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Volatile oil composition and insecticidal activity of some local plants against *Sitophilus zeamais*

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Abstract
The essential oils from the leaves of *Hyptis suaveolen, Thuja orientalis, Cymbopogon citratus,* and *Eucalyptus camaldunensis* plants were obtained using hydrodistillation method. The oil composition were reviewed using literature and are found to have similar prominent compounds, although in different concentration. The insecticidal potential of the oils were carried out against grain pest, *Sitophilus zeamais* using adult mortality, adult emergence, and percentage reduction in adult emergence. The results obtained in adult mortality increases as the exposure time increases even at the lowest concentration. The four plants oil extract were able to evoked 100% mortality of adult *Sitophilus zeamais* at the rate of 0.1,0.2,0.3,0.4,0.5 and 1.0ml/20g of maize grains after 72 hours of post treatment. The results obtained from this study revealed that the oil extracts of these plants can be used as insecticides against *S. zeamais*. These plants are medicinal, biodegradable, readily available and poses no harm to man.

Keywords: Essential oils, sitophilus zeamais, adult mortality, adult emergence

1. Introduction

Essential oils are highly concentrated substances extracted from flowers, leaves, stems, roots, seeds, barks, resins, or fruit rinds. These oils are often used for their flavor and their therapeutic or odoriferous properties, in a wide selection of products such as foods, medicines, and cosmetics. Extraction of essential oils is one of the most time- and effort-consuming processes. The way in which oils are extracted from plants is important because some processes use solvents that can destroy the therapeutic properties [1]. There are wide number of ways to extract the essential oil but the quality never remains the same.

The essence (essential oils) contains highly volatile substances that are isolated by a physical method or process from plants of a single botanical species. The oils normally bear the name of the plant species from which they are derived. Essential oils are so termed as they are believed to represent the very essence of odor and flavor. Essential oil plants and culinary herbs include a broad range of plant species that are used for their aromatic value as flavorings in foods and beverages and as fragrances in pharmaceutical and industrial products [2]. Many plant essential oils show a broad spectrum of activity against pest insects and plant pathogenic fungi ranging from insecticidal, anti-feedant, repellent, oviposition deterrent, growth regulatory and anti-vector activities.

Recent investigations indicate that some chemical constituents of these oils interfere with the octopaminergic nervous system in insects. Because the target site is not present in mammals, most essential oil are relatively non-toxic to mammals and fish in toxicological tests. Some of these oils and their constituent chemicals are widely used as flavoring agents in foods and beverages and are even exempt from pesticide registration. As resistance development continues to be an area of concern for many synthetic pesticides, it is predictable that resistance will develop more slowly to essential-oil-based pesticides owing to the complex mixtures of constituents that characterize many of these oils [3].

Maize is an important cereal crop in Nigeria as it serves as one of the component of their diet [4]. It is a source of dietary carbohydrate for humans. Fresh ripe maize could be boiled and eaten as food, and when dry, maize grains are used for brewing and distillation of alcoholic drinks. Maize flour could be used in bakeries and production of laundry starch. However, the problem with maize production has been attributed to attack by a wide range of insect pests including weevils, beetle and moths [5]. *Sitophilus zeamais* is a serious primary and a major pest of maize in Nigeria and other parts of the world, responsible for most of the losses incurred in maize production annually [6].

Both the larval and adult stages of this field-to-store insect destroys the inner segment of the grain, leading to total weight loss of the grains [7].

Recently, controlling many of these destructive insect pests has strictly been carried out with the use of synthetic insecticides which reportedly have many negative impact on the non-targeted organism thus impeding their widespread use nowadays. Also high cost of procurement, pest resurgence and resistance, poisonous residue accumulation in foods, risks of user's contamination, and effect on both human and environmental health is also an area of concern. Hence public awareness of the adverse effects of synthetic chemical insecticides has called for the urgent need to find a safer alternatives that could equally contend with chemical insecticides in action both preferably and adequately. In order to avert the use of synthetic chemical insecticides, research interest have been focused on the plant kingdom as a new tool of controlling insect pests of stored products [8, 9, 10, 11]. Hence, the objective of this research was to investigate the contact toxicity of four different medicinal plants oil extracts against *S. zeamais.*

2. Materials and Methods

2.1 Sample collection and identification

The plants evaluated in this work were *Eucalyptus camaldunensis*, *Thuja orientalis*, *Hyptis suaveolen* and Lemon Grass (*Cymbopogon spp.*). They were obtained in fresh form from a farm land around Akungba-Akoko, Ondo State, Nigeria and authenticated in the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba Akoko, Ondo State Nigeria.

