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EFFICACY OF BOTANICALS IN THE CONTROL AND MANAGEMENT OF INSECT PESTS OF CASHEW (*Anacardium occidentale*): A REVIEW

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ABSTRACT

Cashew (Anacardium occidentale L.) is an essential cash crop tree grown in Nigeria and other countries worldwide, providing a livelihood for many people. However, insect pests such as Analeptes trifasciata, Selenothrips rubrocinctus, Pachnoda cordata, Helopeltis spp. (H. anacardii, H. schoutedeni), Plocaederus ferrugineus can cause significant damage to the crop. Several measures have been adopted by farmers, particularly, the use of synthetic insecticides which have harmful effects on both man and the environment. Globally, some researches have been conducted to investigate the efficacy of extracts and essential oils of some botanicals against these pests. The results obtained showed that the plant samples tested were found effective against the insect pests, though some were dose dependent. Therefore, any of the plant samples used in these researches can be explored as biopesticides against the pests. Future research should concentrate on isolation and characterization of active components in these plants samples.

Key words: Cashew, Botanicals, Insect pests, Insecticides

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INTRODUCTION

Cashew, scientifically known as *Anacardium occidentale* L., is an evergreen tree from the flowering plant family Anacardiaceae. It is native to Central and Southern America, particularly North Eastern Brazil. It has become a significant source of income for small and large-scale farmers in Nigeria due to its multiple uses (Adeigbe *et al.,* 2015; Asogwa *et al.,* 2008). Cashew trees are grown to combat desertification and soil erosion, and their nuts, apples, and wood are precious. Roasted cashew kernels taste pleasant, and cashew nut shell liquid, kernel oil, juice, jam, and alcohol can all be produced from different parts. Additionally, ripe cashew apples contain high levels of vitamin C and produce delicious juice (Asogwa *et al.,* 2009). However, cultivating cashew trees faces several challenges, with pests and diseases being the most significant threat. At every stage of growth, cashew trees are infested by numerous insect pests, including the striped mealy bug, stem and root borer, Red-banded thrips, cashew stem girdler, Fruit scraper, Tea mosquito bug, and others (Plates 1 - 4) (Muntala *et al*., 2020).

Cashew trees are often plagued by pests that can infest different parts of the tree, such as the roots, stems, branches, flowers, inflorescence, and pseudo-apples. These pests can cause extensive damage to the foliage and fruits, resulting in the death of floral-flushing shoots, early abortion of young nuts, and significant yield loss (Vanitha *et al.,* 2015, Adeigbe *et al.,* 2015, Asogwa *et al.,* 2009). Table 1 below shows the major pests of cashew in the cashew growing continents.

Table 1: Major Insect Pests of Cashew

	Scientific Name	Family	Common Name	Part Affected	Status	Reference
1	*Plocaederus ferrugineus* L.	(Coleoptera: Cerambycidae)	Trunk and root borer	Trunk/ roots	Major Pest	Munj *et al.*, 2022 ; Asogwa *et al*., 2008
2	*Selenothrips rubrocinctus* Giard	(Thysanoptera: Thripidae)	Red-banded thrips	Leaves/ shoots	Major Pest	Munj *et al.*, 2022; Asogwa *et al*., 2008
3	*Analeptes trifasciata*	Fabricius (Coleotera: Carambycidae)	Cashew stem girdler	Stem	Major Pest	Asogwa *et al*., 2008; Asogwa *et al*., 2011
4	*Pachnoda cordata*	(Coleoptera: Scarabidae)	Fruit scraper	Fruits	Major Pest	Asogwa *et al*., 2008
5	*Helopeltis antonii* Signoret	(Hemiptera: Miridae)	Tea mosquito bug	Foliage, flowers, fruits and nuts	Major Pest	Damasia *et al*., 2020; Munj *et al*., 2022
6	*Aleurodicus cocois* (Curtis, 1846)	(Hemiptera: Aleyrodidae)	Whitefly	Phloem	Major Pest	Saraiva *et al*., 2008
7	*Ferrisia virgate*	(Pseudococcidae: Heteroptera)	Mealy bug	shoots, twigs and fruit	Major Pest	Munj *et al*., 2022

Insect Pests of Cashew

The first four plates exhibit images of insect pests commonly found in cashew trees. These specimens have been carefully preserved at the Insect Museum Reference Collection Center, part of the Department of Crop Protection and Environmental Biology at the University of Ibadan. *Plocaederus denticornis* Villers 1968 adult image is displayed on Plate 1. The insect's reference number is 87. On Plate 2 is the adult *Analeptes trifasciata* Fabricius, preserved in the Insect Museum Collection Reference, No. 87, pp 69. The Department mentioned above manages this collection. Displayed on Plate 3 is the adult stage of *Pachnoda cordata* Drury, which can be found in the Insect Museum Collection Reference No. 85, pp 163. This fascinating insect is lodged at the Insect Museum of the Department of Crop Protection and Environmental Biology at the University of Ibadan. The image of *Helopeltis schoutedeni* Reuter adult specimen is displayed on Plate 4. The insect is housed at the insect museum with reference number 12, page 82.

