Original Research Article

The Effectiveness of D*ennettiatripetalla (G.Backer), Xylopiaaethiopica (A. Rich)* and *Aframomummelegueta(K. Schum)* Extracts for the Control of *Cylaspuncticolis*(Boheman)

ABSTRACT

Laboratory investigations were performed to ascertain the efficacy of D*ennettiatripetalla (G.Backer), Xylopiaaethiopica (A. Rich)* and *Aframomummelegueta (K. Schum)* for the control of *Cylaspuncticolis*() a sweet potato weevil.Extracts of the leaves and fruits of the test plants were separately applied at concentration of 1, 3 and 5 % (w/v) for investigation. The biological assays were conducted for six months under plethoric temperature, relative humidity (28±3^{0}C, 65±5% RH) and 12Hr light/dark photoperiods; laid out in a completely randomized design with each treatment replicated four times. Results disclosed that 3 and 5 % extracts of the three test plants led to significantly (P<0.05) higher mortality of *C. puncticollis* as compared to 1% and control (3.75 extract of the tubers. n-hexane extracts of all the test plant products significantly (P <0.05) repelled more than 60% of *C. puncticollis* within one-hour of exposure. . Extracts of *A. melegueta* fruit (at 3 and 5%) and *X. aethiopica* fruit (at 5%) had the most significant (P<0.05) insecticidal activity, followed by extract of *D. tripetalla* (at 5%). Adult emergence was also significantly higher in control than treated tubers with *A. melegueta* products giving the lowest significant number of emerged adults. Quantitative analysis of the plant products revealed the presence of active phytochemicals, such as alkaloids flavonoids, tannins, saponins, steroids, carotenoids and phenols in various proportions. The results of this research demonstrate the efficacy of the test plants products for the control of *C. puncticollis* on sweet potato during post-harvest storage at the small scale farming level in Calabar, Nigeria.

Keywords: Extracts, *Cylaspuncticolis,* plethoric temperature, mortality and insecticidal activity

1. INTRODUCTION

1.1 Background

Sweet potato (*Ipomoea batatas* [L] Lam) is a dicotyledonous plant and a member of the family convolvulaceae. It originated from Central America [1] and is now widely grown in many parts of the tropics, subtropics and temperate regions of the world [2]. A small herbaceous, annual or perennial, trailing root crop, it is believed to have evolved from the non-tuberous wild relative, *Ipomoea trifrida*which has the same chromosome number 2n = 90 with *Ipomoea*

batatas[3]. The crop has many cultivars differentiated on the basis of the texture and color of the tuber, leaf shape and structure, root depth in the soil and maturation time. It is propagated vegetatively and has a growth period that varies between four to six months depending on the variety and place of cultivation. It can be grown on relatively infertile ground with little input and can withstand irregular periods of drought and rainfall [4].

Globally, Sweet potato is the seventh most important crop among all known edible crops. About ninety-two percent of the sweet potato produced universally is done in Asia and Pacific Islands, and 89% of this is cultivated in China. The United States produces 1million metric ton (MT) valued at $200million annually, however, about two thirds of the world production is utilized in one country, China [5]. In Africa, Nigeria ranks first with sweet potato production level of 3.49 million metric tons, but this is about 0.2% of the world's sweet potato [6] Sweet potato is exploited as a basic ingredient of diet, vegetable (the succulent roots, leaf stalks and tender leaves), snack, feed for animals, starch is obtained from it industrially, amongst others [7].

Sweet potato, unlike other tubers(yam and cassava) is grown in smaller volumes in Africa. In Nigeria for example, root crop survey by National Root Crops Research Institute, Umudike, Abia State in 2000 and 2005, showed that the crop was grown mainly in the North and Middle Belts regions of the country. It has however been introduced to the South and is becoming a very popular staple food among the low income earners [1]. Though, still considered a minor crop in Cross River State, its cultivation and use is gaining grounds and the crop will undoubtedly become increasingly popular in the years to come, as increasing population generally necessitates an expansion of food supply options in any community, and especially as there has been some increase in market prices of cassava, cocoyam, and yam, in Calabar, and other urban areas in the State, in recent times. Due to the aforementioned situation, and in addition to increasing agricultural awareness, there is a diversification of emphasis from

cultivation of yam, cocoyam and cassava, to the production of sweet potato, which until recently had been grown by crude methods on circumscribed areas of Northern Nigeria [8].