2.2 Extraction of the essential oil by hydro distillation

Prior to extraction, fresh aerial parts of the plants were washed off sand and other impurities, and were cut into small pieces. The plant materials (*Eucalyptus camaldunensis* (EC), *Thuja orientalis* (TO), *Hyptis suaveolen* (HS) and Lemon Grass (LG) (*Cymbopogon spp.*), were then subjected to exhaustive hydro distillation for about two hours in all glass Clevenger apparatus. The pure oil obtained was dried over anhydrous magnesium sulphate, transferred into sample bottle and stored in the refrigerator until ready for analysis.

2.3 Rearing of s. zeamais (insect culture)

The parent stock of *S. zeamais* used for this study was obtained from Research Laboratory of the Department of Environmental Biology and Fisheries, Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria where the research was undertaken. The insects were cultured in the laboratory under ambient temperature of 28±2ºC and 75±5% relative humidity. This was done by weighing 800g of the maize grains into a kilner jar. Fifty unsexed adult of *S. zeamais* were then introduced into the kilner jar and kept in the laboratory for one month for the insects to lay eggs and multiply. New generations of the maize weevil were subsequently reared on cleaned disinfested maize grains in the laboratory (without prior exposure to insecticides).

2.4 Identification and sexing of adult sitophilus zeamais

The identification and sexing of *S. zeamais* was carried out using Binocular Microscope. According to some study, it was observed that the females have comparatively longer abdomen and the dorsal side of the terminal segment is only slightly bent downward. The female also has two dark visible spots on their elytra [12]. In contrast male have comparative shorter abdomen and the dorsal side of the terminal segment is sharply curved downward and inward [13].

2.5 Application and assessment of the extracted oils for insecticidal activity on *sitophilus zeamais*

2.5.1 Toxicity of oil extracts on mortality of adult Sitophilus zeamais

Twenty grams of clean and undamaged maize grains were weighed into 250ml plastic containers and portions of 0.1, 0.2, 0.3, 0.4, 0.5 and 1.0/ml of each plant oils were measured with a calibrated syringe and each was thereafter added to the 20g of the clean and undamaged maize grains, each container was gently shaken to ensure thorough mixture of the oils and grains. Control treatments were also set up, without extracted oils (untreated control). Ten pairs of adult insects were introduced into each container and covered. Four replicates of the treatments and untreated controls were laid out in Complete Randomized Design. Adult mortality was observed after 24, 48, 72 and 96hours of application.

Both dead and alive insects were removed on the fourth day and experiments were left for 35days to allow for adult emergence of F1 generation and the numbers of emerged adults were counted with an aspirator. At week 6, the grains were reweighed by using Metler weighing balance.

2.5.2 Toxicity of oil extract on oviposition and adult emergence of adult s. zeamais

After 35 days, the containers were sieved out and newly emerged adult maize weevils were counted and recorded, however the four plants oil extract evoked almost 100% mortality, and as a result of this no egg was laid because the adult *S. zeamais* were unable to mate after treatment hence no adult emergence, in contrast to the control (untreated maize grains) where there is adult emergence.

2.6 Data analysis

Four replicates of the treatments and untreated controls were laid out in Complete Randomized Design. The adult mortality was assessed after every 24 hours for 4 days. Adults were considered dead when probed with sharp objects and there were no responses. On day 5, all insects, both dead and alive were removed from each container and the seeds returned to their respective containers. Progeny emergence (F1) was then recorded at 5 weeks (35 days). The containers were sieved out and newly emerged adult weevils were counted with an aspirator. At week 6, the grains were reweighed by using Metler weighing balance and the percentage loss in weight was determined as follow.

$$\%weight = \frac{initial\ weight - final\ weight}{final\ weight} \times \frac{100}{1}$$

After re-weighing, the numbers of damaged grains were evaluated by counting wholesome and bored or seed with weevil emergent holes. Percentage seed damaged was also calculated as follows:

$$\%\,Seed\ \ damage = \frac{Number\ \ of\ \ perforated\ grains}{Total\ number\ of\ \ grains\ counted} \times \frac{100}{1}$$

3. Results and Discussion

3.1 Some characteristics of the essential oils

Table 1 shows some characteristics of the essential oils. The highest oil yield was observed in *Cymbopogon citratus* with 3.14ml per kilogram weight of the fresh leaves and the least was found in *Hyptis suaveolen* with 0.35ml per kilogram. Other parameters such as colour, local usage are stated in table 1.

