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Termiticidal Potential of *Parkia biglobosa* Aqueous Seed Extract Rates and Location on Termites Infestation in Niger State, Nigeria

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ABSTRACT

Termites constitute a nuisance to both the environment and human properties anywhere they exist. Consequently, this research was conducted at Mokwa Local Government area of Niger State to evaluate the rate of bio-insecticide for their control. Mokwa is located on latitude 09˚ 18ˡN and longitude 05˚ 14ˡE in Southern Guinea Savanna agro ecological Zone of Nigeria. This experiment was aimed at determining the termiticidal potential of acqueous solution rates of locust bean tree *(Parkia biglobosa)* seed and location on termites˝. The main treatments were four *Parkia biglobosa* seed extract rates at 0, 5, 10, and 15 millilitres while the sub treatments were three termites locations at Mokwa, Muwo and Kudu. The trial was factorially combined in a 4 x 3 arrangement and fitted into a completely randomized design (CRD) with three replications. Data collection were on number of termite per meter of tunnel, length of tunnels in meter, number of life termites and the number of dead termites found after treating with the extract solution rates.
The result showed that *Parkia biglobosa* seed extract rates differed significantly on termites' mortality rate irrespective of the location. Moreover, the *Parkia biglobosa* seed extract rates had significant effect on termites throughout the period of the study**.** The *P. biglobosa* seed extract rates at 10 and 15 millilitres were effective for the control of termites in all the test locations and are thus suggested for use as an alternative to synthetic termiticides in the Southern Guinea Savanna zone of Nigeria for termite control.

Keywords: Bio-insecticide, Live termites, Mortality rates, Termiticidal potential, Southern Guinea Savanna zone

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1. INTRODUCTION

The locust bean tree (*Parkia biglobosa*) is well known to be an economic tree throughout the savanna tropical countries of the world (Abdou et al*.* 2019). On the other hand, termites are highly destructive insect pests, which largely damage wooden portions of buildings, furniture, books, utility poles, plants and agricultural crops such as sugar cane, millet, barley, cotton, wheat and paddy (Addisu, et al. 2014; Elango et al*.* 2012). Termites are eurytopic as they are distributed throughout the world. They feed largely on cellulose and lingo cellulose and process 50- 100% of dead plant and decaying biomass in the tropics (Ohkuma and Brune, 2011). Damage results from the feeding activities of termites aided by the symbiotic microbes like bacteria and fungi which are capable of digesting cellulose (Ohkuma and Brune, 2011). The common genera associated with the destruction include: *Coptotremes, Rhinotermes, Marotermes, Odontotermes, Reticulitertermes, Microcerotermes, Ancistrotermes, Microtermes* (Elango et al. 2012).

Although termites are abundant worldwide, Africa seems to be the richest in number of termites species with about 38% of recognised termites (Ugbomeh and Diboyesuku, 2019). Ahmed et al. (2011) reported that the species richness is a result of the friendly climatic conditions in Africa*.* Termites' colonies generally affect plants either by attacking the trunks and pods or by making tunnels under the plant which eventually weaken plant stems, causing them to collapse or giving access to fungi microorganisms (Badshah et al. 2012). In the past, control of termites had relied on synthetic termiticides including DDT, aldrin, dieldrin, chlordane, heptachlor, phosphorothioate, and BHC (Dyer et al. 2012*).*

Synthetic insecticides have been successfully employed as soil treatment against termites *(*Elango et al. 2012*).* However, the use of synthetic termiticides for a long time poses a great hazard to the environment including toxicity to non-target organisms and residual effects. In addition, resistance development in pest populations further derives the need to search for new bioactive compounds with a wide range of new modes of action (Elango et al. 2012*)*. Hence, the search for alternative economically viable, environmentally friendly and effective insecticides has been the concern of many researchers *(*Arihara et al. 2004*;* Elango et al. 2012). In order to avoid environmental pollution and health problems caused by the use of synthetic pesticides, there has been increasing interest in naturally occurring toxicants from plants *(*Chang et al. 2001; Osbrink et al. 2001).

Many plants may be used as alternative sources of termites control agents because they are rich source of bioactive compounds mainly secondary metabolites (Osbrink et al. 2001*).* Plant based insecticides might be used as alternative in pest management strategies as they are generally insect specific, relatively harmless to non-target organisms, less expensive and biodegradable (Satti et al. 2004).