1.2 Problem statement/justification of study

The cultivation and storage of sweet potato tubers are bordered by certain determinants, such as climatic conditions, soil fertility, pathogenic nematodes and insect pests, cause both qualitative and quantitative losses. Insect pests are major cause of damage to the tuber during these processes, resulting in enormous losses. Sweet potato weevils of the genus *Cylas*is predominant insect pest, limiting cultivation and storage of sweet potato tubers worldwide [9].

Although chemical pesticides are known to have effective and rapid reduction of pests on crops, but because of their toxic effects on the environment and non- target organisms [10], there is currently a preference for "integrated pest management", a decline in absolute dependence on chemical pesticides. One approach being explored vigorously is the utilization of available plant materials as bio-pesticides, for local pest control especially in poor communities [11]. In Cross River State, the impact of *C. puncticollis* on sweet potato has been reported by Nta and Oku, [12] but there is no documentation of any substantial effective post-harvest control measure against this insect, especially with regards to bio-pesticides.

Cross River State has favourable indices for the cultivation of three sets of sweet potato in a year. The increase cultivation implies an impending increase in population density of *Cyclas* sp.,hence the necessity for locally suited, cheap and eco-friendly control strategies involving the use of available plant materials for this important pest in small-scale cultivation and storage systems.

Many spices and other plant substances in form of extracts, powders and pellets could be channeled as possible 'entomotoxicants', deterrants, anti-feedant and anti-reproductive agents for the riddance of pests in stored tubers.

Dennettiatripetalla(G. Baker) (Annonaceae) commonly known as pepper fruit because of the strong pepperish and pungent taste of the leaves, bark and root is commonly found in the tropical rainforest of southern Nigeria. *D. tripetalla*have been reported to have analgesic and anti-inflammatory effects on mice and rats [13], antifungal effects [14] and insecticidal activities against *Sitophilusoryzae* [15].

Xylopiaaethiopica (Dunal)(Annonaceae); the African spice plant, is an evergreen plant distributed in West Africa. It is reported to have medicinal value against skin infection, candidiasis, stomach ache, antibacterial, antifungal action [16] and insecticidal effects against mosquitoes and termites [17].

Aframomummelegueta (K. Schum) is a perennial and herbaceous, aromatic plant in the family Zingiberaceae, cultivated for its spicy, fleshy, pungent and aromatic fruits/seeds. Commonly called grains of paradise, it is widely distributed along the coast of West Africa. *A. melegueta* is used to control post-partum bleeding, helminthic infestation, congestion, heartburn and inflammatory conditions in humans.Oparaeke*et al*., [18] reported that the fruit has insecticidal action against post-flowering insect pests of cowpea and storage insect pests [19].

This research is undertaken to assess the insecticidal effects of *A. melegueta*, *X. aethopica* and *D. tripetalla* leaves and fruits extracts against *C. puncticolis*, a sweet potato tuber weevil.

2. MATERIALS AND METHODS

The experiments were done atthe Department of Zoology and Environmental Biology, University of Calabar in Calabar Municipality of Cross River State (5^0 45" N, and 8^0 30' E),

Nigeria, between September, 2012 and March, 2013. The climate in Cross River State is characterized by a pattern of alternating wet (April to September) and dry (October to March) seasons with mean annual precipitation of 260.0mm in 2012 and 220.6mm in 2013,atmospheric temperature range34.3^{0}C to 22.3^{0}C and an average relative humidity in the range of 68-92 percent.

2.1 Collection of test plant materials

The leaves and fruits of *D. tripetalla, X. aethopica* and *A. melegueta* were used. The leaves were collected from Germplasmof Department of Genetics and Biotechnology, University of Calabar, Nigeria, while the dry fruits were bought from a local market in Calabar. The plant parts were carried in aseptic polythene packs to the Herbarium unit in Botany Department of University of Calabar, and the plant identities confirmed.

