

Pesticidal Effects of *Mesosphaerum suaveolens* (L. Poit Kuntze, 1891) on Cowpea weevil *Callosobruchus maculatus* (Fabricius, 1775)

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Abstract

Mesosphaerum suaveolens of the family Lamiaceae is a weedy plant that is traditionally known to possess insecticidal properties. The experiment was carried out at Biological Science Laboratory of Gombe State University. The study examined the phytochemical constituents of parts of *M. suaveolens*; and analysed the effects of its exposure on the mortality rate of *Callosobruchus maculatus*. Spectrophotometric and gravimetric methods were used for the quantitative analysis. The experiment involved exposing *C. maculatus* to different concentrations (0.00, 2.00, 4.00, 6.00, 8.00, 10.00 v/v, and 1.00 g powder) of the leaves, roots and stems treatments and monitored 96 hr mortality rate. The study revealed that there was no mortality in the control group, while mortality rates varied among the plant materials although there were no significant differences among the treatments. The highest percentage mortality of 11.66% was recorded in the 1 g stem powder. The study showed the presence of phytochemicals such as saponins, alkaloids, flavonoids, steroids and terpenoids, however, only saponins which possessed insecticidal properties are found in all the examined parts. Inference from the study revealed that *M. suaveolens* insecticidal properties against *C. maculatus* were in the order leaves > stem > roots. The local cultivation and use of *M. suaveolens* could promote sustainable agriculture, reduce environmental risks and support the development of cheaper biotechnological solutions for pest control.

Keywords: *Mesosphaerum suaveolens*, Phytochemical, *Callosobruchus maculatus*, Toxicity, Mortality

Introduction

Plants are extremely rich components of the environment; as the roles they play are not limited to serving as food or for medicinal purposes. Majority of animals completely rely on plants for the supply of food for their growth and existence and in addition, humans largely depend on them for other resources such as medicine, shelter and clothing (Gopalakrishnan & Udayakumar, 2017; Isa *et al.*, 2022). In a quest to meet one of the basic needs of man (food), different pesticides were manufactured in order to curb the damages caused by pests. However, a lot of negative effects have been reported as a result of the long term use of synthetic pesticides despite meeting the immediate need and this encourages the creation of pesticides from natural origin as they are opined to be more ecologically-friendly (Danahap *et al.*, 2024a). *Mesosphaerum suaveolens* (L., Poit) is an erect annual herb of the Lamiaceae family which measures between 50.00 cm and 2.00 m high (Sharma *et al.*, 2013). *M. suaveolens* is also known as Bushmint/Bushtea in English and, "Daidoyar-kare or Sarakuwar-sauro" in Hausa Language. Because of its strong smell, it's used traditionally as a natural mosquito repellent. The leaves of this weed are broad, characterised by strong taproots predominantly found in areas with low altitudes. *M. suaveolens* is opined to be a cheaper and environmentally friendly source of pesticide which could serve as a safer substitute to synthetic pesticides (Sharma *et al.*, 2013). Reports have shown that phytochemical elements play many functions in living systems as chemical compounds in plants can be harnessed and used for agricultural purposes because these plants are known to possess resourceful bioactive substances (Vasu *et al.*, 2009; Okechalu *et al.*, 2020a). These elements can be obtained from the plant materials such as the flowers, leaves, fruits, roots, barks, stems or seeds (Criagg & David, 2001). This study aimed to determine the qualitative and quantitative phytochemical analysis on the leaves, roots and stem of *M. suaveolens* and the potential of using it as organic pesticides on cowpea weevil *C. maculatus*.

Materials and Methods

Collection of Plant Materials

Fresh leaves, stems and roots of *M. suaveolens* were harvested from Off-Ashaka road Gombe Gombe State (10°18' N, 11° 8' E). The plant species was taxonomically identified and authenticated in Herbarium of the Department of Plant Sciences, Gombe State University (Specimen number: GSUH 229). The plant materials (leaves, stems and roots) were washed thoroughly with distilled water and then separately dried under shade. The plant materials were milled into powder using a laboratory blender and a mortar and pestle where necessary, after which it was properly stored and labelled for phytochemical analysis and further study.

Crude Extract Preparation for Analysis

Crude extract of *M. suaveolens* was prepared according to the methods described by Yadav & Agarwala (2011) using distilled water. The dried specimens (leaves, stems and roots) powders were soaked in distilled water in the ratio 1:5 for 48 hr in a beaker. Therefore, 100.00 g of the specimen dissolved in 500.00 ml of distilled water was placed on an orbital shaker in order to obtain the bioactive components of the plant. The resulting suspension was sieved using cheesecloth into a conical flask; and then filtered with a Whatman filter paper. The filtrate collected was heated in an oven so as to get the pure extract. The phytochemical constituents of *M. suaveolens* leaves, stems and roots were further determined from the pure extracts by fetching it into a test tube in little quantities.

