ASSESSMENT OF *DATURA METEL*, LOCAL SOAP AND GARLIC (*ALLIUM SATIVUM*) IN THE MANAGEMENT OF TERMITE (TERMITIDAE: ISOPTERA)

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ABSTRACT: The study investigated the efficacy of extracts from *Datura metel*, local soap and garlic in the management of *Macrotermes bellicosus*. The synthetic insecticide (chlorpyrifos 0.1%) and water were included in the study as controls. In the laboratory, contact toxicity was conducted using the standard method described by Mc Donald et al. (1970). The treatments (10 ml each) were applied to the thorax of worker termite and insect mortality was noted. The repellent action of the treatment was based on an area preference test described by McDonald et al. (1970) and Landani et al. (1955). The "test area" was Whatman filter paper cut into equal halves and placed in a plastic Petri dish. One half was treated with the treatment and the other half with water (control). Four termites were released into the centre of the Petri dishes and the number of insect present on the control (NC) and treatment (NT) halves were recorded after 1hour exposure and percentage repellence (PR) values were computed. The efficacy of the treatments at managing termite populations in the field was tested on five average-sized termitaria. They were demolished and dug 40 – 50 cm below ground level. Five litres each of the treatments was applied to a termitaria with knapsack sprayer and resurgence/rebuilding of termitaria was observed as from the 2nd day till the 90th day. The results showed that all the treatments had repellence value of between 75% - 100 % and caused 100 % mean insect mortality in the laboratory. On the field only *D. metel* and chlorpyrifos were effective at preventing the upsurge and rebuilding of termitaria for 90 days. *Datura metel* could be used as an eco-friendly botanical for the management of termites in the field.

KEY WORDS: *Datura metel*, garlic, mortality, repellence, synthetic insecticide, termitaria.

Termites are an important component of tropical and sub-tropical ecosystems. They are group of social insects that belong to the order Isoptera and family "Termitidae" (Mitchell, 2002). The insect are truly social animals classified along with the ants, some bees and wasps in the order hymenoptera (Myles, 2003). The most important termite pest genera in Africa include: *Odontotermes*, *Macrotermes*, *Pseudacanthotermes*, *Microtermes*, *Ancistrotermes*, *Allodontermes*, *Amitermes*, *Trinervitermes* and *Hodotermes* (Mailu et al., 1995; Mitchell, 2002).

Termites mostly feed on dead plant materials generally in the form of wood, leaf litter, soil or animal dung and about 10 % of the estimated 4000 species of the insect are economically significant as pests that can cause serious structural damage to buildings, crop or plantation forest. Termites are major detrivores particularly in the sub-tropical region, and their recycling of wood and other plant matter is of considerable ecological importance. As an eusocial insect, termites live in mounds that may consist of several hundred to several million individuals (Davis & Williams, 1979). They are prime example of insects that display decentralized, self organized system, swarm intelligence and co-operation among colony members to exploit food sources and environment that could not be available to any single insect acting alone.

A typical colony contains nymphs (semi matured young), workers, soldiers and reproductive individuals, sometimes containing several egg laying queens. A worker termite undertake the labour of foraging, food storage, brood, nest maintains and some of the defense effort in certain species (Watson et al., 1985). They are the main caste in the colony for digestion of cellulose in food and are the most likely to be found in infested wood (Krishnak & Weesner, 1969, 1970). Termites thrive in every type of terrestrial environment where enough food is present. They are soil miners, soil engineers and soil architects and in Africa, Asian, Australian and South America build various impressive nests and mounds that provide protection from predators and help in thermoregulation within the nest (Gay & Calaby, 1970; Davis & Williams, 1979; Howell et al., 1986). They are highly voracious and destructive and cause substantial damage to homes and other wooden structures in our environment; in severe infestation, structural integrity of a building and the safety of the occupiers could be threatened.

