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Anti-termitic properties of Jatropha (Jatropha curcas L.) on wood termites (Macrotermes bellicosus (Smeathman)

Okweche Simon Idoko*, Nnah Comfort Gordon

Department of Forestry and Wildlife Resources Management, University of Calabar
*Corresponding author: idokosi@yahoo.com
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Abstract

The efficacy of *Jatropha curcas* in the management of wood termites, (*Macrotermes bellicosus*) was carried out in the Teaching and Research Farm of the Department of Forestry and Wildlife Resources Management. University of Calabar. The experiment consisted of 5 levels of *J. curcas* oil (0, 0.5, 1.0, 1.5 and 2.0) and a corresponding quantity in powder, replicated 4 times and arranged in Randomized Completely Block Design (RCBD). Each concentration was tested on 20 unsexed adult wood termite placed in grave yard of 8cm x 8cm. Data on mortality rate was taken at 12 hourly up to 72 hours. The result from the experiment showed that *J. curcas* oil was significantly efficacious compared with *J. curcas* powder both in the field and in the laboratory. It was observed that there was progressive increase in mortality rate due to increased concentration and time duration. The management of termite using *J. curcas* should be encouraged due to its environmental friendliness and should also be incorporated into integrated pest management (IPM).

Key words: Jatropha curcas, Macrotermes bellicosus, oil, powder, mortality

Introduction

Termites (*Macrotermes bellicosus)* are social insects living in colonies, they are sometimes called white ants but are not ants, because the true ants belong to the order hymenoptera, while termites belong to the order isoptera (Grimaldi and Engel, 2005). Termites occur in all temperate an d tropical countries of the world, many of which cause extensive damage to wooden structure and to manufactured goods made of wood, paper and cloth. Occasionally, they cause significant damage to growing trees such as teak and agricultural crops such as cotton (Solomon, 1995). The economic importance of a few pest species is so dramatic that the importance of termite breaking down woody tissue and returning nutrient to the soil is obscured (Truman and Robinson, 1982). Termites are responsible for some of the degradation of wood and other cellulose material in the terrestrial environment, mainly in the tropics and subtropics (Bulthman, 1979). Cellulose being the principal food of termites, wood and wood product such as paper, fabrics and wood structures are consumed and destroyed by termite, and hence a constant effort is directed towards their control. Field and laboratory test indicated that some woods are not resistant, but are susceptible to attack by African wood termite causing significant damage. Factors affecting wood consumption by termites are numerous and complexly related. Among the most important of these factors are: wood species, hardness of the wood Presence of toxic substance, feeding inhibitors or deterrents, Presence or absence of fungi or fungal decay, Moisture content of the wood and soil (Carter *et al*., 1974; Peralta *et al.,* 2004).

Termites of the *Macrotermes* spp are fungus growing termite belonging to the family rhinotermitidae, they are mostly mound builders and are the largest termite species (Osipitan and Oseyemi, 2012). The species of the termite under the genus *Macrotermes*, impact the economy negatively by causing damage to various agricultural crops, rangeland, wooden portions of buildings, furniture, books, utility poles and fences in several parts of Africa (Wong *et al.,* 2001*;* Mitchell, 2002; Cox, 2004). It has been reported that *Macrotermes* causes a complete damage of between 80 to 100 % on stored products (Michael, 2000; UNEP and FAO, 2000; Sekematte, 2001;

Nyeko *et al*., 2010). In some part of Africa, *Macrotermes* do cause a yield loss of 30-60% (UNEP and FAO, 2000). In east Africa, the loss caused on various crops and tree species due to termite vary ranging from 50-100% (Sekematte, 2001; Nyeko *et al*., 2010). Pests are organism which are invasive or detrimental, notorious, troublesome, destructive to either plants or animals, or which constitute nuisance to livestock, and humans (Sharma *et al*., 2011). Termite are serious pest of arable crops such as wheat, sugarcane, groundnut, paddy rice causing significant yield loss and also to perennial crops such as forest trees and wooden structures in buildings especially in semi-arid and sub-humid tropics of the world. They are very destructive insect as they feed on both dead wood and living plants. They can eat through the timber of wooden houses and can even attack hard wood such as *Tectona grandis*. Also, they eat furniture, books, boxes and other products of wooden origin. It has been observed that termites conveniently build their nest in fallen logs, stumps of trees, wooden buildings or pieces of wooden debris on the ground, some termite even live the heartwood of large trees (Cox, 2004).

