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Insecticidal Effects of Four Plants Extract Against *Prostephanus truncatus* (Horn) (Coleoptera: Bostrichidae) in Infested Dried Cassava Chips

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Abstract: The biological activity of *Azardiractita indica* (neem leaves), *Tetrapleura tetraptera* (seeds), *Piper guinensee* (alligator pepper seeds) and *Xylopia aethiopica* (black pepper seeds) extracts surface treatment applied at two different concentrations to dried cassava chips (*Esculenta manihot*) against *Prostephanus truncatus* (Horn) to determine infestation rate via mortality and emergence of the pest and weight loss in the dried cassava chips were conducted. The Bio assay was conducted under temperature and relative humidity of 27±2 and 65±5%, respectively within an investigation period of 28 days. Out of the four plants extract *A. indica* has the best insecticidal properties, this was followed by *P. guinensee*, *T. tetraptera* and *X. aethiopica* in a descending order of efficacy.

Key words: Emergence, mortality, plant extract, *Prostephanus truncatus*, weight loss

INTRODUCTION

The large grain borer *Prostephanus truncatus* (Horn) is a devastating storage pest of maize and dried cassava. It was introduced to East Africa from Central America in the early 1970s (Hodges, 1986). Since then, it has spread to 16 countries in which it is one of the most serious pests of stored products constituting a continental problem in Africa. In Kenya, where major staple food is maize, an estimated loss of 15 million U.S. dollars is recorded yearly (Pierce and Schmidt, 1992). Also an enormous damage of 40% and 70% weight loss had been reported in maize and cassava, respectively in same Kenya (Anonymous, 1974). Furthermore, in dried cassava roots, losses can be high to an extent of reducing cassava roots to dust due to adults boring activities (Ingram and Humphries, 1972). Infestation of *P. truncatus* on dried cassava chips (TME-30572 and TME-1) in the laboratory recorded weight loss of 36.92 and 63.20%, respectively over a period of 112 days (Hassan and Popoola, 2001).

Cassava cultivation has been in tropical America for more than 5,000 years ago, but cassava was introduced into Africa about 16th century ago. Cassava cultivation takes place in over 90 countries and it provides food and livelihood for about 500 million people in the developing world. Over 16 million hectares is cultivated with 50% been cultivated in Africa and other 50% from Asia and Latin America (CIAT, 2001). Nigeria is the largest cassava producer among cassava producing countries of the world. It is also a country that other look up to for research on cassava (IITA, 2004). Cassava is the third most important sources of calorie in the tropics, after rice and corn (FAO, 2004).

The wood boring behaviour of *P. truncatus* makes it difficult to control after infestation and impossible to disinfect storage structures. Several researches have been conducted for positive control of *P. truncatus*. However, most of the controls are not conclusively recommended. The most promising aspect of integrated pest management is the use of *Teretrius nigrescens*, the natural enemy of *P. truncatus,* which was released in Kenya in 1992. The release recorded positive impact on the control of *P. truncatus* (Giles *et al.*, 1996). Despite the release, areas where releases were done still shows presence of damage as a result of *P. truncatus* infestation (Meikle *et al.*, 2002). Consequently, there is need for additional control measures in order to reduce the dependant of the farmers on synthetic insecticides which are expensive with high toxic residues for protecting stored foods (Ivbijaro and Agbaje, 1986; Lale and Abdulrahman, 1999; Philippa, 2000).

The objective of this study is to determine the efficacy of four selected plant extracts for the possible control of *P. truncatus* infestation, these four locally available plants extracts were reported to have pesticidal properties.

MATERIALS AND METHODS

This research work was conducted in the Entomology Unit, Department of Zoology, University of Ibadan; the research was completed in the year 2007. Four plant species were used for aqueous crude extracts production. These plants include *Azardirachta indica* (neem) leaves, *Tetrapleura tetraptera* seeds (black pepper), *Piper guinensee* (alligator pepper) and *Xylopia aethiopica* (fruits).

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Neem leaves and black pepper seeds were collected from Botanical Garden in University of Ibadan Nigeria, while alligator pepper fruits and *X. aethropica* fruits were purchased from a market in Ibadan, southwest Nigeria. All the plants materials were air dried for 10 days and followed by further oven drying in a Gallencamp hot box at 60°C for 6 h, for complete dryness. After drying, the plants materials were grounded in hammer Milling Machine to coarse form. Two hundred grammes of neem leaves and black pepper, 350 g of *X. aethiopica* fruits and 1,600 kg of alligator pepper fruits were carefully transferred into Soxhlet extractor separately for extraction; methanol was used as medium of extraction. After the extraction procedures which lasted about 15 h for each plant species, the crude extract collected were distilled off the methanolic solvent completely. The distilled crude extracts were then defat using hexane as solvent, for the removal of oily residues in the crude extracts to make it miscible with water, the crude extract were then stored in refrigerator until needed.

