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EVALUATION OF SELECTED BOTANICAL EXTRACTS ON TERMITE SPECIES IN UMUAGWO OHAJI, IMO STATE, NIGERIA.

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ABSTRACT

The study was conducted to evaluate the toxicity and repellency of *Azadirachta indica, Eucalyptus camaldulensis* and *Zingiber officinale,* extracts, applied at 10% and 20% concentrations against termites (*Macrotermes. bellicocus*) under laboratory and field conditions in Umuagwo Ohaji. The experiment was replicated thrice with distilled water as control. The result revealed that as both ethanol and aqueous concentration of plant extracts increased, mortality was significant ($p< 0.05$) after 72hours of exposure. All the tested plant extracts, *E. camaldulensis, A. indica and Z. officinale* recorded 100% mortality of termite species after 72 hours, on concentration studies and repellence tests. These plant species can be used as plant termiticides as they are readily available and cheap to purchase.

Keywords: *Azadirachta indica, Eucalyptus camaldulensis, Zingiber officinale, Macrotermes bellicosus*, Toxicity, Repellency.

INTRODUCTION

The species of termites have long been recognized as important agricultural, forestry and domestic pests (Engel and Krishna, 2004; Owusu *et al*., 2008; Verma *et al*., 2009; Samb *et al*., 2011). Termites of the *Macrotermes* spp, are a member of fungus growing sub family of Macrotermitinae and family Termitidae. They are mostly mound building and are the largest termite species (Osipitan and Oseyemi, 2012). The species of termite under the genus *Macrotermes*, impact the economy negatively by causing damage to various agricultural crops, range-lands, wooden portions of buildings, furniture, books, utility poles and fence posts in several parts of Africa (Wong *et al*., 2001; Mitchell, 2002; Cox, 2004). It has been reported that *Macrotermes* causes a complete damage (100% loss) to agricultural crops and various domestic products in the world (Michael, 2000; UNEP and FAO, 2000; Sekamatte, 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 termites vary ranging from 50-100% (Sekamatte, 2001; Nyeko *et al*., 2010). In Ethiopia, serious damage, with losses of up to 100% in some localities, occurred on Eucalyptus one to two years after transplanting, 45- 50% (on maize), 50-100% (on teff) and 25% (on sorghum); in highly termite infested districts of Western Wollega zone (Abdurahman, 1990, 2000; Gauchan *et al*., 1998; OADB, 2001).

Pesticide plays an important role in Integrated Pest Managements (IPM) on agricultural production and productivities. Often broad spectrum and persistent organo-chlorinated hydrocarbon insecticides are used for management of termites in the world. However, some of the most potent insecticides used against termites such as aldrin and dieldrin were withdrawn from the market because of their increased cost from time to time; harmful effects on human health, non-target organisms and eventually environmental pollution and due to resistance development (Logan *et al*., 1990; Mulroney *et al*., 2005; Ahmed *et al*., 2006; Dhaliwal and Koul, 2007; Soomro *et al*., 2008; Sileshi *et al*., 2009).

Generally, botanical extracts have safe insecticidal properties with broad spectrum of insecticidal activity, relatively specific mode of action, low mammalian toxicity and non persistence. Besides, their preparation and application method for farmers are more convenient. Cognizant of the above benefits of the use of botanicals in pest management, hence the evaluation of the effect of various plant extracts (Neem, Eucalyptus spp, and Ginger) on the control of termite species in Umuagwo Ohaji, Imo state, South-Eastern Nigeria.

MATERIALS AND METHODS

The experiment was conducted at the central science laboratory of Imo state Polytechnic, Umuagwo Ohaji, Imo State, located in southeastern Nigeria. A field survey was conducted to determine the extent of infestation by the termites. This was based on the areas of high infestation and presence of termitarium (termite mound).

Termite collection for laboratory experiments

Test insects (termites) was collected from the study areas by digging active mounds with spade and putting soil and combs infested with termite worker into plastic containers. A total of ten active termite mounds were sampled, at different locations. Later, they were used for different experiments. Soil samples were collected from all the sampled areas for analysis.