Pesticides play an important role in the integrated pest management (IPM) on agricultural production and productivities (Logan, 1990). For controlling termite, certain synthetic termiticide such as DDT, BHC, aldrin, heptacor, and organochlorinated hydrocarbon have been used for the management of termite but were banned due to the harmful effect on humans, non-targeted spp and the environment (Mulroney *et al* 2005; Soomro *et al*, 2008; Sileshi *et al.,* 2009). As a result of the negative impact of the use of persistent and deleterious synthetic pesticide on the environment, research on the identification of eco-friendly and locally available alternative tool for the control has been the agenda of entomologist. The use of plant materials in the management of insect pest, including termite has been an old strategy in Africa and among many botanicals used in insect pest management plants such as neem (*Azadirachta indica*,), garlic (*Allium sativum*), *Clausena anisata* and have been successfully used to control termite. **(**Owusu*,* 2001**;** Doolittle *et al.,* 2007; Dubley *et al.,* 2008, Muhammad, 2009).

Bio-Pesticides are pesticides that are derived from natural live forms such as plants, bacteria, fungi and nematodes and others (Copping, 2009). They are often important component of integrated pest management (IPM) and used as a component of integrated pest management program, these pesticides can greatly decrease the use of conventional pesticides hence, improve the quality of timber as well as crop production. Bio-pesticide control pests and diseases either selectively or with broad spectrum approach. Bio pesticides are generally target specific and affect only the targeted population (EPA, 2012). Control of termite has been through the use of synthetic insecticides such a DDT, BHC, aldrin, heptacor, which are environmentally hazardous. There is therefore the need to assess the efficacy of non synthetic insecticides which are environmentally friendly.

Materials and Method

Location of the study area

This experiment was conducted at the teaching and research farm of the Department of Forestry and Wildlife Resources Management, University of Calabar, Nigeria

Collection of insect sample

Plastic rubbers, 30 cm in length and 15 cm in diameter were buried in a moist soil that surrounds the termite infested trees. Soil was introduced into the plastic rubbers and pieces of rolled carton were placed inside the rubbers and the rubbers were left in the soil for 3-4 weeks. After that, the plastic rubbers were checked if they were infested with termite and the cartons containing termites were incubated under dark condition with high humidity. The termites were fed with sawdust to ensure their survival. Over 2000 population of wood termite were collected for the experiment.

Preparation of bio-pesticide

Seeds of *Jatropha Curcas* were sourced from the tree, shade-dried for two weeks and made into powder using an electric blender and stored in a cool and dry environment till when needed.

Preparation of plant extract

Alcohol extract: Fifty grams (50 g) of *J. curcas* powder each was taken using a rolled filter paper and placed in a soxhlet extractor in 50^0C with 200 ml of ethanol added to it and kept for 24 hours. This procedure was repeated many times in order to get enough amount of extract. The extract was dried in an oven in 45^0C for one hour and kept for use.

Extraction of essential oil from *Jatropha curcas:*

Fifty grams of the same powder was introduced into a flask containing 500 ml of distilled water and exposed to source of heat. The rising steam from the sample was condensed by condenser connected with a glass cylinder to collect the resultant water of the evaporation. The oil layer accumulating on the surface of water was obtained by separating funnel. The oil was kept in the refrigerator till when needed.

Experimental design

A grave yard experiment of 8 cm x 8 cm was measured, thereafter, 0, 0.5, 1.0, 1.5 and 2.0 g each of the powder and a corresponding quantity of the oil were thoroughly mixed with saw dust and introduced into the grave yard and left for one hour and then 20 unsexed adult termites were introduced into the grave yard. Each treatment and the control was replicated four times and arranged in a Randomized Completely Blocked Design (RCBD). Similar experiment was conducted in the laboratory with four replications in a completely randomized design (CRD).