Crude extract dilution: The miscible parts of all the crude extracts were serially diluted at 40 and 60% concentrations. For *A. indica*, neem leaves extract, a total of 46.2 g aqueous crude extract was prepared from the leaves. *P. guinensee* had 24.4 g aqueous crude extract, while 45.0 g of *X. aethropica* fruits were collected and lastly 56.8 g aqueous *T. tetraptera* was obtained. These volumes of the aqueous crude extracts collected were finally used for the treatments of the stored products.

Insects' species and cassava processing: The sum of 182 adults of *P. truncatus* was used in these studies. They were obtained from stock culture raised in the Entomology laboratory, Department of Zoology, University of Ibadan, Ibadan, Nigeria. Cassava dried chips were prepared in the same laboratory from the cassava collected from an experimental farm in the University of Ibadan, Ibadan, Nigeria.

Application of the aqueous crude extracts on dried cassava chips: A total of 2, 200 g dried cassava chips were used for this study. Weighed 50 g chips in 44 places were divided into 8 groups of 5 replicates and control set-up for each crude extract surface topical application. The control set up were not treated with crude extract, but they were sprayed with distilled water and air dried.

Experimental set-up for Pesticidal effects of aqueous crude extracts: The weighed 50 g treated dried cassava chips were put in 250 mL specimen bottles and they were infested with 4 adults' *P. truncatus* at sex ratio of 2:2 (male and female). Muslin cloth was used to cover the bottles and fastened tightly with rubber band to prevent contamination of the set-up and escape of the pest therein. The set-up were stored in a Griffin cooled incubator for the period of 28 days, under ambient experimental condition of 27±2°C and 65±5% r.h., temperature and relative humidity, respectively.

After the period of infestation, adult mortality rate and progeny emergence of *P. truncatus* and dried cassava chips weight loss were determined. Mean values of all the data obtained were analysed using least significant difference (LSD).

RESULTS

Effects of crude extracts on emergence rate of *P. truncatus:* *A. indica* crude extract treated dried cassava chips recorded a significant difference in progeny emergence ($p<0.05$) (LSD). This observation was recorded between 60% and 40% concentration treatments. *A. indica* (neem leaves) crude extract at both treatments did not allow for progeny emergence, thereby recording zero mean values (Table 1) which was in contrast to the control treatment which recorded a mean value of 0.5(±0.17) with a percentage value of 1% (Table 2). Other three crude extracts namely, *P. guinensee*, *X. aethiopica* and *T. tetraptera* did not record any significant difference in their treatments.

Effects of crude extracts on mortality rate of *P. truncatus*: Crude extract treatments of dried cassava chips with *P. truncatus* infestation recorded relative mortality values. *P. guinensee* treatment at 40% concentration did not show significant difference in the mean mortality values ($p<0.05$) (LSD) when compared with control treatment (Table 1). However, an increase of the crude extract concentration to 60% a significant difference was recorded ($p<0.05$) (LSD) for *P. truncatus* mean mortality value. Percentage mortality values recorded was 85, 97 and 25% at treatment concentrations of 40, 60% and control (0%), respectively (Table 2). *A. indica* crude extract treatment has significant difference between the treatments ($p<0.05$) (LSD). Lastly, the other two plant extract treatments of *X. aethiopica* (fruits) and *T. tetraptera* (Africa pepper fruits) could not produce significant difference on *P. truncatus* mortality rate.

Effects of crude extract treatments on weight loss in dried cassava chips: There was a significant reduction in weight loss caused by *P. truncatus* infestation on treated dried cassava chips with plants crude extracts of *A. indica* (neem leaves) and *P. guinensee* (seeds) between 40% and control (0%); 60% and control (0%) treatments only (Table 1). Comparing 60 and 40%, concentrations did not elicit any significant concentration dependence difference between 40 and 60% treatment.