Plate 1: ***Plocaederus denticornis*** **Villers 1968**
Source: Insect Museum Collection Reference No. 87, pp 69,
Department of Crop Protection and Environmental Biology, University of Ibadan.

Plate 2: ***Analeptes trifasciata*** **Fabricius**
Source: Insect Museum Collection Reference No. 87, pp 69,
Department of Crop Protection and Environmental Biology, University of Ibadan

Plate 3: ***Pachnoda cordata*** Drury
Source: Insect Museum Collection Reference No. 85, pp 163,
Department of Crop Protection and Environmental Biology, University of Ibadan

Plate 4: ***Helopelti sschoutideni*** **Reuter**
Source: Insect Museum Collection Reference No. 12, pp 82,
Department of Crop Protection and Environmental Biology, University of Ibadan.

Management with the Synthetic Pesticides and Effects

Effective pest management is germane due to these organisms' detrimental effects and economic losses on agricultural produce. Synthetic or chemical insecticides have been reported to be very effective in controlling various types of insect pests, including cashew pests (Ugwu *et al.*, 2019, Lale 2002, Jadhav *et al.*, 2010). However, they are considered unsafe as most of these conventional synthesized chemical insecticides in the likes of organophosphate, organochlorines, and carbamates are highly toxic to human health as their consumption can cause harmful and severe medical challenges such as Alzheimer's disease, Parkinson's disease, hormonal imbalance, leukaemia, bladder, thyroid, and brain cancer, coupled with the development of resistance by the insects (Chengala *et al*., 2017).

The detrimental effects of chemical pesticides (insecticides) led to the discovery of the botanical pesticides which serves as a better alternative. Biopesticides are derived from natural materials such as plants, microbes and animals that control pests by non-toxic mechanisms (Chengala *et al.*, 2017). A good number of plant crude extracts, essential oils and compounds have been reported as effective biopesticides against many stored product pests (Mahapatro *et al*., 2008, Alabi and Adewole, 2017; Noudegbessi *et al*., 2021).

Plant Species with Insecticidal Ability to Control the Insect Pests of Cashew

Botanical or plant based insecticides have been used for several decades, most especially, among the resource limited farmers in developing countries to control insect pests affecting agricultural produce, hence, serving as a promising alternative to synthetic insecticides (Akunne *et al*., 2018; Oparaeke *et al.,* 2005). The characteristic features of the botanical pesticides such as non- persistence in the environment, selectivity towards beneficial and non-target organisms and low toxicity to humans enhance significant studies of botanical pesticides from different plant origins (Chengala *et al.*, 2017).

Across different parts of the world where cashew is being cultivated, some researches have been carried out on the effects of plants' essential oils and extracts with insecticidal potential to control the infestation of its insect pests. Table 2 below summarizes studies that have been conducted on some plant species from different families. It is noteworthy that, the use of botanicals in mitigating insect pest infestation on cashew plots has not been well researched. In fact, in the course of this study, it was observed that information on the use of plant based insecticide in controlling a good number of the insect pests of cashew is not well documented, hence, the need to explore this area of research. In this review, desk research was employed with the aid of published articles by various researchers on cashew and the management of several insect pests.

Efficacy of Botanicals to Control the Insect Pests of Cashew

The insecticidal ability of the different plants species evaluated against the cashew insect pests was found to be effective to a large extent. Saraiva *et al*., 2021 evaluated the toxicity of a mixture of the essential oils of *Lippia sidoides* Cham. (Verbenaceae) and *Cymbopogon winterianum* Jowitt. (Poaceae) on the third and fourth nymphal stages of *Aleurodicus cocois* and found that the mixture of the essential oils of L. *sidoides* and C. *winterianum* were toxic to nymphal stages of A. *cocois*. Similar study was conducted by Mota *et al.,* 2017, in which the essential oil (EO) of basil *Ocimum micranthum* Willd was evaluated as an insecticide against whitefly *Aleurodicus cocois*. The study revealed that the EO at 1% concentration showed the highest toxicity against *A. cocois* and faster mortality (6.82 h with a confidence interval of 6.34-7.30 h).

