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Assessment of Food Processing Wastes as Potential Natural Insecticides Against Termites

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Abstract: The efficacy of food processing wastes from commonly consumed food produce in Nigeria in the control of termites was investigated in the laboratory. The wastes; Garri Processing Water (GPW), Fufu Processing Water (FPW), Fufu Supernatant Water (FSW), Pap Processing Water (PPW), Pap Supernatant Water (PSW) and Locust beans Processing Water (LPW), were assayed at three concentrations 25, 50 and 100% with a standard termiticide (Chloropyrifos) and a control treatment for comparison. The mortality rates achieved by most of the various concentrations of the food wastes from the 60th min differed significantly ($p<0.05$) from their controls. However, there was no significant different ($p>0.05$) between the mortality rates of the standard termiticide and GPW, PPW and PSW at 100 and 50% treatment levels at the end of the exposure period. Mortality increased with period of exposure of the termites to these potential natural insecticides and at the least treatment level of 25%, GPW, PPW and PSW achieved termite mortality as high as 72-76% at the 240th min of exposure, while FPW, FSW and LPW gave a low mortality of between 30- 34%. A very low mortality rate of between 0-42% was achieved by all the wastes assayed within the first 60 min when compared with the standard termiticides that achieved a 100% kill of the termites in the 80th min for all applications. However, no mortalities were recorded in the control cages throughout the exposure period.

Key words: Termites, termiticide, food processing wastes, mortality

INTRODUCTION

Termites belong to the order Isoptera, a taxonomic group of insects whose diagnostic features are the similarity in the shape and size of the membraneous fore and hind wings. They are social insects that live in organized colonies comprising hundreds to millions of individuals inside a nest system, which could be aboreal, epigeal or subterranean (Badejo, 2000). A termite colony consists of several castes, which are morphologically and functionally distinct (Pearce, 1997).

Termites have an important place in economic entomology. They have been implicated in soil modification, which can be brought about by their construction of subterranean galleries, changes in distribution of plant nutrients, changes in nature and distribution of organic matter, changes in soil texture and physical disturbance of the soil profile (Wood *et al*., 1980; Umeh *et al*., 1999). However, the degree of damage done by these pests to the crops and wood is so enormous despite the positive roles played by majority of the species in the soil ecosystem.

Damage to crops, wood and buildings by termites can be reduced to acceptable levels by prophylactic use of synthetic insecticides, but due to serious limitations and increasing legal restrictions to application and efficacy of these insecticides, there is the need to develop alternative approaches for their control.

This study therefore, attempts to evaluate food processing wastes as potential natural insecticides for routine protection against termites in Nigeria.

MATERIALS AND METHODS

Preparation of the food processing wastes: In Nigeria, cassava (*Manihot esculentum*), Maize (*Zea mais*) and African locust beans (*Parkia biglobosa*), are among the staple foods. Cassava is processed into “garri and fufu”, maize into “pap” (local custard), while locust beans is processed into a local seasoning called “iru or dawadawa”. A small scale processing of these food items were carried out in an open laboratory at a temperature of 28±3°C and 75±5% relative humidity to generate the wastes for this assessment.

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Garri Processing Water (GPW): Two kilograms of cassava tubers was pealed, washed and grated with a high-speed mill. The grated pulp was filled into a muslin cloth bag and tied securely. Heavy stones or hydraulic pressure was placed or exerted on the sack to press out the cassava water juice. The resulting water is collected into a clean bowl and transferred into a sample collection bottle and labeled.

Fufu Processing Water (FPW): Two kilograms of cassava tubers was pealed and cut into pieces. They were washed and then submerged in 2 L of water to ferment for four days. The cassava was removed after fermentation and the water sieved through a double-fold muslin cloth into a clean bowl and transferred into a sample collection bottle and labeled.

Fufu Supernatant Water (FSW): The fermented cassava above was then mashed and sieved through a small basket or plastic sieve in a bowl containing 2 L of water to remove the lignified central strands. The bowl was allowed to stand for a minimum of 3 h for the cassava paste to settle down. The supernatant water that settles on top was decanted into a clean bowl and transferred into a sample collection bottle and labeled.

Pap Processing Water (PPW): Two kilograms of maize grains was washed and soaked in 2 L of water to soften and ferment for 2-3 days. The maize was removed after 3 days and the water sieved through a double-fold muslin cloth into a clean bowl and transferred into a sample collection bottle and labeled.

Pap Supernatant Water (PSW): The fermented maize above was wet-milled into fine slurry with a high-speed mill and subsequently sieved through a fine cloth sieve or muslin cloth in a bowl containing 2 L of water. The starch, which has been separated from the water, was allowed to stand in the bowl for minimum of 3 h for the sediment to settle down. The supernatant water that settles on top was decanted into a clean bowl and transferred into a sample collection bottle and labeled.