Table 1: Some physical characteristics of the plants

S/N	Plant material	Family	Common name	Vernacular	Used part	Colour of extracted oil	Local usage	Yield (ml/kg)
1	*Eucalyptus camaldunensis*	Myrtaceae	Redriver gum	-	Leaves	Pale yellow	Treatment of diarrhea	2.90
2	*Hyptis suaveolen*	Lamiaceae	Spikenard	Thopo	Leaves	Clear	Treatment of fever	0.35
3	*Thuja orientalis*	Cupressaceae	Oriental arbor-vitae	-	Leaves	Pale yellow	Treatment of cancer	0.71
4	*Cymbopogon citratus*	Gramineae	Lemon grass	Ewe tea	Leaves	Pale yellow	Treatment of malaria	3.14

3.2 Chemical composition review of the plants used

Lemon grass (*Cymbopogon citratus), Eucalyptus camaldunensis, Thuja orientalis* and *Hyptis suaveolen* oils have been reported in literature by the use of GC-MS (gas chromatography and mass spectrophotometer) analysis, to consist of diverse chemical constituents of which the active components of their essential oils has been studied and known to be responsible for their insecticidal activities on various organisms. Table 2 shows the result of GC and GC/MS analyses of the essential oil of *Thuja orientalis*, by some researchers. 21 components were identified representing 94.0% of the total oil, in the study from India, while study from Iran through GC/MS analyses identified 23 components. *α*-Pinene (29.2%), 3-carene (20.1%), *α*-cedrol (9.8%), caryophyllene (7.5%), *α*-humulene (5.6%), limonene (5.4%), *α*-terpinolene (3.8%) and *α*-terpinyl acetate (3.5%) were the main constituents, in the study from India, while in that of iran, *α*-Pinene (35.2%,50.7%), Δ-3-carene(6.3%,13.8%), caryophyllene (5.8%,4.1%) and *α*-cedrol (14.6%,6.9%) were identified as the most abundant component of the leaves and fruits oil respectively. From the result in table 2, it was observed that the major component in all the regions under investigation was α-pinene, 3-carene, β-caryophyllene, limonene, though with different concentration from region to region but these compounds were the dominant compounds in each region. The variation in chemical compositions may be due to the following factors: soil types, geographical factors, season of harvesting, physiological variation, cultivation conditions, chemotypes (maker compounds), and post-harvest processing etc [14]. Table 3 shows the chemical composition and comparison of the oil constituents of *Hyptis suaveolen* obtained by the hydro distillation method from different regions. It was observed from the table that β-carophyllene, α-bergamotene, α-humulene and 1,8-cineole have the highest percentage as major constituent of the essential oil, although there are variation in the constituents which can be attributed to differences previously reported above.

Table 2: Chemical composition of the essential oil of the aerial parts of *Thuja orientalis* in different location

Oil compositions	A (%conc.) [15]	B (%conc.) [16]	C (%conc.) [14]
α-pinene	35.2	22.5	29.2± 0.3
α-fenchene	1.2	-	1.3
Sabinene	1.5	0.55	0.5
β-pinene	0.1	0.9	0.9
Myrcene	3.3	2.18	1.6
α-phellandrene	1.6	-	0.5
3-Carene	6.3	20.65	20.1± 0.3
ρ-Cymene	1.4	0.51	-
Limonene	6.1	3.35	5.4
γ-terpinene	0.4	-	0.2
Terpinolene	2.1	4.53	3.8
Terpinen-4-ol	0.1	0.61	0.3
Bornyl acetate	0.7	0.78	0.5
α-terpenyl acetate	0.5	2.75	3.5
β-elemene	0.7	0.39	0.5
β-cedrene	1.8	-	0.8
β-caryophyllene	5.8	6.13	7.5
Thujopsene	2.1	-	-
α-humulene	1.0	5.68	5.6
Elemol	1.5	-	0.6
α-cedrol	14.6	18.71	9.8±0.2

However, 1, 8-cineole was found to be predominant in the Australia species of the plant but is not much in other regions as seen in table 3. Table 4 shows the comparison of the oil constituents of *Eucalyptus camaldunensis* obtained by the hydro distillation method from different regions. It can be observed from the table that 1, 8-cineole has the highest percentage as a constituent of the essential oil in Argentina but not found in United Kingdom. More also, terpinolene was found to be present in the oil of United Kingdom but not found in Argentina. Other components that are present in both regions are α-pinene, γ-terpinene and β-pinene.

Table 5 shows the comparison of the oil constituents of *Cymbopogon citratus* obtained by the hydro distillation method from different regions. From the results, it was observed that the major components in all the regions under investigation were myrcene, neral, geraniol, and geranial though with different concentration from region to region but these compounds were the dominant compounds in each region. The variation in chemical compositions may be due to the following factors as earlier mentioned soil types, geographical factors, season of harvesting, physiological variation, cultivation conditions, chemotypes (maker compounds), and post-harvest processing etc.

