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Original Article

Warburgia Ugandensis and *Croton Dichogamus*: Possible Botanical Bullets Against *Callosobruchus Maculatus*

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ABSTRACT

Botanical pesticides, derived from plant products, have gained significant popularity as an alternative to conventional synthetic insecticides. These natural products often consist of various bioactive compounds that offer effective pest control and may reduce the chances of pest resistance. However, challenges such as variation in pest response, short residual activity, and difficulties in large-scale production hinder their widespread use. This paper explores different generations of botanical pesticides, focusing on their chemical composition, modes of action, and applications. First-generation botanical pesticides, including nicotine, rotenone, essential oils, sabadilla, and pyrethrum, are discussed, along with their associated limitations. The second-generation botanical pesticides, such as Melia extracts, synthetic pyrethroids, and neem products, are presented as more specific and environmentally friendly alternatives. Furthermore, the insecticidal potential of Croton dichogamus and Warburgia ugandensis, two East African plants, is examined. Both plants possess promising phytochemical properties that show potential for controlling pests like Callosobruchus maculatus in stored grains. This review highlights the ecological and economic value of these plants in pest management strategies and the sustainable use of plant-based pesticides.

Keywords: Botanical pesticides, Callosobruchus maculatus, Insecticidal plants, Phytochemicals, Pest management

INTRODUCTION

Botanical pesticides, derived from plant products have gained popularity over the conventional synthetic pesticides. These natural products often consist of several bioactive compounds, whereby the formulations may be effective against pests and perhaps reduce the chances of pests' resistance (Reddy, 2020). Nevertheless, several challenges stem from the use of botanical pesticides, such as high variation in pest response due to differences in plant chemotypes and environmental conditions, short residual activity compared to many synthetic insecticides (which can translate into higher application rates), registration challenges (including demonstration of safety and efficacy for commercialization), making large quantities of botanical pesticides at consistent active ingredient concentrations, and low host specificity of some botanical products, which often requires the use of more products (Reddy, 2020).

2.0 Classification of Botanical Pesticide

Botanical pesticides are categorized into two generations.

2.1 First Generation Botanical pesticides

First-generation botanical pesticides are plant-extracted compounds, which have been employed in exterminating pests and were among the early products to receive commercialization.

2.1.1 Nicotine

Nicotine which comes from tobacco plants (*Nicotiana* spp.) has been in inclusion in insecticides for many years. It possesses the ability to function as a nerve toxin through the blocking of nicotinic acetylcholine receptors (Reddy, 2020). However, due to its high toxicity especially in mammals, its use has been banned in many countries as noted in the article by Le Foll et al. (2022).

2.1.2 Rotenone

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Rotenone is formed from the roots of *Derris* and *Lonchocarpus* species and interrupts the process of cell respiration in insects (Reddy, 2020). Nonetheless, due to its poisonous effect on fish and controversy of a possible connection with Parkinson's disease, its use has been deemed restricted in the recent years.

2.1.3 Essential plant oils

Different plant essential oils like clove, mint and citrus are insecticidal and repellent in nature. Their modes of action are complex and unknown in several cases but many of the oils are neurotoxins or affect the octopamine system in insects (Reddy, 2020).

2.1.4 Sabadilla

Sabadilla, which is derived from seeds of *Schoenocaulon officinale* contains chemicals that interfere with the nerve cell membrane physiology. It has been used against various pests but is less frequently used because of its higher cost and the problem of skin and respiratory sensitization to human beings (Reddy, 2020).

2.1.5 Pyrethrum

Pyrethrum is an extract obtained from the flowers of the *Chrysanthemum cinerariaefolium* plant and contains potent insecticidal ingredients known as pyrethrins. Pyrethrins act on the nervous system of insects, resulting in fast knockdown effect on the target insects (Reddy, 2020). Pyrethrum's low toxicity against mammals and apparently long residual action have made it to be among the most effective botanical insecticides (Ngegba *et al.*, 2022).

2.2 Second Generation Botanical pesticides

The second-generation botanical pesticides are relatively new and they have been found to have a specific mode of action and environmental benefits as compared to the first-generation ones.

2.2.1 Melia Extracts

The various limonoids from *Melia azedarach*, commonly called chinaberry, have insecticidal properties where the extracts from the plant are used. These compounds have been shown to function as anti-feedents, growth modifiers and toxins against several insect pests (Jaoko *et al.*, 2020).

2.2.2 Synthetic Pyrethroids

Though not botanical in character, synthetic pyrethroids were developed using natural pyrethrins as their model. They are more stable and effective than the natural pyrethrins that are usually sought after in the management of pests; both in agriculture and in households (Hodoșan *et al.*, 2023).

2.2.3 Neem Products (Azadirachtin)

Neem products include neem extracts containing azadirachtin and related compounds that exhibit diverse effects on insects, such as the suppression of feeding, inhibition of moulting, and the modulation of endocrine systems. Neem-based products have received much demand in places such as organic farming and integrated pest management because of its very low toxicity to mammals and its neutrality on the environment (Divekar, 2023).

