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# Studies on efficacy of certain vegetable oils against pulse beetle, *Callosobruchus chinensis* Linn. on chickpea, *Cicer arietinum* (L.)

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**Abstract**
The present research was aimed to study the efficacy of certain vegetable oils against pulse beetle, *Callosobruchus chinensis* linn. on chickpea, *Cicer arietinum* (L.) were conducted under laboratory conditions of 28 ± 1 $^{0}$C temperature and 70 ± 5 per cent relative humidity in a B.O.D. incubator at Department of Agricultural Zoology & Entomology, College of Agriculture, Bikaner. Among the grain protectants four vegetable oils *viz*., *neem*, groundnut, coconut and sesamum @ 4, 8 and 12 ml/kg grains were evaluated. *Neem* oil at 12 ml/kg grains was found to be most effective in inhibiting the oviposition (67.60%), reduction in eggs hatching (69.64%) and reduction in adult emergence (94.27%). Groundnut oil also gave good results giving in same parameters with 60.10, 53.00 and 78.57 per cent, respectively. Coconut and sesamum oils were least effective. The tested vegetable oils did not affect the germination of treated chickpea grains.

**Keywords:** *Callosobruchus chinensis,* Efficacy, Vegetable oils, Chickpea grains

## 1. Introduction
Role of pulses in Indian Agriculture need hardly any emphasis, grain legumes, particularly pulses play an important role to cater the quantitative and qualitative protein requirement of a large parts of humanity. Chickpea, *Cicer arietinum* (L.) Is one of the major pulse crops grown during the *rabi* season. Chickpea, besides a rich source of highly digestible dietary protein (17-20%), is also a rich source of calcium, iron, niacin, vitamin ‘C’ and vitamin ‘B’. Its leaves consist of mallic acid which is very useful for stomach ailments and blood purification. Its feed and straw are highly rich in nutrients and are mostly used as productive ration for animals. Amongst pulses, chickpea is the most important crop and has significant contribution in the pulse economy of the country. In 2014-15, the total area under chickpea cultivation is about 8.2 million hectares and the production is nearby 7.2 million tonnes with the productivity 875 kg/ha in India (Anonymous, 2015-16) [2, 3]. Among gram grown areas in India, Rajasthan is one of the major state which occupies 1256323 hectares with the production of 911085 tonnes with the productivity is 875 kg/ha in 2014-15 (Anonymous, 2014-15) [3]. The annual loss in pulses during post-harvest handling in India is nearly 8.5 per cent of which 5 per cent loss is due to insects.

In case of serious infestation cent-percent damage can be caused by several species of pulse beetle belonging to the genus *Callosobruchus* to the stored pulses including chickpea. Out of these, pulse beetle, *C. chinensis* (Bruchidae: Coleoptera) is one of the most important pulse damaging species. Dias and Yadav (1988 a) [6] reported that damage is caused by the grubs which feed up on the entire content of the grain leaving only the shell behind. The attack of these beetles often starts in the field from where the infestation is carried over to the storage.

Pulse beetle, *C. chinensis* is of Asian origin, where it is still the dominant species, but now widely distributed throughout the warmer parts of the world (Hill, 1990) [9]. The control measures of bruchis infestation including extensive use of fumigants and other toxic chemicals have been suggested by several authors in past. (Munro, 1961; Pingale, 1964 and Lindgran *et al*., 1968) [13, 16, 12]. Alarmingly, these toxic chemicals have evidently posed serious problems like chronic and acute toxicity, residual toxicity, hazards, development of insect resistance, insecticide residue and environmental pollution. Besides this, an enactment of Insecticide Act, 1968 does not allow mixing of any insecticide with the food grains and, therefore, emphasis was being stressed for safer protective techniques.

