OPEN ACCESS Freely available online

Global Journal of Biology, Agriculture & Health Sciences

Review Article

Termicidal Activity of Azadirachta Indica and Khaya Ivorensis Extracts on Subterranean Termites in Mubi,Nigeria

Wahedi, J.A[*1], Oaya, C.S[2]

[1]Department of Zoology, Adamawa State University Mubi, Nigeria; [2]Department of Crop Science, Adamawa State University Mubi, Nigeria

ABSTRACT

This study was carried out in the laboratory of the Department of Zoology, Faculty of Science, Adamawa State University, Mubi to evaluate the efficacy of ethanol and aqueous extracts of Azadirachta indica seed and Khaya ivorensis stem bark against subterranean termites in Mubi. Extracts from these plants were separately prepared into 200 mg/ml and 400 mg/ml concentrations. The extracts were thereafter evaluated for their efficacy against the subterranean termites measured in terms of toxicity and antifeedancy. In the Laboratory mortality was observed for 24 hrs, 48 hrs and 72 hrs, respectively. Antifeedant activity of the treatments was also observed in the field, where 20 pieces of wood of the known weight were used for the field experiment. The wood pieces were dipped in each of the treatments concentration placed vertically and buried in the soil to a depth of 10cm around termite's mounds, including the control experiment. Each treatment was replicated four (4) times. The results showed that both A. indica seed and K. ivorensis stem bark extracts at varying concentrations, effectively controlled the subterranean termites. 100% mortality of termites was recorded in all the treatment jars exposed to both A. indica and K. ivorensis extract after 72hrs of treatment and no mortality was recorded in the control jars. Similar trend of exhibition of potency by the treatments was observed in the weight loss recorded in the exposed woods in the field, as the treatments significantly reduced the weight loss of treated woods to as low as 17.60 g in K. ivorensis treated woods, compared to 153.40g for the control woods at week 3 of exposure, confirming their insecticidal efficacy. Hence, the result of this study further documented the potencies of A. indica and K. ivorensis against insect pests which was measured in terms of toxicity (mortality) and antifeedant (weight loss by the woods) on subterranean termites in Mubi.

Keywords: Azadirachta indica; Khaya ivorensis; Mortality; Mubi, Termites; Weight loss

INTRODUCTION

Termites are considered as one of the major bio-deteriorating agents affecting woods (Olufemi et al., 2011). They feed on organic wastes such as animal dung, living or dead woods etc., and as a result, can cause considerable damages in agriculture, constructions, forestry and housing (Ahmed et al., 2016). They also feed on live plants materials when they do not find their desired food crops like maize, groundnuts, and millets (Zaheer et al., 1998). Subterranean termites, especially the Coptotermes and Macrotermes have been implicated to cause huge damages domestically and in the field. Various agricultural crops, wooden portions of buildings, living trees, furniture, books, poles, logs, etc. have been reported to have been damaged by subterranean termites (Gauchen et al., 1998; Kirton et al., 1999; Cox, 2004; Nyeko et al., 2010; Adedeji et al., 2018). They cause serious material and monetary loss worth millions of dollars (Obi et al., 2008).

Correspondence to: Wahedi, J.A, Department of Zoology, Faculty of Science, Adamawa State University, Mubi, Nigeria, E-mail: wahedijasini010@gmail.com

Received: February 22, 2021; **Accepted**: March 8, 2021; **Published**: March 15, 2021

Citation: Wahedi JA, Oaya, CS (2021) Termicidal Activity of Azadirachta Indica and Khaya Ivorensis Extracts on Subterranean Termites in Mubi, Nigeria. Glob J Agric Health Sci 10:106.

Wood is an essential commodity that can be used for both indoor and outdoor services (Olufemi et al., 2011). Wood has a variety of usage especially for construction purposes like furniture, building, roofing in building, transmission poles for electricity, paper making, fuel, etc. (Akanbi and Ashiru, 2002). However, despite the economic benefit derived from the use of woods, their usage is depleted by insect pest attack, which necessitates the application of chemical insecticides as treatment for preservation of woods whenever they are used, especially in the area of construction (Gosktas et al., 2007).

The use of conventional synthetic insecticides still remains the most effective means of controlling field and stored product insect pests despite their draw backs inclusive of high mammalian toxicity and environmental pollution (Oaya and Jada, 2013; Malgwi and Oaya, 2014). Currently, research on insecticide product development focuses on materials of plant origin which are effective, readily available, affordable and environmental friendly (Oaya and Samaila, 2013; Oaya et al., 2017).