Data collection

Data were collected 12 hourly in each case after administering of the bio-pesticide. Parameters assessed include mortality at 12, 24, 36, 48, 60 and 72 hours after application, respectively.

Data analysis

Data collected were subjected to analysis of variance (ANOVA) using Statview statistical software and significant means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of significance.

Result

Result of the insecticidal properties of *J. curcas* oil and powder showed significant effect on wood termites at ($P< 0.05$) Five levels each of *J. curcas* oil and powder 0, 0.5, 1.0, 1.5, and 2.0mls and the same concentration of the powder were applied to determine their efficacy on the mortality at 12, 24, 36, 48, 60 and 72 hours period of exposure. Generally at 12, 24, 36, 48, 60 and 72 hours of exposure, the mortality rate of termites was higher in oil when compared to powder. At 12 hours of exposure, *J. curcas* oil at 2.0 mls was highly effective compared to other levels and recorded 30% mortality rate. However, 2.0 g of *J. curcas* was as effective as 1.0mls and recorded 22.5% (Fig1). Similarly, at 24 hours of exposure, application of 2.0mls of *J. curcas* oil was effective and recorded significantly higher mortality rate of compared with other levels. Application of 0.5mls was as effective as 1.0ml of *J. curcas* oil in management wood termite. There was no significant difference that existed between 0.5, 1.0 and 1.5 g of the powder. However, the application of 2.0 g was as effective as 1.5 mls of *J. curcas* oil (Fig 2). Similar trends were observed at 36 and 48 hours of exposure. 2.0 mls of *J. curcas* oil was significantly efficacious compared to 0.5, 1.0, 1.5 mls and also the untreated. Similar result were also obtained in the application of the *J. curcas* powder with 2.0 g recording a better performance compared with other levels of application. There was no

significant difference between 1.5ml and 2.0 g (Fig 3&4). At 60 and 72 hours of exposure, application of 1.0 and 1.5 mls were as effective as applying 2.0mls of *J. curcas* oil. Application of 1.5g of *J. curcas* powder was as effective as 2.0 g at both 60 and 72 hours of exposure and were significantly different from 0.5 g, 1.0 g and the untreated. However, application of 1.5 g and 2.0 g were significantly different from 0.5 ml (Fig. 5 & 6). Generally, the mortality rate of the wood termite increased with increase in both hours of exposure and concentration of bio-pesticide.

