***Original Research Article***

**Ovicidal toxicity of plant essential oils against pulse beetle, *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae) in laboratory conditions**

**Abstract**

A Laboratory experiment was conducted on ovicidal activity caused by nine different plant essential oils on *Callosobruchus chinensis* (L.) in the Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi during year 2023-24 and 2024-25. The experiment consisted of nine treatments and replicated thrice and laid out in Completely Randomized Design (CRD). Ovicidal toxicity of the nine plant essential oils, *viz*., *Cinnamonum camphora*, *Cymbopogon citrates, Cymbopogon flexuosus*, *Mentha longifolia,* *Pongamia pinnata, Ricinus communis*, *Madhuca longifolia, Ocimum basilicum* and *Foeniculum vulgare* on *C. chinensis*. Bioassay was employed in Petri dish for ovicidal studies and inner surface of petri dish were used for testing ovicidal activities**.** The highest percent hatching inhibition rate was recorded in citronella oil at all the three doses of 0.25, 0.5 and 1% after 35 days, the values being (21.76±0.38), (26.12±0.34), (57.78±0.30) and(23.62±0.06), (37.56±0.51) and (61.28±0.58) in the two sequential year 2023-24 and 2024-25 respectively.

**Keywords:** Pulse beetle, ovicidal activity, essential oils, laboratory.

**Introduction**

The pulse beetle, *Callosobruchus chinensis* Linnaeus and *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae) are the most important pests of food grains and cause damage to cowpea, gram and soybean (Srinivasan, *et al.* 2008, Sharma, *et al.* 2007, Erler *et al.* 2009, Turanli and Kismali 2011). Pulse beetle*, Callosobruchus chinensis* L*.* (Coleoptera: Bruchidae) is one of the three species that causes significant damage to the stored legumes causing up to 55.7% of damage in severe infestations (Chaubey, 2008).Legumes are rich in protein, fibres and minerals. Consumption of legumes in the diet provides numerous physiological benefits and prevents metabolic disorders like diabetes, colon cancer and coronary heart disease. They also have potent anti-bacterial and anti-oxidant properties (Amarowicz, 2020). Poor storage of pulse seeds may be associated with a declining quality of seeds either used for planting or for human consumption (Chidananda *et al*. 2014). The pulse beetle causes more than 50% loss of grains in storage after three to four months (Mogbo, 2014). The control of stored grain pests generally depends on synthetic insecticides including fumigants (Sharma 2007; Shaheen, 2005).

However, regular and repeated use of insecticides to control stored grain pests has led to insecticide resistance, environmental pollution and human health problems. To reduce complete dependence on synthetic pesticides to control pests on stored grains, the investigation of essential oils becomes the option in the current scenario. Organic growers and safety have increased the use of essential oils to the environment and consumers (Regnault-Roger *et al.*, 2011; Campolo *et al.*, 2018). The problems caused by pesticides and their residues have amplified the need for effective and biodegradable pesticides with great selectivity (Hazaa and Alam EL-Din, 2011)**.** Among various classes of natural substances that introduced as natural biopesticides are essential oils from aromatic plants (Prakash *et al.,* 2014). The advantage of using plant essential oils is that they are easily available and they have been used extensively for medicinal purposes, implying that they have low or no toxicity to humans(Upadhyay, 2013).

The present research was carried out the toxic activities of some plant essential oils on pulse beetle*, Callosobruchus chinensis* (L.) under laboratory conditions for possible use as a safe and alternative to chemical pesticides under the integrated pest management**.**

**Material and methods**

A Laboratory experiment was conducted on ovicidal activity caused by nine different plant essential oils on *Callosobruchus chinensis* (L.) replicated thrice and laid out in Completely Randomized Design (CRD) in the Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi during year 2023 and 2024.

**Rearing and maintenance of culture**

The Pulse beetle, *Callosobruchus chinensis* L.was used as test insect in the present study. The nucleus culture of the test insect was obtained from the infested samples of chickpea in Pulse Research Centre farm store at Birsa Agricultural University, Kanke Ranchi, Jharkhand. The culture of pulse beetle was maintained on chickpea at room temperature in the laboratory, Department of Entomology.

**Estimation of the ovicidal activity of plant essential oils against pulse beetle*, C. chinensis***

The experiment was included nine plant essential oils**.** These were subjected to assessment of the ovicidal activity against *Callosobruchus chinensis* L. in the department of agronomy laboratory. They can be successfully exploited as ovicidal activity against *C. chinensis.* Admixture of plant essential oils (camphor, citronella, mentha and lemongrass oils, karanj oils, Castor oils, Mahua oils, Basil and fennel oils) were obtained from the local market, Kanke, Ranchi (Jharkhand).

**Ovicidal activity**

The nine plant essential oils were tested for their *in vivo* effects on ovicidal activity following Kumar *et al*. (2007) with some modification**.** A series of dilutions of each essential oil (0.25, 0.50 and 1% each) was prepared using acetone as solvent. 0.5 ml of each concentration of the essential oils was applied. One hundred, 0-24 hrs old eggs of *C. chinensis* with average of three to four eggs per seed were put in Petri dishes and replicated three times. Seeds were gently mixed for five minutes for proper mixing of the oils on the seeds. For control sets the seeds were dressed in requisite amount of acetone in place of the oil. The treated samples were kept in B.O.D. to control temperature and humidity (27±2°C. Percent Hatching Inhibition Rate (% HIR) was calculated as:

Per cent Hatching Inhibition Rate =

Whereas,

Cn – number of adults in control and

Tn – number of adults in test.