Neem (Azadirachta indica A. Juss) and Khaya ivorensis, both belonging to the family Meliaceae are widely studied plants because of their varieties of usage. A. indica is widely known for its medicinal properties (Lawal et al., 2010; Olusola and Oyeleke, 2015), as well its insecticidal properties (Oparaeke et al., 1998; Wahedi et al., 2016). K. ivorensis has also been reported by various authors as medicinal and insecticidal (Babajide et al., 2008; Kayode et al., 2009; Stephen et al., 2009; Choudhury and Boshe, 2013; Ji et al., 2014; Wahedi et al., 2017). Both plants have been reported to protect woods from termites by Adedeji et al. (2018) in Ogun State, and Olufemi et al. (2011) in Borno State, Nigeria. However, this study intends to evaluate the repellent effect of ethanol and aqueous extracts of A. indica and K. ivorensis against subterranean termites in Mubi, Adamawa State, Nigeria.

MATERIALS AND METHODS

Description of study area

The study area is Mubi. It is located between latitude 10º12N and longitude 13º10'E, and has a tropical climate and is found within the Sudan savanna (Adebayo, 2004). Average temperature is about 320C, with a minimum of 15.2ºC, usually in December and January period (Adebayo, 2004). The area has an average relative humidity from 28% to 45% and annual rainfall of about 1050 mm. The rainy season is between May and October, while the dry season between November and April (Adebayo and Tukur, 1999; Adebayo, 2004).

Collection of plants materials.

Azadirachta indica

The seeds of Azadirachta indica were collected from tree plantation within the main campus of Adamawa State University Mubi, between the month of August and September 2019. The seed's coats of A indica were decorticated and dried at room temperature for about 2 to 3 weeks before they were grinded into powder form, with the aid of pestle and mortar. The powder sample was stored in a bottle with a screw cap.

Khaya ivorensis

Similarly, fresh stem barks of Khaya ivorensis were peeled from healthy trees from the same tree plantation in the Adamawa State University's main campus. They were subsequently air-dried at room temperature for about two weeks. The air-dried stem barks of K. ivorensis were thereafter, grinded and sieved using wire mesh of relatively smaller size. The powder sample was stored in dark bottle with screw cap for further use.

Preparation of ethanol and aqueous extracts of A. indica Seed and K. ivorensis Stem Bark Powders

Ethanol and aqueous extracts were prepared using maceration method as performed by Dahchar et al. (2016). 100g of each powder sample was soaked in 200 ml of ethanol (80% v/v). This was allowed to stand for 72 hours in a dark cupboard under room temperature. The content was shaken at a regular interval to ensure proper mixture. Thereafter, the mixture content was filtered through Whatman's Filter Paper (No. 42). After the filtrate was obtained, the ethanol content of the mixture was removed using a water bath at 60 to 65C. The stock solution obtained was however, used to constitute 200 and 400 mg/ml concentrations of the treatments that was used for the experiment. For aqueous extract, distilled water was used in place of ethanol and of the same quantity.

Collection of subterranean termites for laboratory toxicity study

The termites were collected behind the fisheries department at Adamawa State University Mubi, using a method described by Tamashiro et al. (1973). This was done by setting ''termite'' wooden trap to collect the termite. The infested stakes where covered by these wooden 'trap' boxes, then, collected after some days when the termites starts infesting the wood.

Collection and preparation of woods for field experiment

An unidentified soft wood plank was purchased from a timber shed at Mubi timber shade. The plank was cut into sizeable pieces by a carpenter, which was used as the experimental woods. The woods were dried to a constant weight in an oven, and the initial weight of each of the experimental woods was noted and recorded after labeling each prior to experiment proper.

Laboratory bioassay

One ml each of the treatment extract concentrations (200 and 400 mg/ml) was introduced into 300 cm 3 experimental jars. These were covered with filter papers (to avoid direct contact of the treatment with the termites), before 10 newly developed subterranean termites were introduced. Pieces of soft woods were place in the experimental jars as food before the jars were covered with muslin cloths with the aid of a rubber band immediately. This was to prevent the termites from escaping,

and also to provide proper aeration. A control experiment was set up with only acetone and the feed added. The treatment jars and the control were replicated 4 times. Mortality counts were observed for 24, 48 and 72 hours post exposure.

