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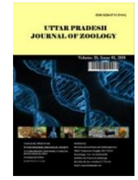

OVICIDAL ACTIVITY OF *Syzygium aromaticum*, *Cinnamonam cassia*, *Carum carvi* AND *Citrus aurantium* PLANT VOLTALIE OIL AGAINST THE PULSE BEETLE *Callosobruchus maculatus*

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author JS conducted the data. Author KE designed and prepared the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

In the present study of ovicidal activity of *S. aromaticum* tested against the freshly laid eggs of *Callosobruchus maculatus* was tested in a environment laboratory. The plant voltile oil indicates that 50 mg/mL concentration of *S. aromaticum* oil-induced 16.00. 24.00 and 35.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods respectively. Similarly, the 100 mg/mL concentration of *S. aromaticum* oil-induced the egg mortality of 23.00. 49.00 and 43.00% when exposed to 24, 48 and 72 hrs exposure periods respectivel in 150 mg/mL concentration of *S. aromaticum* oil-induced the egg mortality of 35.00. 48.00 and 49.00% when exposed to 24, 48, and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *S. aromaticum* oil showed the ovicidal activity of 45.00. 52.00 and 56.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. The ovicidal activity of *C. cassia* tested against the freshly laid eggs of *C. maculatus* was tested, and indicates that 50 mg/mL concentration of *C. cassia* oil-induced 14.00.25.00 and 36.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods, respectively. Similarly, the 100 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 24.00. 31.00 and 42.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Besides, the 150 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 30.00. 38.00 and 51.00% when exposed to 24, 48 and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *C. cassia* oil showed the ovicidal activity of 41.00. 45.00 and 54.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. The ovicidal activity of *Ca. carvi* tested against the freshly laid eggs of *C. maculatus* was tested and the data indicates that 50 mg/mL concentration of *C. cassia* oil-induced 18.00.26.00 and 33.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods, respectively in 100 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 29.00. 37.00 and 46.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Besides, the 150 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 38.00. 46.00 and 53.00% when exposed to 24, 48 and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *C. cassia* oil showed the ovicidal activity of 50.00. 59.00 and 68.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Ovicidal activity of *Ci. aurantium* tested against the freshly laid eggs of *C. maculatus* was tested and the data indicates that 50 mg/mL concentration of *Ci. aurantium* oil-induced 11.00 20.00 and 32.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods respectively

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in 100 mg/ml concentration of *C. cassia* oil-induced the egg mortality of 25.00. 28.00 and 42.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Besides, the 150 mg/mL concentration of *Ci. aurantium* oil-induced the egg mortality of 37.00. 32.00 and 49.00% when exposed to 24, 48 and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *Ci. aurantium* oil showed the ovicidal activity of 40.00. 44.00 and 50.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Thus, it is possibly the infestation of the pest is phytochemical are safer for the environment.

Keywords: Ovicidal activity; *Syzygium aromaticum*; *Cinnamonam cassia*; *Carum carvi* and *Citrus aurantium*; Plant volatile oil; *Callosobruchus maculatus*.

