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Bio-efficacy of *Clerodendrum capitatum* (Willd) Schumachet. Thonn. (Lamiales: Verbenaceae) against *Dermestes maculatus* De Geer, 1774 (Coleoptera: Dermestidae) larvae infestation on smoked catfish *Claria gariepinus* (Burchell, 1822) (Siluriformes: Clariidae)

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Abstract. Studies were conducted under ambient condition to assess the efficacy of *Clerodendrum capitatum* (Willd) Schumachet. Thonn. (Lamiales: Verbenaceae) against larvae infestation and adult emergence of *Dermestes maculatus* De Geer, 1774 (Coleoptera: Dermestidae) on smoked dried catfish *Claria gariepinus* (Burchell, 1822) (Siluriformes: Clariidae). The leaf powder was admixed at 2.5 g, 3.0 g, 4.0 g and 5.0 g/15 g to disinfected smoke-dried catfish *Clarias gariepinus* separately in a 125 mL plastic container. Ten newly emerged (0-72 h) larvae of *D. maculatus* were introduced into each of the plastic containers. Efficacy of *Clerodendrum capitatum* was assessed based on percentage larval mortality, adult emergence reduction and weight loss. Results showed that the plant powder cause significantly ($p < 0.05$) larval mortality compared to the untreated fish at 24 h, 48 h and 72 h post infestation. Percentage reduction of adult emergence was not significant ($p > 0.05$) in treated fish samples compared to untreated sample. While fish sample protected with powder of *Clerodendrum capitatum*, exhibit significant ($p < 0.05$) low weight loss as against weight loss observed in untreated fish. The efficacy of *Clerodendrum capitatum* is inversely proportional to increase in dosage rate. This study clearly demonstrated the larvicidal potential of *Clerodendrum capitatum* powder in offering effective protection against infestation and damage by *D. maculatus* and recommended for utilization in integrated post-harvest management strategies of smoke-dried fish.

Keywords: *Claria gariepinus*; *Clerodendrum capitatum*; *Dermestes maculatus*; Infestation; Smoke-dried fish; Integrated post-harvest management; African sharptooth catfish.

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Introduction

Smoked or dried fish is a highly favored item of many traditional dishes in Nigeria and it is a condiment that greatly enriches the flavor of various dishes and a good alternative to fresh fish, which in many places is not readily available (Obiakor et al., 2013). Adesina et al. (2014) reported that fish constitutes about 50% of total animal protein intake in Nigeria as the cost of beef increases daily and owing to its nutritional and health benefit; this account for its wide acceptability on the menu table of most Nigerians irrespective of socio-economic status, age and religious background. According to Clement (2013), 45% of total fish catch in Nigeria are utilized as smoked fish. However, research has proved that most of the smoked fish that are carried to long distant markets from fishing areas are susceptible to *Dermestes maculatus* De Geer, 1774 infestation (Idris and Omojowo, 2013). Under traditional storage conditions, losses due to beetle infestation for instance, have been estimated at 50% (Nayak et al. 2014; Rajashekar et al., 2014). Larval stages of *D. maculatus* usually accounts for 93% infestation in dried or smoked fish. Losses caused by *D. maculatus* infestation are enormous. They include physical, economic and nutritional loss and their infestation also predisposes the infested fish to microbial attack (Woo, 1992; Brock and Bullis, 2001).

Although many synthetic chemicals are effective against the pests of many stored products, but efforts to reduce losses through insect infestation on smoke-dried fish by the use of insecticides and pesticides have not been fully adopted due to the hazardous nature of these chemicals to health and toxicity at high doses to users (Balogun, 1992); higher costs and less susceptibility of dermestid larvae (Amusan and Okorie, 2002), the use of such insecticides renders smoked fish unattractive to fish consumers (Akinwumi et al., 2007). In order to eliminate much of the shortcomings associated with the use of synthetic insecticides and provide an effective storage techniques; in recent year, there have been increasing and concerted effort at developing plant based toxicants that are environmentally friendly. It was reported that when dried or smoked fish was mixed with leaf, bark, seed powder, or oil extracts of selected plants, there was mortality of beetles, reduced oviposition rate, suppression of adult emergence and reduced fish damage rate (Don-Pedro, 1985, 1989; Weaver and Subramanyam, 2000; Okonkwo and Okoye, 2001; Anyaele and Amusan, 2003a,b).