Qualitative and Quantitative Phytochemical Analysis

The leaves, roots and stem extracts of *M. suaveolens* were tested for the presence of phytochemical compounds by using the standard methods suggested by Yadav & Agarwala (2011) and Morsy (2014). The quantitative phytochemical compounds in *M. suaveolens* stem, leaves and roots extracts were determined using methods described by Harborne (1998) and Morsy (2014).

Experimental Design and Procedure

The experiment was conducted in the Department of Biological Science laboratory, Gombe State University. The powders of *M. suaveolens* screened were used in the following

quantities; 20.00 g, 15.00 g and 20.00 g for the leaves, roots and stem respectively. A 250 ml of distilled water was used to soak each of the weighed powders separately for about 48 hr; the filtrate was filtered using the Whatman filter paper. The organic pesticide extracts were kept in refrigerator when not in use.

Plastic containers served as the experimental bowls which were covered with net so that ventilation was provided and simultaneously prevent the insects from flying out. Seven treatments (0.00, 2.00, 4.00, 6.00, 8.00, 10.00 v/v and sample powder) were used in three replicates. Three pairs of adult *C. maculatus* were introduced into each container. The treatments used were obtained following the format stated by Isa *et al.*, (2022). The adult mortality rate of *C. maculatus* were observed and recorded at 24, 48, 72 and 96 hr respectively. Cowpea weevils were sourced locally from infested beans.

Data Analysis

The data obtained on *C. maculatus* mortality were subjected to Analysis of Variance (ANOVA) using (SPSS) statistical tool, significantly different means at 5.00% level of significance were separated using LSD (Least Significant Difference).

Results

The qualitative phytochemical characteristics of *M. suaveolens* are shown in Table 1. The results indicated the presence of insect repelling compound saponins were present in all the three plant parts studied; the leaves, roots and stem of *M. suaveolens*. Flavonoids were found in the leaves and stem of the studied plant; however, alkaloids were present only in the leaves of *M. suaveolens*. Steroids and terpenoids were found in both the roots and leaves of the studied plant materials but not the stem. Tannins and phenols were completely absent in all the plant materials; leaves, roots and stem of *M. suaveolens*.

The outcome of the quantitative phytochemical screening of *M. suaveolens* stem, roots and leaves are presented in Table 2. Saponin was recorded at its highest in the leaves with the value 165.00 ± 0.32 mg/g while the roots of *M. suaveolens* had the least saponin content with the value 104.14 ± 1.00 mg/g. The lowest phytochemical values were seen in flavonoids which were present only in the leaf and stem of the plant studied with the values 2.14 ± 0.07 mg/100.00 g and 1.26 ± 0.13 mg/100.00 g respectively. Alkaloids present only in the leaves had the value 5.68 ± 0.83 mg/100.00 g. The quantities of both steroids and terpenoids were higher in the leaves as 75.89 ± 0.83 mg/g and 3.65 ± 0.18 mg/100.00 g respectively whereas lower values in the roots of *M. suaveolens* were reported as 61.42 ± 0.58 mg/g and 2.35 ± 0.11 mg/100.00 g respectively.

Table 1: Qualitative Phytochemical Screening of *Mesosphaerum suaveolens*

Parameters	Stem	Roots	Leaves
Saponins	+	+	+
Alkaloids	-	-	+
Flavonoids	+	-	+
Steroids	-	+	+
Terpenoids	-	+	+
Tannins	-	-	-
Phenols	-	-	-
Key: +	Present		
-	Absent		

Table 2: Quantitative Phytochemical Analysis of *Mesosphaerum suaveolens*

Parameters	Quantitative Composition		
	<i>Stem</i>	<i>Roots</i>	<i>Leaves</i>
Saponins (mg/g Diosgenin eqv.)	140.45 ± 45.00	104.14 ± 1.00	165.00 ± 0.32
Alkaloids (mg/100.00 g Gravimetric)	ND	ND	5.68 ± 0.83
Flavonoids (mg/100.00 g Gravimetric)	2.14 ± 0.07	ND	1.26 ± 0.13
Steroids (mg/g Cholesterol eqv.)	ND	61.42 ± 0.58	75.89 ± 0.83
Terpenoids (mg/100.00 g Gravimetric)	ND	2.35 ± 0.11	3.65 ± 0.18
Tannins (mg/g Cholesterol eqv.)	ND	ND	ND
Phenols (mg/g Cholesterol eqv.)	ND	ND	ND