Locust-beans Processing Water (LPW): Two kilograms of African locust beans seeds was boiled in pots over fire woods for a minimum of 12 h to soften the tough testa and cotyledons. The water level in the pot is checked hourly and additional water added. The water was allowed to stand overnight before been filtered through a double-fold of muslin cloth into a clean bowl and transferred into a sample collection bottle and labeled.

Collection of termites: Termite samples consisting of workers castes were collected from decaying woods at the coffee experimental plots of the Cocoa Research Institute of Nigeria (CRIN), Ibadan. The fresh and healthy termites were taken to the laboratory for immediate bioassay test with the food processing wastes.

Bioassay test: The bioassay test was carried out with petridishes fitted with filter papers. The petridishes were perforated on the top to provide adequate aeration and prevent the suffocation of the termites. The processing wastes were applied at three treatment levels (25, 50 and 100%) with a standard termiticide (Chloropyrifos) treatment for comparism. The filter papers were drenched with 1 mL of the various concentrations of the treatments. The treated filter papers in the petridishes were allowed to dry up for 5 min before the introduction of ten termites into each petridish. The control test had their petridishes containing untreated filter papers. Each treatment was replicated five times. Mortality counts were taken and recorded after every 20 min for 4 h (which was the maximum time period taken to achieve 100% mortality in over 50% of the petridishes).

Statistical analysis: All the data obtained were subjected to the analysis of variance and significant means were separated at 5% level using the Tukey's Honestly Significance Difference (HSD).

RESULTS

The effects of Garri Processing Water (GPW), Fufu Processing Water (FPW), Fufu Supernatant Water (FSW), Pap Processing Water (PPW), Pap Supernatant Water (PSW) and Locust beans Processing Water (LPW) on mean mortalities of termites (worker castes) showed that the various processing wastes achieved high mortality rates at the various treatment levels (Table 1-6). The mortality rates achieved by most of the various concentrations of the food wastes from the 60th min 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 GPW, PPW and PSW at 100 and 50% treatment levels. The mortality rates of GPW, PPW and PSW at 100% concentration were similar to the standard termiticide as they all gave a 100% kill of termites at the 180th min (Table 1, 4 and 5).

Mortality increased with period of exposure of the termites to these potential natural insecticides and at the least treatment level of 25%, GPW, PPW and PSW

Table 1: Relative laboratory toxicity of GPW* to termites in Nigeria

%	Exposure periods (min)											
Conc.	20	40	60	80	100	120	140	160	180	200	220	240
	%Termite mortality**											
25	0	4	16	18	34	40	48	56	68	70	72	72^{c***}
50	6	16	26	42	48	68	68	80	82	88	96	96^{b}
100	10	24	30	54	68	80	82	92	100	100	100	100^{b}
Standard	20	40	60	100	100	100	100	100	100	100	100	100^{b}
Control	0	0	0	0	0	0	0	0	0	0	0	0^{a}

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

Table 2: Relative laboratory toxicity of FPW* to termites in Nigeria

%	Exposure periods (min)											
Conc.	20	40	60	80	100	120	140	160	180	200	220	240
	%Termite mortality**											
25	0	0	4	8	10	16	20	24	26	30	34	34^{d***}
50	0	0	10	12	22	38	40	46	54	60	68	68^{c}
100	0	0	12	16	24	50	54	58	66	68	76	76^{c}
Standard	20	40	60	100	100	100	100	100	100	100	100	100^{b}
Control	0	0	0	0	0	0	0	0	0	0	0	0^{a}

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

Table 3: Relative laboratory toxicity of FSW* to termites in Nigeria

%	Exposure periods (min)											
Conc.	20	40	60	80	100	120	140	160	180	200	220	240
	%Termite mortality**											
25	0	0	2	8	12	16	20	24	28	28	30	30^{d***}
50	0	0	10	16	22	38	44	56	58	68	72	72^{c}
100	0	0	14	20	26	54	60	64	68	78	80	80^{c}
Standard	20	40	60	100	100	100	100	100	100	100	100	100^{b}
Control	0	0	0	0	0	0	0	0	0	0	0	0^{a}

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

Table 4. Relative laboratory toxicity of PPW* to termites in Nigeria

%	Exposure periods (min)											
Conc.	20	40	60	80	100	120	140	160	180	200	220	240
	%Termite mortality**											
25	6	10	12	16	22	40	42	60	62	66	74	76^{c***}
50	4	10	22	32	40	64	78	78	88	88	96	98^{b}
100	18	20	34	42	58	78	86	90	100	100	100	100^{b}
Standard	20	40	60	100	100	100	100	100	100	100	100	100^{b}
Control	0	0	0	0	0	0	0	0	0	0	0	0^{a}

