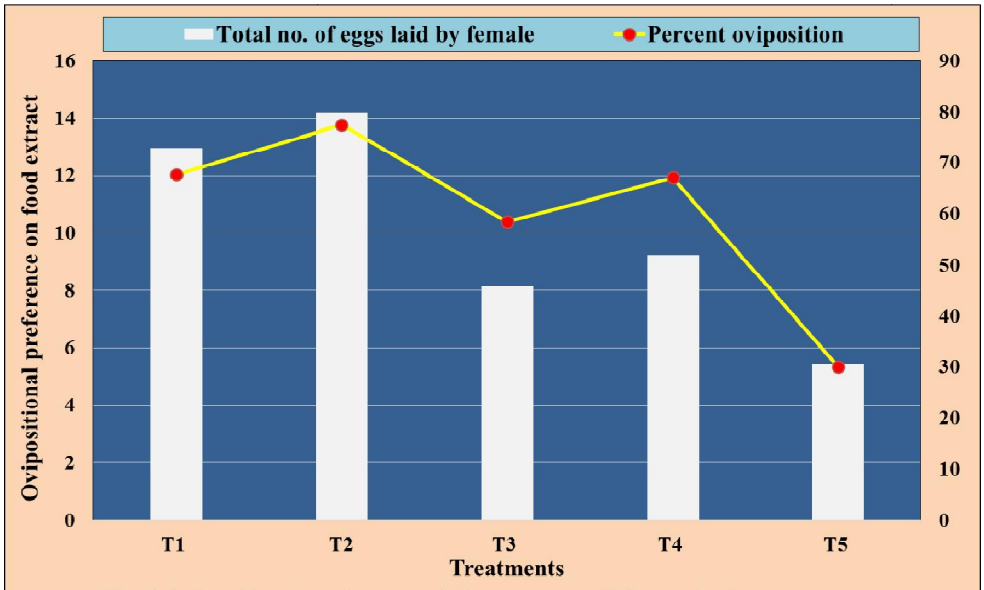

Fig. 4 Ovipositional preference of *C. serratus* on different food extract

Table 5. Ovipositional preference of *C. serratus* on different food extract test

T.N.	Host food extract	Total no. of eggs laid by female	Eggs with seed (%)
T_1	Groundnut (*Acacia hypogea*)	12.16* (147.80)	68.95** (86.92)
T_2	Ambali (*Tamarindus indica*)	11.16 (124.60)	62.97 (79.29)
T_3	Garmalo (*Cassia fistula*)	6.75 (45.60)	37.46 (37.00)
T_4	Babul (*Acacia nilotica*)	8.29 (68.80)	50.66 (59.80)
T_5	Gando Baval (*Prosopis juliflora*)	3.82 (14.60)	24.04 (16.60)
S.Em.±		1.84	1.22
C.D. at 5 %		5.43	3.60
C.V. %		5.13	4.88

**Square root transformation*
***Arcsine percentage transformation*
Figures in parenthesis are retransformed values

4. CONCLUSION

The treatment of black pepper powder @ 5 g per 50 g seeds of groundnut caused maximum repellence effect of 90.35, 88.95, 87.09, 86.75 and 85.46 per cent at 15 min, 30 min, 1 h, 2 h and 24 h, respectively which was at par with custard apple leaf powder and garlic powder. The minimum repellence effect of 62.78, 62.64, 62.54, 62.00 and 58.43 per cent at 15 min, 30 min, 1 h, 2 h and 24 h, respectively was caused by datura leaf powder followed by mint leaf powder.

Tamarindus indica (Ambali) recorded the highest oviposition of 201.00 eggs laid by female which was statistically at par with *Arachis hypogaea* (Groundnut) (167.80), *Acacia nilotica* (Babul) (85.40) and *Cassia fistula* (Garmalo) (66.20). Significantly less oviposition (29.60 eggs) was noticed in case of *Prosopis juliflora* (Gandobaval). In case of ovipositional preference of *C. serratus* on different food extracts, significantly maximum number of eggs (124.60) was found in *Arachis hypogaea* (Groundnut) extract, which was at par with the *Tamarindus indica* (Ambali) (124.60), *Acacia nilotica* (Babul) (68.80) and *Cassia fistula* (Garmalo) (45.60) extracts. Significantly less oviposition (14.60 eggs) was noticed with *Prosopis juliflora* (Gandobaval).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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