Table 3: Chemical composition of the essential oil of the aerial parts of *Hyptis suaveolen* in different locations

Oil compositions	D (%conc.) [17]	E (%conc.) [18]	F (%conc.) [19]
α- pinene	1.32	2.5	0.12
Sabinene	9.97	3.9	1.39
2-β-pinene	4.80	4.2	0.31
α-terpinene	0.67	-	0.08
Limonene	5.04	-	0.35
1,8-cineole	7.12	32	4.02
γ –terpinene	1.08	0.7	-
α-terpinolene	8.64	0.3	0.08
Fenchol	-	0.3	1.17
Terpinen-4-ol	3.62	2.3	0.98
β-elemene	0.60	1.0	1.62
β-caryophyllene	24.03	29	34.65
α-bergamotene	2.63	2.0	6.56
α-humulene	1.53	1.6	2.28
β-selinene	1.16	-	1.57
Bicyclogermacrene	6.02	-	10.32
Spatulenol	3.44	-	-
Caryophylene oxide	2.99	-`	0.65
Bergamotol	2.76	-	1.13

Table 4: Chemical composition of the essential oil of the aerial parts of *Eucalyptus camaldunensis* in different locations

Oil compositions	G (%conc.) [20]	H (%conc.) [21]	I (%conc.) [22]
β-pinene	0.1	9.2	0.34
α- pinene	5.4	4.6	2.35
α- thujene	0.6	-	0.14
Myrcene	0.2	0.7	0.84
Camphene	1.6	0.1	0.26
α-phellandrene	-	-	2.82
1,8-cineole	58.9	40	-
y-terpinene	2.8	-	2.72
Para-cymene	2.1	4.7	3.94
Terpinolene	-	0.4	5.64
α-terpineol	2.7	5.1	1.66
Cryptone	1.1	0.1	0.51
α-terpenyl acetate	2.1	-	0.09
Globulol	1.6	5.4	-

Table 5: Chemical composition of the essential oil of the aerial parts of Lemon Grass (*Cymbopogon citratus*) in different locations.

Oil compositions	J (% conc.) [23]	K (% conc.) [24]	L (% conc.) [25]
Myrcene	11.41	15.69	3.18
β-Ocimene	0.69	0.97	0.9
Linalool	1.29	1.03	0.58
Citronellal	0.12	0.60	0.21
Nerol	0.34	0.17	3.14
β-Citronellal	0.34	-	-
Neral	33.31	34.98	31.5
Geraniol	3.05	0.53	-
Geranial	39.53	40.72	43.95
Geranyl acetate	0.24	0.51	1.06
β-Caryophyllene	0.15	0.28	-

3.3 Effect of plant oils on mortality of *S. zeamais*

Table 6 below shows the effect of *H. suaveolen*, *T. orientalis, C. citratus, and E. camaldunensis* oils on the mortality of maize weevil (*S. zeamais*). All the plants oil at all tested concentration evoked above 85% mortality after 48 hours of post treatement. *T. orientalis* oil evoked 80%, 95%, 100%, 100%, 100%, and 100% mortality of adult *Sitophilus zeamais* at rates of 0.1ml/20g, 0.2ml/20g, 0.3ml/20g, 0.4ml/20g, 0.5ml/20g, and 1.0ml/20g of maize grain after 24hours of post treatment respectively. Similarly, *H. suaveolen* caused 90%, 95%, 100%, 100%, 100%, and 100% mortality of *Sitophilus zeamais* at rates of 0.1ml/20g, 0.2ml/20g, 0.3ml/20g, 0.4ml/20g, 0.5ml/20g, and 1.0ml/20g of maize grain after 24 hours of post treatment respectively.

However the grains treated with the oil obtained from *C. citratus* aeriel part there was 85%, 90%, 95%, 100%, 100%,and 100% mortality of adult *Sitophilus zeamais* at rates of 0.1ml/20g, 0.2ml/20g, 0.3ml/20g, 0.4ml/20g, 0.5ml/20g, and 1.0ml/20g of maize grain after 24hours of post treatment respectively, while *E. camaldunensis* evoked 100% mortality of *Sitophilus zeamais* at rates of 0.1ml/20g, 0.2ml/20g, 0.3ml/20g, 0.4ml/20g, 0.5ml/20g, and 1.0ml/20g of maize grain after 24 hours of post treatment respectively.

