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Annals of Experimental Biology, 2021, 9 (4): 1-6

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ISSN:2348-1935

Comparativeness of Insecticidal Action of Local Medicinal Plants against Stored Grains Pest (Weevils)

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ABSTRACT

A study was conducted to evaluate the insecticidal action of four locally available plants namely: Androgaphisp aniculata, Chromolena odorata, Mucuna pruriens, Daturastram onium in Zanjo Jaji area of Lokoja, Kogi State Nigeria against cowpea weevil (Casollobruchusm aculatus), maize weevil (Sitophilus zeamais Motsch.) for repellency, adult mortality and antioviposition and growth inhibition tests. The experiment was carried out in the laboratory of Botany Department, Federal University Lokoja. Leaves of four samples were harvested, air-dried and reduced to powder and 250g were measured, soaked in 1litre of distilled water for 48 hours and filtered. A total of forty plates were used consisting of 10 seeds each with 4 plates per treatments. Results revealed that all test materials exhibited repellency action against cowpea and maize weevil. Extracts from the leaves of Androgaphisp aniculata, Chromolenaodorata, Mucuna pruriens and Daturastram onium were observed to be moderately repellant against bean and maize weevil within some hours of exposure. Extracts from the three plant parts exhibited insecticidal activity by causing varying levels of mortality to C. maculates and Sitophilus zeama is with mortality increasing with increase in exposure time. All the four plant extracts caused deaths in C. maculates and Sitophilus zeamais after 22 days of exposure. The high repellent and insecticidal activities demonstrated by the leaves extract compared to the control suggest that the treated should be prioritized for the control and management of C. maculates and Sitophilus zeamais.

Keywords: Comparative, Insecticidal, Medicinal plants, Grains, Pests

INTRODUCTION

Zea mays L., (Corn) is a cereal grass related to wheat, rice, oat and barley; ranking second after wheat in order of world grain. This plant is regarded as versatile and has many uses since it can thrive in diverse climates; hence, it is grown in many countries. Aside from being one of the major sources of food for both humans and animals, it is also processed into various food and industrial products including starches, sweeteners, oil, beverages, industrial alcohol and fuel ethanol. Moreover, thousands of foods and other items such as toothpaste, cosmetics, adhesives, shoe polish, ceramics, explosives, construction materials, metal moulds, paints, paper goods and textiles contain corn components. In addition, corn products are rapidly replacing petroleum in many industrial applications. Polylactide (PLA), a biodegradable polymer made from corn is being used successfully in the manufacture of a wide variety of everyday items such as clothing, packaging, carpeting, and recreational equipment and food utensils of renewable resources [1].

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most widely adopted, versatile, and nutritious grain legumes. It had been consumed by humans since the earliest practice of agriculture in developing countries of Africa, Asia and Latin America, where it is especially valued as a source of proteins as well as vitamins and minerals [2]. Though substantial quantities of cowpeas are produced, before harvest or during storage the seeds are vulnerable to infestation by many insect pests, constituting the major constraint on food availability. Over 90% of the insect damage to cowpea seeds is caused by the "cowpea weevil" *Callosobruchusm aculastus* F. (*Coeloptera: Bruchidae*). This pest invades and destroys several pulses including chickpeas (*Cicerarietinum* L.), lentils (*Lens culinars* Medik.), and soybeans (*Glycine max* Mer.) and common beans [3]. Indeed *C. maculastus* infestation on stored legumes may reach 50% within 3 months to 4 months of storage. Maize weevil (*Sitophilus zeamais Motschulsky*), infest the corn grain during storage and transport; attack may start in the mature crop when the Moisture Content (MC) of the grain had fallen to 18% to 20%. Subsequent infestations of the store that arose from the transfer of infested grain into the store or from the pest flying into storage facilities, probably attracted by the odour of the stored grain. In stored maize, a heavy infestation of this pest may cause weight losses of as much as 30% to 40%, although losses are commonly 4% to 5% [4]. The chewing damage caused by the weevil (bean and maize), brings about increased respiration in the seeds (hot spots), which promotes the evolution of heat and moisture and in turn provides the favourable living condition for moulds leading to the production of aflatoxin. Subsequently, at very high moisture levels, bacterial growth is favoured which ultimately gives rise to depreciation and finally total loss [5]. Controlling stored pests is not an easy job although synthetic chemicals are available for use. Effective pest control is no longer a matter of the heavy application of pesticides as rural area farmers often resulted to the use of large quantity insecticides because of lack of application knowledge, but largely because excessive use of pesticide promotes faster evolution of the resistant form of pests, destroys natural enemies, turns formerly innocuous species into pests, harms other non-target species and contaminates food [6]. There is, thus, an urgent need for control agents, which are less toxic to man and more readily degradable. This includes the use of botanical pesticides that pose less toxicity to mammals and can effectively prevent and/or suppress invasion by insect pests especially in storage [7]. It had been well reported that extracts from a variety of plants have potent insect pest-control properties, and they have been found to affect the biology of target insects in diverse ways such as ovicides, producing an unpleasant odour that repels insects, antifeedants, fumigants and contact toxicants, and insecticides. Recently, herbal extracts that are not harmful to the environment, are effective natural preservatives [8]. In addition, plant-based pesticides are renewable in nature and heaper. Also, some plants have more than one chemical as an active principle responsible for their biological properties. These may be either for one particular biological effect or they may have diverse ecological effects. Plant-derived pesticides can be transferred into practical applications in natural crop protection, which can help small-scale farmers [9].