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

Table 5: Relative laboratory toxicity of PSW* to termites in Nigeria

%	Exposure periods (min)											
Conc.	20	40	60	80	100	120	140	160	180	200	220	240
	%Termite mortality**											
25	4	8	22	28	48	54	62	67	72	74	74	74^{c***}
50	16	26	30	54	54	60	70	78	78	84	90	96^{b}
100	24	34	42	50	66	76	90	94	100	100	100	100^{b}
Standard	20	40	60	100	100	100	100	100	100	100	100	100^{b}
Control	0	0	0	0	0	0	0	0	0	0	0	0^{a}

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

achieved termite mortality as high as 72-76% at the 240th min of exposure, while FPW, FSW and LPW gave a low mortality of between 30-34%. However, the processing wastes when exposed to the termites at concentrations of 50 and 100% was found to be efficacious as natural plant products (botanicals), which has been utilized by various scientists for the control of termites. Their mode of action was very slow and may be regarded as slow poison. A

Table 6: Relative laboratory toxicity of LPW* to termites in Nigeria

% Conc.	Exposure periods (min) 20	40	60	80	100	120	140	160	180	200	220	240
	%Termite mortality**											
25	0	0	10	10	10	14	16	20	20	24	32	32[e***]
50	0	0	10	20	22	40	44	44	44	46	50	50[d]
100	0	12	16	26	30	52	56	62	68	76	78	78[c]
Standard	20	40	60	100	100	100	100	100	100	100	100	100[b]
Control	0	0	0	0	0	0	0	0	0	0	0	0[a]

*Locust-beans processing water, **Each value represents mean of ten replicates, ***Means followed by the same letter within a column are not significantly different, ($p>0.05$) by Tukey's test

very low mortality rate of between 0-42% was achieved by all the wastes assayed within the first 60 min when compared with the standard termiticide that achieved a 100% kill of the termites in the 80 min for all applications (Table 1-6). However, no mortalities were recorded in the control cages throughout the exposure period.

DISCUSSION

In West Africa, the common fermented cassava products include 'garri', a sour farinaceous meal; 'fufu', a fine paste starchy food; 'lafun' or 'kokonte', a cassava flour product in Nigeria and Ghana, respectively. Cassava fermentation varies from one region to another. However, the various cassava fermentation processes have been broadly categorized into solid-state fermentation and submerged fermentation. Garri is the most important of the fermented cassava products. It is a staple food of about 100 million people in West Africa. In Southern Nigeria, it contributes about 60% of the calorie intake. Garri is a fermented, dewatered and toasted semolina of cassava, widely consumed all over West Africa and in Brazil, is the most popular cassava product consumed and the most important item in the diet of millions of Nigerians (IITA, 1990; Kordylas, 1990). It forms a significant part of the diet in many of these countries where it is called "Farinha de Mandioca" (Lancaster *et al*., 1982). Traditionally it is produced by pressing the juice out of pealed, grated cassava roots, allowing a natural lactic fermentation to take place for 2-5 days.

Pap (ogi or akam) is a sour gruel obtained as a result of the submerged fermentation of some cereals (maize, sorghum, millet, guinea corn). The common cereals used in Nigeria are maize in the Southern parts, while sorghum and millet are used in the North where it is drier. It is an important indigenous, traditional weaning food common in the whole West Africa. It is consumed as a breakfast meal by many and serves as food of choice for the sick in many cases.

African locust bean (iru or dawadawa) is by far the most important food condiments in Nigeria and many countries of West and Central Africa. It is normally used as food condiments, however, in poor families it is added generously to sauces and soups and this serves as a low-cost meat substitute.

The processing wastes generated from these food processing processes in Nigeria are readily available within the various communities and posses no environmental nor health hazards, which was the main reason for their selection for this preliminary assessment as potential insecticides.

The termite worker caste was chosen for this test because of their role in the colony. They are known to be the destructive group of termites in any termite colony. They forage and feed voraciously in order to provide food and shelter for the colony and in the process cause enormous damages to plants. Their eradication therefore will disorganize the whole colony and should be adopted as a first step in termite control.

The food processing wastes studied here can be seen as potential source of useful natural control for termites. There is therefore, the need to carry out field trials with these processing wastes to confirm the effective mortality rates achieved in this study. However, further studies should be carried out on these wastes in order to isolate, identify, characterize and elucidate the structure of their bioactive compounds.

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