

## Toxicity of *Sclerocarya birrea* and *Azadirachta indica* extracts against maize weevil *Sitophilus zeamais* Motchulsky (Coleoptera: Curculionidae) in storage

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### Abstract

Toxicity of *Sclerocarya birrea* A. Rich. (Anacardiaceae) leaf and bark and *Azadirachta indica* A. Juss (Meliaceae) leaf extracts against *Sitophilus zeamais* Motchulsky (Coleoptera: Curculionidae) was evaluated under the laboratory conditions (77±4% relative humidity and 27±3°C temperature). When extracted doses were compared, mortality was dose- and exposure period-dependent. At 1 DAT, *A. indica* leaf extract had significantly ( $p < 0.05$ ) higher mortality (12.50-15.00%) than that of *S. birrea* bark extract (5.00-15.50%). However at 5 DAT, when 0.45 ml/33 cm<sup>2</sup> was applied, mortality was not significantly ( $p > 0.05$ ) different and ranged from 91.25 to 97.5% for all the botanicals. When the extracting solvents were compared, mortality was exposure period-dependent with highest percentage mortality (99.17%) recorded at 5 DAT in *S. birrea* petroleum ether leaf extract, which was significantly higher than that of mortality observed in filter paper treated with the petroleum ether extracts of other botanicals. However, there was no significant difference in the effect of the two studied solvents. The results highlight the insecticidal potentials of the selected Nigerian-grown botanicals against maize weevil and recommend them as component of weevil Integrated Pest Management, in the areas where the botanicals are abundant.

**Keywords:** Insecticidal properties; Botanical extracts; Maize weevil; Marula; Neem

### Introduction

Post-harvest food losses destroy food security throughout the world. Around 20-40% losses have been recorded on cereals in Africa (World Bank *et al.*, 2011) and about 10-100% sometimes in tropical countries (Mugisha-Kamatenezi *et al.*, 2008) culminating into billions of dollars in monetary value. Insect pests constitute the highest source of quantitative and qualitative depreciation to stored products due to their activities in cases of infestation, competing with man for scarce food resource by direct feeding or providing suitable conditions for micro-organisms (Yallapa *et al.*, 2012). Maize (*Zea mays*) is an important cereal crop cultivated in the tropics for its various uses such as food for man, livestock ingredient and raw material for industries. However, the sustainable production of this important crop has been extensively damaged by insect pest infestation both on the field and during storage.

The maize weevil, *Sitophilus zeamais* (Coleoptera: Curculionidae), is a major devastating pest of maize. The infestation of cereal grain by *S. zeamais* and other insect pests have led to heavy losses ranging from 20-30% of total grain production alone in Nigeria (Miyinjiwa, 2002) It is a cosmopolitan pest with its hosts ranging from cereals to

processed tuberous crops and even dried vegetables (Babarinde *et al.*, 2008a, 2013a, 2013b). This wide host range is the more reason why this insect species can cause severe socio-economic problems and food insecurity, if left unattended to.

The management of insect pests of stored product at postharvest level depends on the use of synthetic chemicals (Huang and Subramanyam, 2005; Pretheep-Kumar *et al.*, 2010) over the years. However, several drawbacks such as high cost of chemicals, possibility of user's contamination, pest resurgence and resistance, harmful effect on non-target organisms, food residues and environmental pollution and ozone layer depletion (Gao *et al.*, 2008; Babarinde *et al.*, 2016) have been identified. Hence, there is a need for an economically sound and eco-friendly strategy towards the management of *S. zeamais* to prevent its rising above economic threshold. Botanical insecticides could be considered as appropriate alternatives since they are inexpensive, environmentally safe, easy to obtain and process (Habib *et al.*, 2011; Babarinde *et al.*, 2015). The selected botanicals *Sclerocarya birrea* and *Azadirachta indica*, commonly known as marula and neem respectively,

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have medicinal uses and are presumed to be relatively less toxic to human. This study aims at evaluating the insecticidal potentials of acetone and petroleum ether extracts of *Sclerocarya birrea* leaf and bark and *Azadirachta indica* leaf against *S. zeamais* infesting stored maize.

## Materials and methods

### *Insect culture*

Adult of *Sitophilus zeamais* were obtained from Entomology Unit of Crop and Environmental Protection Laboratory, Ladoko Akintola University of Technology (LAUTECH) Ogbomoso, Nigeria. They were introduced into jars containing clean and un-infested maize obtained from the Teaching and Research farm, LAUTECH. The jars were maintained in the laboratory under ambient conditions ( $27 \pm 3^\circ\text{C}$  temperature and  $77 \pm 4\%$  relative humidity). The insect were allowed 14 day ovipositional period after which the weevils were removed from the culture and the set up kept until the emergence of  $F_1$  progeny. The emerged adults were then used for subsequent infestation to maintain the insect culture throughout the period of the experiment.