Although termites play beneficial roles in ecology; they are also destructive and are a major threat to crops and household properties (Edwards & Mill, 1986; Wood & Pearce, 1991). Crops such as yam and cassava (Atu, 1993), sugar cane (Sands, 1977), groundnuts (Johnson et al., 1981), sorghum (Logan et al., 1990) and maize (Wood et al., 1980) are prone to infestation and damage by termites. Termites also attack grain stores and are commonly responsible for mortality of tree seedlings in forestry and cause considerable damage to buildings and other wooden structures like fence posts and utility poles. *Macrotermes* spp. are members of the fungus-growing sub-family Macrotermitinae. They are mostly mound building and are the largest termite species. The queen could attain a length of nearly 6 inches (15 cm) in *Macrotermes natalensis*. There are about 330 species in the *Macrotermes* genus, spread over tropical Africa and Asia. *Macrotermes* spp build large epigeal nests (mounds) from where they forage outwards to distances up to 50m in galleries/runways. They attack plants at the base of the stem, ring-barking or cutting them completely. The huge mounds of *Macrotermes* termites are complex structures with ventilation, air ducts, heating, cooling systems, and chambers containing fungus gardens which the termites cultivate. In Africa, *Macrotermes* has been a serious pest of some agricultural crops and tree plantations. They are responsible for the majority of crop damage and 90% of tree mortality in forestry. Seedlings in the nurseries and newly planted trees are particularly susceptible to attack during the first 6-9 months after planting. Mortalities vary between 19 - 78%, occasionally approaching 100% in some areas. Bigger (1966) and Munthali et al. (1992) reported *Macrotermes* as the major pest in cassava. Damage by termite to stored products also provides entry for secondary infection by pathogens especially *Aspergillus*, which cause indirect yield loss and contamination of products with aflatoxins (Lynch & Dicko, 1991).

Many plants have developed effective defences against termites, and in most ecosystems, there is an observable balance between the growth of plants and the feeding of termites (Xie et al., 1995). Defence is typically achieved by secreting anti-feedant chemicals (such as oils, resins, and lignins) into the woody cell walls. This reduces the ability of termites to efficiently digest the cellulose. Many of the strongly termite-resistant tree species have heartwood timber that is extremely dense (such as *Eucalyptus camaldulensis*) due to accretion of these resins. Over the years there has been considerable research into these natural defensive chemicals with scientists seeking to add them to timbers from susceptible trees. A commercial product, "Blockaid", has been developed in Australia and uses a range of plant extracts to create a paint-on non-toxic termite barrier for buildings. Termites are strongly repelled by some toxic materials to the extent that they become disoriented and eventually die from starvation rather than consume cross treated samples (Xie et al., 1995; Peterson & Wilson, 2003). The control of termite with synthetic insecticides is prone to pollution of environment and underground water, killing of beneficial pest, pest resistance and resurgence etc. Hence, there is the need for continuous research into testing of extract from natural occurring plants that are cheap, readily available, eco-friendly and effective at managing the population of termite on the field. This study evaluates the effectiveness of *Datura metel,* garlic and local soap at managing the population of termites.

MATERIALS AND METHODS

Collection of termites, plant materials and preparation of extract

The leaves of *Datura metel* were collected from farms in Ogun State, Nigeria. 100 g fresh leaves were crushed in a mortar to soften the leaves: thereafter, 5 litres of water was poured into the crushed leaves and left for 3 days when the liquid was sieved. Dried bulb of garlic – *A. sativum* was ground into powder with an electric grinding machine and left for 48 h to dry. Dried garlic powder (100 g) was thereafter diluted in 5 litres of water. The local soap was sourced from Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria. The soap (100 g) was soaked overnight in 5 litres of water and sieved through cheese cloth. The solution was made up to 10 litres with water. Worker termites used for the laboratory studies were sourced from termite mounds in FUNAAB. They were collected about 1 hour prior to use in 250cm^3 Kilner jars and placed in the deep freeze for one minute to reduce their activeness for ease of handling.

