Research Journal of Applied Sciences 2 (9): 939-942, 2007
ISSN: 1815-932X

Evaluation of Cashew Nut Shell Liqiud (CNSL) as a Potential Natural Insecticide Against Termites (Soldiers and Workers Castes)

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Abstract: The effectiveness of Cashew Nut Shell Liquid (CNSL) extracted by soxhlet extraction process was evaluated against termites (soldiers and workers castes) in the laboratory. The experimental design was a Completely Randomized Design (CRD) with 8 treatments, which was replicated 4 times. The mortality rates of the various treatments differed significantly ($p<0.05$) from the control treatment at each exposure time period. However, there was no significant different ($p>0.05$) between the mortality of the standard termiticide and the CNSL at 6, 8 and 10% treatment levels, as they all gave a 100% kill of termites at the 90th min for the soldiers caste and 60th min for the workers caste. Zero percent mortality was recorded in the control cages throughout the exposure period. There is therefore an indication that CNSL can be used to control termites.

Key words: CNSL, termiticide, mortality, potential, natural insecticide

INTRODUCTION

The common wood preservatives generally known to be effective against termites include chlorinated products, boric acid and arsenic compounds. In the past, much emphasis was placed on chlordane, aldrin and dieldrin for the control of termites because of their persistent effects in the soil (Harris, 1971). However, these commonly used termiticides poses a negative environmental threat as their effluent streams contain particularly persistent toxic compounds such as pentachlorophenol, arsenic and chromium compounds (Mwalongo *et al*., 1999). These chemicals could enter the food chain and finally reach humans (Pearce, 1997). Consequently, there became public awareness of the long-term effect of organochlorine insecticides and the need to look for alternatives. Often new or alternative pesticides are expensive, so farmers and pest control officers, especially in developing countries could not afford them. Therefore, this has led to the development of alternative source of protectants from natural materials, which involves finding more environmentally acceptable substances from natural sources like wattle tannins and Cashew Nut Shell Liquid (CNSL) that are less toxic than the conventional termiticides. The need to develop non-toxic safe and biodegradable alternatives to synthetic insecticides has in recent years led to concerted international efforts to developing new sources from the vast store of chemical substance in plants (Olaifa *et al*., 1987).

Cashew Nut Shell Liquid (CNSL) is a by-product of cashew industry. It is obtained either by extraction in hot oil or in solvent or by mechanical expulsion from the shells. CNSL consists chiefly of naturally produced phenolic compounds- anacardic acid (about 90%) and cardol (about 10%) (Venmalar and Nagaveni, 2005). Anacardic acid is a derivative of salicycylic acid, which readily decarboxylates on heating, to obtain anacardol or cardol. The cardol is a resorcinol derivative having a long unsaturated hydrocarbon chain (Cornelius, 1996). It is a naturally occurring substituted phenol, which can take part in a variety of reactions. It is a cheap and renewable substance and can be employed for the manufacture of many useful industrial products. For example, new polymeric resins have been derived from this versatile compound (Aigbodion *et al*., 2001; Yahaya, 2003). It can replace phenol in many applications with equivalent better results. CNSL in itself is useful for insecticidal, fungicidal, anti-termite and medicinal applications and as an additive, in many plastic formulations (Lubi and Thachil, 2000; Gowri and Saxena, 1997). In its natural form, CNSL is reported to accord protection against termites and has water repellency (Lepage and Delelis, 1980). This study therefore reports the evaluation of Cashew Nut Shell Liquid (CNSL) as a potential natural insecticide against termites (soldiers and workers castes).

MATERIALS AND METHODS

Extraction of CNSL: Cashew nuts were harvested from the cashew plot of the Cocoa Research Institute of Nigeria (CRIN), Ibadan. The nuts were cracked to remove the kernel. The shell, which contains the shell liquid, was

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extracted using the soxhlet extraction method. The shell was introduced into the soxhlet apparatus with n-hexane as the extraction solvent. The extraction was carried out for a minimum of 6 h, after which the resulting extracts, was disolventized using a rotary evaporator. The following serial dilutions of the extracts were prepared; dilutions of 1, 2, 4, 6, 8 and 10% using 5% alcohol and stored until ready for use.

Efficacy study: The efficacy of Cashew Nut Shell Liqiud (CNSL) against termites under laboratory conditions of temperature 28±3°C and relative humidity 75±5% was tested at six concentrations of 1, 2, 4, 6, 8 and 10%. Termites (soldiers and workers castes) collected from cashew plots at CRIN Headquarters, Ibadan in November/December 2006, were exposed to filter papers impregnated with 0.5 mL of the various concentrations of the extract inside micro-cages of transparent plastic petri-dishes with perforated lids. Ten termites were placed in each cage. A standard termiticide (Chloropyrifos) was used for comparison while distilled water was used as control. The experimental design was completely randomized design with 4 replications per treatment. Mortality counts were taken and recorded for every 10 min for 2 h, which was the maximum time period it took to achieve 100% mortality in over 90% of the petridishes. A termite was regarded dead if it showed no sign of movement when touched lightly with a soft camel hairbrush or when it lies flat on its back with no sign of movement.

