Africa Journal of Physical Sciences Vol. 6, pp. 77-87, June 2021
http://journals.uonbi.ac.ke/index.php/ajps/index
ISSN 2313-3317

Comparative Study on Insecticidal Activity of Permethrin with Dust Formulated Essential Oils of *Monodora myristica, Syzgum caryophyllatum (L) Alston* and *Pinus slvestris*

ADEBISI Segun Akanmu[1a*], AWOJIDE Shola Hezekiah[1b], BAKARE Roheemat Ayobami[1c], and ADEDOTUN Ifeoluwa Samuel[1d]

[1]Department of Pure and Applied Chemistry, Osun State University, Osogbo, Nigeria

[a*]segun.adebisi@uniosun.edu.ng, [b]shola.awojide@uniosun.edu.ng, [c]oluwaseun_joy@yahoo.com, [d]ifeoluwa.adedotun@uniosun.edu.ng

ARTICLE INFO

Available online: 30th June, 2021

Keywords:
Monodora myristica pine needle
stored-grain insects
Syzgum caryophyllatum
Pinus sylvestris.

ABSTRACT

A study was conducted to determine the insecticidal activity of essential oils of Monodora myristica African Nutmeg, Pinus sylvestris pine essential oil and Syzgum caryophyllatum (l) alston clove essential oil on Acanthoscelides obtectus bean weevil, Camponotus pennsylvanicus Carpenter ant and Sitophilus oryzae rice weevil at different exposure time. The essential oils were obtained from the plant materials by steam distillation using Clavenger type apparatus. The major components of the essential oils were determined using Gas Chromatography-Mass Spectrometry. The essential oils were formulated with clay and chalk which serve as the carrier 5%w/w using acetone as the co-solvent. A control formulation was also prepared by mixing 1.5ml of the acetone with chalk and clay respectively. It was observed that the essential oil of Syzgum caryophyllatum (l) alston has the highest insecticidal activities followed by Monodora myristica and lastly Pinus sylvestris. Permethrin also has high insecticidal activities but depreciate fast on exposure. The major components of essential oil of Pinus sylvestry are α-pinene 27.17%, 3-Cyclo 21.82%, borneol 6.75%, Syzgum caryophyllatum (l) alston constituents are eugenol 75.90%, Eugenol acetate 17.53%, benzene, 1-ethyl-3-nitro 9.12%, benzoic acid, 3-(1-methylethyl) 7.95% and β–caryophyllene 5.91% and Monodora myristica with Linalool 91%, Sabinol-cis 17.87%, tr-13-octadecenoie 25.18% and palmitic acid 7.66%. The essential oils of Pinus sylvestry, Monodora myristica and Syzgum caryophyllatum (l) alston have insecticidal activity .

ISSN 2313-3317

INTRODUCTION

An insecticide is a pesticide used against insects which includes the ovicides and larvicides used against the eggs and larvae of insects respectively. Insecticides are used in agriculture, medicine, industry and general home use. The use of insecticide is believed to be one of the major factors behind the increase in agricultural productivity in the 20th century [1]. Nearly all insecticides have the potential to significantly alter ecosystems, many are toxic to human and others are concentrated in the food chain.

Essential oils are complex mixtures of volatile compounds particularly abundant in aromatic plants and are mainly composed of terpenes biogenerated by the mevalonate pathway. These volatile molecules include monoterpenes and also sesquiterpenes. Essential oils do not form a distinctive category for any medical, pharmacological, or culinary purpose [2]. Recent findings have found synthetic insecticides to be the cause of environmental pollution due to their constant usage, it is then important to introduce chemicals that are found in nature and are easily degradable. Essential oil has been found to be safe, easily degradable and capable of getting rid of insects [3].