It can be drawn from the table that all the plants oil evoked 100% mortality of adult *Sitophilus zeamais* at the rates of 0.4ml/20g, 0.5ml/20g, and 1.0ml/20g of maize grain after 24hours of post treatment, but there was no significant different ($p > 0.05$) in mortality of adult *Sitophilus zeamais* among the grains treated with *H. suaveolen, T. orientalis, C. citratus*, and *E. camaldunensis* oils causing 100% mortality at all concentration after 72hours of post treatment. *S. zeamais* mortality in grains treated with different oil extract of *E. camaldunensis, T. orientalis, Lemon grass,* and *H. suaveolen oils* was significantly ($p< 0.05$) different from weevil mortality in untreated grains (Table 6). Adult mortality increased with the length of exposure.

The highest weevil mortality of 100% was recorded in maize grains treated with oil extract of *E. camaldunensis* (0.2ml) at 24 hours post treatment, and it was significantly different from weevil mortality of 95% and 90% in grains treated with *T. orientalis, H. suaveolen* and lemon grass oil extracts (at 0.2 ml) respectively. However, the oil extracts of *E. camaldunensis*, and *H. suaveolen, and C. citratus* shows a higher effectiveness than the oil of *T. orientalis* as they presented 100% mortality of *S. zeamais* within 48h of application at all concentrations. Moreover, the extract of *E. camaldunensis* shows the greatest mortality of *S. zeamais* as it was the only one that achieved 100% mortality of all insects within 24hours at all concentrations since all insect was found dead.

3.4 Effects of oil extracts on the Oviposition and Adult Emergence of adult *Sitophilus Zeamais*

All the different oil extract tested in this study inhibits the oviposition of adult *Sitophilus zeamais* because after 35 days of treatment there is no evidence of adult emergence as shown in the table 7 below, which may be attributed to the inability of the maize weevil to mate after treatment with the oil extracts [26].

Table 6: % mortality of adult maize weevil, *Sitophilus zeamais* on maize grains treated with some plant essential oils.

Plant essential oil	Dosage ml/20g	% Mortality (Mean ± SE) 24 hrs	48 hrs	72 hrs	96 hrs
TO	0.1	80.00±8.17^{b}	90.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.2	95.00±2.9^{bc}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.3	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.4	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.5	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	1.0	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
EC	0.1	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.2	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.3	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.4	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.5	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	1.0	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
HS	0.1	90.00±4.08^{bc}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.2	95.00±2.89^{bc}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.3	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.4	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.5	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	1.0	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
CC	0.1	85.00±2.89^{b}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.2	90.00±4.08^{bc}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.3	95.00±2.89^{bc}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.4	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	0.5	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
	1.0	100.00±0.00^{c}	100.00±0.00^{b}	100.00±0.00^{b}	100.00±0.00^{b}
Control (untreated)	0.0	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}

Each value is a mean ± standard error of four replicates. Means followed by the same letter along the column are not significantly different (p>0.05) using New Duncan's Multiple Range Test.

Twenty grams of clean maize grains were placed in 250ml plastic container and 0.1ml, 0.2ml, 0.3ml, 0.4 ml, 0.5ml and 1.0ml of their oil extract was added. The maize grains and the extracts were thoroughly mixed before the introduction of a copulating pair of newly emerged (0–24 h-old) adult *S. zeamais*. The containers were then covered with lid. A control experiment containing untreated grains was also set up. Each treatment and control was repeated four times. The treatments were left for 7 days in a wooden cage in the laboratory. Afterward, the total number of eggs laid was counted and recorded. This was achieved by identifying the egg plugs of *S. zeamais* after staining S. *zeamais* with acid fuchsin dye solution [12]. The experimental set up was kept inside the insect rearing cage for further 35 days for the emergence of the first filial (F1) generation. The containers were sieved out and newly emerged adult maize weevils were counted and recorded, however the four plants oil extract evoked almost 100% mortality, and as a result of this no egg was laid because the adult *S. zeamais* were unable to mate after treatment hence no adult emergence, in contrast to the control (untreated maize grains) where there is adult emergence.

However at (p>0.05) the result obtained for the effect of the oil extracts on the oviposition of treated maize grains were significantly different from that of the control (untreated maize grains) where about 34 eggs were laid by the adult *S. zeamais* and about 20% of the laid eggs by the adults *S. zeamais* in the control emerged which is approximately 58, as shown in table 7. The result obtained from this study showed that the oil extract of *H. suaveolen, T. orientalis, C. citratus,* and *E. camaldunensis* aerial part were toxic to the maize weevil *S. zeamais* and suppressed their population growth in treated maize grains.