1. INTRODUCTION

Cowpea production is pretentious by several pests and disease infestations deteriorate the pulse quality thereby leads to high forfeiture [1]. The major insect pest that can cause economic loss is cowpea weevil (*C. maculatus*). C. maculatus (F.) (Coleoptera: Bruchidae), is a cosmopolitan field-to-store pest ranked as the significant post-harvest pest of cowpea in the tropics [2,3-14]. The *C. maculatus*, is a significant pest of economically critical leguminous grains, such as cowpeas, lentils, green gram, and black gram [15,16, 17]. The egg and adult stage of *C. maculatus* found on the grain and the larval and pupal stages living inside the grain [18,19,20-26]. The larvae bore into the pulse grains and eat up the endosperms which become unsuitable for human consumption with reduced viability for replanting or the production of sprouts [27-40]. *C. maculatus* are severe pests of pulse crops in Asia and Africa under storage conditions [17,41]. *C. maculatus* breeds in India from March to November, and the larval stage undergoes hibernation in winter. *C. maculatus* infestation is maximum during February to August when all its developmental stages exist simultaneously [42]. During storage to reduce severe losses, various techniques and control methods have developed, and more are yet to develop [43-54]. Management of *C. maculatus,* relies heavily on the use of chemical insecticides [55-57,58,59]. A pesticide also deteriorates the quality of the environment, declines the health status of humans, and affects the population dynamics of non-target and neutral fauna and flora [60-64]. In this context, there is a need to develop cheaper, safer, and secure methods of protecting stored cowpeas against cowpea weevil and preventing the mosquito menace [65-69,70-73,74]. The volatile plant oils possess odors that are believed to repel weevils and mosquitoes, thereby preventing their attack [75,76,77-79]. The information available regarding the biological activities of selected essential oil such as, *S. aromaticum, C. cassia, Ca. carvi, Ci. aurantium* on *C. maculatus* is meager [80-88]. Hence, this present investigation was designed to evaluate the ovicidal, activities of selected oils.

2. METHODOLOGY

2.1 Collection of Essential Oils

Plant volatile oils such as *Syzygium aromaticum, Cinnamomum cassia, Carum carvi,* and *Citrus aurantium* have obtained through hydro distillation process by Clevenger apparatus (Plate 1).

Plate 1. An assemblage of clevenger apparatus used for oil extraction through hydrodistillation process

2.2 Rearing and Maintenance of Stored Grain Pests

Callosobruchus maculatus has obtained from the Unit of Entomology insectarium. The beetles were reared on cowpea over several generations in the Unit of Entomology laboratory for about a year (Approximately five generations). The insect culture was done in a climate chamber at 27 ±1ºC with 12h photoperiod R.H (70-80%) For the experiment, newly emerged (1-5h) insects have used. In the experiments, the day of death of the adult beetles has determined as the day the antennae and legs did not move upon gentle disturbance with forceps.

Plate 2. Culture of *Callosobruchus maculats* on *Vigna unguiculata*

2.3 Cowpea Beans

Cowpea (*Vigna unguiculata*) of the variety susceptible to *C. maculatus* have stored in a freezer at -18ºC for a week and subsequently desiccated in a store at 50ºC for about a week to guarantee the absence of viable insects without having to use chemicals. The beans were stored in hermetically sealed plastic containers at room temperature before use. Only visually uninfected beans were used for the experiments.

Ovicidal bioassay: The ovicidal activity of selected plant volatile oils assessed on the seeds contained freshly laid eggs of *C. maculatus*. The number of eggs on whole seeds exposed to each concentration was recorded before the treatment. Then the seeds were treated withV50, 100, 150 and 200 mg/ml concentrations of S. *aromaticum, C. cassia, C.* and *Ci. aurantium* oils individually and the percentage of eggs hatched after 24, 48 & 72 hrs. The following formula wasVused to assess the ovicidal activity.

$$\%\text{Ovicidal Activity} = \frac{\text{No. of eggs hatched}}{\text{Total no. of eggs treated}} \text{ X } 100$$

Plate 3. Ovicidal bioassay

3. RESULTS

3.1 Ovicidal Activity of *Syzygium aromaticum* Tested against *C. maculates*

Data pertained to the ovicidal activity of S. aromaticum tested against the freshly laid eggs of *C. maculatus* was tested, and the values observed from the experiment is shown in figure 5.5. A perusal of the data indicates that 50 mg/mL concentration of *S. aromaticum* oil-induced 16.00. 24.00 and 35.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods respectively. Similarly, the 100 mg/mL concentration of *S. aromaticum* oil-induced the egg mortality of 23.00. 49.00 and 43.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Besides, the 150 mg/mL concentration of *S. aromaticum* oil-induced the egg mortality of 35.00. 48.00 and 49.00% when exposed to 24, 48, and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *S. aromaticum* oil showed the ovicidal activity of 45.00. 52.00 and 56.00% when exposed to 24, 48 and 72 hrs exposure periods respectively (Fig. 1).