Clerodendrum capitatum (Willd) Schumachet. Thonn. var *capitatum* (Family Verbenaceae), locally named “Fèrèmomi” in Yoruba, is an indigenous Tropical Africa fast growing, erect, well branched, perennial under shrub which grows up to 0.5-2 m high (Adeneye et al., 2008). The plant popularly called as medicinal-magical plant for bone healing in fractures (Houngnon et al., 1990), it is equally reputed for local management of diabetes mellitus, obesity and hypertension. Recently, Juvekar et al. (2006) reported immune stimulatory activity of aqueous extract of *Clerodendrum serratum* L. roots in mice. Sharma and Bhuyan (2006) equally reported the hypolipidemic activities of glycosides isolated from *Clerodendrum colebrookianum* Walp leaves in mice. However, there are no reports on insecticidal activity of *Clerodendrum capitatum* against coleopteran pests. Therefore, the present study aims to investigate the efficacy of *Clerodendrum capitatum* leaves powder in suppressing infestation and damage caused by *D. maculatus* larvae on smoked catfish *Claria gariepinus* (Burchell, 1822).

Materials and methods

Insect culture and maintenance

The initial source of *D. maculatus* culture used for this study was obtained from natural infested smoked catfish (*Clarias gariepinus*) collected from smoked fish market stall in Owo, Ondo State, Nigeria. This was maintained in a kilner jar covered with muslin cloth under laboratory

conditions of temperature 30 ± 2 °C under relative humidity 65 ± 5% to breed and multiply. New generations was produced by removing newly emerged larvae from a stock culture, placed them on fresh uninfected fish, and then the parent adult removed after 2-3 weeks oviposition period.

Smoked samples of the fish (*Clarias gariepinus*) were purchased from the fish market stall at Oja Oba Market, Owo, Ondo State, Nigeria. The cured fish samples were sterilized in a hot air oven at 100 °C in order to kill any insect pests that may be present (Atijegbe, 2004), and allowed to cool at room temperature.

Preparation of *Clerodendrum capitatum* leaves powder

Whole plant of *Clarias capitatum* was collected from Ilutitun Community in Okitipupa of Ondo State, Nigeria, and the identity of the plant was confirmed at the Forestry and Wood Technology Department, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. The plant material was washed in clean water to remove any dirt material and shade dried for two weeks, and leaves plucked and pulverized using an electric grinder and sieved. The plant powder was kept in a separate sterile plastic container and placed in a cool dry place till further use.

Effect of *Clerodendrum capitatum* leaves powder on larvae and adult emergence of *D. maculatus*

Twenty grams (20 g) of clean uninfested fish sample was weighed into 250 mL plastic vials. To each vials various dosages (2.5 g, 3.0 g, 4.0g and 5.0 g) of plant powder was added. Another set of fish samples without plant powder was served as control. Ten newly emerged larvae of *D. maculatus* was introduced into each treated and control vials containing fish samples and covered. The content of the vials was thoroughly mixed to ensure the coating of the powder on fish samples. Each treatment was replicated three times and arranged in Completely Randomized Design (CRD). The number of dead larvae was counted after 24 h, 48 h and 72 h to determine larvae mortality.

Insect subsequently emerging was counted to estimate percentage reduction in adult emergence of F1 progeny using method described by Tapondju et al. (2002) and modified by Adesina et al. (2014).

Weight loss was determined by re-weighing the fish samples at the end of the experiment.

Percentage larvae mortality =

$$\frac{\text{no of live larvae before treatment} - \text{no of live larvae after treatment}}{\text{no of larvae before treatment}} \times \frac{100}{1}$$

Percentage adult emergence reduction:

$$= \frac{\text{no of adult insect emerged in control dish} - \text{no of adult insect emerged in treated dish}}{\text{no of adult insect emerged in control dish}} \text{x} \frac{100}{1}$$

% Weight loss (Adesina et al., 2014) =

$$\frac{\text{initial weight of fish sample} - \text{final weight of fish sample}}{\text{initial weight of fish sample}} \text{x} \frac{100}{1}$$

Statistical analysis

All data obtained was subjected to analysis of variance and where significant differences existed, treatment means was separated using Least Significant Difference (LSD) at 5% probability level. Data in percentage were arcsine transformed, before analysis (Gomez and Gomez, 1984).