Table 7: Oviposition and adult emergence of adult *S. zeamais* in maize grain treated with some plant essential oils

Plant essential oils	Dosage (ml)	Mean number of eggs laid	% Adult emergence
TO	0.1	0.00±0.00^{a}	0.00±0.00^{a}
	0.2	0.00±0.00^{a}	0.00±0.00^{a}
	0.3	0.00±0.00^{a}	0.00±0.00^{a}
	0.4	0.00±0.00^{a}	0.00±0.00^{a}
	0.5	0.00±0.00^{a}	0.00±0.00^{a}
	1.0	0.00±0.00^{a}	0.00±0.00^{a}
EC	0.1	0.00±0.00^{a}	0.00±0.00^{a}
	0.2	0.00±0.00^{a}	0.00±0.00^{a}
	0.3	0.00±0.00^{a}	0.00±0.00^{a}
	0.4	0.00±0.00^{a}	0.00±0.00^{a}
	0.5	0.00±0.00^{a}	0.00±0.00^{a}
	1.0	0.00±0.00^{a}	0.00±0.00^{a}
HS	0.1	0.00±0.00^{a}	0.00±0.00^{a}
	0.2	0.00±0.00^{a}	0.00±0.00^{a}
	0.3	0.00±0.00^{a}	0.00±0.00^{a}
	0.4	0.00±0.00^{a}	0.00±0.00^{a}

	0.5	0.00±0.00^a	0.00±0.00^a
	1.0	0.00±0.00^a	0.00±0.00^a
CC	0.1	0.00±0.00^a	0.00±0.00^a
	0.2	0.00±0.00^a	0.00±0.00^a
	0.3	0.00±0.00^a	0.00±0.00^a
	0.4	0.00±0.00^a	0.00±0.00^a
	0.5	0.00±0.00^a	0.00±0.00^a
	1.0	0.00±0.00^a	0.00±0.00^a
Control (Untreated)	0.0	34.25±2.27^b	58.40±2.61^b

Each value is a mean ± standard error of four replicates. Means followed by the same letter(s) along the column are not significantly different (p>0.05) using New Duncan's Multiple Range Test.

The toxicity of *E. camaldunensis* may be attributed to the toxicity of some of its chemical constituents to the insect pest, the main constituent in *E. camaldunensis* are reported to be 1, 8-cineole, α-pinene and β-phellandrene. The monoterpene 1,8-cineole possesses a broad insecticidal activity against stored-product insects, as more detailed study demonstrated the potent toxic effect of 1,8-cineole against some stored-product insects. Therefore, the higher toxicity of the Eucalyptus oil as part could be attributed to higher concentrations of the 1, 8-cineole [27, 28].

The main components of *P. orientalis* leaves oils and fruit oils were reported to be α-pinene, sabinene and α-cedrol Δ -3-carene, Limonene, β-caryophyllene, myrcene, ρ-cymene, and β-phellandrene. However, Limonene, α- pinene, terpinolene, and bornyl acetate are the main components of *P. orientalis* oil that have insecticidal activity [29, 30, 31]. For example, limonene had insecticidal and repellent bioactivities to *T. castaneum.* As the major constituents of *P. orientalis* are monoterpenoids, which are typically volatile and rather lipophilic compounds that can penetrate into insects rapidly and interfere with their physiological functions. Toxic effect of myrcene has also been evaluated on *S. oryzae*, so the toxic effects of *P. orientalis* oil could also be attributed to α-pinene and other components [32, 33, 34].

Citral, neral and geranial are the main constituent in lemon grass essential oil. Citral is an essential raw material used in the pharmaceutical, perfumery and cosmetic industries, ususally used for the synthesis of Vitamin A. The insecticidal activity *of C. citratus* is assigned conventionally to Citral, its major component. This isomeric mix has been used as a steaming agent against *Culex pipiens quinquefasciatus*, due to the antifeeding activity of neral and geranial, therefore the toxicity of the oil extract of lemon grass may be attributed to the presence of these constituent [35, 36, 37].

However in *H. suaveolin* as literature shows, β -caryophyllene and 1,8 cineole showed broad spectrum activity against *Aspergilus* species [38] and these is suggested to be responsible for its toxicity on the adult *S. zeamais* treated with the plant oil extract in agreement to previous studies of plants that has some of these constituents discuss ealier. The high mortality effect of these botanical oil extracts could be due to the inability of the insects to feed on the maize grains that has been coated with these botanicals, thereby leading to their starvation. The oils may have also blocked the spiracles of these insects hence disrupting the normal respiratory activities of these insects leading to the asphyxiation, and death [7]. The results obtained from this study agrees with the previous studies in which oils of *E. camaldunensis, T. orientalis, H. suaveolen* and *C. citratus* have been used as protectant against different storage insects and this justified that their oil extract can be used as biopesticides against *S. zeamais*.