In India, efforts have been made to minimize storage loss in pulses due to insects by using various locally available materials such as sand, ash, clay, talc etc. and other mineral powders. The problem of grain adulteration is the reason that most of these materials are not universally accepted (Singh *et al*; 1978, Doharey *et al*., 1985) [19, 7]. Among the other protection techniques the use of plant part powders & edible oils as grain protectant is an age old practice and gaining rapid popularity providing safer conditions to human health, easy to handle and with no deleterious effect on stored products. Therefore, the studies have been proposed to explore the possibility of using some plant products as grain protectants oils against pulse beetle, *C. chinensis.*

## 2. Materials and Methods

### 2.1 Maintenance of the insect culture

The present studies on efficacy of certain vegetable oils against pulse beetle, *C. chinensis* Linn. On chickpea were conducted under laboratory conditions at Department of Agricultural Zoology & Entomology, College of Agriculture, Bikaner. A culture of the pulse beetle, *C. chinensis* was developed on conditioned chickpea grains by releasing a single gravid mated female. Subsequently, for maintaining further insect culture 50 pairs of one day old adult insects of 1st generation were released in the glass jars containing 200 g grains for oviposition for a period of three days. The jars were covered with muslin cloth which was kept in position with rubber bands. After 3 days the insects were removed from the jars. In order to obtain a continuous supply of the *C. chinensis* adults for experimentation dated culture was maintained at a regular time interval from the nucleus culture following above described procedure. The jars containing egged grains were subjected to 28 ± 1 $^{0}$C temperature and 70 ± 5 per cent relative humidity in a B.O.D. incubator. Utmost care was taken not to touch the grains and test insects by hand. During experimentation forceps and camel hairs brushes were invariably used for transferring the grains and insects, respectively.

### 2.2 Preparation of the concentration of oils

Different concentrations of four test oils were prepared in acetone for which a stock solution of each of the oil was prepared by taking 12 ml of the oil and mixing thoroughly with 100 ml acetone. Now for the concentration of 12.0 ml oil/kg grain treatment 10 ml of this stock solution of each oil was used for treating 100 g chickpea grains. For 8.0 ml oil/kg grain treatment 6.67 ml of the stock solutions were made up to 10 ml by adding acetone and were used for treating 100 g grains. Similarly 3.33 ml of the stock solutions were made up to 10 ml by adding acetone and were used for 4.0 ml oil/kg grain treatment by mixing with 100 g grains. For control, 100 g grains were treated with 10 ml acetone only. All the treated grains were kept open for 2-3 hours to let acetone evaporate so that only a film of oil remains on the grains.

**Table1:** Details of different vegetable oils

| S. No. | Common Name | Scientific Name | Source | Doses |
|---|---|---|---|---|
| 1. | *Neem* | *Azadirachta indica* A. Juss | Local market | 4, 8 and 12 ml/kg grains |
| 2. | Groundnut | *Arachis hypogaea* L. | Local market | 4, 8 and 12 ml/kg grains |
| 3. | Coconut | *Cocos nucifera* L. | Local market | 4, 8 and 12 ml/kg grains |
| 4. | Sesamum | *Sesamum indicum* L. | Local market | 4, 8 and 12 ml/kg grains |

### 2.3 Effect of Grain Protectant Oils

In each plastic container having 200 treated/untreated chickpea grains five freshly emerged unmated pairs of pulse beetle, *C. chinensis* adults were released. The containers were covered with muslin cloth held in position with the help of rubber bands. These containers were kept in B.O.D. at a temperature of 28 ± 1 $^{0}$C and 70 ± 5 per cent relative humidity. The adults released were removed after 10 days.

To evaluate the effect of the vegetable oils and three parameters were undertaken: (i) Oviposition inhibition (ii) Effect on hatching and (iii) Adult emergence. The observations were taken for egg count in each treatment 10 days after the release of test insect. For the oviposition, total egg count was considered. For fetching effect the shrunken egg shells were counted as hatched and white dry eggs were taken as dead & unviable. To determine the effect of tested materials on the adult emergence, total number of adults emerged in each treatment were counted 35 days after the oviposition.

### 2.4 Effect of Oils on Germination of Chickpea Grains

To examine the effect of test materials on viability of the treated grains, the germination of untreated and treated grains was observed. For this, 100 grains from each treatment in three replications were taken at random from treated and untreated unused grain lots and were placed in petri dishes (15 cm diameter) lined with moistened blotting paper. These petri dishes were kept at room temperature (28-32 $^{0}$C) for six days which allowed the grains sufficient time to germinate. The number of sprouted and unsprouted grains was counted and germination percentage was determined.