Botanical insecticides are naturally occurring insecticides that are derived from plants [4]. Plant extracts play an increasingly prominent role as alternatives to synthetic pesticides due to the increasing concern on health hazards, environmental pollution and negative effects on non-target organisms [5]. There is hope that botanical pesticides will take a long way in fighting the dangers associated with conventional pesticides, however, there is also need to check for their risk assessment and hazard characterization in relation to human intake for a given time [6]. Botanical pesticides are observed to have a broad spectrum of activity, being easy to process, having a short residual activity and for not accumulating in the environment or in fatty tissues of warm blooded animals [7]. They act in many ways on various types of pests and can be applied to plants or stored products in the same way as other conventional insecticides [8]. Many essential oils are known to possess ovicidal, repellent and insecticidal activities [8].

However, it is important to note that botanical pesticides, much as they are derived from plants, do not guarantee safety to humans and the environment [9]. There is a need to carry out intensive studies on African plants and their possible usage in pesticide elimination. Botanical pesticides, if sufficiently exploited, can play a big role in reducing pollution, health risks and crop losses to pests. Studies have been conducted in accessing the insecticidal activities of various plants, but much emphasis have not being placed on the effects of this essential oil in relation to exposure time as well as the minimal concentration of formulation needed to achieve the desired effect. In this study, the insecticidal activities of essential oil from *M. myristica*, *P. sylvestris and S. caryophyllatum* against *A. obtectus*, *Sitophilus oryzae* and *C. pennysylvanicus* was evaluated in relation to the exposure period at various concentrations. The objective was to examine the possibility of replacing synthetic insecticides with less toxic and biodegradable plant sourced insecticides.

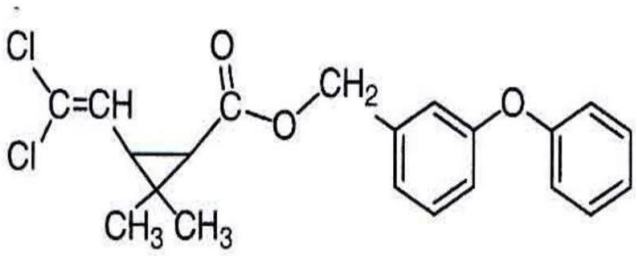

Figure 1: Structure of permethrin

1. MATERIALS AND METHODS

PLANT COLLECTION

Pinus sylvestris needles, clove needles and African nutmeg seeds were gotten from Oke Bale Market near Osun State University Osogbo, Osun State, Nigeria and authenticated in the Department of Biological Science, Osun State University Osogbo, Nigeria.

SAMPLES COLLECTION

Clay soil was collected from the garden of Osun state University. Calcium carbonate ($CaCO_3$) commercially known as chalk was purchased from a local market at Oja-Oba in Osogbo, Osun State. All other materials were of analytical grades.

INSECT COLLECTION

The founding insect culture of rice weevil (*S. oryzae)* and bean weevil *(A. obtectus)* were collected and stored in 5-litres plastic container at room temperature. The sampling was done thrice with five insects each of the trio insect samples. Adult insects were stored in 1-litre glass jars. To allow air passage, a hole 2cm in diameter was opened in the centre of each jar lid and a sterile cloth was glued to the underside of each jar.

ANT COLLECTION

The founding carpenter ants (*C. pennsylvanicus)* were collected in a warm environment with warm soil insect inside a transparent container, water were added to the soil to retain the warmness in it. Five ants were collected per regime of sampling.

METHODS

EXTRACTION OF ESSENTIAL OILS

Extraction of essential oils from Pine needle, Clove needles and African nutmeg seeds (which has already been removed from its shell and crushed) were extracted using steam distillation method and the experiment was conducted in a Clevenger's apparatus. Pine needles was grounded and transferred into a 100ml round bottom flask; 60ml of distilled water was then added and stirred using a glass-stirring rod. The initial level of the mixture was marked at the side of the flask with a permanent marker. The steam distillation apparatus was assembled; all glass joint were lightly greased. The round bottom flask was used as the boiling pot. The flow of water true the condenser commenced. The heating mantle was adjusted to lessen the hot central cone. The mixture was not heated rapidly because; pine oils tend to foam when heated rapidly. The heating mantle was sometime withdrawn to control the heating rate. A distillation rate of 1 drop of every 5 seconds was maintained. Additional water was needed in the 100ml round bottom flask to keep the water level on the mark. The distillation was stopped when approximately 30ml of distillate have been collected. The water level in the boiling pot was kept at 60ml, and the boiling continues until the milky or cloudy

nature of the distillate cleared off. In the case of Clove oil, the milky or cloudy distillate was collected together with water and trichloromethane was used to separate the oils from water inside a separating funnel, the oils were later fully separated from the reagent using a water bath. Distillate of essential oils were dried over anhydrous sulphate, filtered and stored at -4°C until analyzed.