### *Source and extraction of the plant materials*

The leaves of *Azadirachta indica* used for the study were obtained from the Teaching and Research Farm, LAUTECH, Ogbomoso, while *Sclerocarya birrea* leaves and bark were obtained from the campus of the University of Ibadan, Ibadan, Nigeria. The leaves of each botanical and the bark of *S. birrea* were separately dried under shade for 7 days then pulverized using a milling machine. Ten g of each pulverized botanical were mixed with 100 ml of either acetone or petroleum ether separately for 18 hours. The acetone and petroleum ether extracts obtained were then decanted and sieved with the aid of filter paper into a glass jar under ambient temperature. Each extract was stored in sample bottle, labelled and stored at  $4^\circ\text{C}$  until use.

### *Bioassays and data analysis*

Different doses (0.15, 0.3, 0.45 ml) of *S. birrea* leaf, *S. birrea* bark and *A. indica* leaf extracts were applied on 9 cm diameter Whatman No. 1 filter paper (approximately  $33\text{ cm}^2$  area) and placed inside 9 cm diameter Petri dishes. Two sets of control comprising 0.2 ml of either acetone or petroleum ether were included. Each treatment and control were left for 30 min for the solvent to evaporate from the treated filter papers, before introduction of the weevils. Thereafter, ten mixed-sex *S. zeamais* were taken into each Petri dish. Mortality data were taken starting at 24 hours after the treatment for 5 consecutive days, and expressed as a

percentage of the number of insects assayed. Where there was mortality in the control, it was corrected using Abbott (1925) Formula.

$$P_T = \frac{P_O - P_C}{100 - P_C}$$

$P_T$  = corrected mortality,  $P_O$  = observed mortality,  $P_C$  = control mortality.

Weevils were adjudged to be dead when they could not respond to pin probe. The bioassay was set up in four replicates. Standard errors were indicated to show variation between the replicates. The data were later subjected to Analysis of variance (ANOVA) and Duncan Multiple Range Test was used to separate significant means at 5% probability level.

## Results and discussion

Mortality was dosage- and exposure period-dependent with highest percentage mortality recorded as 5 day after treatment (DAT). At 1 DAT, *A. indica* had significantly higher mortality than other botanicals when 0.15 and 0.3 ml/  $33\text{ cm}^2$  were applied. However when 0.45 ml/  $33\text{ cm}^2$  was applied, the highest mortality (17.15%) was observed in *S. birrea* leaf extract. Also at 2, 3 and 4 DAT, *S. birrea* leaf at 0.15 and 0.3 ml/ $33\text{ cm}^2$  concentrations had significantly higher mortality than other plants. However when 0.3 ml/  $33\text{ cm}^2$  was applied, the highest mortality (95.00%) was observed in *A. indica* which was not significantly different from the mortality observed in *S. birrea* bark (91.25 %) (Table I).

Table II shows the effect of different extracting solvents on the toxicity of the botanicals on *S. zeamais*. Mortality was exposure period-dependent with highest percentage mortality (99.17%) recorded at 5 DAT in *S. birrea* leaf extracts. At 1 DAT, *S. birrea* bark had the highest percentage mortality (21%) in acetone extracts while *S. birrea* leaf showed the highest mortality (15%) in petroleum ether extracts which was not significantly different from *A. indica* extracted with petroleum ether. There was no significant difference in the effect of the tested solvents on the efficacy of the extracts.

Several researchers have screened many plants products for the control of insects pest of stored cereals and grains (Adedire and Ajayi, 2003; Isman, 2007; Ogendo *et al.*, 2008; Oyegoke *et al.*, 2010; Asawalam *et al.*, 2012; Akinneye and Ogungbite, 2013; Babarinde *et al.*, 2008b, 2013 2014, 2015, 2016). In this study, the results show that extracts of *S. birrea* leaf significantly reduced the abundance of *S. zeamais*

**Table I. Effect of application doses on mortality of *Sitophilus zeamais* exposed to selected botanical extracts**

Botanicals	Days after treatment	Dose ml/33 cm <sup>2</sup>		
		0.15	0.30	0.45
<i>Azadiractha indica</i> leaf	1	15.00±2.67bB	18.75±3.98aB	12.50±3.66aB
<i>Sclerocarya birrea</i> leaf	1	7.50±3.66aA	10.00±3.27aA	17.50±1.64cB
<i>Sclerocarya birrea</i> bark	1	12.50±6.48bA	15.00±5.98bA	5.00±3.27aA
<i>Azadiractha indica</i> leaf	2	36.25±3.75aA	42.50±1.64bBC	28.75±2.95aA
<i>Sclerocarya birrea</i> leaf	2	40.00±9.26aB	32.50±8.81aA	56.75±2.95aA
<i>Sclerocarya birrea</i> bark	2	28.75±8.75aA	30.00±9.99aA	28.75±8.54aA
<i>Azadiractha indica</i> leaf	3	65.00±4.99aB	77.50±5.90bBc	71.25±7.18aB
<i>Sclerocarya birrea</i> leaf	3	66.25±5.32aB	57.50±7.96aB	72.50±7.73bB
<i>Sclerocarya birrea</i> bark	3	51.25±7.89aA	46.25±11.01aA	46.25±10.68aA
<i>Azadiractha indica</i> leaf	4	76.25±4.60aA	88.75±3.98bBC	83.75±6.53aB
<i>Sclerocarya birrea</i> leaf	4	88.75±2.95bBC	76.25±5.65aA	93.75±2.63bBC
<i>Sclerocarya birrea</i> bark	4	73.75±4.60aA	70.00±7.79aA	68.75±6.11aA
<i>Azadiractha indica</i> leaf	5	78.75±10.59aA	95.00±3.27bB	92.50±3.66bA
<i>Sclerocarya birrea</i> leaf	5	98.75±1.25bBc	83.75±5.65aA	97.50±1.64bA
<i>Sclerocarya birrea</i> bark	5	85.00±3.78aA	91.25±3.98aB	91.25±3.98aA