### 2.5 Calculations

The oviposition inhibition percentage was calculated by using following formula:

$$O.I. = 100\left(1-\frac{ET}{EC}\right)$$

Where,

OI = Oviposition inhibition

ET = Mean number of eggs in treatment/female

EC = Mean number of eggs in control/female

Similarly, per cent hatching inhibition was calculated.

Observations on adult emergence were converted to per cent adult emergence in each treatment using the number of eggs laid and the number of adults emerged out of them. The per cent adult emergence inhibition was also computed using similar formula as above.

The percentage of grain weight loss caused by *C. chinensis* was calculated with the help of following formula:

$$\text{Per cent weight loss} = \frac{(U.Nd)-(D.Nu)}{U(Nd+Nu)} \times 100$$

Where,

U = Weight of undamaged grains

Nu = Number of undamaged grains

D = Weight of damaged grains

Nd = Number of damaged grains

The germination percentage of grains was calculated by using the formula given below:

$$G.P. = \left(\frac{TG - UG}{TG}\right) \times 100$$

Where,
G.P. = Germination percentage
T.G. = Number of total grains
U.G. = Number of ingeminated grains
The data obtained with regards to oviposition inhibition, adult emergence, weight loss and germination were subjected to analysis of variance after their angular transformation. S. Em. values & critical difference at 5 per cent level of significance were also worked out.

## 3. Result and Discussion
Laboratory experiments were conducted using the most susceptible variety i.e. Bikaner Local to test the efficacy of vegetable oils on the basis of following criteria:

### 3.1 Effect on oviposition
The data presented in Table2 revealed that all the vegetable oils were significantly effective over control in reducing the oviposition. Data revealed that higher doses of all the treatments gave more oviposition inhibition as compared to lower doses. *Neem* oil, groundnut oil, coconut oil and sesamum oil at the highest dose of 12 ml/kg grains gave an oviposition inhibition of 67.60, 60.10, 39.30 and 40.95 per cent respectively as compared to control. In the next dose of 8 ml/kg an inhibition of oviposition recorded was 52.78, 47.36, 35.98 and 33.65 per cent in case of *Neem* oil, groundnut, coconut and sesamum oils, respectively. Similarly, in the lowest dose of 4 ml/kg in above treatments the oviposition inhibition observed was 37.79, 34.11 35.14 and 28.45 per cent, respectively. The mean per cent oviposition inhibition was highest (52.80) in *Neem* oil followed by groundnut oil (47.18), coconut oil (36.78) and sesamum oil (34.26) as compared to control where it was only no inhibition. Similarly, among the doses the mean per cent oviposition inhibition was highest (52.06) in the dose of 12 ml/kg followed by 42.35 (8 ml/kg dose) and 33.83 (4 ml/kg dose) as compared to untreated grains. The egg laying capacity gradually decreased with the increase in doses of each treatment.
Singh *et al*. (1978) [19], Doharey *et al*. (1985) [7], Nanda (1990) [14], Singal and Singh (1990) [18], Khaire *et al*. (1992) [10], Chaudhary (1992) [5], Bhargava and Meena (2000) also found the vegetable oils effective in inhibiting the oviposition capacity of pulse beetle at doses ranging from 0.1 to 1.0 ml/100 g grains.

**Table 2:** Effect of vegetable oils on anti-ovipositional activity, egg hatching, and adult emergence of *C. chinensis* with on germination of chickpea grains