Laboratory studies

Contact toxicity by topical application

Test of contact toxicity of the extracts to termite was conducted by topical application of the treatments to the insect using standard method described by McDonald et al. (1970). Four termites of unknown age and sex were placed in a Petri dish lined with moist Whatman filter paper. 10 ml each of the extracts and the synthetic insecticide (0.1% chlorpyrifos) was applied to the dorsal surface of thorax of each insect individually with a micro applicator (Obeng-Ofori and Reichmuth, 1997; Ebenezer, 2000). The treatments were arranged on worktable in the laboratory using complete randomized design (CRD). Percentage insect mortality was calculated according to Baba-Tierto Niber (1994) using the formulae:

$$\% \text{ mortality} = \frac{\text{No of dead insect}}{\text{Total number of insect}}$$

Repellency study by treated paper method

The study was based on an area of preference test described by Landani et al. (1955) and Mc Donald et al. (1970). Test area was number 1 Whatman filter paper (11cm diameter) cut into equal halves that have no contact with each other to prevent exchange of content. One half was dipped into each of the treatment with forceps and allowed to drain before being placed into the plastic Petri dish. The other half was placed into distilled water (control), allowed to drain and was placed sideway with the first halve. Four termites were released separately into the centre of each filter paper in the Petri dish. Each treatment was replicated four times and arranged on the work table in the laboratory using complete randomized design (CRD). The number of insects present on control (NC) and treatments (NT) half was recorded after 1 hour exposure. Percent repellence (PR) values was computed using the method of Hossanah *et al.* (1990) as follows:

$$PR = \frac{(NC - NT)}{(NC - NT)}$$

FIELD STUDY

The field trial of the extracts and local soap was conducted on two field locations in UNAAB. Five average-sized termitaria of between 0.5 and 1m heights were used for the study. The termitaria were demolished and dug to depth of 40 - 50 cm below the ground level to expose the termite to application of the treatments. The king and queen were not injured nor killed during the digging. Five litres of the extracts were evenly applied to the dug termitaria with the aid of Cooper Peegler (CP15) Knapsack sprayer. One of the demolished termitaria was sprayed with 5 litres of 0.1% chlorpyrifos (synthetic insecticide) and another 5 litres of distilled water and these served as controls. The termitaria were observed for re-built and termite resurgence as from the second day after application of extract.

STATISTICAL ANALYSIS

Statistical analysis of data was based on SAS's general linear model procedure (SAS Institute, 1988). The data was subjected to Analysis of Variance (ANOVA) and mean separation was done using Least Significant Difference (LSD).

RESULTS

Repellence of termite by the treatments

The repellence effects of the treatments on termite are shown on Table 1. Garlic repelled the entire termite population (100%), followed by *Datura metel* (83.3%). Their repellence values were however, not significantly ($P > 0.05$) difference from each other. Local soap induced 75% repellence and it was significantly ($P < 0.50$) lower than percentage repellence induced by garlic and *D. metel*. The synthetic insecticide, chlorpyrifos induced 100% repellence. It was however, not significantly ($P > 0.05$) difference from repellence induced by garlic (100%) and *D. metel* (83.3%).

Mortality of termites topically treated with the treatments

Table 2 shows the mortality of the termites after the treatments were topically applied on them. All the treatments induced 100% mortality and they were not significantly ($P > 0.05$) difference from each other.

Field trial of treatments

The effectiveness of the treatments in the management of the termite on the field was based on the rating according to Osipitan (2008) as shown in Table 3. As shown in Table 4, the synthetic insecticide was highly effective, while the extract of *Datura metel* was effective. Local soap solution and garlic solution were not effective at managing the termite population as the termite resurged and rebuilt the demolished termitaria.