2.2 Preparation of extract of test plant substances

The extraction of essential oil from each plant substance was done using n-hexane as solvent. Two hundred grams (200g) of individual ground sample was liquesce in 500cm^3 of n-hexane in an absractingtimbel and put in a soxhlet apparatus for abstraction. The condenser of the apparatus was connected to water supply. Temperature of the heating mantle was maintained at 60 – 65^{0}C. The extraction process was carried out for 5–6 hours for each sample. The filtrate was evaporated in a rotary evaporator under reduced pressure at 40^{0}C. The resultant essential oil from each plant was sealed in a labeled reagent bottle and stored in refrigerator for further biological assay.

2.3Rearing and maintenance of *Cylaspuncticollis* population.

Cylaspuncticollis infested tubers harvested from an abandoned Sweet potatofarm in University of Calabar were used to establish the stock. These insects were reared and maintained on sweet potato tubers under environmental temperature of 28±2^{0}C and relative humidity of 70±5%, 12 hour dark/light photoperiods. Rearing was done in wooden–netted cages of dimension (20 x 20 x 20) cm^3 each and mesh size 0.25mm. 150g of sterile sweet potato tubers were weighed using Mettler Toledo-technology digital weighing balance) and placed in each cage. Thirty pairs (15 males and 15 females) of adult *C. puncticollis*were later introduced into each cage and the door shut.

Adult insects in each rearing cage was held for 14 days to mate and oviposit succeeding which they were taken out and thrown out. Insects for the experiments were taken from this stock.

2.4 Experimental designs

Laboratory assays were conducted ina completely randomized design, using fruits and leaves extracts of *A. melegueta, X. aethiopica*and *D. tripetalla;* applied at three treatment doses (1 percent, 3 percent and 5 percent) for each plant and a control; giving a total of nineteen treatment groups. Each treatment was replicated four times giving a total of seventy six experimental units.

2.5 Application of treatments and collection of data

2.5.1 Weevil mortality test

To assess the contact effects of n–hexane extract of test plant parts on mortality of *Cylaspuncticollis* (adults), 100g of disinfected sweet potato tubers were weighed into a transparent plastic container [(12 x 12 x 6.0)cm^3] for each replicate. Each treatment was administered by direct admixture to the tubers at different rates (1 percent,3 percent and 5

percent), calculated on the basis of weight of test plant extract to weight of sweet potato tuber (w/w) while the control received no treatment. Ten pairs ofone-day old *Cylaspuncticollis* full grown insects were imported into exclusive test containers to mate and oviposit for 5 days. Test containers had their covers bored through and covered by nylon mesh (size = 0.25mm) to facilitate confinement of weevils and aeration. The layout was done on the laboratory bench in a completely randomized design (CRD) with each treatment replicated four times.

Adult mortality count was done at 24, 48, 72 and 96 hour post-treatment. At each count the numbers of dead weevils were noted, the dead weevils removed and thrown out while the ones alive were left to continue the experiment. Insect was considered dead, when no movement was exhibited by it when pricked with an entomological needle. After one week the weevils were thown out, and the tubers kept aside for F_1 progeny emergence. From these data, percentage weevil mortality at 24, 48, 72 and 96 hours succeeding treatment were calculated as;

$$\frac{\text{Number of dead weevil/treatment}}{\text{Total number of weevils}} \text{ x } 100$$

2.5.2 Adult *C. puncticollis* emergence and reproductive potential inhibition test (RPI)

The emergence and percentage reproductive potential inhibition test of adult *C. puncticollis* were determined based on the emergence of first filial generation (F_1) progeny. Five weeks following the removal of the weevils from the weevil mortality bioassay, the full grown weevils coming out from each treatment were numbered and noted. These count data gave a measure of the effect of the extract on weevils' reproduction (reproductive capacity inhibition test). Emerged weevils were sieved out daily to prevent mating and subsequent oviposition by

F_1 progeny (Statherset *al.*, 2005). The bioassay was concluded after seven weeks when there were no more emergence of adults. All data obtained for RPI test were determined from adult emergence using the formulae;

ReproductivePotentialInhibition **(**RPI**) =**

$$\frac{No.of\ adult\ emerging\ in\ Control - \ Adults\ emerging\ in\ treatment}{Number\ of\ Adults\ Emerging\ in\ Control} x\ 100$$

2.5.3 Weevil damage test

Effects of test plant extract on degree of weevil damage of tubers were assessed based on number of tubers perforated with more than five exit – holes at ten weeks post treatment. Count data were taken on number of tubers perforated.