Manzoor et al. (2011) have reported that the ethyl acetate methanol, butanol, hexane, water and chloroform extract of *Ocimum sanctum* leaves showed termiticidal activity against *Heterotermes indicola* (Isoptera; Rhinotermitidae). Similarly, black heatwood of *Cryptomeria japonica* showed good termiticidal activity against *Coptotermes formosanus* (Taxodiaceae*)* (Arihara et al. 2004)*.* Oyedokun et al. (2011) tested insecticide activity of the *Phyllanthus amarus, Acasia albida* and *Tithonia diversifolia* leaf crude extracts against the workers of *Macrotermes bellicosus* in vitro. Aqueous extracts of *P. amarus, A. albida* and *T. diversifolia* caused 40-56%, 24-60% and 42-88% mortality respectively after 140 minutes of exposure to the extracts. Similarly, ethanolic extracts of *P. amarus, A. albda and T. diversifolia* resulted in higher percentage mean mortality of 64-91%, 36.4-76% and 36-68% respectively.

In another work Elango et al*.* (2012) reported anti-termites activity of the crude leaf hexane ethyl acetate, acetone and methanol extract of medicinal plants of *Andrognatphis lineata, Andrographis paniculata, Argemone mexicana* L*., Aristolochia bracteolate, Datura metel* L*., Eclipta prostrate* L., *Sesbania grandifilora* and *Tagetes erecta* L. against *Coptotermes formosanus*.

Dadawa/iru is a food seasoning agent produced from the solid subtrate fermentation of cotyledons of locust bean (*P. biglobosa*). The hausa ethnic group of northern Nigeria use it to flavour soup and many other traditional dishes. Details of the kitchen process of manufacturing dawadawa /iru differ very slightly between cultures. Abdou et al. (2019) reported that basically, Africa locust bean seeds are boiled for 12-24 hour or until they are tender and the cotyledons have enlarged significantly. This is followed by de-hulling by gently pounding in a mortar, by rubbing the seeds between palms or by use of different abrasive procedures.

The de-hulled cotyledons are washed and boiled again for 1 h then spread to a few depth in basket or calabash lined with some leaves or wrapped in jute bag and allowed to ferment for 3-4days. In some cultures, the boiled water during fermentation processes of *P. biglobosa* seeds may be effective in controlling termite's infestation. The cotyledons are molded on to small balls and wrapped in papaya or banana leaves (Aworth, 2008*),* then covered with additional banana leaves or raffia mats and allowed to ferment for 2 – 4 days and used as condiments in soups (Egwim et al. 2013).

There has been no scientific investigation on efficacy of *P. biglobosa* in controlling terminates in Niger state. Therefore, the present study was aimed at determining the termiticidal potential of *P. biglobosa* aqueous seed extract rates on termites. This was to ascertain their efficacy and to evaluate the effect of termites' location on their activities and prevalence as well as to determine the interaction effect between *P. biglobosa* seed extract concentration rates and termite's location in Mokwa Local Government Area of Niger State, Nigeria, to evaluate their rates for their control.

MATERIALS AND METHODS

The experiment was carried out in Mokwa Local Government Area at Mokwa, Muwo and Kudu in Niger State. Mokwa is located on latitude 09˚ 18ᴵN and Longitude 05˚14ᴵ E Southern Guinea Savanna agro-ecological zone of Nigeria.

Experimental materials

The water used by the villagers who engage in "*dadawa*" preparation was collected in Mokwa, Muwo and Kudu in Mokwa local government area in beakers and stored at room temperature for further bioassay.

Layout and experimental design

The trial was conducted on bioassay to determine the termiticidal potential of *Parkia bigilobosa* (dawadawa) seed extracts concentration rates. The experiment was laid out in a complete randomized design (CRD) in three replications. The main treatment consisted of four *Parkia biglobos*a seed extracts concentration in solution rates of 0, 5, 10, and 15 millilitres while the sub treatments were three existing termiteria in Mokwa, Muwo, and Kudu locations. To ascertain the efficacy of *Parkia biglobos*a seed extract solution rates; 50 workers of termites were collected into four containers of different extract concentration rates and were monitored every 20 minutes for 3 hours to determine the live condition of the termites.

