***Original Research Article***

**Ovicidal Toxicity of Some Plant Essential Oils against Pulse Beetle, *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae) under Laboratory Conditions**

**Abstract**

A study investigating the ovicidal activity of nine different plant essential oils *viz.* *Cinnamonum camphora* (Camphor), *Cymbopogon citratus* (Lemongrass)*, Cymbopogon flexuosus* (Citronella), *Mentha longifolia* (Mentha)*,* *Pongamia pinnata* (Karanj)*, Ricinus communis* (Castor), *Madhuca longifolia* (Mahua)*, Ocimum basilicum* (Basil) and *Foeniculum vulgare* (Fennel)on *Callosobruchus chinensis* (L.) was carried out at the Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi during the years 2023-24 and 2024-25. The experiment comprised of nine treatments replicated thrice and was arranged in a Completely Randomized Design (CRD). The ovicidal toxicity of the nine plant essential oils was assessed against *C. chinensis*. Bioassay was conducted in Petri dishes for ovicidal studies, with the inner surfaces of the Petri dishes used to evaluate ovicidal activity. The highest percentage of hatching inhibition was observed with citronella oil at doses of 0.25%, 0.5% and 1% after 35 days. Specifically, the hatching inhibition rates were (21.76±0.38), (26.12±0.34), and (57.78±0.30) for the year 2023-24, and (23.62±0.06), (37.56±0.51) and (61.28±0.58) for the year 2024-25, respectively.

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

**Introduction**

The most significant pests of food grains are the pulse beetles, *Callosobruchus chinensis* Linnaeus and *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae), which injure soybean, gram and cowpea (Srinivasan *et al.* 2008, Sharma *et al.* 2007, Erler *et al.* 2009, Turanli and Kismali 2011). One of the three species that seriously harms stored legumes is the pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae), which can cause up to 55.7% of damage in heavy infestations (Chaubey, 2008). Minerals, fibre, and protein are plentiful in legumes and so the legumes have several physiological benefits and contribute to preventing metabolic diseases such as diabetes, colon cancer, and coronary heart disease, Furthermore, they possess excellent antioxidant and antibacterial capabilities (Amarowicz, 2020). The quality of pulse seeds used for planting or for consumption by humans may decline as a result of improper storage (Chidananda *et al*. 2014). After three to four months in storage, the pulse beetle destroys more than 50 percent of the grains (Mogbo, 2014). Synthetic pesticides, such as fumigants, usually are used to manage stored grain pests (Sharma, 2007). Insecticide resistance, damage to the environment, and health issues for people have arisen from the frequent and repetitive usage of pesticides to manage stored grain pests Shaheen, (2005) but in the current situation, the study of essential oils provides a possibility to lessen total reliance on synthetic pesticides to control pests on stored crops. The usage of essential oils for consumers and the environment has expanded due to organic farmers and safety (Regnault-Roger *et al*., 2011; Campolo *et al*., 2018). The necessity for efficient, biodegradable insecticides with high selectivity has increased due to the issues produced by pesticides and their residues (Hazaa and Alam EL-Din, 2011).

 Essential oils from fragrant plants are one of a variety of natural compounds that have been presented as natural biopesticides (Prakash *et al*., 2014). The benefit of employing plant essential oils is their accessibility and widespread use in medicine, which suggests that they are either non-toxic or very safe for human consumption (Upadhyay, 2013).
The goal of this study was to determine whether certain plant essential oils may be used as an appropriate replacement for chemical pesticides in integrated pest management by investigating their toxic impact on the *Callosobruchus chinensis* (L.) pulse beetle in a lab setting.

**Material and methods**

In the years 2023–2024 and 2024–2025, a laboratory experiment was carried out in the Department of Agronomy at Birsa Agricultural University, Kanke, Ranchi, on the ovicidal activity caused by nine distinct plant essential oils on *Callosobruchus chinensis* (L.). The experiment was replicated three times and set up in a completely randomised design (CRD).