| Vegetable oils | Percent oviposition inhibition* | | | | Percent egg hatching inhibition* | | | | Percent adult emergence inhibition* | | | | Percent germination* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dose (ml/kg grains) | | | | Dose (ml/kg grains) | | | | Dose (ml/kg grains) | | | | Dose (ml/kg grains) | | | |
| | 4 | 8 | 12 | Mean | 4 | 8 | 12 | Mean | 4 | 8 | 12 | Mean | 4 | 8 | 12 | Mean |
| *Neem* | 37.79 | 52.78 | 67.60 | 52.80 | 49.34 | 57.31 | 69.64 | 58.98 | 74.56 | 85.56 | 94.27 | 85.78 | 91.40 | 91.35 | 90.71 | 91.16 |
| | (37.93)** | (46.60) | (55.30) | (47.61) | (44.62) | (49.21) | (56.58) | (50.14) | (59.71) | (67.68) | (76.14) | (67.84) | (72.95) | (72.90) | (72.25) | (72.70) |
| Groundnut | 34.11 | 47.36 | 60.10 | 47.18 | 37.67 | 42.32 | 53.00 | 44.29 | 63.34 | 70.22 | 78.57 | 71.01 | 90.39 | 90.71 | 90.74 | 90.61 |
| | (35.54) | (43.49) | (50.83) | (43.35) | (37.86) | (40.59) | (46.72) | (41.72) | (52.73) | (56.93) | (62.42) | (57.36) | (71.94) | (72.25) | (72.28) | (72.16) |
| Coconut | 35.14 | 35.98 | 39.30 | 36.78 | 35.31 | 44.31 | 54.34 | 44.59 | 55.54 | 66.27 | 75.91 | 66.17 | 90.69 | 91.08 | 92.79 | 91.54 |
| | (36.35) | (36.85) | (38.82) | (37.34) | (36.46) | (41.74) | (47.48) | (41.89) | (48.18) | (54.49) | (60.62) | (54.43) | (72.23) | (72.61) | (74.43) | (73.09) |
| Sesamum | 28.45 | 33.65 | 40.95 | 34.06 | 34.32 | 45.64 | 51.68 | 43.80 | 57.25 | 66.60 | 74.27 | 66.21 | 88.34 | 90.68 | 93.80 | 90.90 |
| | (32.24) | (35.46) | (39.79) | (35.83) | (35.87) | (42.51) | (45.96) | (41.44) | (49.17) | (54.70) | (59.52) | (54.46) | (70.04) | (72.22) | (75.07) | (72.44) |
| Mean | 33.83 | 42.35 | 52.06 | | 39.10 | 47.40 | 57.28 | | 62.85 | 72.61 | 81.70 | 91 | 90.24 | 90.95 | 91.94 | |
| | (35.57) | (40.60) | (46.18) | | 38.70 | (43.51) | (49.19) | | (52.45) | (58.45) | (64.67) | | (71.79) | (72.49) | (73.50) | |
| | S.Em± | | CD at 5% | C.V. (%) | S.Em± | | CD at 5% | C.V. (%) | S.Em± | | CD at 5% | C.V.(%) | S.Em± | CD at 5% | | C.V.(%) |
| Treatments (T) | 0.31 | | 0.64 | 1.62 | 0.52 | | 1.07 | 2.51 | 0.38 | | 0.79 | 1.39 | 0.79 | | NS | 2.34 |
| Doses (D) | 0.27 | | 0.56 | | 0.45 | | 1.92 | | 0.33 | | 0.69 | | 0.69 | | NS | |
| T×D | 0.54 | | 1.12 | | 0.90 | | 1.85 | | 0.66 | | 1.37 | | 1.38 | | NS | |

*Average of 3 replications
** ( ) = Percentage transformed to angles; outside values are back transformation to percentages.

### 3.2 Effect on egg hatching
All the vegetable oils were effective significantly over control in reducing the egg hatching. The higher doses of all the treatments gave more egg hatch inhibition as compared to the lower doses. *Neem*, groundnut, coconut and sesamum oils at the highest dose of 12 ml/kg grains gave an egg hatch inhibition of 69.64, 53.00, 54.34 and 51.68 per cent respectively as compared to control. The lower dose of 8 ml/kg gave 57.31, 42.32, 44.31 and 45.64 per cent egg hatch inhibition in the treatments of *Neem*, groundnut, coconut and sesamum oils, respectively. Likewise, in the lowest dose of 4 ml/kg of *Neem*, groundnut, coconut and sesamum oils the egg hatching inhibition was recorded as 49.34, 37.67, 35.31 and 34.32 per cent, respectively.
The mean data of Table showed that among the treatments, the mean egg hatch inhibition was highest in *Neem* oil reaching to 58.98 per cent followed by groundnut oil (44.29 %), coconut oil (44.59%), sesamum oil (43.80%). Also, among the doses the mean egg hatch inhibition was highest (57.28%) in the dose of 12 ml/kg followed by 47.40% in 8 ml/kg and 39.10% in 4 ml/kg.
It is postulated by Singh *et al.* (1978) [19] that egg hatch is retarded due to entry of the oil through the micropyle thus stopping the protoplasmic movement and resulting in its coagulation. Sharma & Srivastava (1984) [17] also reported similar observations.