On the other hand, *X. aethiopia* and *T. tetreptera* could not reduce weight loss in dried cassava chips to any

Table 1: Summary of the least significant difference of plant species crude extracts on *P. truncatus* Emergence and Mortality and Weight loss in dried cassava chips

Plant crude extracts	Crude extract concentrations	Mean values of *P. truncatus* Adult emergence (±SE)	Mean values of *P. truncatus* Adult mortality rate (±SE)	Mean values of weight loss in dried cassava chips (g)
Piper guinensee	40%	0.40 (±0.2)^{a}	0.70 (±0.21)^{b}	0.50 (±0.07)^{b}
(Alligator pepper seeds)	60%	0.40 (±0.33)^{a}	1.70 (±0.22)^{a}	0.40 (±0.04)^{b}
	Control	0.50 (±0.16)^{a}	0.50 (±0.17)^{b}	0.85 (±0.12)^{a}
Xylopia aethiopica (fruits)	40%	7.30 (±3.81)^{a}	3.90 (±0.41)^{a}	1.47 (±0.54)^{a}
	60%	6.90 (±3.41)^{a}	3.80 (±0.55)^{a}	1.28 (±0.42)^{a}
	Control	10.90 (±3.94)^{a}	3.90 (±0.41)^{a}	1.71 (±0.43)^{a}
Tetraptera tetraptera	40%	3.60 (±2.23)^{a}	3.60 (±0.22)^{a}	1.16 (±0.29)^{a}
(African pepper fruits)	60%	2.60 (±1.92)^{a}	3.80 (±0.36)^{a}	0.68 (±0.33)^{a}
	Control	3.50 (±1.38)^{a}	3.40 (±0.22)^{a}	1.45 (±0.42)^{a}
Azardirachta indica	40%	0.00 (±0.00)^{b}	3.40 (±0.27)^{a}	0.16 (±0.04)^{b}
(neem leaves)	60%	0.00 (±0.00)^{b}	3.90 (±0.10)^{a}	0.13 (±0.04)^{b}
	Control	0.50 (±0.17)^{a}	0.50 (±0.17)^{b}	0.85 (±0.12)^{a}

Each datum is a mean of 4 replicate. Mean followed by the same letters are not significantly different (LSD) ($p<0.05$)

Table 2: Percentage values of progeny emergence mortality of *P. truncatus* and weight loss in dried cassava chips treated with plants crude extracts

Plant crude extracts	Crude extract concentrations	Mean values of *P. truncatus* Adult emergence (±SE)	Mean values of *P. truncatus* Adult mortality rate (±SE)	Mean values of weight loss in dried cassava chips (g)
Piper guinensee	40%	10.00	17.50	0.00
(Alligator pepper seeds)	60%	10.00	42.50	0.80
	Control	12.50	12.50	1.70
Xylopia aethiopica (fruits)	40%	13.80	95.00	2.94
	60%	15.00	97.50	1.82
	Control	21.80	85.00	3.42
Tetrapleura tetraptera	40%	65.00	90.00	2.32
(African pepper fruits)	60%	87.00	95.00	1.36
	Control	90.00	84.00	2.90
Azardirachta indica	40%	0.00	85.00	0.32
(neem leaves)	60%	0.00	97.50	0.26
	Control	1.00	25.00	1.70

significant level (Table 1). The percentage weight loss can be fide on Table 2.

Mean values of all the parameters at different concentrations and control were analysed with least significant different (LSD) ($p<0.05$) level.

DISCUSSION

The study has revealed that plant crude extracts applied to dried cassava chips significantly reduced progeny development of *P. truncatus,* which buttress results obtained and published by previous researches. Despite the plant extracts different qualities, origin and constituents, all of them showed pesticidal properties in the present study. In general, the efficacy is relative for the control of *P. truncatus* and protection of dried cassava chips. Earlier studies confirmed the pesticidal effects of these plants species; *A. indica* (Makanjuola, 1989; Niber, 1994); *P. guinensee* (Lathrop and Keirstend, 1996); *T. tetraptera* (Burkhill, 1995) and *X. aethiopica* (Philippa, 2000).

A. indica (Neem) crude extract conferred complete protection on the treated dried cassava chips. This may have been due to the suppressant and deterrent effects of *A. indica* to oviposition, fertility and development of *P. truncatus* as reported by Singh and Srivastara (1983) that the plant species have those aforementioned effects. Consequently, zero emergence was recorded at both concentrations, thereby recording a significant reduction in emergence between treatment and control. Furthermore, neem leaves crude extract have been reported to significantly reduce *Schistocerca* eggs in treated sand.

P. guinensee (black pepper) have been reported to have negative effects on pest fecundity in moths (Freeborn and Waymore, 1926; Ivbijaro and Agbaje, 1989) reported the effects of whole fruits of *P. guinensee*, which greatly reduce egg laying by female *C. maculatus* at doses of 1.0 and 1.5 g and it suppressed emergence of F_1 generation. *X. aethiopica* had an insignificant effect on emergence of treated dried cassava chips with *P. truncatus* infestation despite the antifeedant property and toxic nature of the plant extract as reported by Howard (1983). This antifeedant property is expected to bring about a significant difference in emergence of *P. truncatus* on treated dried cassava chips and control and even between the different concentration treatments which was never the case. Furthermore, some insignificant difference was recorded in *T. tetraptera* treated chips, although Howard (1983) submitted that saponin and coumarin toxicity in the crude extract of *T. tetraptera* causes a lot of mortality that may reduce the rate of emergence due to high death rate in adults that are expected to raise the offspring.