More so, essential oils mixture of citronella, lemon grass and clove was used to evaluate the rate mortality and oviposition of *Helopeltis antonii*. 1:1 mixture of the essential oil of citronella and clove; lemon grass and clove at 10 mL/L concentration the oviposition of *H. antonii* by 60.18 % and 46.56 % respectively and resulted into adult mortality by 79.17 % and 62.50 %, as well as the nymphs' mortality at 87.50 % and 82.50 % respectively, hence, comparing effectively with the commercial citronella oil formula (Tri Lestari Mardiningsih and Ma'mun, 2017). Jadhav *et al*., 2010 examined the effect of the unripe fruit extract of *Balanites aegyptiaca* (L.) in controlling mealy bugs, *Ferrisia virgate.* The result of the experiment showed that 25% concentration, the insect mortality was 73% and increased to 84% at 100%, implying that, as the concentration of the sprayed plant extract was increasing, the mortality rate also increased.

Table 2: Plants materials used experimentally for the control of some cashew pests

Insect Pest	Plant Species Tested	Common Name	Family Name	Form Used	Reference
Plocaederus ferrugineus L.	*Azadirachta indica*	Neem	Meliaceae	Neem oil and Cake	Sahu *et al.*, 2008
Helopeltis antonii Signoret	*Azadirachta indica*	Neem	Meliaceae	Extract (derivatives)	Mahapatro, 2008.
	Milletia (pontamia) pinnata	Indian beech	Fabaceae	Extract	Angaiah, 1995
	Cymbopogon nardus	Citronella leaf	Poaceae	Essential oil	Bhat *et al.*, 1994
	Syzygium aromaticum	Clove	Myrtaceae	Essential oil	Tri Lestari
	Cymbopogon citratus	Lemon grass	Poaceae	Essential oil	Mardiningsih and
	Annona reticulata	Custard Apple	Annonaceae	Seed extract	Ma'mun, 2017
	Annona squamosal	Sugar apple			Vanitha *et al.*, 2015
Aleurodicus cocois	*Ocimum micranthum* Wild	Basil	Lamiaceae	Essential oil	Mota *et al.*, 2017
	Lippia sidoides Cham.	Pepper- rosemary	Verbenaceae	Essential oil	Saraiva *et al.*, 2021
	Cymbopogon winterianum Jowitt	Citronella grass	Paoceae	Essential Oil	Saraiva *et al.*, 2021
Ferrisia virgate	*Balanites aegyptiaca* (L.) Delile	Desert date	Zygophyllaceae	Extract	Jadhay *et al.*, 2010

Table 3: Phytochemical Constituents of Plants Materials Used Experimentally for the Control of Some Cashew Pests

Plant species	Flavonoids	Tannins	Alkaloids	Saponins	Phenols	Glycosides	References
Azadirachta indica	+	+	+	+	+	+	Ujah *et al.*, 2021; Alka *et al.*, 2018
Milletia pinnata	+	+	+	+	+	-	Mishra *et al.*, 2019; Prashanth *et al.*, 2014
Cymbopogon nardus	+	+	+	+	+	+	Muttalib, *et al.*,2018
Syzygium aromaticum	+	+	+	+	+	+	Gowri *et al.*, 2019; Jimoh *et al.*, 2017
Cymbopogon citratus	+	+	+	-	+	+	Gupta *et al.*, 2019; Amer *et al.*, 2018
Annona reticulata	+	+	+	+	+	-	Sangeetha *et al.*, 2014
Annona. squamosa	+	+	+	+	+	+	Safira *et al.*, 2022
Balanites aegyptiaca (L.)	+	+	+	+	+	+	Abdulhamid *et al.*, 2016, Tula *et al.*, 2014

Key: + (present) - (absent)

Table 4: Some Active Chemical Compositions of the Essential Oil of Plants Materials Used for the Control of Some Cashew Pests