Plant material collection and preparation

Plant botanicals for the study include Neem (*Azadirachta indica*) (leaves), *Eucalyptus camaldulensi* (leaves), and Ginger (*Zingiber officinal,*) (rhizome)

Ethanoic extraction

One hundred gram (100 g) of powder from each of the plants was extracted in 200 ml of 80% ethanol in the ratio of 1:2 (w/v) by following method of extraction (Rheman *et al,* 2005*)*. It was kept for 72 hours at room temperature and shaken at intervals to get a better extraction. Thereafter, the extract was filtered through Whatman filter paper No. 42. After filtering, the ethanol was removed at 60°C using rotary evaporator, to obtain solid extract, and dried in vacuum desiccators. The final yield of dry material was used to prepare percent solution of crude extract with 2% ethanol.

Aqueous extracts

To get the aqueous extracts, above procedure was followed except powder was extracted in distilled water. The filtrates were stored in a refrigerator at 5°C for subsequent use in bioassays.

Bioassay

Soil preparation for bioassay

The soil used in bioassays was sandy clay loam (50% sand, 20% silt and 20% clay). The soil was sieved through a 30mm mesh screen and moisture was determined with the help of a moisture meter. Water was added in this soil to simulate 50% of water holding capacity, to avoid mortality of termites due to dehydration during assays.

Filter paper bioassay

Whatman filter paper was treated with the concentrations of plant extracts and placed in Petri dishes (95 × 15mm). 10 workers of termites was released in the Petri dishes having treated and

untreated filter paper. The Petri dishes having filter paper and/or soil bioassay were placed in growth chamber under controlled conditions of 28±2°C and 80%±5 humidity. Data for mortality was recorded after every 2 hours up to 12 hours, and then after every 12 hours until all workers and soldiers died. Each treatment was repeated three times.

Indirect Exposure Test

During the indirect exposure test, an extract treated filter paper disk (2 cm diameter) was attached to the lid of the petri plate. Throughout this experiment termite had no direct contact with extract treated filter paper disk. The bottom contained the moistened, untreated filter paper disk (5 cm diameter) for food and water supply. Ten (10) termite workers were introduced in the petri plates. Blank and solvent controls were conducted with untreated, unstained moistened filter paper and solvent treated unstained filter paper respectively. Starvation control unit contained 3grams of moistened soil covering the bottom of the petri plate instead of the filter paper. Three replicates were conducted for treated and control units. This experiment was conducted for about seven days and on each, percentage mortality was calculated per day.

RESULTS

The result of experiment revealed that at 5% probability level ($p<0.05$), ethanol extracts of *Eucalyptus* and Neem leaves, caused high mortality in the worker termites which significantly differed from aqueous extracts and the control . The mortality rate of the 10% and 20% concentration was between 50% and 95.5% after 24 hours and increased to100% after 72 hours, of ethanoic extracts, followed by the aqueous extracts with mortality rate of 45% and 80.4 % for concentration 10% and 20% after 24 hours and reached to 68.3% and 100% for the same concentration after 72 hours.