GAS CHROMATOGRAPHY MASS SPECTROSCOPY ANALYSIS

The essential oils were analysed using GC-MS, HP 8060 series 11 gas chromatography coupled to VG platform 11 Mass spectroscopy in order to identify the essential oils constituents. The MS was operated in the Electron Impact mode (EI) at 70eV and an emission current of 200microA. The temperature of the source was held at 180^0C and the multiplier voltage at 300V, the pressure of the ion source and MS detector were held at 9.4x10 -6mbar respectively. The MS has a scan range cycle of 1.5sec (scan duration of 1sec and inter-scan delay, 0.5 sec) the mass and scan range was set at m/z 1-1400 and 38-650, respectively. The instrument was calibrated using heptacosafluorotributyl amine, $[CF_3(CF_2)_3]_3N$, Apollo scientific Ltd., UK. The column used for GC-MS temperature programmed as in the case of GC-MS analysis were made in the split less mode with helium as the carrier gas.

FORMULATION

Acetone 1.5ml was added to 0.263g of essential oils of pine needles, clove needles, and African nutmeg to form an oil base emulsion. Calcium carbonate, Chalk was mixed with the oil based emulsion and then mixed manually to assume a homogeneous mixture (5% w/w). Similar procedure was used to make clay formulation.

INSECTICIDAL ACTIVITY

Plastic Petri dish was labelled and used for the bio assay. Five to Six adults *(S. oryzae)*, *(A. obtectus)* and (*C. pennsylvanicus)* were transferred into the Petri dish containing the essential oils formulations. The control consisted of a similar set up but with $CaCO_3$ mixed with 1.5ml of acetone alone. These set up was repeated for permethrin and clay soil formulations.

Mortality counts were made at 10 minutes' interval after formulations for 60minutes. Six hours after the formulations, another set of 5 insects each was used to replace the initial ones and the mortality count was made after the next one hour. Mortality count were also made after 6, 24 and in the next 48hours after exposure to sunlight. Each time, new sets of insects were being introduced to the different formulations of the essential oils and each experiment was conducted in triplicate.

STATISTICAL ANALYSIS

The data were subjected to probit analyses using SPSS (2001) for Windows to estimate LD_{50} and LD_{95} values of the essential oils against each stored-product insect species. Percentage mortality values for different exposure times were subjected to analysis of variance (one-way ANOVA) using the same statistical program (SPSS 2001) for probit analysis.

2. RESULTS

Table 1 shows the mortality of *S. oryzae* after an hour of exposure to the different dust formulations of *S. caryophyllatum*, clay formulation of *S. caryophyllatum* recorded the fastest activity, 40% mortality was recorded after 30mins of exposure to while other formulations including Rambo shows no activity against *S. oryzae*. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity on *S. oryzae*.

Table 1: The percentage mortality of *S. oryzae* by the dust formulations of *S. caryophyllatum* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference ($P < 0.05$). *Key: Rambo (commercial dust insecticides which active ingredient is permethrin); Control (Standard insecticide)*

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	20.00±5.80^b	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
20	40.00±5.80^c	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
30	40.00±5.80^c	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
40	60.00±5.80^c	20.00±5.80^b	20.00±5.80^b	0.00±0.00^a
50	80.00±5.80^d	60.00±5.80^c	80.00±5.80^d	0.00±0.00^a
60	100.00±0.00^e	100.00±0.00^e	100.00±0.00^e	0.00±0.00^a