Chromolena odorata is a herb belonging to *Asteraceae*. The common names are Siam weed, devil weed and French weeds. It is native to North America, from Florida and Texa to Mexico and has been introduced to West Africa. *C. odorata* is known for its medicinal value.

Mucuna pruriens (Velvet bean). This is a tropical legume. It is found all over the world in the woodland of tropical-like Africa, Indian and Carebian [10]. The plant is almost covered with fuzzy hairs and is a twining annual weed that can be up to 15 m in length. It has a dark purple, white or lavender colour flower. The leaves are trifoliate with a medicinal record of being a stimulant, aphrodisiac and purgative in man [11].

Daturatum stramonium is commonly known as a thorn apple and belongs to *Solanaceae*. It is known to be a useful remedy for human ailments including ulcers, wounds, and fever, asthma with antimicrobial and insecticidal effects [12].

Andrograhis paniculata commonly known as Nees is an annual herhaceous plant in the family *Acanthaceae* native to Indian. It is used in traditional medicine as a remedy for cold, fever, antibacterial and is also a laxative [13].

Plants are known for their insecticidal property against other insects including some stored product insect pests; therefore, four locally available plants including *Androgaphis paniculata*, *Chromolena odorata*, *Mucuna pruriens*, *and Datura stramonium* were evaluated to determine their nature as grain protectants against weevils.

OBJECTIVES

- It determines the insecticidal action on adult mortality, repellency and anti-ovipositional
- It determines the growth inhibitory effect of powdered leaves of the different plant

MATERIALS AND METHODS

The experiment site

The experiment was carried out in the Biological Laboratory, Federal University Lokoja using the plant extract of *Andrographispaniculata, Daturastramonium, Chromoleanaodorata*, and *Mucuna pruriens.*

Preparation of plant extracts

The preparation of the extracts was carried out following the procedure as described by Obadofin and Fatoba [14]. Fresh leaves of *A. paniculata, D. stramonium, C. odorata*, and *M. pruriens*were collected and air dried at room temperature in the laboratory after which they were ground to powdery form (using pestle and mortar). 250 g of the resulting powders were measured and soaked in 1 liter of distilled water for 48 hours. The extract was filtered after 48 hours through a Whatman no 42 (125 mm) filtered paper. The filtrate was then stored until use.

Insect cuture

Insect culture was done following the procedure described by Oyedokun with little modifications [15]. Adult maize weevil (*S. zeamais)* and bean weevil (*C.maculatus* (F.) were isolated respectively from already infested maize grains (*Zea mays*) and cowpea (*V. unguicalata* (L.) Walp) obtained from the market in Lokoja. Materials such as corn seeds and cowpea were used to culture the weevil. The treated seeds of corn and cowpea were then respectively put inside washed, dried and sterilized rubber containers. Into the containers containing corn, seeds were added isolated maize weevil and to the container containing cowpea seeds were added bean weevil, respectively, from infested maize and bean grains. The rearing of the insects was carried out in the laboratory to adapt them to the laboratory condition. The rearing was given enough time until new adult insects emerged.

Insecticidal activity of the plant extracts

Prepared stocked solutions were used to soak the maize and cowpea grain in four replicates and set on the laboratory bench. Insect mortality, oviposition and adult emergence, Grain damage and viability bioassays were tested against the plant extracts as described by obembe and kayode, with slight modifications [16].