Results and discussion

Effect of *Clarias capitatum* on larvae mortality

Percentage larvae mortality of *D. maculatus* was summarized in Figure 1. The results revealed that pulverized *Clarias capitatum* leaves powder exerted significant ($p < 0.05$) larvae mortality in all the treated dishes compared to control. The percentage mortality of *D. maculatus* larvae depends on the concentration level and exposure time. For the entire dosage rate used, percentage larvae mortality increased as exposure time increases. At 72 h post infestation larvae exposed to 5 g plant powder had the highest larvae mortality (37.2%), lowest mortality recorded from fish protected with 2.5 g powder (17.2%). No mortality was observed in control treatment (Figure 1). However, 100% mortality was not achieved in any of the treatment rates.

The mortality caused by the powder might be due to its tendency to block the spiracles of insects when in contact with their body. Most insects breathe through the trachea which usually leads to the opening of the spiracles (Kemabonta and Falodu, 2013). The powder may cause death through dessication of insects or through occlusion of their spiracles, thereby preventing respiration via tracheal system (Copping and Menn, 2000). This supports the findings of other researchers who had earlier reported on the efficacy of larvicidal activities of various plant products as surface protectant against *D. maculatus* infestation (Fasakin and Aberejo, 2002; Adebote et al., 2006; Akinwumi et al., 2007).

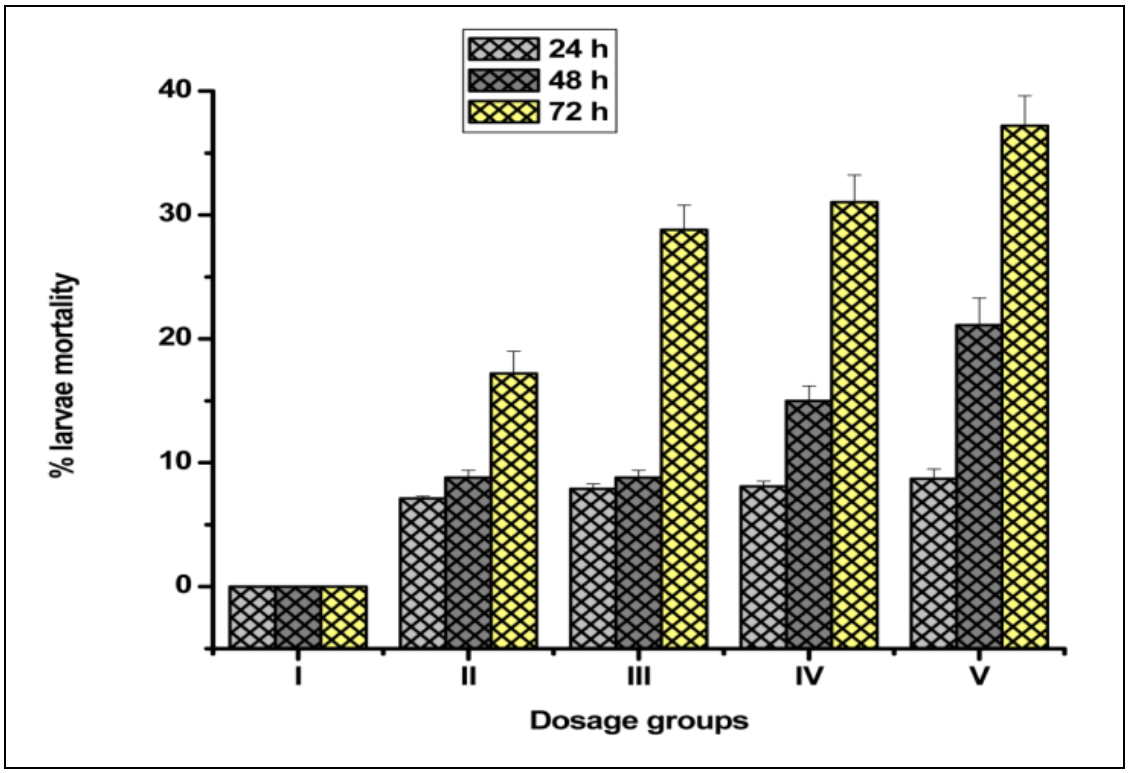

Figure 1. The effect of *Clerodendrum capitatum* on percentage larvae mortality of *D. maculates*. **I** = 0 g; **II** = 2.5 g; **III** = 3.0 g; **IV** = 4.0 g; **IV** = 5.0 g (n = 4, error bars, SEM).

Effect of *Clerodendrum capitatum* on percentage adult emergence reduction

Figure 2 shows the effect of *Clerodendrum capitatum* powder on percentage adult emergence reduction. Result obtained from the study clearly shows that unprotected fish samples had the lowest adult emergence reduction percentage compared to treated samples that recorded varying promising percentage adult emergence reduction ranging 28.8%-26.7% and with the highest emergence reduction percentage obtained from fish admixed with 5 g plant powder (26.7%). However, the plant powder suppressed adult emergence, but the observed differences were not statistically significant between the treatments.