RESULTS AND DISCUSSION

Table 1 shows the physico chemical properties of cashew nut shell liquid. Results obtained showed that virtually all the concentrations of CNSL were efficacious on the termites (soldier and worker castes) in the laboratory bioassay (Table 2 and 3). The mortality rates achieved by the various concentrations of the CNSL differed significantly ($p<0.05$) from their control treatments; however, there was no significant different ($p>0.05$) between the mortality of the standard termiticide (Chloropyrifos) and the CNSL at 6, 8 and 10% treatment levels. At the least treatment level of 1%, the termite mortality was as high as 53% at the 30th min of exposure of both the soldier and the worker termite. However, the termite mortality increased with period of exposure and at the 100th min, the mortality increased to 97% (workers caste) and 73% (soldiers caste) (Table 1 and 2). The mortality rates of CNSL at 6, 8 and 10% compare effectively with the standard termiticide as they all gave a 100% kill of the termites at the 90th min for the soldiers caste and 60th min for the workers caste. No mortality was recorded in the control cages throughout the exposure period.

Table 1: Physico-chemical characteristics of Cashew Nut Shell Liquid

Parameters	Values
Colour	Dark brown
Specific gravity (29°C)	0.91-0.94
Moisture content	0.001-0.005
P^H	6.8
Viscosity (Cp at 30°C)	520-550
Non volatile matter (%)	83-85
Iodine value (SLI_2/100g)	210-215
Hydroxyl value (Mg/KOH)	185-200

Some derivatives from cashew nuts, kernels and leaves are known to have many industrial uses. The tannin from the testa is used in leather industry, while the gum from the bark is used for bookbinding and the sap as wood preservatives. The Cashew Nut Shell Liquid (CNSL) is used for wood and fabric preservatives, paints, plastics, printing ink, germicides, insecticides, water-proofing compounds, synthetic resins, dyes and anti-fade agents in brake lining and clutch facing. A yellow dye extracted from the leaves is used for dyeing fishing nets in Sengal (Irvine, 1961; Pillai *et al.*, 1990; Walker and Sillans, 1961; Bouquet, 1969; Dastur, 1952). Therefore, the high mortality recorded in this study is just a confirmation of such industrial/commercial values of cashew nut shell liquid and in line with the work of Lepage and Delelis (1980).

Cashew nut shell liquid is a complex mixture of the compounds anacardic acid, which constitutes larger percentage cardol, which is embedded with two hydroxyl functional groups and cardanol, which has one hydroxyl group attached to the meta-position of the ring. These additive functional groups, carboxylic and hydroxyl groups thus confer added functionality to this complex monomer. The physico-chemical characteristic of CNSL also shows that the liquid is slightly acidic (Table 1). The reactive nature of CNSL constituents makes it an important material for insecticide formulation. Hence, the mortality of termites achieved by this liquid may be attributed to the reactivity of these groups to the termites.

Similar reports indicate that *Anchonames difformis* root extract have some potent effect as a wood preservative against termites (Oluyege *et al.*, 2007). Report by Burkill (1985) indicates the tuber of the plant as caustic in nature. Strong presence of alkaloids, which are considered to be one of the classes of natural attractiveness that are toxic to termites, are reported to be present in the plant tuber (Ifebueme, 1977).

Table 2: Laboratory toxicity of potential natural insecticide (CNSL) to the soldier termite castes

	Exposure periods (minutes)											
	10	20	30	40	50	60	70	80	90	100	110	120
% Conc.	% Mortality*											
1	13	20	53	53	53	67	67	67	73 ^{d**}	73	73	73
2	13	20	40	53	53	60	67	67	73 ^{d}	80	80	87
4	20	47	60	60	67	67	73	80	87 ^{c}	87	87	87
6	20	40	73	80	87	87	87	93	100 ^{b}	100	100	100
8	20	47	67	73	80	80	80	93	100 ^{b}	100	100	100
10	27	53	73	73	80	87	87	100	100 ^{b}	100	100	100
Std.	40	73	80	93	100	100	100	100	100 ^{b}	100	100	100
Control	0	0	0	0	0	0	0	0	0 ^{a}	0	0	0

*Each value represents mean of four replicates, **Means followed by the same letter within a column are not significantly different (p>0.05) by Tukey's test

Table 3: Laboratory toxicity of potential natural insecticide (CNSL) to the worker termite castes

	Exposure periods (minutes)											
	10	20	30	40	50	60	70	80	90	100	110	120
% Conc.	% Mortality*											
1	37	53	53	53	67	67 ^{d**}	73	83	87	97	97	100
2	40	47	60	67	73	73 ^{d}	87	87	97	100	100	100
4	53	67	73	77	87	87 ^{c}	93	97	100	100	100	100
6	53	67	77	87	97	100 ^{b}	100	100	100	100	100	100
8	60	67	87	93	100	100 ^{b}	100	100	100	100	100	100
10	60	73	97	100	100	100 ^{b}	100	100	100	100	100	100
Std.	60	87	100	100	100	100 ^{b}	100	100	100	100	100	100
Control	0	0	0	0	0	0 ^{a}	0	0	0	0	0	0

*Each value represents mean of four replicates, **Means followed by the same letter within a column are not significantly different (p>0.05) by Tukey's test

CONCLUSION

Thus, it is probable that the high mortality rates achieved in this present study with CNSL were due to the presence of its constituents cardol and anarcadic acids.

ACKNOWLEDGEMENT

The authors are grateful to the staff and Management of Cocoa Research Institute of Nigeria, Ibadan, Nigeria.

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