Bioactivity test

The bioactivity of the plant's extract was carried out as described by Pflanzen with slight modifications [17]. Four different test concentrations prepared using varying concentration was poured inside different petri-dishes that had been previously washed, sterilized and dried, while cowpea and corn seeds were respectively placed in the different petri-dishes, (including the control). Ten active adult bean weevil (*C. maculatus*) and maize weevil (*S. zeamais)* were placed in each of the petri-dishes containing the cowpea and maize seeds, respectively. The Petri-dishes were then covered. Weevil mortality was assessed and recorded after some days.

Adult Mortality the numbers of dead and living insects were recorded weekly from one to four weeks after the introduction of the treatment material. Both living and dead insects were discarded after each week recording.

Damage assessment was done through the counting of the total number and distribution of holes per seed of cowpea. The number of holes per sub-sample of four randomly selected seeds and the number of these seeds with holes was recorded.

Statistical analysis

Data obtained were subjected to statistical analysis. Analysis of Variance (ANOVA) was performed on transformed data and the means separated by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The plant materials significantly reduced the activities of *C. maculatus* on the cowpea seed in all the treatments compared to the control. Incident of mortalities occur gradually following the same trends till day 22 when all the treated cowpea recorded 100%. Also, there was the reduction in the number of eggs laid by *C. maculatus* on the cowpea seed in order of *D. stramonium*<*M. pruriens*<*A. Paniculata*<*C. odorata* and they are similar ($p<0.05$) (Table 1). The feeding effect of *C. maculatus* on the treated seed shows a significant effect in *M. Pruriens*>*C. odorata*>*A. paniculata*>*D. stramonium* and comparable to control ($p<0.05$). The viability test revealed that all the tested seed were similar ($p>0.05$) despite the infestation of the *C. maculatus* (Table 2). Exposure of the seeds to the weevils significantly reduced the seed damage in all treatments. The lowest seed damage was observed on *M. pruriens*in maize grains and this was not significantly different ($p>0.05$) from the weight loss of *A. paniculata, C. odorata,* and *D. stramonium*. Significantly high seed damage was recorded in the control. All of the plant extracts were found to affect the adult emergence of insect pests attacking stored grains such as cowpea and maize.

The incidence of adult emergence in the control was significantly higher than in the treated groups. Aqueous extracts from the test plant were able to reduce the adult emergence than the control. *S. zeamais* preventing them from burrowing holes inside the *Zea mays* to lay their eggs, therefore, making it difficult for their eggs to be counted. There were no significant differences (p>0.05) in the germination and viability of 100% recorded (Table 3).

Table 1: Effects of different plants extract treatment on mortality of *C. maculatus*

Treatment	DAY 7	DAY 12	DAY 17	DAY 22	DAY27
Control	0^c	0^b	0^b	0^b	0^b
A. *Paniculata*	6.24^a	7.21^a	8.35^a	9.50^a	10.00^a
C. *Odorata*	5.50^{ab}	7.50^a	8.10^a	9.00^a	10.00^a
D. *Sramonium*	4.70^b	6.25^a	7.55^a	10.00^a	10.00^a
M. *Pruriens*	6.20^a	7.25^a	8.00^a	10.00^a	10.00^a
S.E	1.343	1.523	0.974	0.827	-
a,b: Values along the same row with different superscripts are significant (p<0.05)					
S.E=Standard Error					

Table 2: Effect of aqueous extracts of different plants species on mortality of adult *C. maculatus*

Test	% Mortality at days of post-treatments					No of eggs laid	No of grains damage	% of grains damage	Viability	Total seed used
	7 days	12 days	17 days	22 days	27 days					
Control	0^c	0^c	0^b	0^b	0^b	48.5	55	91.66	0	60
A. *Paniculata*	45.50^b	55.50^b	60.0^a	85^a	100^a	17.55	0	0	100	60
C. *Odorata*	60.0^a	75^a	80.0^a	95^a	100^a	28.2	0	0	100	60
D. *Stramonium*	35.0^b	48.50^b	65.0^a	80^a	100^a	10.5	0	0	100	60
M. *Pruriens*	65.0^a	70.5^a	80.0^a	100^a	100^a	15.45	0	0	100	60
S.E	0.971	1.44	0.888	0.93	0.968	0.77	-	-	-	-
a,b,c: Values along the same row with different superscripts are significant (p<0.05)										
S.E=Standard Error										

Table 3: Effect of aqueous extracts of different plants species on mortality of adult *S. zeamais*