Neem and black pepper crude extracts treatments conferred a significant difference on mortality rate of *P. truncatus.* The pesticidal properties of the two plants species extracts were not surprising considering the work of previous researches. Makanjuola (1989) concluded in her work that neem crude extract inhibits and suppress feeding rate of *Callosobruchus maculatus* and *Sitophilus oryzae*, which results in high mortality. In *Luceme weevil*, *Hypera postica*, 25% mortality was recorded when fed on juice of neem leaves (Chopra, 1978). Also, (Anonymous, 1974) neem seed cake when mixed with soil was found to be appreciably toxic against *Microtermites* sp., it kills insects that get in contact with it within 24 h of treatment (Dutta, 1974).

The pesticidal effect of powdered black pepper was confirmed by Ivbijaro and Agbaje (1986). Ogboewu (1973) further reported that this plant species is toxic to both nymphs and adults' grasshopper, *Zonocerus variegates* L. due to present of poperine acting in synergism with guineesine. Furthermore, Su (1977) reported that 95% of ethanolic crude extract of *P. inigrum* had high toxic effect on cowpea weevil, *C. maculatus* and rice weevil *Sitophilus oryzae.*

Considerable mortality was recorded due to *X. eathiopica* activities on treated products. This was attributed to the poisoning symptoms observed on *S. seamais,* Okoro *et al.* (1991) reported that it causes hyper excitability in insect `mortality rate was encountered during this present study where at both treatments concentrations and control, no significant effects were recorded. Same situation was recorded for *T. tetraptera* with insignificant effect. Although the presence of coumarin in the crude extract is expected to slow down the biological activities of an organism that has the treatment in their food. According to Adesina and Sofowora (1979), but this treatment at these concentrations for this study did not conform to this submission.

Weight loss in stored products is a function of food availability, time and pests population every things being equal. Due to the infertility and starvation effects of neem extract, treated chips recorded high mortality leaving few parent pests *P. truncatus* to damage the treated chips without any progeny. Moreso, some of the stock parent pests were recorded dead which further reduced the pest activities that might have led to weight loss of treated dried cassava chips. Lavie *et al.* (1967) stated that the presence of *Azardirachtin* and Meliantriol inhibits and suppress pest activities. While Henderson *et al.* (1964) reported the presence of salanin which have negative impact on feeding rate in pests. Makanjuola (1989) also agreed in her work that neem crude extract exhibits suppressant effects on feeding rate of *Callosobruchus maculatus* and *Sitophilus oryzae* for 5 months on maize. The aforementioned reasons could by responsible for the significant difference recovered in he treated dried chips with neem crude extract treatment in the current study.

Black pepper seed crude extract had a significant difference in the weight loss recorded simply became of the significant difference recorded for mortality rate ($p<0.05$). Weight loss was only significantly different between control and the two concentrations. The 40% and 60% concentrations did not show any significant difference.

African pepper fruits and *X. aethiopica* did not revealed any significant difference in weight loss of dried chips as it was observed in the progeny emergence and mortality of the *P. truncatus* in the treated dried cassava chips. Although Okoro *et al.* (1991) reported that *X. aethiopica* causes mortality in pest when mortality is linearly increased from 48 hours to 96 hours. In his work he did not state whether this mortality was significant or not, but it worth mentioning more so that this present study also show mortality, which was not significant ($p<0.05$) (LSD).

Adewumi (1984) referred to *T. tetraptera* as heart-slowing agents in pest. This consequently, caused reduced boring, feeding and even reproductive activities. A reduction in these factors brings about very little weight loss of stored products. Although the weight loss in the treatment was not the same value but the mean value were not significantly different. This study findings deviates from the above submission since significant difference was not recorded in the treatment to translate to the significance weight loss. More so, Philippa (2000) states that *X. aethiopica* does not confer compile protection on stored products but only reduce infestation rates of *C. maculatus.*

This study did not set out to compare the efficacy of the crude extract plant species but could be said that neem in better follow by blank pepper where Africa pepper fruits and *X. aethiopica* are the least effective.

Although low significant pesticidal effect was achieved in two of the plant species extracts and the others provided required protection on the treated dried cassava chips.

Therefore, it may be necessary to combine those extracts where significant different was not achieved with conventional synthetic insecticides in simple mixture as a means of making their use more cost effective and attractive. Furthermore, this extracts may be redirected at larval to consider how effective they may be.

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