3.2 Ovicidal Activity of *Cinnamonam cassia* Tested against *C. maculates*

Data pertained to the ovicidal activity of *C. cassia* tested against the freshly laid eggs of *C. maculatus* was tested, and the values observed from the experiment is shown in figure 5.6. A perusal of the data indicates that 50 mg/mL concentration of *C. cassia* oil-induced 14.00.25.00 and 36.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods, respectively. Similarly, the 100 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 24.00. 31.00 and 42.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Besides, the 150 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 30.00. 38.00 and 51.00% when exposed to 24, 48 and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *C. cassia* oil showed the ovicidal activity of 41.00. 45.00 and 54.00% when exposed to 24, 48 and 72 hrs exposure periods respectively (Fig. 2).

3.3 Ovicidal Activity of *Carum carvi* against *C. maculates*

Data pertained to the ovicidal activity of *Ca. carvi* tested against the freshly laid eggs of *C. maculatus* was tested and the values observed from the experiment is shown in figure 5.7. A perusal of the data indicates that 50 mg/mL concentration of *C. cassia* oil-induced 18.00.26.00 and 33.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods, respectively. Similarly, the 100 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 29.00. 37.00 and 46.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Besides, the 150 mg/mL concentration of *C. cassia* oil-induced the egg mortality of 38.00. 46.00 and 53.00% when exposed to 24, 48 and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *C. cassia* oil showed the ovicidal activity of 50.00. 59.00 and 68.00% when exposed to 24, 48 and 72 hrs exposure periods respectively (Fig. 3).

3.4 Ovicidal Activity of *Citrus aurantium* Tested against *C. maculates*

Data pertained to the ovicidal activity of *Ci. aurantium* tested against the freshly laid eggs of *C. maculatus* was tested and the values observed from