Test	% Mortality at days of post treatments					No of egg laid	No of grains damage	% of grains damage	Viability %	Total seed used
	7 days	12 days	17 days	22 days	27 days					
Control	0^d	0^c	0^c	0.02^c	0.42^b	32	48	80	20	60
A. *Paniculata*	16.67^c	40^b	50.0^b	83.5^a	100^a	0	0	0	100	60
C. *Odorata*	37.5^b	52.1^b	66.7^b	86.7^a	100^a	0	0	0	100	60
D. *Stramonium*	45^b	70^a	$82.^{3ab}$	93.3^a	100^a	0	0	0	100	60
M. *Pruriens*	76.7^a	88.3^a	100^a	100^a	100^a	0	0	0	100	60
S.E	0.983	0.762	0.034	0.013	0.011	-	-	-	-	-
a,b,c: Values along the same row with different superscripts are significant (p<0.05)										
S.E=Standard Error										

The plant extracts showed great potential against the stored pest. The percentage mortality rate of the adult *C. maculatus* decreases from 91.66% (untreated) to 0% when treated with all the botanical extracts. The percentage mortality of adult *S. zeamais* decreased from 80% (control or untreated) to 0% when grains were treated with aqueous extract of all the plants used. Several workers have reported that plant powders and extracts from the local source often reduce the adult beetles' emergence from the seed [14]. Both the cowpea and maize showed protection *via* the plant extract against the weevil when all the pesticide plants were compared. In the untreated seeds, damage occurred as revealed by emergent holes of the bruchids as a result of the feeding activities of *C. maculatus and S. zeamais* larvae on the cowpea and maize seeds respectively. All the extract proved effective because it abolished deposition of eggs, seed damage and weight loss as found in the untreated seeds with the aqueous extracts most effective against *D. stramonium* followed by *M. pruriens*, *A. paniculata* and *C. odorata* respectively as the eggs laid 27th day post-treatment with botanical extracts decreased in reversed order 10.5<15.45<17.20<28.20 thereby reducing the multiplication of the pests on the infested grains which agrees with the work of Sithisut who reported that the different modes of action of plants such as repellant, insecticidal, antibacterial, antifungal, antifeedant, oviposition, growth-inhibiting, the crop are grain protectant [17].

The weevils found at the sides of the petri dishes indicate that the extract is a rich source of bioactive compounds possessing a strong repellency effect to the insect during the period. The consistent and significant decrease in the numbers of weevils on the treated confirms the effectiveness of the plant extracts. This agrees with the findings of Mankundi who reported that the active ingredient such as triterpenoid is responsible for its antifeedant properties of plant extracts on maize, *Mucuna pruiensis* and *Andrographis paniculata*at the same application rates were the most effective [4]. The study revealed that plant materials are effective over a short period both in maize and cowpeas therefore, the farmer must ensure application of the biopesticides before infestation or at the early stage to prevent escape route for the pest. Since the plant materials are suitable for short term storage, reapplication at a 4-week interval is recommended subject to the availability of plant materials. To get the exact time over which the plant materials will be effective, the residual properties of the plant material should be tested and which helps in avoiding unnecessary applications. Emerging evidence suggests that active ingredients in some pesticidal plants' efficacy vary depending on the time of year harvested and geographical location. The mode of action of the plant materials also needs further investigation to ensure the plant materials are correctly and effectively used. The result demonstrated by the maize could be adduced to the presence of the hardness of the pericarp which could resist the immersion of the extract. The insecticidal effect of the plants' aqueous extracts on C. *maculatus and S. zeamais*in the treated cowpea and maize seeds might be a result of contact toxicity. Since most insects breathe through the trachea which usually opens at the surface of the body through spiracles. The extracts that were mixed with the seed might have blocked these spiracles thereby leading to suffocation and death of the insect. It also revealed that the extract of all tested plants showed contact and systemic effects, as it caused high rates of mortality in all the treatments. High concentrations of these plants could hinder the reproductive capacity and feeding of *C. maculatus and S. zeama.*

CONCLUSION

Many synthetic pesticides have been found effective against stored product pests but proved to be hazardous to men and domestic animals. In addition, the risk of developing insect resistance and the high cost-benefit ratio of synthetic chemical has made researchers to find alternative means. They have recently concentrated their efforts on the search for active natural products from plants as alternatives to conventional insecticides. Some of these researchers reported that plant materials and local traditional methods are much safer than chemical insecticides and suggested that their use needed exploitation.

ACKNOWLEDGEMENT

Special thanks to every author cited in this work and my acknowledgement to the member of staff of Botany Department, Federal University Lokoja, Kogi State Nigeria and members of staff of Biological Sciences Department, Olusegun Agagu Univesity of Science and Technology and my coauthor A.S. Bagbe.s.

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