DISCUSSION

The study indicated the ability of garlic, *Datura metel* and local soap to repel and cause high mortality of termite in the laboratory. This is in consonance with the report of Zhu et al. (2001) who reported that naturally occurring anti-termite compounds extracted from locally available plants or trees have potential for managing termite population. Khan & Gumbs (2003) reported that repellent offer protection and drive away insect pest from treated materials. In this study, although garlic and local soap were effective in the laboratory, they were not effective at managing the population of termite on the field. This result is in consonance with the results from the use of other control options such as biological control (Logan et al., 1990; Grace, 1997), use of entomopathogenic nematodes and bacteria (Mauldin & Beal, 1989; Milner & Staples, 1995), use of entomopathogenic fungi (Milner & Staples, 1996; Rath, 2000) that indicated successful control of termites in the laboratory, but failure on the field. The ineffectiveness of garlic and local soap at controlling termite on the field in this study may result from the likely instability of their active ingredients on the when exposed to high atmospheric condition especially temperature or due to the field composite castes (queen, king, soldier, worker) to which the extract were applied on the field as against single caste (workers) trial in the laboratory study.

On the field, the extract of *Datura metel* and the synthetic insecticide were effective at managing the population of termites. The termitaria disinfested with the two treatments were not rebuilt three months after application of the treatments and the termite population did not resurge. This implies that the extract of *D. metel* could effectively manage the population of termites on the field. This result is similar to the findings of Osipitan and Oseyemi (2012) that indicated the bio-activity of aqueous extract from citrus (*Citrus cinensis*), cocoa (*Theobroma cacao*), cashew (*Anarcardium occidentals*) and sunflower (*Tithonia diversifolia*) at managing the population of *macrotermes bellicosus* on the field.

Termites are usually controlled with persistent organochlorines such as aldrin, lindane, chlordane and dieldrin applied as seed treatments, on seedlings, mature These chemicals plants and for tree protection (Sands, 1977). The banning of these organochlorines, has shifted use to products like organophosphates, carbamates, and synthetic pyrethroids. are however expensive and prone to side effects such as pest resistance and resurgence, biomagnifications, death of beneficial insects etc. Similarly, cultural practices such as crop rotation, demolishing of mounds, intercropping etc are labour-intensive and have not achieved much success (Gethi et al., 1995). Most of the African farmers are subsistence farmers with small farm holdings and could not afford high cost of synthetic termiticides. It beholds therefore that steady efforts should be geared at exploring the potentials of extracts from plants that abound in Africa and easily accessible. The comparable effectiveness of the extract of *D. metel* with the synthetic insecticide in this study is a good development for the management of termite as the plant thrive in forest and the technology of its extraction could be easily adapted.

In this study, the extracts of *D. metel* was effective in the management of the population of termite in the laboratory and on the field and could therefore be explored in the management of termite.

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Table 1. Repellency of termites by the treatments.

Treatments	% repellency± SE
Datura metel	83.33±16.67a
Garlic	100±0.00a
Local soap	75.00±14.43b
chlorpyrifos	100±0.00a

Means followed by the same letter are not significantly different from each other at P < 0.05 using least significant difference (LSD)

Table 2. Mean % mortality of termites with treatments topically applied.

Treatments	% Mortality± SE
Datura metel	100±0.00a
Garlic	100±0.00a
Local soap	100±0.00a
chlorpyrifos	100±0.00a

Means followed by the same letter are not significantly different from each other at $P < 0.05$ using least significant difference (LSD)

Table 3. Scale of measuring effectiveness of treatments in the management of termites.

Upsurge/rebuilding of termitaria	
Days after application of the treatments	Rating
1 – 20	Not effective
21 – 40	Slightly effective
41 – 60	Effective
61 days and longer	Highly effective

Table 4. Effectiveness of extracts in the management of termites on the field.

Upsurge/rebuilding of termitaria	
Treatments	Rating
Datura metel	Effective
Garlic	Not effective
Local soap	Not Effective
Water	Not effective
chlorpyrifos	Highly effective