Parameters observed

1. Number of termites
2. Length of tunnels in metres at 2, 4, and 6 months
3. Number of live termites found at 2, 4 and 6 months
4. Number of dead termites found at 2, 4 and 6 months

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) using GENSTAT 12.1 released edition and means were separated or partitioned using least significant difference (LSD) at a 5% level of probability where differences existed between the means.

RESULTS

Effect of *Parkia biglobosa* seed extract concentration rates and location on a number of termites per metre of the tunnel at Kudu, Muwo, and Mokwa at 2, 4 and 6 Months after infestation (MAI)

Throughout the period of the study, the result indicated that *Pakia biglobosa* seed extract concentration rates differed significantly on the number of termites per metre of tunnel. The treatment applied with control (0) millilitres of the seed extracts recorded a significantly higher number of termites per metre of tunnel at 2, 4, and 6 MAI of 115, 191, and 220 compared to the application of 10 and 15 millilitres that resulted in significantly lower number of termites per metre of tunnel of 11 at 6 MAI respectively (Table 1).

Effect of *Parkia biglobosa* seed extract concentration rates and location on length of termites tunnel in meters in Kudu, Muwo, and Mokwa at 2, 4 and 6 Months after infestation (MAI).

Throughout the period of the study, the result showed that *Parkia biglobosa* seed extract concentration rates differed significantly on tunnel length of termites per metre of tunnel. The treatment applied with control 0 millilitres of the seed extracts recorded significantly higher tunnel length of termites per metre of tunnel at 2, 4, and 6 MAI of 21, 25, and 30 metres respectively compared to application of 10, and 15 millilitres that resulted in significantly lower tunnel length of termites per metre of tunnel of 1 at 6 MAI metre of tunnel throughout the study period. The termiterium at Mokwa location which recorded significantly higher tunnel length of termites per metre of tunnel of 1 at 6 MAI was significant compared to the termiterium at Kudu (Table 2).

Table 1: Effect of *Parkia biglobosa* seed extract concentration rates and location on the number of termites per meter of the tunnel at Kudu, Muwo and Mokwa at 2, 4 and 6 Months after infestation (MAI).

Treatments	**Number of termites per metre of tunnel**		
Parkia biglobosa seed extract concentration rates (P)	Months after infestation		
	2	4	6
5 Mills	92b	81b	44b
10 Mills	55c	35c	21c
15 Mills	26d	15d	11d
Control (0 mills)	115a	191a	220a
LSD (0.05)	10.50 *	12.20*	10.50*
Termites location (L)			
Mokwa	75a	54a	52a
Muwo	52b	25b	21b
Kudu	31c	15c	11c
LSD (0.05)	8.50*	8.10*	10.10*
Interaction (PxL)	**	**	**

Interaction (PxL): P= *Parkia biglosa* seed Extract concentration rates x Termites Location (L), NS= No significant difference, * =significant difference, Means with the same letter (s) within the same column are not significantly different at (P≤ 0.05).

Table 2: Effect *Parkia biglobosa* seed extract concentration rates and location on length of termite's tunnel per metre of in Kudu, Muwo, and Mokwa at 2, 4 and 6 Months after infestation (MAI)

Treatments	**Length of termites Tunnel (m) at:-**		
Parkia biglobosa seed extract concentration rates (P)	Months after infestation		
	2	4	6
5 Mills	5b	7b	13b
10 Mills	2c	2c	3c
15 Mills	1d	1d	1d
Control (0 mills)	21a	25a	30a
LSD (0.05)	4.22*	3.10*	5.23*
Termites location (L)			
Mokwa	8a	10a	12a
Muwo	5b	6b	8b
Kudu	2c	2c	1c
LSD (0.05)	3.22*	2.24*	3.40*
Interaction (PxL)	**	**	**

Interaction (P x L) P = *Parkia biglosa* seed Extract concentration rates x Termites Location (L), NS = No significant difference * = significant difference, Means with the same letter (s) within the same column are not significantly different at (P≤ 0.05).

Effect *Parkia biglobosa* seed extract concentration rates and location on the number of termites found alive at 2, 4 and 6 Months after infestation (MAI)

Results presented in Table 3 showed that *Pakia biglobosa* seed extract concentration rates differed significantly on termites found alive per metre of tunnel. The treatment applied with control 0 millilitres of the seed extracts recorded a significantly higher number of live termites per metre of tunnel at 2, 4, and 6 MAI of 56, 72, and 95 respectively.