Table 2: The percentage mortality of *S. oryzae* by the dust formulations of *P. sylvestris* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference ($P < 0.05$).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Commercial	Control
10	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
20	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
30	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
40	40.00±5.80^c	40.00±5.80^c	20.00±5.80^b	0.00±0.00^a
50	80.00±5.80^d	80.00±5.80^d	80.00±5.80^d	0.00±0.00^a
60	100.00±0.00^e	100.00±0.00^e	100.00±0.00^e	0.00±0.00^a

After an hour of exposure of *S. oryzae* to the different dust formulations of *P. sylvestris,* clay and $CaCO_3$ formulation of *P. sylvestris* recorded the fastest activity, 40% mortality was recorded after 40mins of exposure to *S. oryzae* in both cases while Rambo shows 20% activity against *S. oryzae*. 100% mortality was recorded by all formulation after 60mins of exposure time, except for the control that had no activity on *S. oryzae* as shown in table 2.

Table 3: The percentage mortality of *S. oryzae* by the dust formulations of *M. myristica* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference ($P < 0.05$).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
20	20.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
30	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
40	80.00 ± 5.80^{d}	20.00 ± 5.80^{b}	20.00 ± 5.80^{b}	0.00 ± 0.00^{a}
50	100.00 ± 0.00^{e}	80.00 ± 5.80^{d}	80.00 ± 5.80^{d}	0.00 ± 0.00^{a}
60	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}

The result in table 3 shows that after an hour of exposure of *S. oryzae* to the different dust formulation of *M. myristica*, clay formulation of *M. myristica* recorded the fastest activity, 40% mortality was recorded after 30mins of exposure to *S. oryzae* while other formulations including Rambo shows no activity against *S. oryzae*. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity on *S. oryzae*.

Table 4: The percentage mortality of *A. obtectus* by the dust formulations of *S. caryophyllatum* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference ($P < 0.05$).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	20.00 ± 5.80^{b}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
20	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
30	80.00 ± 5.80^{d}	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
40	100.00 ± 0.00^{e}	60.00 ± 5.80^{c}	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}
50	100.00 ± 0.00^{e}	80.00 ± 5.80^{d}	80.00 ± 5.80^{d}	0.00 ± 0.00^{a}
60	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}

According to table 4, the result revealed that after an hour of exposure of *A. obtectus* to the different dust formulations of *S. caryophyllatum*, clay formulation of *S. caryophyllatum* recorded the fastest activity, 40% mortality was recorded after 20mins of exposure to *A. obtectus* while other formulations including Rambo shows no activity against *A. obtectus*. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity on the insects.

Table 5: The percentage mortality of *A. obtectus* by the dust formulations of *P. sylvestris* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference (P < 0.05).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
20	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
30	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
40	40.00±5.80^c	0.00±0.00^a	40.00±5.80^c	0.00±0.00^a
50	80.00±5.80^d	80.00±5.80^d	80.00±5.80^d	0.00±0.00^a
60	100.00±0.00^e	100.00±0.00^e	100.00±0.00^e	0.00±0.00^a

After an hour of exposure to the different dust formulations of *P. sylvestris*, both clay formulation of *P. sylvestris* and Rambo recorded the fastest activity as revealed in table 5, 40% mortality was recorded in both after 40mins of exposure to *A. obtectus* while $CaCO_3$ shows no activity against *A. obtectus*. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity *A. obtectus*.

Table 6: The percentage mortality of *A. obtectus* by the dust formulations of *M. myristica* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference (P < 0.05).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	20.00±5.80^b	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
20	40.00±5.80^c	0.00±0.00^a	0.00±0.00^a	0.00±0.00^a
30	100.00±0.00^e	20.00±5.80^b	0.00±0.00^a	0.00±0.00^a
40	100.00±0.00^e	60.00±5.80^c	40.00±5.80^c	0.00±0.00^a
50	100.00±0.00^e	80.00±5.80^d	80.00±5.80^d	0.00±0.00^a
60	100.00±0.00^e	100.00±0.00^e	100.00±0.00^e	0.00±0.00^a

After an hour of exposure to the different dust formulation of *M. myristica*, clay formulation of *M. myristica* recorded the fastest activity as revealed in table 6, 40% mortality was recorded after 40mins of exposure to *A. obtectus* while there is no activity for the rest. 20% activity was recorded for $CaCO_3$ formulation of *M. myristica*, 100% for clay formulation of *M. myristica* and no activity for Rambo against *A. obtectus*. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity on *A. obtectus*.