Plant species	Active compounds	References
Azadirachta indica	α,β,γ-elemene, germacrene-B, trans-caryophyllene, hexadecanal, methyl linoleat, Copaene, α-Patchoulene, γ-Muurolene, α-Humulene	Javad Hadian *et al.*, 2010
Cymbopogon nardus	Limonene, Camphene, geraniol, geranyl acetate, nerol, citronellol, farnesol, linalool, borneol and methyl, citronellal, citral, citronellol, citronellal, eugenol, chavicol, elemol, citronellyl oxide, δ-cadinene, γ-cadinene.	Wany *et al.*, 2013, Rani *et al.*, 2013
Cymbopogon citratus	Citral, α-terpinol, β-*O*-cimene, α-pinene oxide, 1-Octyn-3-ol, neral, geranial, citronellol, γ-muurolene, α-farnesene, δ-cadinene, β-myrcene, linalool, citronellal, nerol, geranyl-acetate, *t*-cadinol	Ekpenyong *et al.*, 2015
Ocimum micranthum	1,8-cineole, linalool, γ-elemene, eugenol, β-caryophyllene, α-humulene, β-selinene, germacrene A, β-bisabolene, elemene	Trevisan *et al.*, 2006
Lippia sidoides	1,8-cineole, caryophyllene oxide, thymol, myrecene, α-phelandrene, E-caryophyllene, α-humulene, β-selinene, thymol acetate, α-terpinene, γ- terpinene, carvacrol	Lima *et al.*, 2011
Cymbopogon winterianus	Citronellal, geraniol, citronellol, citronellyl acetate, citral, linalool, elemol, 1, 8-cineole, limonene, geraniol, β-carophyllene, farnesol, camphene, α-bisabolene, trans-ocimene, boreol, γ-cardinene, sarbinene	Katiyar *et al.*, 2011, Singh *et al.*, 2017
Annona reticulata	Terpinen-4-ol, Germacrene D, Limonene, Pinene, Myrcene, Spathenelol, Copaene, Eudesmol, Muurolene, Dopamine, Salsolinol, Spathenelol	Al Kazman *et al.*, 2022
Annona squamosa	(E)-caryophyllene, bicyclogermacrene, caryophyllene oxide, germacrene D, spathulenol, α-pinene, β-pinene, limonene and β-elemene	Cascaes *et al.*, 2021

Relationship Between Insecticidal Properties of Botanicals and their Phytochemical Constituents

Secondary metabolites are metabolites produced by plants. They have diverse arrays of functions and they are involved in plant defense and environmental communication. More so, they are involved in cessation of both biotic and abiotic infections (Jan *et al.,* 2021). From Table 3 above, all the plants species used have the major phytochemicals such as tannins, saponins, alkaloids, flavonoids, and phenols. These are known to have activity against pathogens and therefore aid the insecticidal activities of botanicals.

Tannins act as plant defensive agents, protect trees from fungi, pathogens, insects and herbivorous animals (Sarma *et al*., 2019). Generally, tannins are toxins that significantly minimize the growth and survival of many herbivores and also serve as feeding repellent to a great number of insects and animals. Saponins are a group of steroidal or triterpenoid secondary plant metabolites having different biological activities as they are responsible for plant defense against pathogens and insects (Hussain *et al.,* 2019). They have numerous biological roles including anti-inflammatory, allelopathic action, anti-carcinogenic, mitigating cell reinforcement, heamolytic, resistance stimulators, cell layer permeabilizing characteristics, as well as can influence feeding behavior and cause mortality (Hussain *et al.,* 2019).The toxicity of saponins to different organisms is connected to their interaction with biological membranes as some of them form complexes with proteins, thus, inhibiting proteinases and consequently affect digestion in insect gut, hence, death (De Geyter *et al.,* 2012, Soetan *et al.,* 2014).

Alkaloids are toxic to some degree and serve primarily in defense against microbial infection and attacks by herbivores. They are generally produced to expedite the survival of plants in the ecosystem, because they have the potential to exhibit allelopathy (Pagare *et al*., 2015). The alkaloids produced from the plants are not toxic in themselves but they are easily broken down to give off volatile poisonous substance like hydrogen cyanide and volatile hydrogen sulfide whose presence brings about feeding deterrents in insects and other herbivores (Pagare *et al*., 2015).

More so, essential oils constituents of the various plants samples are shown in Table 4. These have been reported to act as toxins, feeding and oviposition deterrents to a large variety of insect pests (Zaridah *et al*., 2003, Koul et al., 2008, Pinto *et al*., 2015). The dominance of terpenes in essential oils provide a vital defense strategy against insect pest infestation (Pinto *et al*., 2015). Sun *et al*. (2020) reported that α-pinene, caryophyllene and β-myrcene had contact toxicity and showed repellent effects on *Tribolium castaneum* Herbst, *Lasioderma* and *Liposc elis bostrychophila* Badonnel. Similarly, according to Abdallah *et al*., 2017, when limonene makes contact with an insect, it removes the protective wax layer from the exoskeletons of insect, resulting into its suffocation and death eventually.

CONCLUSION

The cultivation of the economically important cashew tree is threatened by the infestation of some insect pests at every stage of its growth. The use of chemical insecticides has been discouraged due to their adverse effects on humans and the environment coupled with development of resistance by the insects. The detrimental effects of chemical insecticides led to the discovery of the botanical pesticides which serves as a better alternative. It is very important to preserve cashew tree from the infestation by its various pests using any of the botanicals listed in this review since they showed a great deal of insecticidal potentials against the insect pests. Further works have to be done to identify and characterize the active ingredients present in these botanical.

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