Field experiment on anti-feedant properties of azadirachta indica and khaya ivorensis against subterranean termites

The experimental woods of known weights were treated with 400 mg/ml and 200 mg/ml of both aqueous and ethanol extracts of Azadirachta indica and Khaya ivorensis, simply by rubbing the entire surface area of the woods with the aid of a paint brush. Different paint brushes were used for different treatment extracts, as well as the extract concentrations, in order to avoid possible contamination. The control experimental woods were treated with acetone. The experimental woods for each of the extract concentration and the control experiment were replicated four times. The experimental woods were thereafter buried in the soil partially, to a depth of 10 cm around termite mound within Adamawa State University Main Campus. About 2.5 cm of the woods remained visible above the soil surface. Weekly observation for weight loss was done for four (4) weeks. At the weekly interval, woods were removed, weigh and recorded, and then subsequently put back in the same soil.

Data analysis

Analysis of variance (ANOVA) was employed in the analysis of data, and Duncan Range Multiple Test was used to separate the mean differences, at 5% level of significance ($p>0.05$). The analysis was performed using SPSS version 19.0.

RESULTS

Mortality counts of termites exposed to ethanol and aqueous extracts of Azadirachta indica revealed a very high toxicity effect of the treatments. The result showed that there was no significant differences ($P>0.01$) between the mortality recorded in the treatment jars when compared to the control (untreated experiment), where no mortality (0.0%) was recorded throughout the experiment. Meanwhile, there was no significant difference ($p>0.05$) in the number of mortality recorded in the treatment jars at 24, 48, and 72 hours. The extracts at 200 mg/ml and 400 mg/ml recorded 100% mortality at 72 hours post exposure period. Khaya ivorensis extracts recorded similar result as A indica; as 100% mortality was achieved in all the treatment jars at 72 hours of treatment exposure with no significant difference ($p>0.05$). Also, there was no significant difference in the toxicity effect of the treatment extracts at 24, 48 and 72 hours based on the mortalities recorded. However, there was a significant difference between the mortality recorded in the treatment jars and the control jars.

The antifeedant effect of the treatment extracts, which was measured in terms of weight loss caused by attack on the experimental wood samples as a result of the invasion by termites when exposed to termite mound revealed their strong antifeedant properties. Both A indica and K ivorensis significantly reduced the feeding rate of the termites on the experimental woods when compared with the control experiment. However, ethanol extracts of A. indica and K. ivorensis proved to be more effective than the aqueous extracts of the same treatments, as they recorded a significant lower weight loss.

DISCUSSION

The pressure exerted from the use of chemical insecticides against insect pests has led to environmental degradation and has caused harm to the ecosystem. As part of the global strategy in tapping plant products in the quest of finding an alternate control measure rather than the use of chemical insecticides against insect pests, Azadirachta indica and Khaya ivorensis extracts were evaluated for their termicidal potential in terms of toxicity and anti-feedancy in this study.

The ethanol and aqueous extracts of A indica and K ivorensis did not differ significantly ($p>0.05$) in terms of toxicity which was measured in terms of mortality. However, the treatments differ significantly when compared to the control, as 100% mortality was achieved in the treated jars, whereas, no (0%) mortality was recorded in the control (untreated experiment). As the concentration of each of the treatment increases, the toxicity effect also increases as shown by the result. This revealed that both A indica and K ivorensis are potentially promising agents against subterranean termites, which have continued to destroy human valuables both at home and in the field. This is in agreement with the findings by Ibe et al. (2018) who reported that neem and other plant sourced treatments recorded 100% mortality of termites after 72 hours of treatment exposure in Imo State, Nigeria. Similarly, Daniel and Bekele (2006) reported neem seed powder as a potential agent for the control of termites as 100% mortality was also achieved when termites were exposed to crude extracts of neem seed powder.

Termicidal activity of A. indica seed and K. ivorensis stem bark extracts against subterranean termites on treated woods and control (untreated woods) buried around termite mounds in Mubi was evaluated through weight loss by the woods. As revealed, the treated woods significantly reduced attack by termites on woods when compared to the control experiment (untreated woods). K. ivorensis stem bark extracts performed better than A. indica seed extracts, since the former significantly reduced the weight loss more than the later. This indicates that better protection of woods is more swiftly produced by the K. ivorensis against subterranean termites compared to A. indica. This finding is in agreement with the findings by Adedeji et al. (2018), who also reported K. ivorensis as a potential agent for termite control; the stem bark extracts of K. ivorensis significantly protected woods against termites in Ogun State, Nigeria. Neem has been reported for its inability to effectively prevent feeding on woods by termites because of its inability to penetrate the wood in its raw state, thereby recording high weight loss of woods (Olufemi et al., 2011). The fact that the wood samples were only coated with treatments by simply rubbing the surface of the woods using paint brush, could be the reason why K. ivorensis, was superior to A. indica in preventing the wood samples from subterranean termites in Mubi. However, neem treatments have been reported to

effectively control insect pests because of its toxicity, repellent or anti-feedant properties against organic vegetables (Mochiah et al., 2011; Wahedi et al., 2017), Sitophilus zeamais on maize grains (Yusuf et al., 1998; Wahedi, 2012), and Callosobruchus maculatus on cowpea seeds (Lale and Abdulrahman, 1999; Wahedi et al., 2015).