**Rearing and maintenance of culture**

In this study, the pulse beetle, or *Callosobruchus chinensis* L., was employed as the test insect. The nucleus culture of the test bug was collected 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***

Nine plant essential oils were used in the experiment. In the agronomy department laboratory, they were evaluated for ovicidal efficacy against *Callosobruchus chinensis* L. When used as ovicidal activity against C. chinensis, they can be effectively utilised. Camphor, citronella, mentha, lemongrass, karanj, castor, mahua, basil, and fennel oils were among the plant essential oils that were bought from a nearby marketplace in Kanke, Ranchi, Jharkhand.

With modest modifications, the in-vivo effects of the nine plant essential oils on ovicidal activity were examined in accordance with Kumar *et al*. (2007). Each essential oil was diluted in increments of 0.25, 0.50, and 1% using acetone as the solvent of choice. Each essential oil dosage was administered in 0.5 ml. One hundred *Callosobruchus chinensis* L.eggs, ranging in age from 0 to 24 hours, were placed on Petri dishes and multiplied three times on average. To ensure that the oils on the seeds were properly combined, the seeds were gently stirred for five minutes. Instead of oil, the seeds were treated with the appropriate amount of acetone for the control sets. The treated samples were maintained at 27±2°C in B.O.D. to regulate humidity and temperature. The percentage HIR, or hatching inhibition rate, was computed according to the method used by Kumar *et al* 2007, as

Per cent Hatching Inhibition Rate = $\frac{Cn - Tn}{Cn} ×100$

 Whereas,

 Cn – number of adults in control and

Tn – number of adults in test.

**Results and discussion**

Plant essential oils' ovicidal efficacy against C. chinensis was assessed in a lab setting for two years in a row, 2023–2024 and 2024–2025. The plant essential oils' ovicidal action data are shown in Tables 1 and 2. According to the data, when ovicidal treatment with nine plant essential oils was compared to control, the percent hatching inhibition rate was much higher. At all three doses of 0.25, 0.5, and 1% after 35 days, the highest percentage hatching inhibition rate was found in citronella oil; the values were 21.76±0.38, 26.12±0.34, and 57.78±0.30 percent, and 23.62±0.06, 37.56±0.51, and 61.28±0.58 percent in 2023 and 2024, respectively.

At all three doses of 0.25, 0.5, and 1% after 35 days, the lowest percentage of hatching inhibition was found in karanj oil; the values were 8.12±0.06, 13.39±0.19, and 23.50±0.15 percent, and 6.81±0.07, 14.18±0.08, and 23.77±0.31 percent in 2023 and 2024, respectively. Comparing the % hatching inhibition rate of the remaining essential oils to the control, which shows no restriction on hatching, revealed a substantial difference. Accordingly, the current ovicidal research findings revealed that the potencies of several plant essential oils against *C. chinensis* varied. Additionally, mung pulses treated with black seed, sesame, and soybean oil showed reduced rates of oviposition and the mean number of emerging adults of *C. chinensis* compared to their respective control pulses (Akter *et al*., 2019). At doses of 1 μl, 3 μl, and 6 μl, respectively, soybean oil treated seeds produced the fewest eggs (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, and 21.0 ± 5.54). When applied at a rate of 6μl/50 seeds, soybean oil significantly inhibited egg deposition (10.0 ± 1.82). Subedi *et al*. (2020) also found a similar outcome with *C. chinensis*. In addition, chickpea seeds treated with citronella oil had the lowest egg counts on 15 DAT, 45 DAT, and 75 DAT across all data recording dates (4.00, 5.00, 4.33), 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 (2023-24)

|  |  |  |
| --- | --- | --- |
| **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 Ten experiments**

**Table 2:** Per cent hatching inhibition rate of *C. chinensis* adultsdue toessential oils at different concentrations (2024-25)

|  |  |  |
| --- | --- | --- |
| **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** |

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

**Conclusion**

As essential oils may be found in nature, the research suggests that using them as a substitute in insect pest management programs is a sustainable option. Because plant essential oils include oviposition-inhibiting properties that affect the insects at several phases of growth, there is little chance that resistance will develop. Therefore, these oils might be suggested as biological and environmentally acceptable substitutes for synthetic pesticides in order to control insect infestation in grains that are kept in an airtight, closed environment.

**Disclaimer (Artificial intelligence)**

I hereby declare that no generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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