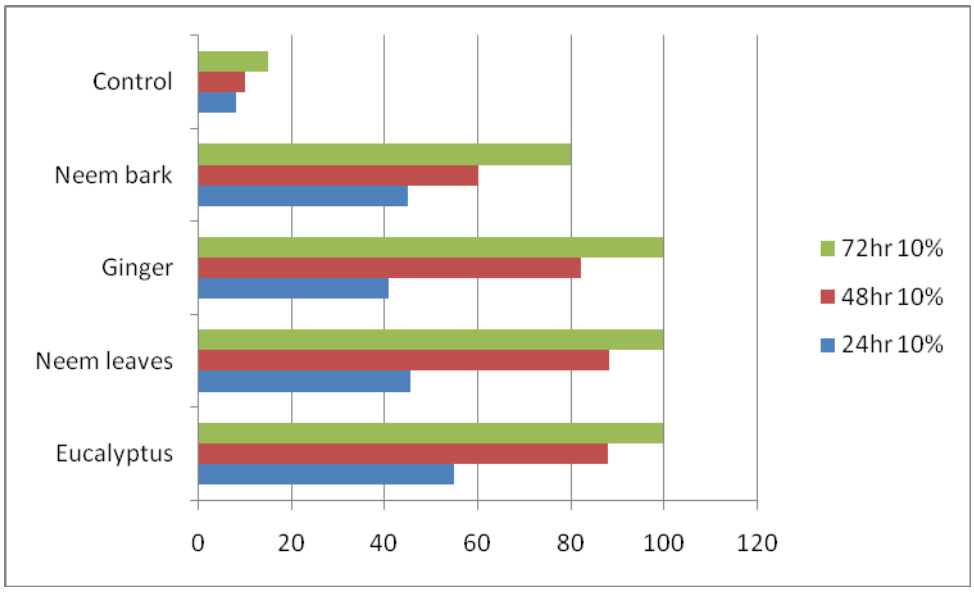

Fig1: Percentage mortality of worker termite as influenced by 10% aqueous extracts of different plants under laboratory condition.

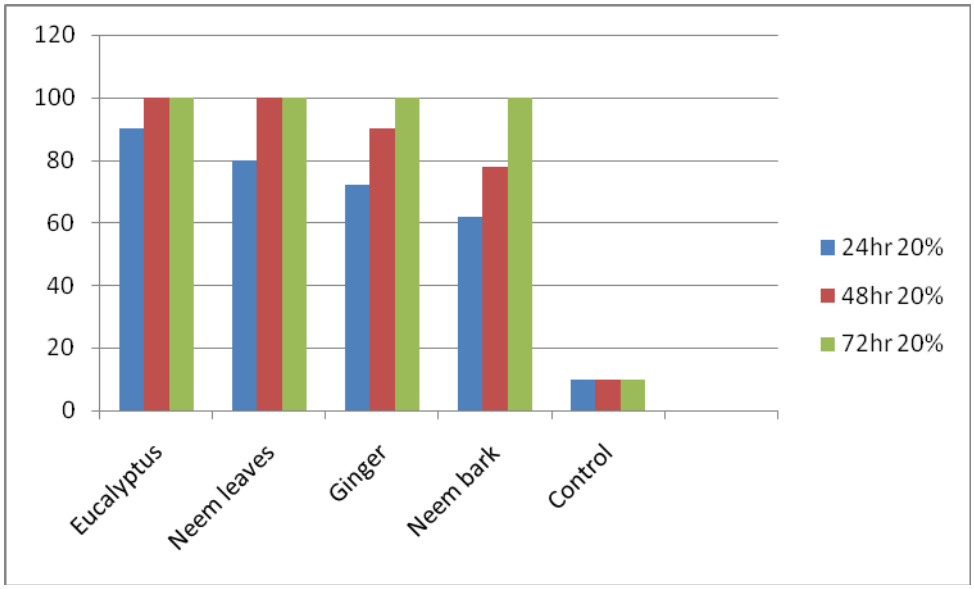

Fig 2: Percentage mortality of worker termite as influenced by 20% aqueous extracts of different plants under laboratory condition.

The ethanol extracts of *Eucalyptus,* Ginger, Neem leaves and bark did not differ from its aqueous extracts in mortality rate which was 100% ,78.9% for concentration 20%, 10 % after 72 hours of treatment . The aqueous extract of Ginger and Neem bark scored lesser effectiveness in mortality rate of termites (78.9% and 71.8% for 10% concentration respectively) after 72 hours of treatment, while 20% concentrations of both aqueous and ethanol extracts of the plant materials recorded high mortality rates under 24 and 48 hour periods. However among the three species, species A and C were highly susceptible to the treatments of both aqueous and ethanol extracts at 24 hr period, while mortalities were only recorded in *Eucalyptus* and Neem leaves extract for species B after 48 hr period, this statistically differed ($P<0.05$), from Ginger and Neem bark of both aqueous and ethanol extracts at 20% and 10% concentrations. The difference in effect of ethanol extracts from the aqueous extract may be related to the types of compounds extracted from the plants.