Table 3: Effect *Parkia biglobosa* seed extract concentration rates and location on number of termites found alive in Kudu, Muwo, and Mokwa at 2, 4 and 6 Months after infestation (MAI).

Treatments	**Length of termites Tunnel (m)**		
Parkia biglobosa seed extract concentration rates (P)	Months after infestation		
	2	4	6
5 Mills	48b	45b	32b
10 Mills	32c	18c	12c
15 Mills	21d	11d	8d
Control (0 mills)	56a	72a	95a
LSD (0.05)	9.21*	10.20*	12.52*
Termites location (L)			
Mokwa	49a	38a	28a
Muwo	32b	25b	13b
Kudu	21c	12c	6c
LSD (0.05)	9.34*	6.33*	7.52*
Interaction (PxL)	**	**	**

Interaction (PxL) = *Parkia biglobosa* seed extract concentration rates (P)x Termites Location (L), NS =Not significant, *= Significant difference and Means with the same letter (s) within the same column are not significantly different at P≤ 0.05.

Table 4. Effect *Parkia biglobosa* seed extract concentration rates and location on the number of termites found dead in Kudu, Muwo, and Mokwa at 2, 4 and 6 Months after infestation (MAI).

Treatments	**Number of dead termites per metre of tunnel**		
Parkia biglobosa seed extract concentration rates (P)	Months after application		
	2	4	6
5 Mills	12c	10c	9c
10 Mills	12c	12b	12b
15 Mills	34a	23a	20a
Control (0 mills)	5d	6d	7d
LSD (0.05)	4.89*	4.33*	2.11*
Termites location (L)			
Mokwa	21a	19a	15a
Muwo	13b	10b	10b
Kudu	11c	8c	6c
LSD (0.05)	2.69*	2.58*	4.20*
Interaction (PxL)	**	**	**

Interaction (PxL) P= *Parkia biglobosa* seed Extract concentration rates x L= Termites Location NS= No significant difference, *= significant difference, Means with the same letter (s) within the same column are not significantly different at P≤ 0.05.

Effect *Parkia biglobosa* seed extract concentration rates and location on a number of termites found dead in 2, 4 and 6 Months after infestation (MAI).

Results shown in Table 4 indicated that *Pakia biglobosa* seed extract concentration rates differed significantly on dead termites per metre of the tunnel. The treatment applied with 15 millilitres of the seed extracts recorded significantly higher dead termites per metre of the tunnel at 2, 4, and 6 MAI of 34, 23 and 20 when compared to application of 5, and 10 millilitres that resulted in significantly lower termites dead per meter of tunnel of 5 at 2 MAI respectively.

Furthermore, the termite's location consistently recorded significantly different effects on dead termites per metre of tunnel throughout the study period. The termiterium at the Mokwa location recorded significantly higher dead termites per metre of tunnels of 21 at 2 MAI compared to termiterium at Kudu that recorded lower dead termites per metre of tunnel of 6 at 6 MAI respectively (Table 4).

DISCUSSION

In the present, report the varied rates of *Parkia biglobosa* seed extract consistently differed significantly in termite mortality rate throughout the duration of the study. The treatments with *Parkia biglobosa* seed extract solution rates of 10 and 15 millilitres consistently and effectively controlled termites probably due to the organic repellants and toxic effect of the antidote present in them that prevented or reduced their activities in building termiteria or tunnels. This finding agrees with the report by Tripathi et al. (2014) who asserted that some organic plant materials are effective and perform better in the control of termites.

In addition, this study shows that the control treatment led to colossal damage or losses due to termites' infestation as no lethal dosage was applied. This result conforms to that of Senthilkumar et al. (2009**)** who reported that the essential oils of many plant species are known to have repellent and bio-insecticidal properties. Plant based insecticides can be used as alternatives in pest control strategies as they are generally insect-specific, relatively harmless to non-target organisms, less expensive, environmentally friendly and biodegradable as reported by Satti et al. (2004).

CONCLUSION

In the present study, treatment of *P. biglobosa* seed extracts rates on termites differed significantly in the mortality rates throughout the period of investigation. Consequently, *P. biglobosa* seed extract rates at 10 and 15 millilitres controlled termites better than other rates. Irrespective of the location the bio-insecticides of *P. biglobosa* seed extracts were effective in controlling termites and are suggested as alternative to synthetic insecticides. Uncontrolled termite's infestation treatments resulted in higher number of life termites of 56, 72, and 95 per metre respectively.

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