The significant reduction in the adult emergence could be as a result of higher mortality of *D. maculatus* larva. The reduction in adult emergence can also be attributed to the contact effect of the plant material, similar observations were made by (Kedia et al., 2015). Further, this is in agreement with the findings of Don Pedro (1985) who reported that orange peel powder reduced progeny development and slowed larval development of *D. maculatus*.

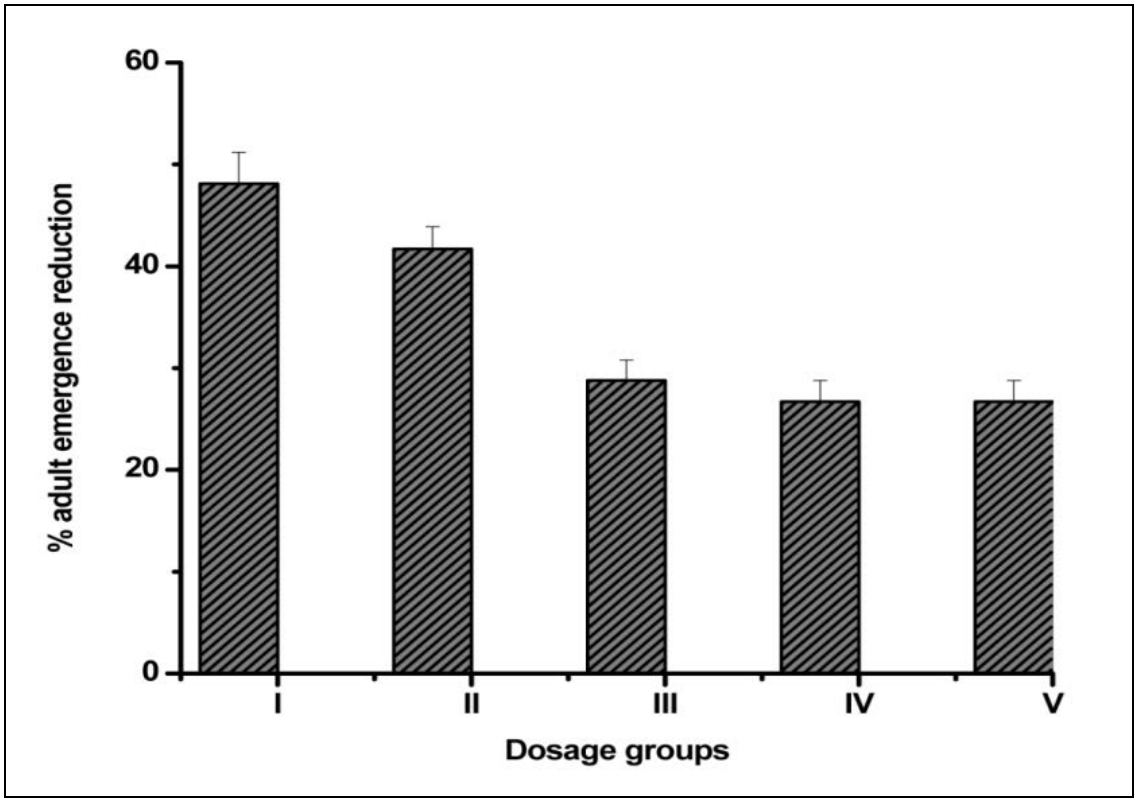

Figure 2. The effect of *Clerodendrum capitatum* on percentage adult emergence reduction of *D. maculates*. **I** = 0 g; **II** = 2.5 g; **III** = 3.0 g; **IV** = 4.0 g; **IV** = 5.0 g (n = 4, error bars, SEM).

Effect of *Clerodendrum capitatum* on percentage weight loss of protected fish samples

Percentage weight loss obtained from the result shows that unprotected fish suffer significant ($p < 0.05$) weight loss (35.07%) compared to fish protected with *Clarias capitatum* leaves powder with the lowest weight loss (23.77%) recorded from fish treated with 5 g powder (Figure 3). This could be attributed to larvae mortality recorded and this is in accordance with the findings of Jose and Adesina (2014) who reported that pulverized *Secamone afzelii* (Schult) K. Schum leaves significantly suppressed weight loss in smoked dried fish. Osuji (1975) stated that the larval stages of *D. maculatus* usually account for about 93.2% of the beetles and account for 62.7% weight loss due to its infestation.