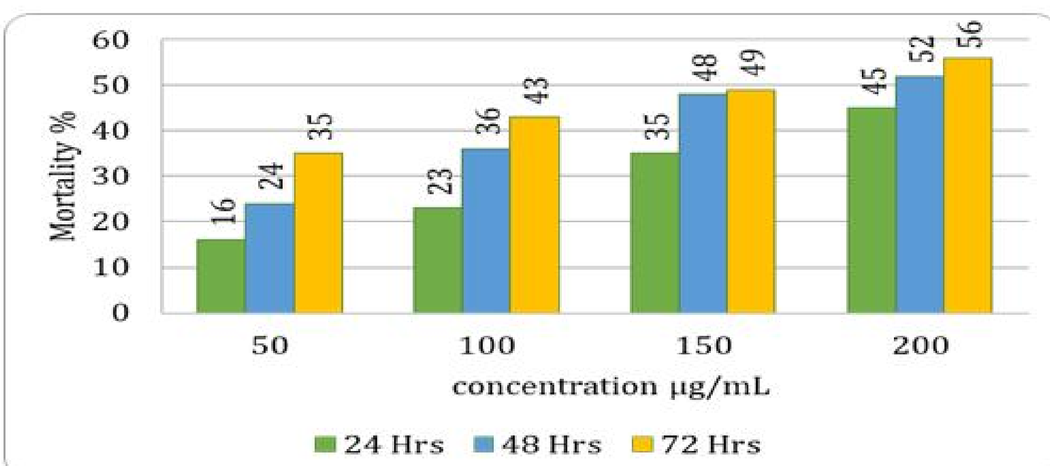

Fig. 1. Ovicidal activity of *Syzygium aromaticum* tested against *C. maculatus*

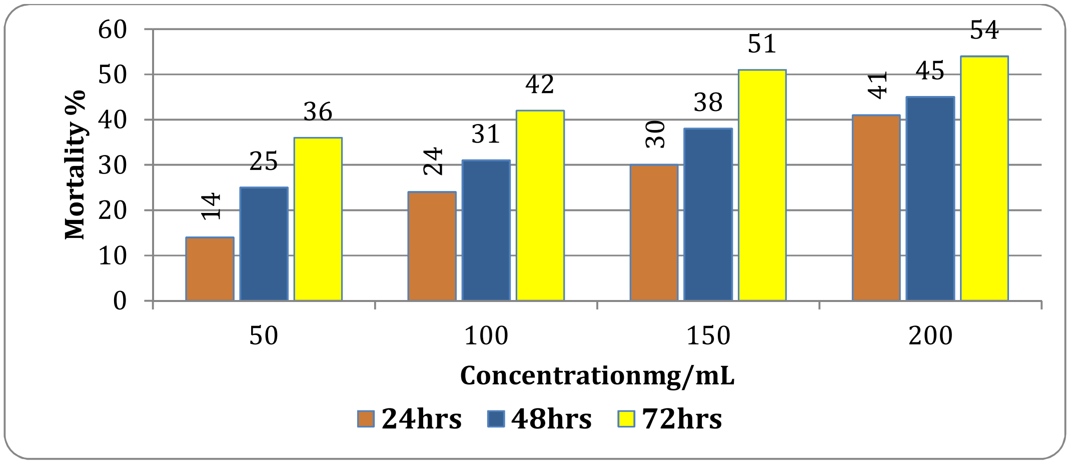

Fig. 2. Ovicidal activity of *Cinnamonam cassia* tested against *C. maculatus*

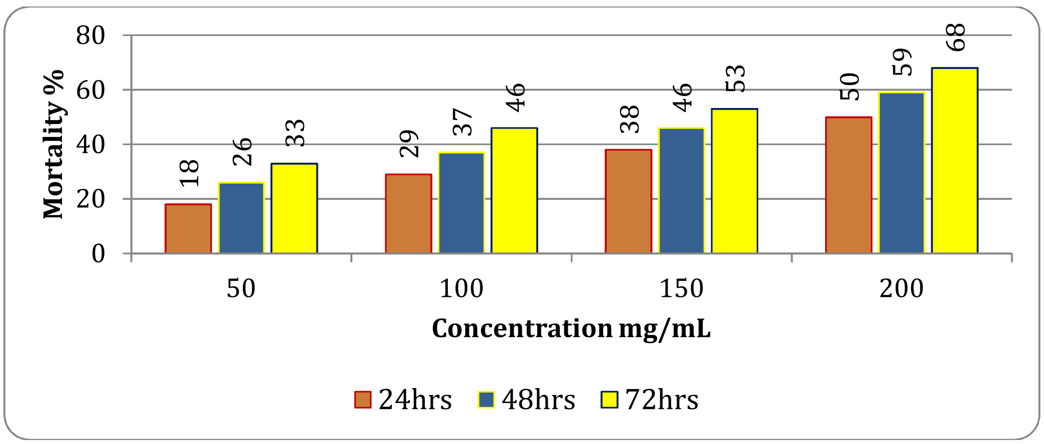

Fig. 3. Ovicidal activity of *Carum carvi* tested against *C. maculates*

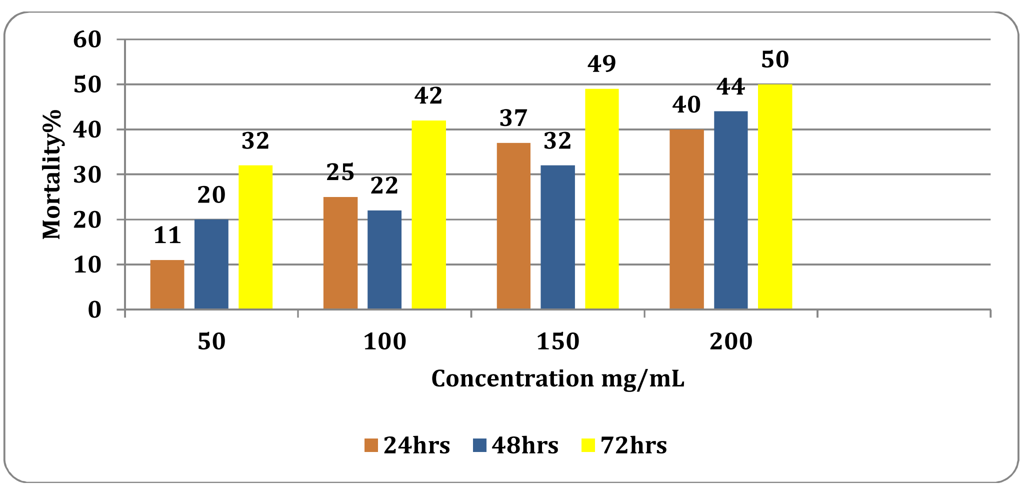

Fig. 4. Ovicidal activity of *Citrus aurantium* tested against *C. maculates*

the experiment is shown in figure 5.8. A perusal of the data indicates that 50 mg/mL concentration of *Ci. aurantium* oil-induced 11.00.20.00 and 32.00% egg mortality when exposed to 24, 48 and 72 hrs exposure periods respectively. Similarly, the 100 mg/ml concentration of *C. cassia* oil-induced the egg mortality of 25.00. 28.00 and 42.00% when exposed to 24, 48 and 72 hrs exposure periods respectively. Besides, the 150 mg/mL concentration of *Ci. aurantium* oil-induced the egg mortality of 37.00. 32.00 and 49.00% when exposed to 24, 48 and 72 hrs exposure periods. Remarkably, the 200 mg/mL concentration of *Ci. aurantium* oil showed the ovicidal activity of 40.00. 44.00 and 50.00% when exposed to 24, 48 and 72 hrs exposure periods respectively (Fig. 4).

4. DISCUSSION

The contact toxicity of plant volatile oils toward stored product pests as an insecticide is due to their volatility and thus meager persistency. These characteristics forced the researchers with repeated applications. In the present investigation also the selected volatile oils showed remarkable insecticidal activities against the selected stored grain pest, *C. maculatus*. Our findings as mentioned in the previous chapter are in agreeing with the results of several earlier researchers who have been reported that the insecticidal activity of plant oils against spectrum of stored product insects either individually or in combination (synergistic) with other oils. Control of this pest was achieved using syntheticβchemical [1]. However, due to hazardsβcaused by these chemicalsβto plants, manβand theβenvironment, there has been the move to search for anβalternative using plant materials as a bio pesticide to control *C. maculatus* [89]. The objective of this investigationβis to guise into the accomplishments of the use of plant oil in the management and control of *C. maculatus*. The dataβobserved from