Table 7: The percentage mortality of *C. pennsylvanicus* by the dust formulations of *S. caryophyllatum* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference ($P < 0.05$).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	20.00 ± 5.80^{b}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
20	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}
30	80.00 ± 5.80^{d}	40.00 ± 5.80^{c}	60.00 ± 5.80^{c}	0.00 ± 0.00^{a}
40	100.00 ± 0.00^{e}	60.00 ± 5.80^{c}	80.00 ± 5.80^{d}	0.00 ± 0.00^{a}
50	100.00 ± 0.00^{e}	80.00 ± 5.80^{d}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}
60	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}

From the table 7, the result shows that after an hour of exposure to the different dust formulation of *S. caryophyllatum*, clay formulation of *S. caryophyllatum* recorded the fastest activity, 20% mortality was recorded after 10mins of exposure to *C. pennsylvanicus* while there is no activity for the rest formulations. No activity was recorded for $CaCO_3$ formulation of *S. caryophyllatum*, 40% for clay formulation of *S. caryophyllatum* and Rambo against *C. pennsylvanicus* after 20mins. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity on *C. pennsylvanicus*.

Table 8: The percentage mortality of *C. pennsylvanicus* by the dust formulations of *P. sylvestris* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference ($P < 0.05$).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
20	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}
30	20.00 ± 5.80^{b}	0.00 ± 0.00^{a}	60.00 ± 5.80^{c}	0.00 ± 0.00^{a}
40	40.00 ± 5.80^{c}	40.00 ± 5.80^{c}	80.00 ± 5.80^{d}	0.00 ± 0.00^{a}
50	60.00 ± 5.80^{c}	60.00 ± 5.80^{c}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}
60	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}

From the table 8, the result shows that after an hour of exposure to the different dust formulation of *P. sylvestris*, Rambo recorded the fastest activity, 40% mortality was recorded after 20mins of exposure to *C. pennsylvanicus* while there is no activity for the rest formulations. No activity was recorded for $CaCO_3$ formulation of *P. sylvestris* 20% for clay formulation of *P. sylvestris* and 60% for Rambo against *C. pennsylvanicus* after 30mins. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity *C. pennsylvanicus*.

Table 9: The percentage mortality of *C. pennsylvanicus* by the dust formulations of *M. myristica* and Rambo an hour of preparation. Values are mean ± standard deviation of three samples of clove essential oil analyzed in triplicate. Means followed by different superscript letter in a same represent significant difference ($P < 0.05$).

Exposure Time(Min)	% mortality			
	Clay	$CaCO_3$	Rambo	Control
10	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
20	20.00 ± 5.80^{b}	0.00 ± 0.00^{a}	40.00 ± 0.00^{a}	0.00 ± 0.00^{a}
30	40.00 ± 5.80^{c}	0.00 ± 0.00^{a}	60.00 ± 5.80^{c}	0.00 ± 0.00^{a}
40	60.00 ± 5.80^{c}	60.00 ± 5.80^{c}	80.00 ± 5.80^{d}	0.00 ± 0.00^{a}
50	80.00 ± 5.80^{d}	80.00 ± 5.80^{d}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}
60	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	100.00 ± 0.00^{e}	0.00 ± 0.00^{a}

From the table 9, the result shows that after an hour of exposure to the different dust formulation, Rambo recorded the fastest activity, 40% mortality was recorded after 20mins of exposure to the insects while 20% for clay formulation and no activity for $CaCO_3$ formulations. No activity was recorded for $CaCO_3$, 40% for clay formulation and 60% for Rambo against the insects after 30mins. 100% mortality was recorded by all formulations after 60mins of exposure time, except for the control that had no activity on the insects.