3.0 *Croton dichogamus*

3.1 Description and Geographical distribution

Croton dichogamus, Pax, is a shrub or small tree species of the Euphorbiaceae family. The plant is an East African species, found ranging from Ethiopia to Somalia and south to United Republic of Tanzania. It is largely associated with dry bushland and woodland habitats and commonly grows on rocky slopes or soils that may be saturated with water for only a short period every morning. The stems have a smooth grey-brown barks which can be peeled off in small pieces. The shrub has simple, alternate leaves, which often appear to be silvery due to scales on the surface of the leave. The flowers are small and arranged in terminal racemes in male flowers while female flowers are also small and have terminal racemes (Matara *et al.*, 2021a).

Figure 1: *Croton dichogamus* Plant

Croton dichogamus commonly called East African croton, is known by several vernacular names. Matara et al. (2021a) tabulates the names, wherein among the Maasai people, it is known as 'Enkitaru' or 'Oloiborbenek'. The Kamba community has a special name for the plant and calls it 'Muthinia.' In Swahili, the shrub is known as 'Mhande,' Dholuo call it 'Rachar' and the Mbeere call it 'Muthima.' Although these names may not be unique to the plant and may refer to other species of the Croton genus as well. In local languages, it is referred to by the name that describes its uses or the appearance.

3.2 Cultural uses

In different communities of East-African region, *C. dichogamus* has a range of uses, including as a source of firewood, in traditional religions where leaves or barks may be burned for fumigation, and as a live fence or barrier in agroforestry (Matara *et al.*, 2021a). The aromatic nature of the plant also saw some communities, using it to clean the air, or as a repellent for insects, in their living spaces.

3.3 Medicinal Value or Uses

C. dichogamus is used in traditional medicine practices in its natural habitat. Some of the described uses are as follows: respiratory diseases (the decoction of the leaves is used for coughs, colds, chest congestion, tuberculosis etc), digestive disorders (the preparations of roots or barks are used for stomach pains, diarrhoea, intestinal worms, etc), pains (the preparations of the leaves or root are useful for joint pains and other aches), and malaria (the plant parts are used for treatment of malaria and its related (Matara *et al.,* 2021a). Recent research has revealed various phytochemical constituents of *C. dichogamus* among them being diterpenoids, flavonoids, and alkaloids. Some of these compounds have been reported to exhibit antimicrobial, anti-inflammatory, and antioxidant effects in early experiments which corresponds to some of the traditional uses (Matara *et al.*, 2021b). The potential insecticidal properties of *C. dichogamus*, which are the focus of the current study, are likely related to its rich phytochemical profile. Croton species contain some terpenoids and alkaloids that act as repellent or toxic agents on insects thus *C. dichogamus* extracts hold promise as botanical insecticides for storage pests such as *C. maculatus* (Bezerra *et al.*, 2020).

4.0 *Warburgia ugandensis*

4.1 Description and Geographical Distribution

Another species with potential insecticidal properties is *Warburgia ugandensis*, Sprague, a tree that belongs to the family Canellaceae. The tree is commonly referred to as the East African greenwood and has glossy black-green leaves and a pepper-like taste of the bark, hence the common name of pepper bark tree (Okello & Kang, 2021). The tree is also commonly referred to as the 'East African greenheart.' PROTA4U. (n.d.) documented the tree's vernacular names among the Kenyan communities including, 'apacha' (Luyha), 'mûthîga' (Kikuyu), 'olosogoni' (Maasai), 'soget' (Kipsigis) and 'Mumbaume' (Kamba). The tree belongs to the Eastern Africa region, with some of the locations it grows being Ethiopia in the north and South Africa in the south. It is mainly in the montane and riverine forests and commonly occurs at altitudes of 1000-2000 metres above sea level (Dharani, 2020).

Figure Error! No text of specified style in document.**.1:** ***Warburgia ugandensis*** **Plant**

The tree has an erect and straight trunk, which can reach up to 25 m in height with a smooth and grey-coloured bark that develops cracks as the tree ages. The trees are rotationally simple, and their arrangement is alternately elliptic to lanceolate with a peppery aroma when rubbed. The flowers are small, yellowish-green and borne in axillary clusters. The fruit is a fleshy berry, green when immature and black-purple when mature (Dharani, 2020). *W. ugandensis* is considered a keystone species in its native ecosystems, playing crucial roles in forest dynamics and providing resources for various wildlife species.

4.2 Cultural/Traditional Uses

W. ugandensis has cultural value in most parts of its habitat because several societies use different parts of the plant for a wide range of uses. *W. ugandensis* is famous for its durable and termite-resistant formation thus being commonly used for construction, furniture, and tools and utensils. Due to the fragrance, the tree has been utilized in ceremonial proceedings and functions where it may be employed as a sort of incense or in ceremonies of purification involving the bark or the leaves of the plant (Okello & Kang, 2021). In agroforestry systems, *W. ugandensis* is used mostly for shade for crops such as coffee among others. The tree has a very thick foliage, which makes it a good cover and comes with tap root which helps to control soil erosion. The leaves of this tree are used as spices or for flavouring foods according to traditional culinary preparations since they possess a peppery taste. Also, different parts of the tree especially the bark and the leaves are used traditionally in veterinary practices to treat diseases affecting livestock (Dokata *et al.*, 2023).