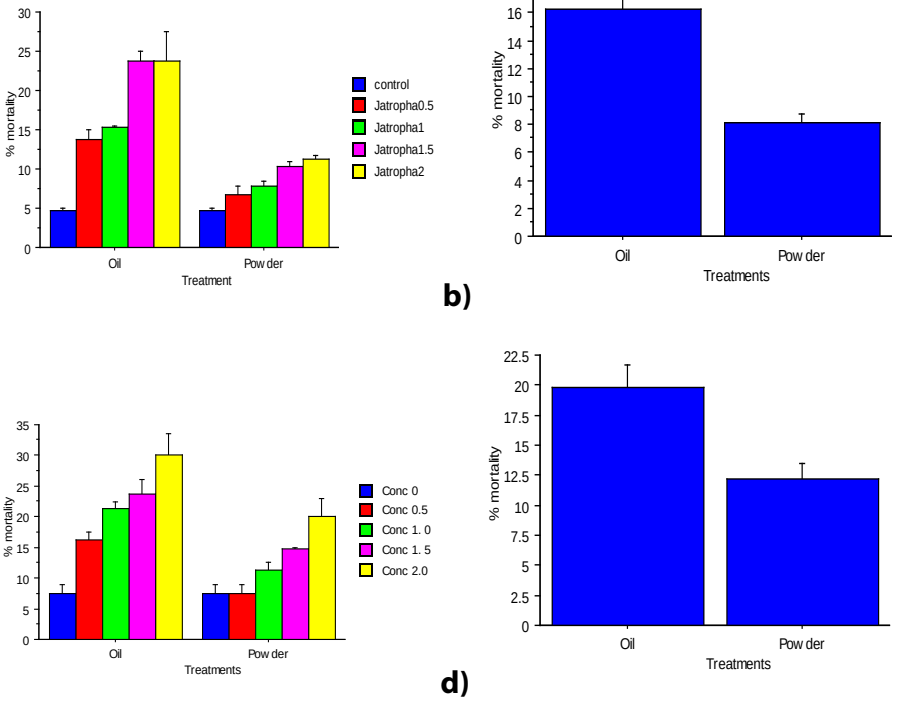
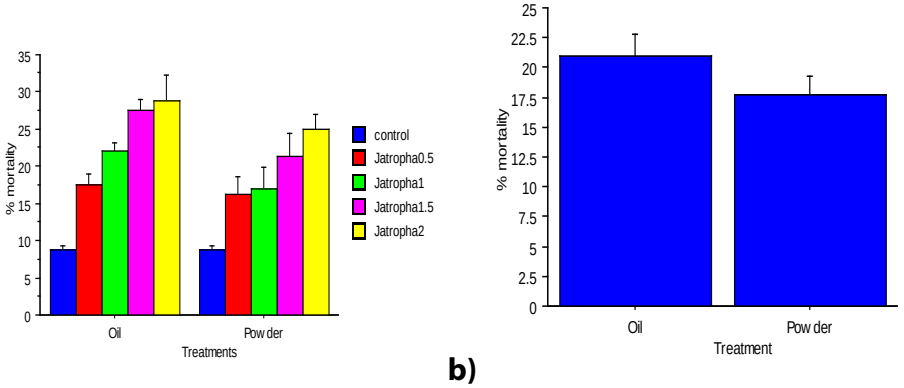


Fig 1: Effect of *J. curcas* oil and powder on percent mortality at 12 hours of exposure; a & b = laboratory result; c & d = field result



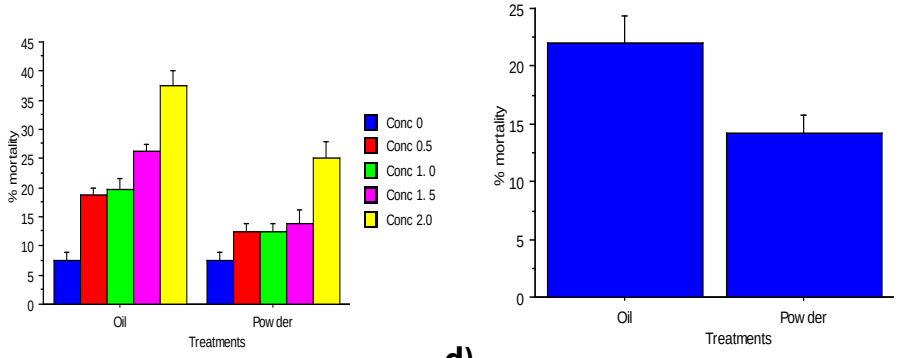
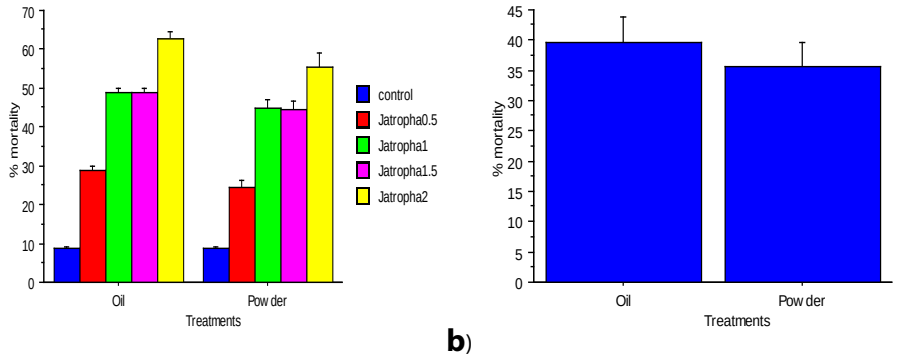