Table 10: Chemical composition of *S. caryophyllatum*, *M. myristica* and *P. sylvestris*

Components	% in Sample		
	Clove oil	African nutmeg	Pinus sylvestris
Linalool	-	19.1	-
βCaryophyllene	5.91		
Eugenol acetate	17.53		
Caryophyllene	-	-	-
Aromadendrene	-	-	-
γ Bisabolene	-	-	-
Germacrene	-	-	-
Sabinol-cis	-	17.87	-
tr-13-octadecenoic acid	-	25.18	-
Palmitic acid	-	7.66	-
β Farnescene	-	-	-
Terpinen-4-ol	-	-	21.82
β Terpineol	-	-	14.07
Borneol	-	-	6.72
Longifolene			5.45
Eugenol	75.90		
α Terpineol	-	-	27.17
1-ethyl-3-nitro	9.12		
3-(1-methyethyl)	7.95		

Table 10 shows the GC-MS analysis of *M. myristica* with four major compounds which are; linalool 19.1%, sabinol-cis 17.87%, tr-13-octadecenoic 25.18% and palmitic acid 7.66%. In pine essential oil, *P. sylvestris,* five major compounds were identified which are; Terpinen-4-ol 21.82%, β terpineol 14.07%, borneol 6.72% and α Terpineol 27.17%. five major compounds were identified in *S. caryophyllatum*; eugenol 75.90%, 1-ethyl-3-nitro 9.12%, 3-(1-methyethyl) 7.95%. It was observed that tr-13-octadecanoic 25.18% is the highest out of all the constituents for *M. myristica,* for *P. sylvestris* α Terpineol 27.17% is the highest for all the major constituents while *S. caryophyllatum* eugenol 75.90% is the highest. The differences in the component of the essential oils result in the difference in the insecticidal activities.

3. DISCUSSION

From the results above, 75.90% eugenol, 27.17% α Terpineol and 25.18% tr-13-octadecanoic insecticidal activities was observed in the essential oils of *S. caryophyllatum* followed by *M. myristica* and lastly *P. sylvestris* respectively. Commercial permethrin also has higher insecticidal activities but it depreciates when it was exposed to *A. obtectus*, *C pennsylvanicus* and *S. oryzae* at different exposure time. The control formulation has no insecticidal effect. The results show that the chalk and the clay soil used as a carrier for the formulation releases the fume faster than each other. A Clay formulation has higher activity than $CaCO_3$ formulations but the activity of these formulations were time dependent, this occurs due to the particle size. The dust formulation prepared from the essential oils of *S. caryophyllatum, M. myristica* and *P. sylvestris* have insecticidal activities which is comparable to the popular permethrin dust formulation found in the market. The results revealed that permethrin though effective but the effectiveness reduces with time because they are degradable on exposure to sunlight. Dust formulation from the essential oils of *S. caryophyllatum, M. myristica* and *P. sylvestris* could replace it. For *S. oryzae*, clay formulation of *S. caryophyllatum* could be used. Studies revealed that essential oil from *A. altissima* bark had strong insecticidal activity against *T. castaneum*, *O. surinamensis*, *S. Oryzae* and *L. paeta* adults [10, 11]. The insecticidal activity could be as a result of the pungent smell from the volatile oil. The different structural components of the essential oils are responsible for the different efficacies as insecticides. The essential oil of *S. caryophyllatum* in which the major component is sesquiterpenes was found to be more effective in insecticidal treatment this could as a result of its been less volatile. They are very viscous [12]. The essential oil of *P. sylvestris and M. myristica in* which their major components are monoterpenes were found to be less effective in insecticidal treatment this could as a result of their being volatile. They react readily to air and heat sources [13].

Several works have been conducted on the contact activity of different plant extracts on pest. The result of the contact activity revealed that the essential oil of *M. myristica* against pest was dose and time dependent. This has also been reported [14]. Studies revealed that *A. altissima* bark oil also possessed strong contact toxicity on *S. oryzae* adults which gradually enhanced with increased exposure time and the corrected percentage mortality reached 76.5% after 72 h treatment [11]. Okonkwo and Okoye in 1996 reported the effectiveness of M. myristica against *C. maculatus*. The

result shows that the contact effect of essential oil from African Nutmeg was more effective against *C. maculatus* than *S. oryzae*.