4.3 Medicinal Uses/Value

W. ugandensis has been used to treat diseases and enhance the general health of people in the eastern and southern parts of Africa. The most utilized parts of the tree are the bark, the leaves and the roots (Dokata *et al.*, 2023). The plant is especially used in the treatment of cystic pneumonia and other respiratory tract ailments. The decoctions from its bark and infusions from the leaves are used to treat illnesses related to coughs, colds and chest illness, among others. It is also used to treat various infections that affect the respiratory, digestive and the urinary system. Furthermore, *W. ugandensis* has been used in some communities for the treatment of malaria and other febrile illnesses suggesting antimalarial activity of the plant (Dharani, 2020). Dokata *et al*. (2023) also point out that concerning preparation techniques, traditional healers and communities used extracts like decoctions, infusions and powders in order to obtain the curative potential of the plant. Further, the plant has other uses such as to relieve pain and reduce inflammation. Exteriorly, the juice of its bark or leaves is used in arthritis, rheumatic pains and inflammation skin diseases. The twigs of *W. ugandensis* are also used as chewing stick for cleaning teeth because the twigs kill bacteria that causes tooth ache. In additional to the plant's medicinal values, a study by Okello and Kang (2021), more evidence is testified on how the plant can cure parasitic worm and other diseases affecting both human beings and animals. Modern scientific works are conducting early research in an attempt to explain scientifically why *W. ugandensis* is used in traditional medicines. The plant has several classes of bioactive compounds such as sesquiterpenes, drimane derivatives, and flavonoids. Of particular interest are the sesquiterpene dialdehydes; for example, warburganal and muzigadial which have shown to possess antimicrobial, antifungal and insecticidal properties in some laboratory studies (Nkqenkqa & Mundembe, 2023). The compounds are believed to be involved in majority of the cures provided by the plant and due to these characteristics, have drawn lots of interest for the production of new drugs and pesticides. Concerning the use of *W. ugandensis*, recent research has been directed to elucidating its antimalarial effect since malaria is rampant in areas where the herb is employed. In vitro tests and in vivo studies have established high potentialities, with extracts significantly effective against Plasmodium falciparum strains (Were, 2021). This research agrees with the common application of the plant but, at the same time, creates further prospects for the synthesis of new medicines against malaria. The pesticidal aspects of *W. ugandensis*, which form the core of the current study in the context of controlling *C. maculatus*, can be attributed to the same sesquiterpene compounds that give the plant it medicinal values. These compounds have demonstrated repellent and toxic properties on some insects hence implying its use in pest control (Araújo, Castanheira & Sousa, 2023). There is increased interest globally in seeking new ecological and sustainable means of controlling pests and thus the study as a source of botanical pesticides falls squarely in the marked trend. Lastly, *Warburgia ugandensis* is a species of considerable use, cultural, economic as well as medicinal importance throughout its distribution area. The plants versatility in traditional applications especially as medicine has led to researchers focus of its phytochemical content and functionality (Araújo, Castanheira & Sousa, 2023). The fact that the investigations on its insecticidal potential are still being carried out even today, this research having established its effectiveness against *C. maculatus*, gives credence to the role of traditional knowledge in addressing current issues in crop production and pest control. As it is with many other beneficial plant species, preservation of *W. ugandensis* and sustainable exploitation of its benefits is very important in order to forward future generations the same benefits.

CONCLUSION

Botanical pesticides offer a promising alternative to synthetic insecticides in pest control, providing several ecological and health benefits. While first-generation botanical pesticides like nicotine, rotenone, essential oils, sabadilla, and pyrethrum have been effective in pest management, they present limitations, including high toxicity, short residual activity, and potential environmental impacts. The development of second-generation botanical pesticides, such as Melia extracts, synthetic pyrethroids, and neem products, has shown advancements in specific pest control and environmental sustainability, with reduced risks to mammals and beneficial organisms. The insecticidal potential of *Croton dichogamus* and *Warburgia ugandensis* from East Africa holds promise for pest management, particularly against *Callosobruchus maculatus*, a common storage pest. Both plants contain a variety of bioactive compounds, including terpenoids, flavonoids, and alkaloids, which exhibit antimicrobial, anti-inflammatory, and insecticidal activities. These findings underscore the importance of exploring local plant species with insecticidal properties as a means of providing more sustainable and accessible pest control solutions. However, challenges remain, such as variation in the composition and efficacy of plant extracts, difficulties in large-scale production, and limited research on the long-term environmental impact. Future research should focus on standardizing the production of botanical pesticides, improving the efficacy of plant extracts, and assessing their broader ecological impacts. The sustainable exploitation of plants like *C. dichogamus* and *W. ugandensis* could contribute significantly to integrated pest management strategies and support agricultural practices that are both effective and environmentally friendly

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