**Results and discussion**

The ovicidal activity of plant essential oils was estimated against *C. chinensis* under laboratory conditions two consecutive years 2023 and 2024 presented in Table 1 and 2. The ovicidal activity of plant essential oils was estimated against *C. chinensis* under laboratory conditions presented in Table 1 and 2. The data indicated that ovicidal treatment with nine plant essential oils caused significant percent hatching inhibition rate as compared to control**.** The highest per cent hatching inhibition rate was analysed in citronella oil at all three doses of 0.25, 0.5 and 1% after 35 days, the values being (21.76±0.38), (26.12±0.34) and (57.78±0.30) and (23.62±0.06), (37.56±0.51), (61.28±0.58) per cent, during year 2023 and 2024 respectively.The lowest per cent hatching inhibition was observed in karanj oilat all three doses of 0.25, 0.5 and 1% after 35 days, the value being (8.12±0.06), (13.39±0.19) and (23.50±0.15) per cent, and (6.81±0.07), (14.18±0.08), (23.77±0.31)during year2023 and 2024 respectively.All the remaining essential oils reflected percent hatching inhibition rate was significantly different as compared to control where there is no inhibition on hatching.

Thus, the results of the present ovicidal studies discovered that different plant essential oilsshowed different potencies against *C. chinensis*. Further, Likewise, Akter *et al.,* 2019; also indicated that the rate of oviposition and the mean number of emerged adults of *C. chinensis* on mung pulses treated with black seed, sesame and soybean oil were lower than their respective control pulses. The lowest number of eggs were recorded in soybean oil treated seeds (13.8 ± 1.07, 12.6 ±1.36, 10.0 ± 1.82) followed by sesame (51.8 ± 4.63, 25.8 ± 8.52, 14.2 ± 4.50) and black seed oil (67.2 ± 9.71, 27.4 ± 5.52, 21.0 ± 5.54) at dose 1 μl, 3 μl and 6 μl, respectively in order. Soybean oil at the rate of 6μl/50 seeds was significantly effective (10.0 ± 1.82) to inhibit egg deposition.A similar result was also revealed by Subedi *et al.* (2020) *C. chinensis.* egg counts on 15 DAT, 45 DAT and 75 DAT were also recorded lowest in chickpea seed treated with Citronella oil (4.00, 5.00, 4.33) in all the dates of data recording followed by Mentha oil (4.33, 6.66, 6.00) and Eucalyptus oil (9.66, 13.00, 12.33), respectively

**Table 1:** Per cent hatching inhibition rate of *C. chinensis* adultsdue to essential oils at different concentrations (2023)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **No. of eggs** | **Hatching Inhibition Rate (% HIR)** | | |
| **0.25%** | **0.5%** | **1%** |
| Camphor oil | 100 | 16.19±0.23 | 36.61±0.07 | 55.30±0.97 |
| Citronella oil | 100 | **21.76±0.38** | **26.12±0.34** | **57.78±0.30** |
| Mentha oil | 100 | 22.02±0.07 | 24.70±0.37 | 56.54±0.88 |
| Lemongrass oil | 100 | 24.51±0.24 | 29.56±0.46 | 37.38±0.36 |
| Karanj oil | 100 | **8.12±0.06** | **13.39±0.19** | **23.50±0.15** |
| Castor oil | 100 | 18.52±0.04 | 44.05±0.29 | 47.54±0.35 |
| Mahua oil | 100 | 18.02±0.17 | 39.21±0.31 | 47.15±0.63 |
| Basil oil | 100 | 14.27±0.12 | 42.32±0.57 | 49.17±0.44 |
| Fennel oil | 100 | 11.65±0.27 | 27.82±0.37 | 36.92±0.51 |
| Control | 100 | 7.16±0.29 | 7.60±0.08 | 7.69±0.10 |
| SEm± | **0.21** | **0.27** | **0.54** |
|  | CD at 5% | **0.63** | **0.82** | **1.62** |

*Mean ± S.E.M\* = Mean values ± Standard error of means of six experiments*

**Table 2:** Per cent hatching inhibition rate of *C. chinensis* adultsdue toessential oils at different concentrations (2024)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **No. of eggs** | **Hatching Inhibition Rate (% HIR)** | | |
| **0.25%** | **0.5%** | **1%** |
| Camphor oil | 100 | 16.28 ±0.28 | 28.30±0.17 | 58.08±0.80 |
| Citronella oil | 100 | **23.62±0.06** | **37.56±0.51** | **61.28±0.58** |
| Mentha oil | 100 | 22.96±0.10 | 27.29±0.16 | 56.36±0.44 |
| Lemongrass oil | 100 | 21.24±0.17 | 22.57±0.17 | 37.81±0.33 |
| Karanj oil | 100 | **6.81±0.07** | **14.18±0.08** | **23.77±0.31** |
| Castor oil | 100 | 17.04±0.08 | 42.17±0.25 | 47.70±0.31 |
| Mahua oil | 100 | 18.63±0.27 | 38.17±0.43 | 47.00±0.48 |
| Basil oil | 100 | 14.74±0.21 | 43.24±0.51 | 48.44±0.50 |
| Fennel oil | 100 | 13.80±0.22 | 28.22±0.09 | 36.43±0.18 |
| Control | 100 | 6.98±0.28 | 7.68±0.06 | 7.69±0.08 |
| SEm± | **0.16** | **0.29** | **0.45** |
|  | CD at 5% | **0.48** | **0.88** | **1.34** |

**Conclusion**

It can be concluded from the research that use of essential oils as an alternative in insect pest management programmes is a sustainable alternative as they can be obtained from nature. Plant essential oils caused oviposition inhibitory activities act on different growth stages in the insects, so that possibility of generating resistance is low. Thus, these oils can be recommended as eco-friendly and biological alternatives to synthetic pesticides to manage insect infestation in grains stored under closed airtight conditions.

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