Key: Values are presented as mean ± Standard Error of the Mean (SEM) of replicate readings

ND = Not Detected

Pesticidal Effects of Mesosphaerum suaveolens Leaves, Roots and Stem Formulated Organic Pesticides on Callosobruchus maculatus

The mortality rate of *C. maculatus* exposed to leaves of *M. suaveolens* was presented in Table 3. The results revealed that as concentration and time of exposure increases, all part of the plant materials recorded significantly higher ($p < 0.05$) mortality. Leave powder of *M. suaveolens* and 8.00% concentrations showed the highest mortality rates. No mortality was recorded in the untreated control. Similarly, low mortalities were recorded at 2.00% and 4.00% concentrations after 96 hr exposure period.

The mortality rate of *C. maculatus* exposed to the roots of *M. suaveolens* at 10.00% concentration recorded the highest mortality; however, low mortalities were recorded in 6.00% concentration and the root powder as presented in Table 4.

The mortality rate of *C. maculatus* exposed to the stem of *M. suaveolens* was presented in Table 5. The stem powder showed the highest mortality. No mortality was recorded in the control and low mortality was recorded in 4.00% concentration. No significant differences ($p < 0.05$) were obtained between the different concentrations.

Table 3: Mortality Rate of *C. maculatus* Exposed to Leaves of *Mesosphaerum suaveolens*

Conc. (v/v)% of <i>M. suaveolens</i>	N	24 hr	48 hr	72 hr	96 hr	Total mortality
0	15	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

2	15	0.67±0.33	1.00±0.58	0.00±0.00	1.33±0.33	3.00±0.58
4	15	0.33±0.33	0.33±0.33	0.33±0.33	2.00±0.00	3.00±0.00
6	15	0.67±0.33	0.33±0.33	1.00±0.00	2.00±1.00	4.00±0.58
8	15	1.00±0.00	2.33±0.33	0.67±0.33	0.33±0.33	4.33±0.33
10	15	0.67±0.33	0.67±0.33	0.67±0.33	1.67±0.33	3.67±0.33
Leave powder	15	1.00±1.00	2.33±0.88	0.00±0.00	1.00±0.58	4.33±0.67

Table 4: Mortality Rate of *C. maculatus* Exposed to Roots of *Mesosphaerum suaveolens*

Conc. (v/v)% of <i>M. suaveolens</i>	N	24 hr	48 hr	72 hr	96 hr	Total mortality
0	15	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
2	15	0.33±0.33	0.67±0.67	1.33±0.88	0.00±0.00	2.33±1.20
4	15	0.67±0.33	0.00±0.00	1.00±0.00	1.33±0.33	3.00±0.58
6	15	1.00±0.00	1.00±0.58	0.33±0.33	1.00±0.58	0.33±0.88
8	15	0.00±0.00	0.33±0.33	1.00±0.00	2.33±0.88	3.67±0.67
10	15	0.67±0.33	1.33±0.33	0.67±0.33	1.33±0.33	4.00±0.00
Root powder	15	2.00±1.00	0.00±0.00	0.00±0.00	1.33±0.67	0.33±0.33

Table 5: Mortality Rate of *C. maculatus* Exposed to Stem of *Mesosphaerum suaveolens*

Conc. (v/v)% of <i>M. suaveolens</i>	N	24 hr	48 hr	72 hr	96 hr	Total mortality
0	15	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
2	15	0.67±0.33	1.00±0.58	0.33±0.33	1.00±0.00	3.00±0.58
4	15	0.33±0.33	0.00±0.00	1.00±0.58	1.33±0.33	2.67±0.33
6	15	1.33±1.33	0.33±0.33	1.33±0.67	0.67±0.33	3.67±0.33
8	15	1.67±0.67	0.67±0.67	1.33±0.33	0.67±0.33	4.33±0.33
10	15	1.00±0.58	0.67±0.67	1.00±0.58	0.33±0.33	3.00±1.00
Stem powder	15	1.33±0.33	2.33±0.33	0.67±0.33	0.33±0.33	4.67±0.33

Discussion

In this study, phytochemical screening was conducted on *M. suaveolens* leaf, stem and root extract to qualitatively detect the presence of saponins, alkaloids, flavonoids, tannins,

terpenoids, steroids and phenols however, saponins, flavonoids and alkaloids were present in this study the findings which disagrees with the reports of Okechalu *et al.* (2020a), who reported the absence of both flavonoids and alkaloids *M. suaveolens* leaves. These

differences may have resulted due the location and age of plants collected or the season of the year the plants were collected. Phenols and tannins which were found in high concentration in the leaves in the report of Okechalu *et al.* (2020a) were not detected in all the plants materials investigated in this research. This could be as a result of the difference in methods used for the determination process.