Mean having the same small letter of alphabet long the row, are not significant different at 5% probability level (DMRT). Mean having the same capital letter of alphabet long the column, are not significant different at 5% probability level (DMRT).

through increased mortality. Mortality was solvent- and exposure period- dependent with highest percentage mortality (99%) recorded at 5 days after treatment (DAT) when *S. birrea* leaf was applied at 0.15 ml/33 cm<sup>2</sup> filter paper, which was significantly ( $p < 0.05$ ) higher than 79 and 85% observed in *A. indica* and *S. birrea* bark respectively. When acetone was used as solvent, mortality was not significant ( $p > 0.05$ ) and ranged between 81-93%. However, 99% mortality observed in *S. birrea* leaf was significantly ( $p < 0.05$ ) higher than 85 and 86% in other botanicals when petroleum ether was used. Mortality of *S. zeamais* due to the extracts indicates their toxicity to *S. zeamais* either through contact or oral poisoning. *A. indica* leaf showed prospects as a very good protectant. The part of *A. indica* that had been

well-studied for insecticidal properties is the seed due to its high level of azadirachtin, the main active ingredient. In this work, we evaluated the leaf extract in order to establish the insecticidal potentials of the leaf against maize weevil, *S. zeamais*. The high mortality of *S. zeamais* despite its thick exoskeleton could probably be due to contact toxicity when lethal dose of plant materials were taken up in the cause of the movement of the weevil on the extract-treated surface of the filter paper. The result of the toxicity of the botanicals against *S. zeamais* agrees with earlier researchers (Kestenholtz *et al.*, 2007; Babarinde *et al.*, 2008b, 2008c; Oyegoke *et al.*, 2010; Akinneye and Ogunbite, 2013; Edelduok *et al.*, 2015) who reported the utilization of plant products as protectants against *Sitophilus* species.

**Table II. Effect of extraction solvents on the mortality of *Sitophilus zeamais* exposed to selected botanical extracts**

Botanicals	Days after treatment	Solvents	
		Acetone	Petroleum ether
<i>Azadirachta indica</i> leaf	1	16.67±3.65bA	14.17±1.93bA
<i>Sclerocarya birrea</i> leaf	1	7.50±2.49aA	15.83±2.29bB
<i>Sclerocarya birrea</i> bark	1	21.67±4.41bB	0.00±0.00aA
<i>Azadirachta indica</i> leaf	2	37.50±3.29bA	34.17±2.29bA
<i>Sclerocarya birrea</i> leaf	2	28.33±6.13aA	60.83±6.09bcB
<i>Sclerocarya birrea</i> bark	2	49.17±4.34bcB	9.17±3.79aA
<i>Azadirachta indica</i> leaf	3	75.83±5.57bB	66.67±4.14bA
<i>Sclerocarya birrea</i> leaf	3	54.17±5.83aA	76.67±3.76bcB
<i>Sclerocarya birrea</i> bark	3	70.00±3.48bB	75.83±5.14bcB
<i>Azadirachta indica</i> leaf	4	84.17±4.99aA	81.67±3.6bA
<i>Sclerocarya birrea</i> leaf	4	80.83±4.34aA	91.67±2.41bcB
<i>Sclerocarya birrea</i> bark	4	81.83±4.05aB	60.00±3.69aA
<i>Azadirachta indica</i> leaf	5	90.83±3.36aA	86.67±7.42aA
<i>Sclerocarya birrea</i> leaf	5	81.50±4.11aA	99.17±0.83bcB
<i>Sclerocarya birrea</i> bark	5	93.33±2.84aA	85.00±3.14aA

Means having the same small letter of alphabet along the column are not significantly different at 5% probability level (DMRT). Means having the same capital letter of alphabet along the row are not significantly different at 5% probability level (DMRT)

## Conclusion

The results highlight the insecticidal potentials of the selected Nigerian-grown *Sclerocarya birrea* and *Azadirachta indica* against maize weevil. Therefore, these plant based products are recommended as component of integrated pest management of storage insect pests, in the areas where the botanicals are available. There was no clear-cut disparity in the efficacy of the two extracting solvents; hence either of the solvents could be used for extraction and field application of the botanicals.

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