Fig 2: Effect of *J. curcas* oil and powder on percent mortality at 24 hours of exposure, a & b = laboratory result; c & d = field result



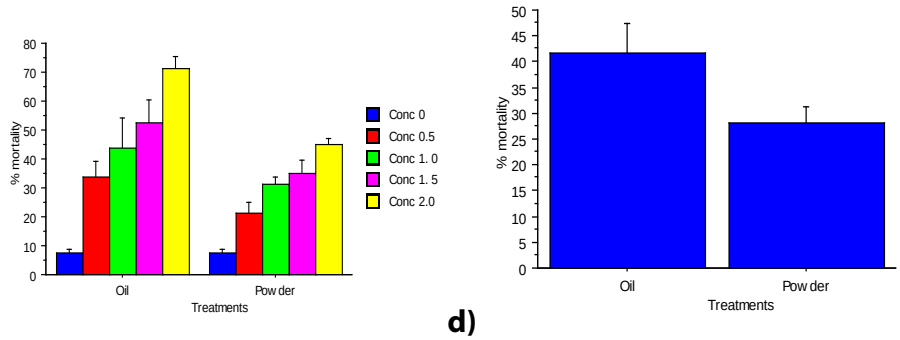


Fig 3: Effect of *J. curcas* oil and powder on percent mortality at 36 hours of exposure; a & b = laboratory result; c & d = field result

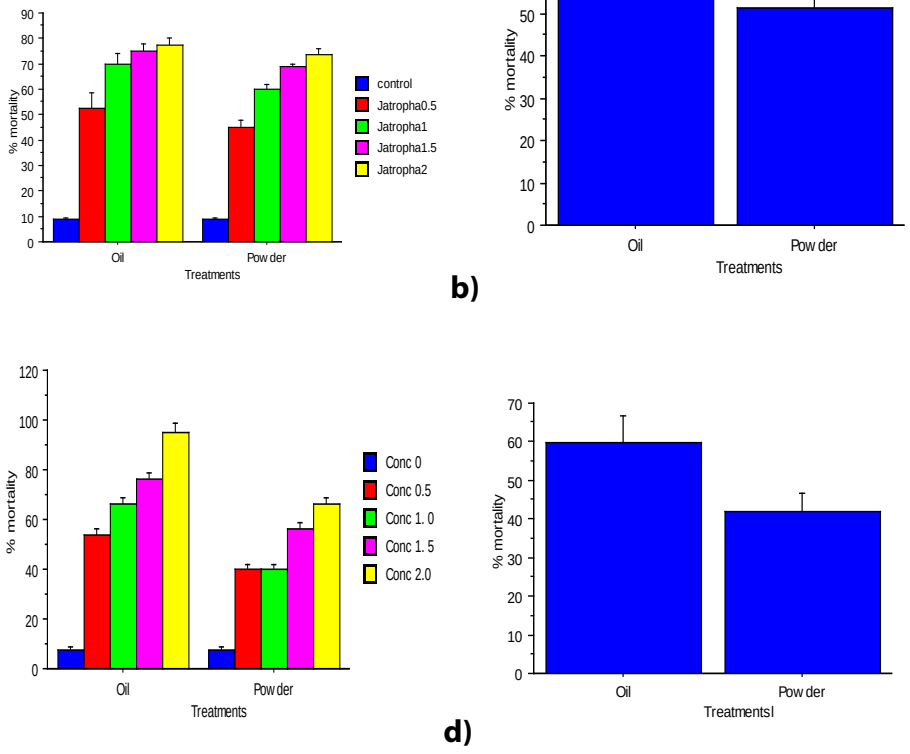
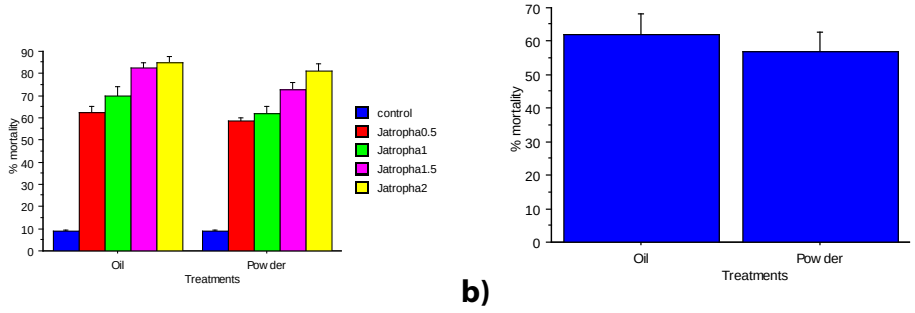