All biological assays were repeated five times and data obtained were pulled and subjected to analysis. The percentage of damage caused by the *C. puncticollis* to the tubers was computed following the method of Adedire and Ajayi (1996)

1. Percentage Damage (PD) = $\frac{\text{No.of treated tubers perforated}}{\text{Total number of tubers}}$ x 100

2. Weevil perforation index (WPI) was also calculated from the obtained data by Fatope*et al*., (1995) method.

Weevil perforation index (WPI) =

$$\frac{\%\ of\ perforated\ tubers\ in\ treatment}{(\%\ of\ perforated\ tubers\ in\ control) + \ (\%\ of\ perforated\ tubers\ in\ treatment)} x\ 100$$

2.6 Statistical analysis

Data obtained for respective study parameters were evaluated employing one way analysis of variance (ANOVA) to check for significant differences between the various treatments. All data analyses were undertaken using SPSS version 17.0 software for windows, and conclusions drawn at 95% probability level.

3. RESULTS

3.1 Toxicity Biological Assays

3.1.1 Weevil mortality

At 96 hours post treatment, significant differences ($P < 0.05$) were observed among the plant products extracts of *Xylopiaaethiopica, Dennettiatripetalla*, *Aframomummelegueta* and control on cumulative mean mortality (%) of adult *Cylaspuncticolis*.

n-hexane extract of the three test plant significantly ($P < 0.05$) increased cumulative mean mortality of adult's *C. puncticollis* than their control. Fruit extracts of *A. melegueta* was the most potent giving the highest mortality of 100 percent at 3 percent and 5 percent concentrations. This was followed by fruits extract of *A. melegueta* at 1 percent, *X. aethiopica* at 1 percent and *D. tripetalla*at 1 percent and 3 percent which gave 80.0 percent, 77.50 percent, 73.75 percent, and 81.25 percent mortality of insects respectively. There were also variations on the effects of the leaves extract on mortality. *A. melegueta* leaves extracts at 3 percent and 5 percent were significantly ($P < 0.05$) more lethal to *C. puncticollis* than other leaves extractsand control. 1 percent *A. melegueta* leaves extract however similar effect with 5 percent *X. aethiopica* had and 5 percent *D. tripetalla* leaves extracts.

3.1.2 Effects of n-hexane extracts of test plant on repellent of adult *C.puncticollis*

The repellent bioassay showed that extracts of *A. melegueta* had the greatest repellent effect on *C.punticollis*, followed by *X. aethiopica* and then *D. tripetalla*. With respect to plant parts, fruits extract of *A. melegueta* was the most potent while fruit extract of *D. tripetalla* had the least repellent effect on adult *C.punticollis*. A similar trend was observed on the repellent potency of the leaves extracts with *A. melegueta* repelling 72.08%, followed by *X. aethiopica* which repelled (70.41%) and the least being *D. tripetalla* which repelled 60.41% of the insects.

At 3 and 5%, *A. melegueta* fruits and leaves extracts, *X. aethiopica* fruits and leaves extracts, as well as 5% *D. tripetalla* leaves and fruits extracts, *C.punticollis* adults were repelled significantly ($P<0.05$) more than at all other concentrations.

1% *A. melegueta* and 3% *D. tripetalla* fruits extract repelled a similar percentage of *C.punticollis* while 3% *D. tripetalla* leaves extract and 1% *X. aethiopica* fruit extract had comparable effects. The concentrations that were least repellent were; 1% leaves extract of *X. aethiopica*, *D. tripetalla* and *A. melegueta*, as well as 1% fruit extract of *D. tripetalla*.