The total weight loss recorded in wood samples treated with ethanol extracts at 400mg/ml (24.95g in A. indica and 17.60g in K. ivorensis) showed its superiority of effectiveness over aqueous extracts at the same concentration (81.30g in A. indica and 37.60g in K. ivorensis). This also revealed that ethanol treatment extracts are more effective than the aqueous extracts in controlling termites in Mubi.

CONCLUSION

In this study, Azadirachta indica and Khaya ivorensis offered desirable results in terms of toxicity and repellent properties measured in terms of mortality and weight loss, respectively against the subterranean termites in Mubi, Adamawa State. The ethanol extracts was more potent than the aqueous extracts, while K. ivorensis offered more protection to wood samples than indica. Therefore, sustainable use of this biopesticides, which are cheap and readily available, against insect pests like termites will go a long way in protecting our environment and the ecosystem at large against the dangerous termicides or insecticides, which are costly, non-biodegradable, and harmful to the user.

REFERENCES

1. Deatherage BL, Cookson BT. Membrane Vesicle Release in Bacteria, Eukaryotes, and Archaea: a Conserved yet Underappreciated Aspect of Microbial Life. Andrews-Polymenis HL, editor. Infect Immun . 2012;80(6):1948–1957.
2. Schorey JS, Cheng Y, Singh PP, Smith VL. Exosomes and other extracellular vesicles in host–pathogen interactions. EMBO Rep [Internet]. 2015;16(1):24–43.
3. Ratajczak J, Wysoczynski M, Hayek F, Janowska-Wieczorek A, Ratajczak MZ. Membrane-derived microvesicles: Important and underappreciated mediators of cell-to-cell communication. Leukemia. 2006;20(9):1487–495.
4. Quesenberry PJ, Aliotta J, Deregibus MC, Camussi G. Role of extracellular RNA-carrying vesicles in cell differentiation and reprogramming. Stem Cell Res Ther. 2015;6(1):1–10.
5. Tao SC, Guo SC. Role of extracellular vesicles in tumour microenvironment. Cell Commun Signal. 2020;18(1):1–24.
6. Dai J, Su Y, Zhong S, Cong L, Liu B, Yang J, et al. Exosomes: key players in cancer and potential therapeutic strategy. Signal Transduct Target Ther. 2020;5(1).
7. Huotari J, Helenius A. Endosome maturation. EMBO J. 2011;30(17): 3481–3500.
8. Johnstone RM, Adam M, Hammond JR, Orr L, Turbide C. Vesicle formation during reticulocyte maturation. Association of plasma membrane activities with released vesicles (exosomes). J Biol Chem. 1987;262(19):9412–9420.
9. Rashed MH, Bayraktar E, Helal GK, Abd-Ellah MF, Amero P, Chavez-Reyes A, et al. Exosomes: From garbage bins to promising therapeutic targets. Int J Mol Sci. 2017;18(3).
10. Silva VO, Maia MM, Torrecilhas AC, Taniwaki NN, Namiyama GM, Oliveira KC, et al. Extracellular vesicles isolated from Toxoplasma gondii induce host immune response. Parasite Immunol. 2018;40(9): 1–11.
11. Li Y, Liu Y, Xiu F, Wang J, Cong H, He S, et al. Characterization of exosomes derived from Toxoplasma gondii and their functions in modulating immune responses. Int J Nanomedicine. 2018;19(13):467–477.
12. Wowk PF, Zardo ML, Miot HT, Goldenberg S, Carvalho PC, Mörking PA. Proteomic profiling of extracellular vesicles secreted from Toxoplasma gondii. Proteomics. 2017;17:15–16.
13. Li Y, Xiu F, Mou Z, Xue Z, Du H, Zhou C, et al. Exosomes derived from Toxoplasma gondii stimulate an inflammatory response through JNK signaling pathway. Nanomedicine (Lond). 2018;13(10):1157–1168.
14. Kim MJ, Jung BK, Cho J, Song H, Pyo KH, Lee JM, et al. Exosomes secreted by Toxoplasma gondii-infected L6 cells: Their effects on host cell proliferation and cell cycle changes. Korean J Parasitol. 2016;54(2): 147–154.
15. Jung BK, Kim E Do, Song H, Chai JY, Seo KY. Immunogenicity of exosomes from dendritic cells stimulated with toxoplasma gondii lysates in ocularly immunized mice. Korean J Parasitol. 2020;58(2): 185–189.
16. Soo CY, Song Y, Zheng Y, Campbell EC, Riches AC, Gunn-Moore F, et al. Nanoparticle tracking analysis monitors microvesicle and exosome secretion from immune cells. Immunology. 2012;136(2):192–197.
17. Vestad B, Llorente A, Neurauter A, Phuyal S, Kierulf B, Kierulf P, et al. Size and concentration analyses of extracellular vesicles by nanoparticle tracking analysis: a variation study. J Extracell Vesicles. 2017;6(1):1344087.
18. Zabeo D, Cvjetkovic A, Lässer C, Schorb M, Lötvall J, Höög JL. Exosomes purified from a single cell type have diverse morphology. J Extracell Vesicles. 2017;6(1).
19. Blanc L, Vidal M. New insights into the function of Rab GTPases in the context of exosomal secretion. Small GTPases. 2018;9(1–2):95–106.
20. Zhang Y, Lai BS, Juhas M, Zhang Y. Toxoplasma gondii secretory proteins and their role in invasion and pathogenesis. Microbiol Res. 2019;227:126-293.
21. Rezaei F, Sarvi S, Sharif M, Hejazi SH, Pagheh A sattar, Aghayan SA, et al. A systematic review of Toxoplasma gondii antigens to find the best vaccine candidates for immunization. Microb Pathog . 2019; 126:172–184.
22. Ngô HM, Yang M, Joiner KA. Are rhoptries in Apicomplexan parasites secretory granules or secretory lysosomal granules? Mol Microbiol. 2004; 52(6):1531–1541.
23. Heaslip AT, Nelson SR, Warshaw DM. Dense granule trafficking in Toxoplasma gondii requires a unique class 27 myosin and action filaments. Mol Biol Cell. 2016; 27(13):2080–2089.
24. Venugopal K, Chehade S, Werkmeister E, Barois N, Periz J, Lafont F, et al. Rab11A regulates dense granule transport and secretion during Toxoplasma gondii invasion of host cells and parasite replication. PLoS Pathog. 2020;16(5):1–28.
25. Mercier C, Cesbron-Delauw MF. Toxoplasma secretory granules: One population or more? Trends Parasitol .2015;31(2):60–71.
26. Magno RC, Lemgruber L, Vommaro RC, De Souza W, Attias M. Intravacuolar network may act as a mechanical support for Toxoplasma gondii inside the parasitophorous vacuole. Microsc Res Tech. 2005;67(1):45–52.
27. Muiz-Hernández S, González Del Carmen M, Mondragn M, Mercier C, Cesbron MF, Mondragn-González SL, et al. Contribution of the residual body in the spatial organization of toxoplasma gondii tachyzoites within the parasitophorous vacuole. J Biomed Biotechnol. 2011.