4. Conclusion

The results obtained from this study confirmed that *H. suaveolen, T. orientalis, C. citratus*, and *E. camaldunensis* oils extracts, shows a broad insecticidal activity against the tested insect (*S. zeamais*) even at the lowest oil volume adopted in this study. Hence it can be recommended that the oil extracts of these plants could serve as an alternative to synthetic insecticides, as the oil extract is relatively non- toxic to humans, easily bio-degradable, and they are relatively cheap when compared to the synthetic pesticides.

5. References

1. Virendra PS, Diwaker P. Extraction of essential oil and its applications. A World of Aromatherapy.com/essential oils; Rourkela, 2006, 6.
2. Kumar KS. Extraction of essential oil using steam distillation, Dept. of Chemical Engineering, National Institute of Technology, Rourkela, 2010, 3-4.
3. Suresh W, Koul O, Dhaliwal GS. Essential oil as green pesticides. Biopestic. Int. 2008; 4(1):63-64.
4. Ileke KD, Odeyemi OO, Ashamo MO. Response of cowpea bruchid, *Callosobruchus maculatus* (Fabr.) [Coleoptera: Chrysomelidae] to cheese wood, *Alstonia boonei* de wild stem bark oil extracted with different solvents. Archives Phytopathology and Plant Protection. 2013; 46(11):1357-1360.
5. Ogungbite OC, Oyeniyi E. *Newbouldia laevis* (Seem) as an Entomocide against *Sitophilus oryzae and Sitophilus zeamais* Infesting Maize Grain. Jordan Journal of Biological Science. 2014; 7(1):49-55.
6. Nwana IE. A survey of storage coleoptiles which attack dry cocoyam chips in Nigeria were previously protected with plant extracts. Journal of Stored Product Research. 1993; 29(1):95-98.
7. Adedire CO. Ecology and control of insect pests of stored grains. African Journal of Agricultural Research. 2001; 6(13):59.
8. Akinkurolere RO. Assessment of the insecticidal properties of Anhomanes difformis (P. Beauv.) powder on five beetles of stored produce. Journal of Entomology. 2007; 4(1):51.
9. Akinneye JO, Ogungbite OC. Insecticidal activities of some medicinal plants against Sitophilus zeamais (Motschulsky) (*Coleoptera: Curculionidae*) on stored maize. Archive Phytopathology Plant Protect. 2013; 46(10):1206-1208.
10. Ashamo MO, Akinnawonu O. Insecticidal efficacy of some plant powders and extracts against the Angoumois grain moth, *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae). Archive Phytopathology Plant Protect. 2012; 45(9):1051-1052.
11. Ogungbite OC, Oyeniyi E. Newbouldia laevis (Seem) as an Entomocide against *Sitophilus oryzae and Sitophilus zeamais* Infesting Maize Grain. Jordan Journal of Biological Science. 2014; 7(1):49-52.