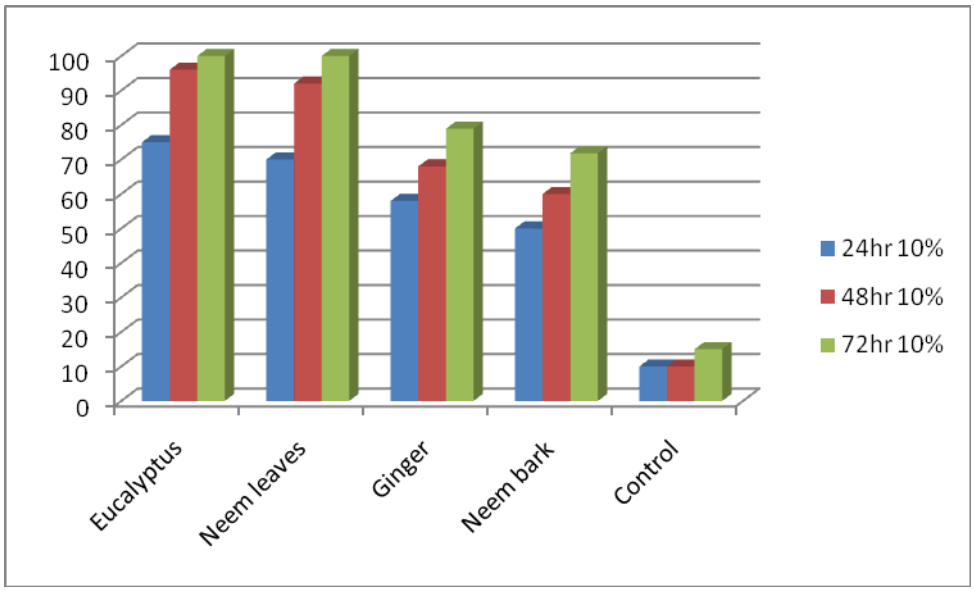

Fig 3: Percentage mortality of worker termite as influenced with 10% ethanol extracts of different plants under laboratory condition.

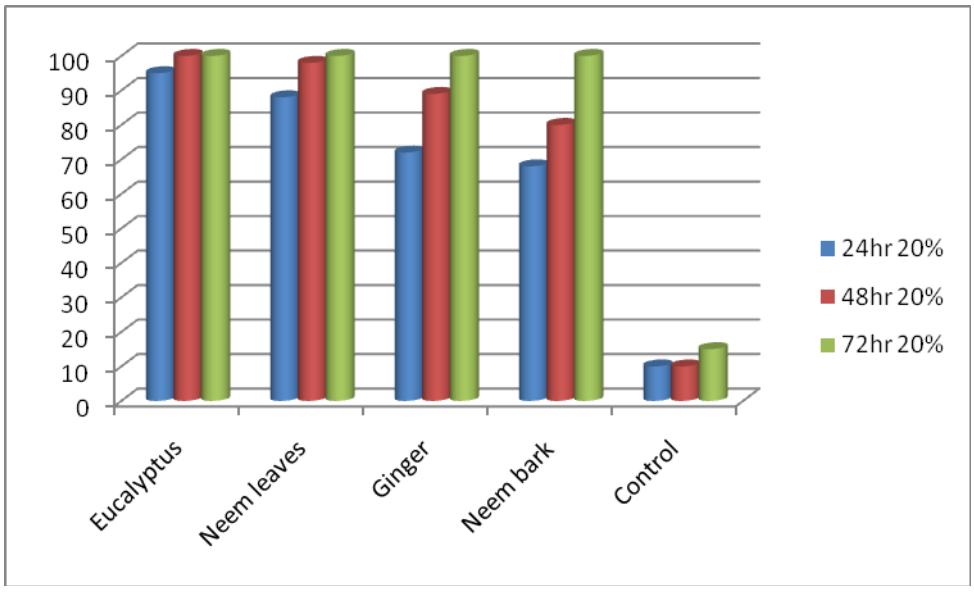

Fig 4: Percentage mortality of worker termite as influenced with 20% ethanol extracts of different plants under laboratory condition.

Repellent effect of plant extracts:

The result in Fig. 5 showed all tested aqueous and ethanol extracts of different plants have repellent effect against termites at both 10% and 20% concentrations, and the most effective was the *E. camaldulensis* where no insect presence was recorded on the treated part of the filter paper and caused zero mortality to insects on the untreated filter paper. This is followed by the aqueous and ethanol extracts of *A.indica leaves, A. indica bark and Z. officinale.*

The percentage rate of insects present on the treated part was 1% or 0% after 4 hours of treatment. The filter papers treated with aqueous or ethanol extracts of the plant materials showed no feeding activity of termite species on the treated papers, the effectiveness of the extracts is either from the contact or fumigant effect of the plant extracts.