the present experimentsβrevealed that *C. aurantium* oil significantlyβcontrolled the infestation of *C. maculatus* [90-95]. This is due to the presence of several novel phytochemicals present in the selected plant volatile oil. The use of chemicalβinsecticides is the best way of controlling this selected pest [96-102]. Ekeh et al., 2013 stated thatβfumigation is appropriate to control insects. Insecticides are having quick knockdown action and are persistent, efficient and effective means of control. There is incomplete information on the use of plant products as an alternative control method for controlling weevils in storage [103, 104-107]. The use of plant products may offer a sustainable, environmentally friendly and safer alternative to synthetic insecticides [108-111].

5. CONCLUSION

In the past few years, pesticides play a major role to control the insect pests in field. Undifferentiating use of such chemical pesticides once used to control the insect pests caused several deadly effects in the environment and other non-target organisms. As a part of it, in the present investigation the ovicidal action of selected four plant volatile oils are well documented. The most attractive aspect of using essential oils and their constituents for pest as well as vector mosquito control is due to their non-toxic nature on non-target organisms, because, plants and plant-based products are commonly used as culinary herbs and spices and as medicines. It is opined that the use of bio pesticides will help in preventing the eliminating of synthetic pesticides on the earth and provide residue-free food and a safe environment. Essential oils comprise mixtures of various molecules. However, in that sense, this present investigation warrants new insight, it could be more informative to ascertain the biological activities of the entire oil rather than some of its components because the concept of synergism seems to be necessary. Finally, we conclude that the development of natural or biological insecticides will help to mitigate the adverse effects of synthetic chemicals. These oils can be cheaper than chemical pesticides, ecofriendly in nature and will substantially.

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COMPETING INTERESTS

Authors have declared that no competing interest exists.

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