Quantitatively, all the phytochemical compounds present in *M. suaveolens* leaves, roots and stem were obtained in higher amount in the leaves except flavonoids which was higher in the stem. The results of the phytochemical screening of papaya (*Carica papaya*) leaves conducted by Mathur *et al.*, (2024) indicated the presence of different bioactive compounds such as alkaloids, tannins, flavonoids, saponins, phenolic compounds, glycosides, terpenoids, and steroids. In a like manner, all the compounds obtained in leaves in the present study have been reported to be present in papaya leaves and this suggests that these plants have abundant medically potential phytochemical materials.

Reportedly, phytochemicals are secondary metabolites that contain saponins, alkaloids, steroids, terpenoids are plant natural products that play roles such as plant defence against disease and herbivores due to its bitter taste; their harmful effects are usually against insects, parasitic worms, mollusks, fish and some micro-organisms such as bacteria (Isa *et al.*, 2022). This study reveals that saponins are the main constituent present in all the plant materials studied and it could be responsible for causing mortality in the insect *C. maculatus*. Similarly, alkaloids are certified to be compounds that serve as natural pesticides that deter herbivorous organisms like some insects and nematodes (Ebuete *et al.*, 2022). Hence, the presence of saponins and alkaloids could possibly infer that *M. suaveolens* is a toxin to some life forms but simultaneously, the presence of these phytochemicals could aid in boosting crop yields (Okechalu *et al.*, 2020b). The findings of Danahap *et al.*, (2024b) stated that the presence of terpenoids showed that plants can act as anti-feedant and growth disruptor and poses considerable toxicity to insects. Insecticidal properties in the leaves of *M. suaveolens* in this study were the highest,

and then followed by the stem, additionally; there was no significant mortality differences ($p < 0.05$) in *C. maculatus* between the treatments or plant materials investigated. The studies of Dauda *et al.*, (2014) on the protective bioactivity of *Moringa oleifera* seed oil (MSO) against *C. maculatus* infestation in some stored cowpea varieties revealed that the mean number of adult emergence and the severity of damage compared to the control grains were statistically significant ($p < 0.05$) relative to all the treated grains which indicated the plant essential oil's ability to offer protection to stored cowpea grains by inhibiting *C. maculatus* adult emergence in higher concentrations, this shows that both moringa and *M. suaveolens* plants possess essential properties that curb *C. maculatus* pest. The ethanolic extract from whole plants of *Hyptis suaveolens* was examined by Sharma *et al.*, (2013) in order to detect its toxicity on the larvae of *Aedes aegypti* and on brine shrimps; it was observed to have caused mortality at varying doses, hence, the study suggest the presence of highly active, bioactive compounds in *H. suaveolens*. The report of Tawfeek *et al.*, (2017) on the effects of nutmeg, fennel, caraway, cinnamon, citronella and black cumin oils against three insects namely *Sitophilus oryzae*, *Rhizopertha dominica* and *Tribolium castaneum* revealed that increase in concentration and exposure time increased death rate in the insect species similar to this study and these showed the effectiveness of plant-based extracts as pesticides. The findings of this study revealed that the leaves, stem and roots of *M. suaveolens* have pesticidal effects and their extracts were lethal to *C. maculatus*. Therefore, the plant materials studied could serve as viable substitute to synthetic insecticides in mitigating *C. maculatus* as there were insignificant differences in the mortality rates and this is in agreement with the study of Araujo *et al.*, (2023) that discouraged the use of synthetic insecticides due to concerns over their environmental impacts.

Conclusion

M. suaveolens contains phytochemical elements that serve as a natural pesticide as the presence of some compounds was effective in causing death in *C. maculatus*. The use of *M. suaveolens* as an insecticide to *C. maculatus* is safer and cheaper because the plant could be grown

locally, harvested easily and it is toxic to insects that infest farmlands. The extract of this plant has potential to be used in order to control other pests or produce value added product concomitantly. The local cultivation and use of *M. suaveolens* could promote sustainable agriculture, reduce environmental risks and support the development of cheaper biotechnological solutions for pest control. Given the phytochemical constituents of *M. suaveolens*, it is recommended that its cultivation locally should be encouraged as it could be harvested as an organic pesticide as toxins to insects that affect crop yield and storage.

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