12. Odeyemi OO, Daramola AM. Storage practices in the tropics: Food storage and pest problems. First Edition, Dave Collims Publication, Nigeria. 2000; 2:233-235.
13. Ileke KD. Insecticidal and toxicological studies of Alstonia boonei De Wild used as cowpea protectant against *Callosobruchus maculate.* Archives Phytopathology and Plant Protections. 2014; 46(10):29-30.
14. Sanjay G, Ashok K, Ashok T. Chemical composition and fungitoxic activity of essential oil of Thuja Orientalis L.grown in the north-western Himalaya. Agricultural Research and Extension Centre, Kangra (HP) _176001, India, 2008, 210.
15. Seyed MH, Mehdi TO, Seyed AS. Chemical constituents and toxicity of essential oils of oriental arborvitae, *Platycladus orientalis* against three stored product beetles. Chilean Journal of agricultural research. 2012; 72(2):190.
16. Mohamad JK, Ghaytha M, Bahira Z. Antibacterial and Phytochemical Investigation of *Thuja orientalis* (L.) Leaves Essential Oil from Syria. International Journal of Current Pharmaceutical Review and Research. 2016; 7(5):243-245.
17. Umedum L, Nwajagu U, Udeozo PI, Anarado EC, Egwuatu CI. The Efficacy of *Hyptis Suaveolens.* European journal of medicinal plants. 2014; 4(6):647.
18. Peerzada N. Chemical Composition of the essential oil of Hyptis Suaveolen. Journal (molecules). 1997; 2(3):167-168.
19. Moralita C, Amri B, Mansyurdin, Perri A. Chemical Components of Essential Oils of the Leaves of *Hyptis suaveolens* (L.) Poit from Indonesia. American Journal of Research Communication. 2014; 2(10):30-38.
20. Leicach SR, Yaber MA, Grass HD, Chludil AM. Chemical defenses in eucalyptus species; a sustainable strategy based on antique knowledge to diminish agrochemical dependency. New advances and contributions to Forestry Research. 2014; 13(4):226-227.
21. Pagula FP. Essential oil composition of *Eucalyptus camaldunensis* Dehn from Mozambique. Journal of essential oil research. 2000; 12:333.
22. Alastair CL, Mustafa ZO, Fahretin G. Composition of *Eucalyptus camaldunensis* volatiles using direct thermal desorption. Journal of chromatographic science. 2008; 46(2):82-85.
23. Josphat C, Matasyoh I, Wagara N, Jesca L, Anderson M. Chemical composition of Cymbopogon citratus essential oil and its effect on mycotoxigenic Aspergillus species. International Food Research Journal. 2010; 19(2):140-142.
24. Mohamed AR, Sallam YI, El-Leithy AS, Safaa EA. Lemongrass (*Cymbopogon citratus*) essential oil as affected by drying methods. Annals of Agricultural Science. 2012; 57(2):113-116.
25. Tajidin NE, Ahmad SH, Rosenani AB, Azimah H, Munirah M. Chemical composition and citral content in lemongrass (*Cymbopogon citratus*) essential oil at three maturity stages. African Journal of Biotechnology. 2011; 11(11):2685.
26. Nwana IE. A survey of storage coleoptiles which attack dry cocoyam chips in Nigeria were previously protected with plant extracts. Journal of Stored Product Research. 1993; 29(1):95.
27. Della BE, Fernandes BV, Almeida JH, Barros NF. Efeito do extrato de serrapilheira de *Eucalyptus* sobre o crescimento microbiano. Pesq. Agropec. Bras. 1989; 24(2):1523-1528.
28. Moura VTL, Marques MS, Gonçalves LMB, Scotti MRM, Valle MTS, Lemos FJP. Nodulação e crescimento de leguminosas cultivadas em solos coletados sob eucaliptal e sob mata atlântica: relação com os efeitos alelopáticos do Eucalyptus. R. Bras. Ci. Solos. 1996; 20:399-405.
29. Hassanzadeh MK, Rahimizadeh BS, Fazly BH, Emami SA and Assili JS. Chemical and antimicrobial studies of *Platycladus orientalis* essential oils. Pharmaceutical Biology. 2001; 3(9):388-390.
30. Nickavar B, Amin G, Parhami S. Volatile constituents of the fruit and leaf oils of *Thuja orientalis* L. grown in Iran. Verlag der Zeitschrift für Naturforschung. 2003; 58c:171-172.
31. Emami SA, Asili M, Malekian S, Hassanzadeh MK. Antioxidant effects of the essential oils of different parts of *Platycladus orientalis* L. (Franco) and their components. Journal of Essential Oil Bearing Plants. 2011a; 1(4):54-56.
32. Garcia M, Donadel OJ, Ardanaz CE, Sosa ME. Toxic and repellent effects of *Baccharis salicifolia* essential oil on *Tribolium castaneum*. Pest Management Science. 2005; 6(1):104-105.
33. Lee BH, Lee SE, Annis PC, Pratt SJ, Park BS, Tumaalii F. Fumigant toxicity of essential oils and monoterpenes against the red flour beetle, *Tribolium castaneum* Herbst. Journal of Asia-Pacific Entomology. 2002; 2(5):237-240.
34. Coats JR, Karr LL, Drewes CD. Toxicity and neurotoxic effects of monoterpenoids in insects and earthworms. Hedin, P.A. (ed.) naturally occurring pest bioregulators. ACS Symposium Series N° 449z. *American Chemical Society*, Washington DC, USA, 1991, 305-316.
35. Efraim L, Nativ D, Yaakov T, Irena K, Uzi R, Eli P *et al*. Localization of Citral Accumulation in Lemongrass Leaves (*Cymbopogon citratus* (DC.) Stapf. Poaceae). Annals of Botany. 1998; 12(4):101-103.
36. Leal WS, Uchida K. Application of GC-EAD to the determination of mosquito repellents derived from a plant, *Cymbopogon citratus.* J Asiaschultzei (Thysanoptera: Thripidae) and Myzus persicae (Hemiptera: Aphididae). Bioscience. Journal. 1998; 29(6):1840-1847.
37. Yang P, Ma Y, Zheng S. Adulticidal activity of five essential oils against *Culex pipiens quinquefasciatus*. Journal of Pest Science. 2005; 30(2):84-89.
38. Ana CP, Moreira OL, Paulo AW, Egberto SC, Evandro LS. Chemical components of essential oils of the leaves of *Hyptis suaveolen*, Brazilian Journal of Microbiology. 2014; 41(2):30-37.