3.2 Weevil damage/weevil perforation index (WPI)

When compared with controls where plant materials were not applied, all test plants extracts gave significantly lower ($P < 0.05$) percentage tuber damage. Extracts of the three test plants also followed a similar trend with the control having the highest and significantly different ($P<0.05$) weevil damage on sweet potato tubers (38.29 percent). *A. melegueta* fruit extracts at 3 percent (7.57 percent) and 5 percent (5.47 percent); *X. aethiopica* fruits extract at 1 percent (10.62 percent), 3 percent (8.52 percent) and 5 percent (8.57 percent) and *X. aethiopica* leaves at 5 percent (8.48 percent) all had comparable effects and lowest percentage weevil damage on the tubers.

3.3 Cumulative progeny emergence and weevil reproductive potential inhibition (RPI)

All the test plants extracts individually showed a significant effect (P< 0.05) on progeny emergence when compared with the control. The control gave the highest cumulative mean progeny emergence of *C.punticollis* (160.00) which was statistically significant (P<0.05) from progeny emergence in all other treatments.

The extract of the respective plant part was potent in inhibiting reproduction and reducing adult emergence. The lowest number of progeny emerged was in 5% *A. melegueta* fruit extract (13.75, RPI – 97.40%). At 5%,*X. aethiopica* fruit (28.00, RPI – 82.50%), *D. tripetalla* fruits (29.50, RPI – 81.56%) and *A. melegueta* leaves extracts had similar effect (26.75, RPI = 85.28%) on cumulative progeny emergence and reproductive potential inhibition (RPI).

Table1

Effect of extracts of *A. melegueta, D. tripetalla* and *X. aethiopica* on *C. puncticollis* damage (%) and weevil perforation index (WPI) of sweet potato tubers

	Plant parts	Conc. %w/w	Weevil damage (%) extracts	WPI (extracts)
A.melegueta	Fruits	1	$11.52^{b} \pm 2.53.$	$22.54^{b} \pm 3.87$
		3	$7.51^{a} \pm 0.88$	$16.30^{a} \pm 158$
		5	$5.47^{a} \pm 0.86$	$12.39^{a} \pm 1.72$
	Leaves	1	$14.95^{e} \pm 1.06$	$27.99^{f} \pm 1.44$
		3	$12.47^{b} \pm 1.78$	$22.80^{b} \pm 2.52$
		5	$18.57^{a} \pm 1.76$	$14.93^{a} \pm 2.56$
D.tripetalla	Fruits	1	$15.09^{e} \pm 2.33$	$27.86^{f} \pm 3.68$
		3	$13.60^{c} \pm 2.20$	$25.79^{e} \pm 3.27$
		5	$12.03^{b} \pm 1.76$	$23.89^{c} \pm 2.41$
	Leaves	1	$15.16^{10} \pm 1.34$	$28.23^{f} \pm 1.81$
		3	$14.25^{d} \pm 1.51$	$26.93^{f} \pm 2.22$
		5	$12.45^{d} \pm 1.86$	$24.23^{d} \pm 2.81$

X.aethiopica	Fruits	1	$10.62^{a} \pm 1.28$	$21.54^{b} \pm 2.08$
		3	$8.52^{a} \pm 1.01$	$18.08^{a} \pm 1.80$
		5	$7.02^{a} \pm 1.21$	$15.31^{a} \pm 2.28$
	Leaves	1	$13.55^{c} \pm 1.60$	$25.92^{e} \pm 2.32$
		3	$11.60^{b} \pm 1.47$	$23.04^{b} \pm 2.29$
		5	$8.48^{a} \pm 0.91$	$18.03^{a} \pm 1.60$
Control	0	0	$38.29^{f} \pm 4.29$	$49.53^{g} \pm 2.75$

Values are presented as Mean ± SEM. Values in each column having similar superscript are not significantly different based on Waller-Duncan Post hoc. test

Table2

Effect of n-hexane extracts of *D. tripetalla*, *A. melegueta* and *X. aethiopica* on cumulative progeny emergence and reproduce potential inhibition (RPI) of *C.punticollis*