The larvae especially at the 1st-4th instar larval stage are voracious eaters because of growth requirements, in contrast to the adult insects which tend to have a reduced feeding habit.

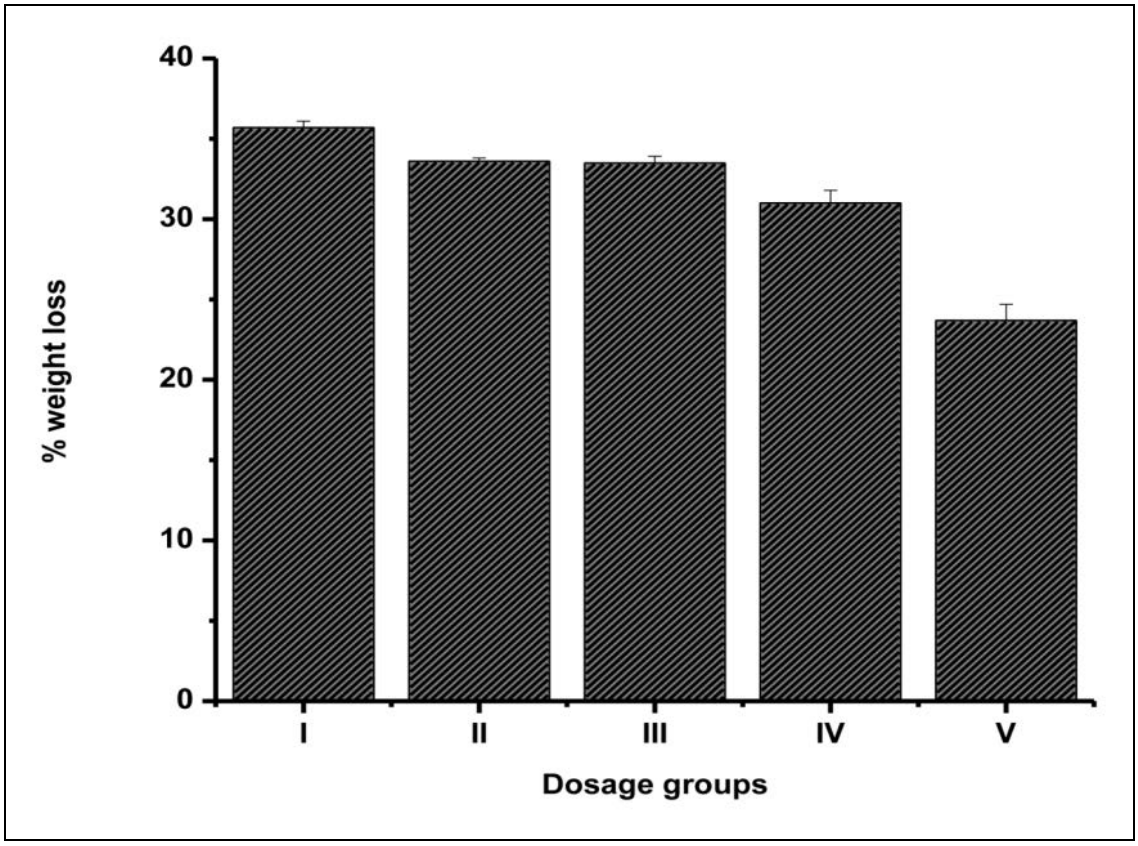

Figure 3. The effect of *Clerodendrum capitatum* on percentage weight loss of fish samples. **I** = 0 g; **II** = 2.5 g; **III** = 3.0 g; **IV** = 4.0 g; **IV** = 5.0 g (n = 4, error bars, SEM).

Conclusion

The results obtained in this study showed that leaf powder of *Clerodendrum capitatum* was toxic to the fish bettle, *D. maculatus*, causing significant larvae mortality and suppressed adult emergence. The weight loss is also significant when compared to the control treatments. The use of *Clerodendrum capitatum* among poor resource fisher farmers and traders should be advocated for the control of *D. maculatus* infestation during processing, storage, transportation and marketing of smoked dried fish, since the plant is readily available and widely distributed in the rural area of rain forest zone in Nigeria and used among rural folks for its ethno medical importance. Further study needs to be conducted to understand the mode of action of the plant toxicity effects and also the characterization and isolation of the chemical constituents needs to be conducted with the likely formulation into herbal insecticide as alternative to synthetic insecticides.

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Conflict of interest statement

Authors declare that they have no conflict of interests.

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