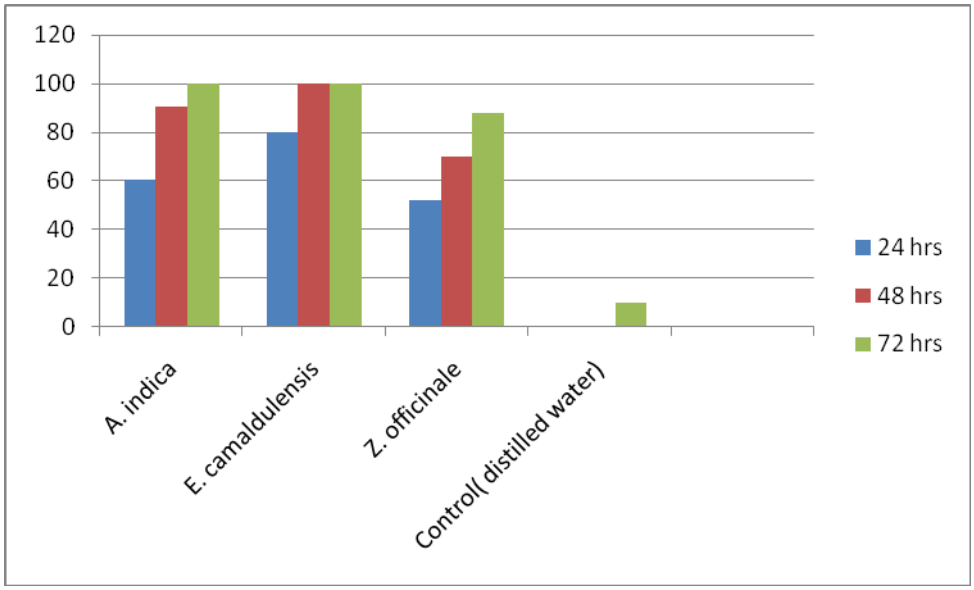

Fig 5: Percentage repellence obtained in different plant extracts under laboratory condition.

Soil barrier

In the different plant material residue and soil mix treatments, termites built significantly fewer and shorter tunnels and never penetrated the barriers when compared with controls. Additionally,

the barriers with *E. camaldulensis* and *A. indica* leaves showed greater repellency and 100% mortality to termite foragers after 48hrs than the barriers with *Z. officinale* and *A. indica* bark residues which were 89.6% and 87.3% respectively. The residue soil mix barriers had a significantly greater repellent effect on the termite species but in the controls, termite species tunnelled throughout the entire arena of all the replicates and infested the food sources at opposite locations, indicating no repellent effect on termites. No dead termites were observed in the control test, and there was no significant difference in survival among the different residue soil mix barriers ($P < 0.05$). This result confirms that *E. camaldulensis* combinatorial mixtures have successfully obstructed tunnelling, feeding and penetration of termites in the soil.