Fig 4: Effect of *J. curcas* oil and powder on percent mortality at 48 hours of exposure, a & b = laboratory result; c & d = field result



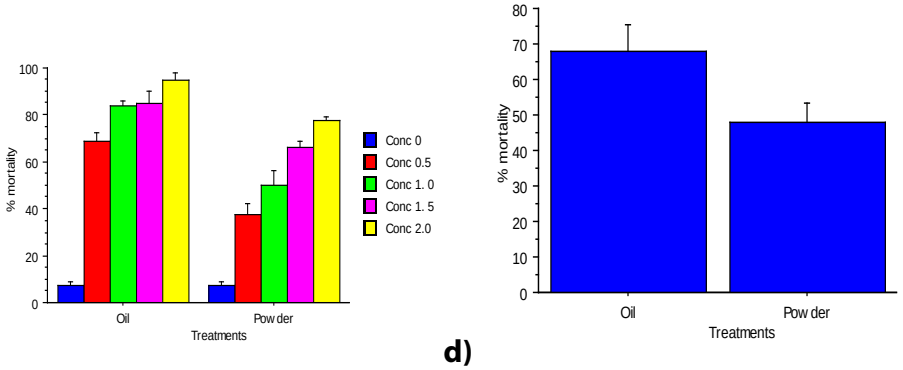
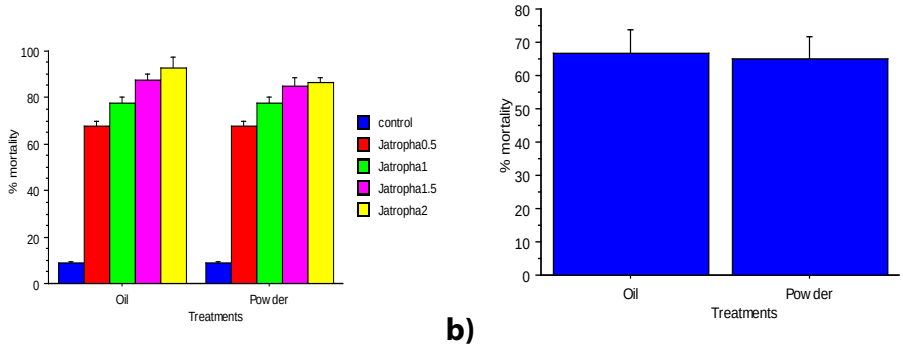


Fig 5: Effect of *J. curcas* oil and powder on percent mortality at 60 hours of exposure, a & b = laboratory result; c & d = field result



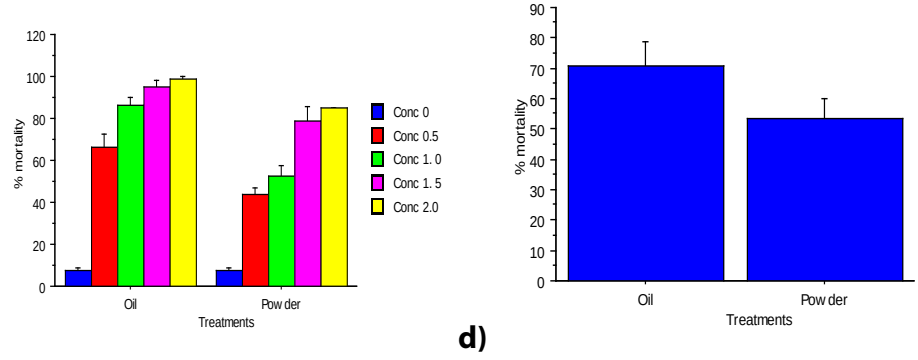


Fig 6: Effect of *J. curcas* oil and powder on percent mortality at 12 hours of exposure, a & b = laboratory result; c & d = field result