4. CONCLUSION

In the present study, A. obtectus, C pennsylvanicus and S. oryzae were found to be knocked down by the essential oils of S. caryophyllatum, M. myristica and P. sylvestris with 5%w/w dose employed in the study but at 60 minutes of exposure. The study revealed that essential oils of S. caryophyllatum has the highest insecticidal activity followed by essential oil of M. myristica and P. sylvestris due to 75.90% eugenol, 27.17% α Terpineol and 25.18% tr-13-octadecanoic respectively. Thus, they have a remarkable insecticidal activity.

REFERENCES

[1] Bakkali, F., Averbeck, D. and Laomar, M.M. (2008) Biological effects of essential oils- A review. Food chemistry Toxicology, **46**: 446-475.

[2] Belmain, S., Neal, S.R., Ray, G.E. and Golob, D.E. (2001) Ethnobotanicals in Ghana. Insecticidal and Vertebrate toxicity associated with ethno botanicals. J. of Toxicol. **39**(3): 287-291.

[3] Dales, M.J. (1996) A review of plant materials used for controlling insect pests of stored products. NRI Bulletin 65, 88.

[4] Igwe, C.C., Yayi, E. and Moudachirou, M. (2005) Chemical constituents of the solvent extracted and hydrodistilled essential oils of African nutmeg (Monodora myristica) and turmeric (Curcuma domestica) from South West Nigeria. Nigerian Food Journal **23**: 21-32.

[5] Isman, M.B., (2000) Plant essential oils for pest and disease management. Crop Prot., **19**: 603–608.

[6] Jianhua Lu and Shuhui Wu (2010) Wu Bioactivity of essential oil from Ailanthus altissima bark against 4 major stored-grain insects African Journal of Microbiology Research Vol. **4** (3) pp. 154-157.

[7] Kroes, R. and Walker, R. (2004) Safety issues of botanical and botanical preparations in functional foods. Toxicol. **198**:213-220.

[8] Lamaty, G., Menut, C., Bessiere, J.M., Amvam Zoilo, P.H. and Fekam (2006) Aromatic plants of tropical central Africa. I. Volatile components of two annonaceae from Cameroon: *Xylopia aethiopica* (dunal) A. Richard and *Monodora myristica* (Gaertn.) Dunal. Flavour and Fragrance Journal 2(3):91 - 94.

[9] Mondal, M. and Khalequzzaman, M. (2006) Toxicity of essential oils against red flour Beetle, *Tribolium Castaneum* (Herbst) (Coleoptera: Tenebrionidae). Journal of Bio-Science,**14**, 43 -48.

[10] Mugisha-K. M., Deng, A. L., Ogendo, J.O., Omolo, E. O., Mihale, M. J., Otim, M., Buyungo, J. P. and Bett, P. K. (2008) Indigenous knowledge of field insect pests and their management around Lake Victoria basin in Uganda. African Journal of Environmental Science and Technology Vol. **2** (8). pp. 342-348.

[11] Ngamo T.S.L., Ngatanko, I., Ngassoum, M.B., Mapongmestsem, P.M. and Hance, T. (2007) Persistence of insecticidal activities of crude essential oils of three aromatic plants towards four major stored product insect pests. African journal of Agricultural Research **2**, 173 – 177.

[12] Papachristes, D. P. and Stamopoulos, D. C. (2002) Toxicity of vapours of three essential oils to the immature stages of *Acanthoscelides obtectus* (Say) (Coleoptera: Bruchidae). Journal Stored Product Research **38**: 365-373.

[13] Sumangala, K.B. and Vivek, K. (2009). Biocidal potential of clove oils against Aedes albopictus. Afr J Biotechnol 2009; **8**(24): 6933-6937.

[14] Tapondjou, L.A., Alder, C., Bouda, H. and Fonten D.A. (2002) Efficacy of powder and essential oil from *Chenopodium ambrosioidies* leaves as post-harvest grain protectants against six-stored products beetles. Journal of stored products Research **38**, 395 – 402.