### 3.3 Effect on adult emergence
Data given in the Table2 further revealed that higher doses of all the treatments brought about higher adult emergence inhibition as compared to lower doses. *Neem* oil, groundnut oil, coconut oil and sesamum oil at the highest dose of 12 ml/kg grains resulted in adult emergence inhibition as 94.27, 78.57, 75.91 and 74.27 per cent respectively as compared to

control. In 8 ml/kg treatment inhibition was recorded as 85.57, 70.22, 66.27 and 66.60 per cent in case of *Neem* oil, groundnut oil, coconut oil and sesamum oil, respectively. Likewise, in the lowest dose of 4 ml/kg of *Neem*, groundnut, coconut and sesamum oils the per cent adult emergence inhibition obtained was 74.56, 63.34, 55.54 and 57.25, respectively.

The mean data of Table showed that among the treatments, the mean adult emergence inhibition was highest in *Neem* oil reaching to 85.78 per cent followed by groundnut oil (71.01 %), coconut oil (66.17%) & sesamum oil (66.21%) as compared to control. Also, among the doses the mean adult emergence inhibition was highest (81.70%) in the dose of 12 ml/kg followed by 72.61% in 8 ml/kg and 62.85% in 4 ml/kg as compared to untreated grains where it was considered as nil. The results of present investigation are in accordance with the work of Sujatha and Punnaiah (1985) [20], Kulariya (1989) [11], Chaudhary (1992) [5], Ahmed *et al.* (1993) [1] and Danglish *et al*. (1993) who reprted significant reduction in adult emergence of pulse beetle by *Neem* oil at doses ranging from 0.1 to 1.0 ml/100 g grains. Among all the oils tested *Neem* oil at 12 ml/kg proved to be most effective (94.27 per cent), as also observed by Khaire *et al.* (1992) [10] who observed complete prevention of adult emergence with one per cent *Neem* oil.

Groundnut oil was also found to be effective gaining 78.57% reduction in adult emergence at 12 ml/kg grains dose. Whereas, Singh *et al*. (1978) [19] obtained cent per cent prevention of adult emergence with the treatment of 5 ml/kg groundnut oil. Chaudhary (1992) [5] also obtained a significant reduction in adult emergence in *C. chinensis* using *Neem*, groundnut, coconut & sesamum oil @ 0.25 to 1.0 ml/100 g grains. In the present work, the reduction in adult emergence of pulse beetle by coconut oil was recorded in the range of 55.54 to 75.91% at doses ranging from 4 to 12 ml/kg grains.

### 3.4 Effect of Vegetable Oils on the Germination of Chickpea Grains

All the treatments including control the germination of chickpea grains was above 90%. All the treatments showed no significant effect on the germination of chickpea when compared with each other as well as with control. In the germination process in treatments as well as in control no abnormality was observed. Such findings conclude that these grain protectants are quite safe for the grains stored for seed purposes. Present findings are in agreement with those of Pandey *et al.* (1976) [15], Gupta *et al.* (1991) [8], Khaire *et al.* (1992) [10] who used different vegetable oils.

## 4. Conclusion

Efficacy of vegetable oils against *C. chinensis* at the doses of 0.4, 0.8 and 1.2 ml/100 g chickpea grains were undertaken using the parameters of oviposition, egg hatching, adult emergence and germination of treated grains. The *neem* oil was highly effective as compared to other treatments. The maximum oviposition inhibition (67.60%) was observed in *neem* oil at the dose of 1.2 ml/100 g grains, followed by groundnut oil (60.10%), coconut oil (39.30%) and sesamum oil (40.95%). The maximum egg hatching inhibition (69.64%) and reduction in adult emergence (94.27%) was observed in *neem* oil at the same dose level. The lowest dose of 0.4 ml/100 g grains also could bring down. No adverse effect of the tested vegetable oils was observed on the germination of chickpea grains.

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