Discussion

Jatropha curas has been shown to poses bio-pesticidal properties that works against many pests. Previous works have reported the insecticidal activities of *J. curcas* oil against *Busseola fusca* and *Sesamia calamistis* (Makhar *et al.,* 2007, *Helicoverpa zea* (Olapeju *et al*., 2008), termite (Acda, 2009), mites (Juliet *et al*., 2012), desert locust (Bashir & Shafie, 2013) and *Sitophilus zeamais* (Ojiako *et al.,* 2014). This study demonstrated the toxic effect of *J. curcas* oil and powder in the management of

wood termite. The plant extract generally increased the mortality rate of termite and oil of *J. curcas* was found to be significantly efficacious in the management of wood termite when compared to the powder and there was an increase in the mortality rate of termite in the application of the oil than the powder. This experiment is in accordance with Habou *et al.,* (2011) who reported that *J. curcas* oil was effective against many insect pest associated with cowpea under laboratory and field condition. Also, Adebowale and Adedire, (2006) conducted a similar experiment in the laboratory on *C. maculatus* Fabr devastating insect of cowpea in Nigeria. They observed a significant reduction in egg laying of all tested concentrations and a total inhibition of eggs and larvae. The number of eggs laid by *C. maculatus* females was also reduced due to the application of *J. curcas* oil. Markkar *et al.,* (1998) reported that the *J. curcas* oil contained more phorbol esters which exerted potential insecticidal effect on *Busseola fusca* and *Sesamia calamistis.* A higher mortality rate of (70%) was recorded after 36th hour of exposure. This may be due to the breakdown of protective barriers of the insect and the active ingredient of the plant extract. Plants extract are slow to act and degrades easily in the environment. Earlier research findings therefore recommended their application at higher rates and at an increased frequency to achieve effective pest control (Ewete *et al*, (1996). At 72 hours of exposure, all the levels of *J. curcas* oil were highly effective and 2.0 ml recorded 100% mortality and this is in accordance with (Boateng, 2008) who reported that the susceptibility of *Callosobrunchus maculatus* to the *J. curcas* seed oil was highly toxic at 72 hours of exposure. *Jatropha curcas* oil being more effective than the powder and resulting in higher mortality rate in this research was due to the extraction of the bio-pesticide using ethanol. This is in conformity with the work of (Goel *et al*., 2007) who reported that enhancing the phorbol ester or curcin extract using ethanol indicated significant improvement in insecticidal and molluscicidal properties of the plant. Various methods like heat and chemical had been found to render other toxins in the plant inactive except phorbol esters. This study has revealed that treatment of wood products with bio-pesticide will protect wood from destruction by termite infestation. The bio-pesticide used in this study had a lethal effect on wood termite and has shown to be highly effective towards the management of termites in agronomic and forest crop, as well as domestic materials. *Jatropha curcas* is readily available, biodegradable and has proven to be environmentally friendly. It could serve as a valuable alternative to synthetic insecticide in the management of wood termite.

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The use of essential oils for the control of *Callosobruchus subinnotatus* (Pic) in stored *Vigna subterranea* L.

Sylvia BasseyUmoetok[1], Boniface Effiong Archibong[1], Simon Idoko Okweche[2]

[1]Department of Crop Science, University of Calabar, Nigeria
[2]Department of Forestry and Wildlife Resources Management, University of Calabar, Nigeria
*Corresponding author: sbaumoetok@yahoo.com
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