28. Marino ND, Panas MW, Franco M, Theisen TC, Naor A, Rastogi S, et al. Identification of a novel protein complex essential for effector translocation across the parasitophorous vacuole membrane of Toxoplasma gondii. Coppens I, editor. PLOS Pathog . 2018;14(1): 1006828.
29. Chen Y, Li G, Liu ML. Microvesicles as Emerging Biomarkers and Therapeutic Targets in Cardiometabolic Diseases. Genomics, Proteomics Bioinforma . 2018;16(1):50–62.
30. Cocucci E, Meldolesi J. Ectosomes and exosomes: Shedding the confusion between extracellular vesicles. Trends Cell Biol. 2015;25(6): 364–372.
31. Pizzirani C, Ferrari D, Chiozzi P, Adinolfi E, Sandonà D, Savaglio E, et al. Stimulation of P2 receptors causes release of IL-1β-loaded microvesicles from human dendritic cells. Blood. 2007;109(9):3856–3864.
32. Cocucci E, Racchetti G, Meldolesi J. Shedding microvesicles: artefacts no more. Trends Cell Biol. 2009;19(2):43–51.
33. Hugel B, Martínez MC, Kunzelmann C, Freyssinet JM. Membrane microparticles: Two sides of the coin. Physiology. 2005;20(1):22–27.
34. Sun Y, Huo C, Qiao Z, Shang Z, Uzzaman A, Liu S, et al. Comparative Proteomic Analysis of Exosomes and Microvesicles in Human Saliva for Lung Cancer. J Proteome Res. 2018;17(3):1101–1107.