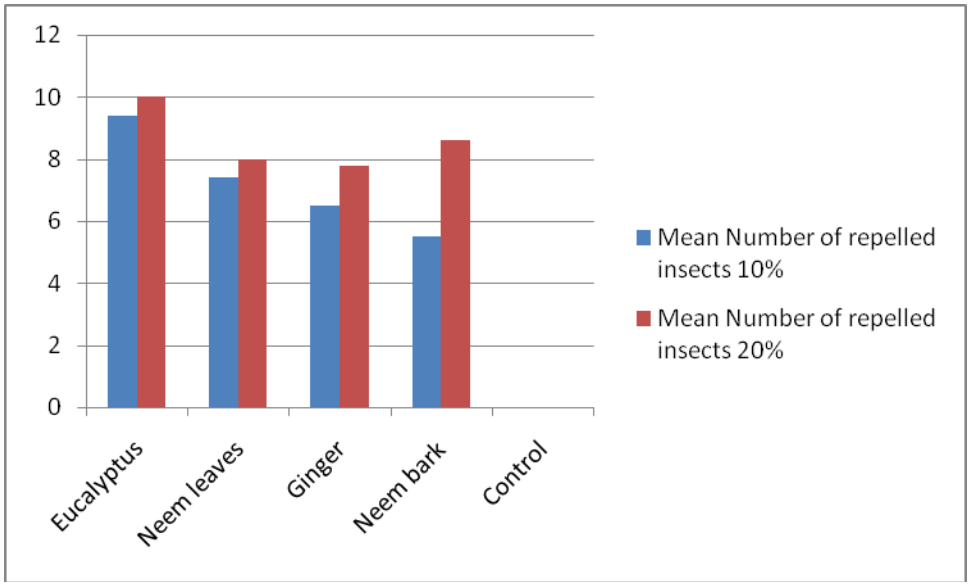

Fig 6: The mean number of repelled termites species under laboratory condition

DISCUSSION

Toxicity effect of plant extacts

From figure 1 and 2 and figure 3and 4, it can be deduced that aqueous and ethanol extracts of the three plant species increased in toxicity as the concentration increased and showed 100% mortality after 72 hour exposure of the termites. This finding agrees with Daniel and Bekele

(2006) who found that seed powder of *M. ferruginea* and *A. indica* water extracts were effective against termite. On the other hand, Mulatu and Gebremedhin (2000) reported from a laboratory study that the seed oils of *M. Ferruginea* and *A. indica* were able to prevent the infestation of faba bean by partially or completely preventing egg laying by bruchid beetle and no bruchid emerged from the few eggs laid. Moreover, consistent with our results, *E. camaldulensis* leaf extract and *A. indica* leaf extract caused greater mortality than *Z. officinale* and Neem bark extract. The less effect of the Ginger rhizome and Neem bark extracts may be related to differences in nature of compounds in these plant parts.

Repellent effect of plant extracts:

Figure 5 shows the potency of the plant extracts in having contact or fumigant qualities against termite species and the most effective strength shown by *E. camaldulensis.* Mulatu and Gebremedhin (2000) also reported that *Eucalyptus* seed powder treatment caused the death of emerging adults of *Callosobruchus chinensis.* The efficacy of *A. indica* observed in the present study also agrees with that of Gold *et al.* (1991) and Epilla and Ruyooka (1988) who reported that, *A. indica* possess insecticidal, repellent, or anti-feedant properties. Jembere *et al.* (2002) reported that the effect of different plants on insects may depend on several factors including chemical composition and species susceptibility. Ordinarily

E. camaldulensis, *A. indica* and *Z. officinale* combinatorial mixtures successfully obstructed tunnelling, feeding and penetration of termites into the soil. Similar results were observed by Boue and Raina (2003) and Blaske and Hertel (2001). Also *Diospyros sylvatica*, (Ganapaty *et al.,* 2004), *Polygonum hydropiper* and *Pogostemon paviflorus* (Rehman *et al.,* 2005), *Aleurits fordii* (Tung tree) (Hutchins, 2006), Garlic (*Allium sativum*) *and Euphorbia kansuii* (Shi *et al.,* 2008) extracts have shown anti-termite activity. Similar termiticidal activity occurs in Cajuput oil (*Melunuca cajuputi*) against *Coptotermes formosanus* due to presence of monoterpene, diterpenes, sesquiterpene and hydrocarbons (Kim *et al.,* 2006). Tunnelling of termites through sand treated with plant essential oils and other natural compounds has been extensively studied, the concept being that a barrier of treated sand placed around a structure could prevent subterranean termites from invading it.

CONCLUSION

It was assessed from the results that the present plant species, *Eucalyptus*, Neem and Ginger may have active compounds with diverse biological activity, which could be successfully used for termite control. Active compounds from these plants certainly deter feeding, orientation and tunnelling behaviour in termites. However, for elimination of field termites, natural pesticides may be either applied in form of baits, fumigants or soil treatment. Toxicants use for natural pesticides strengthen the cost benefit model developed for agro economic fields, such methods are more feasible for sustainable agricultural development and are much able to check the environmental deterioration.

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