Plants	**Plant parts**	**Conc. %w/w**	**Cumulative progeny emergence (extract)**	**Reproductive Potential Inhibition (RPI) extract**
A. melegueta		1	$38.75^{c} \pm 1.10$	$75.78^{e} \pm 0.69$
	Fruits	3	$32.00^{c} \pm 0.91$	$79.99^{gh} \pm 0.5$
		5	$13.75^{a} \pm 0.85$	$91.40^{k} \pm 0.53$
		1	$58.00^{i} \pm 1.08$	$63.74^{c} \pm 0.67$
	Leaves	3	$33.75^{d} \pm 0.94$	$78.90^{g} \pm 0.59$
		5	$26.75^{b} \pm 1.17$	$83.28^{j} \pm 0.69$
D. tripetalla		1	$80.00^{k} \pm 0.81$	$50.00^{a} \pm 0.51$
	Fruits	3	$57.00^{i} \pm 0.81$	$64.37^{c} \pm 0.51$
		5	$29.50^{b} \pm 2.39$	$81.56^{hi} \pm 1.49$
	Leaves	1	$84.00^{L} \pm 1.82$	$47.50^{a} \pm 1.14$

		3	$80.00^{k} \pm 1.08$	$49.99^{a} \pm 0.67$
		5	$71.75^{j} \pm 1.10$	$55.15^{b} \pm 0.69$
	Fruits	1	$51.00^{b} \pm 1.29$	$68.12^{d} \pm 0.80$
X. aethiopica		3	$42.25^{a} \pm 1.10$	$73.59^{e} \pm 0.69$
		5	$28.00^{b} \pm 1.82$	$82.50^{i} \pm 1.14$
	Leaves	1	$68.50^{j} \pm 1.55$	$56.71^{d} \pm 0.69$
		3	$49.50^{h} \pm 1.70$	$69.06^{d} \pm 1.06$
		5	$36.00^{e} \pm 0.91$	$77.49^{f} \pm 0.57$
Control	0	0	$160.00^{m} \pm 1.08$	

Values are presented as Mean ± SEM. Values in each column having similar superscript are not significantly different based on Waller-Duncan test

4. DISCUSSION

The results obtained from this research showed that the leaves and fruits of *Aframonummelegueta, Dennettiatripetalla and Xylopiaaethiopica* had varying levels of insecticidal activities. When compared to the control, all the plant materials were effective in reducing insect population under laboratory conditions,however their effectiveness increased with increase in concentration.

Plants have been reported to have phytochemicals which act as chemical defenses against herbivores and other organisms in the environment [20]. It is therefore possible that the strong pungent odour produced by these plants prevented the weevil from normal feeding which resulted in starvation and their subsequent death [21] [22].

Results from the biological assays indicated that all plants extracts had significantly higher insect mortality than the control. The highest mortality observed in *A. melegueta* fruit extract at 3% and 5% and *X. aethiopica* fruit extract at 5% treatment doses, within 24 hour exposure time,

confirmed the report by Kouninki*et al.,* [23] that essential oils from whole fruits or leaves of aromatic plants exhibited acute toxicity on coleopteran storage pests such as *C. puncticolis* and *S. zeamais*.

The Phytochemical screening of *X. aethiopica* showed the presence of ∞-*pinene,* β-*pinene*, 3-carene and terpinene-4-ol, that of *D. tripetalla* revealed the presence of β-phenylnitroethane, alkaloids, dennettine, three phenanthrine alkaloids, spotted as ovariopsine, stephenanthrine and argentinine and a simple phenolic compound vanillin [24], while that of *A. melegueta* contained five mono-terpenoids; ®-Linalools, 1,8-cineols, (S)-2 heptylacetate, (S)-2-heptanol and citrate. The presence of these anti-oxidant and semio-chemical in the test plants must have been responsible for the toxicity of the oil extracts.

Biological assay on adult repellent indicated that the leaves and fruits of the three test plants at 3 and 5% application doses repelled *C. puncticollis* in a similar way within 60 minute of exposure. The observed increase in repellence effect with increasing concentration at limited time of exposure was due to the presence of semio-chemicals in the test plants that may have probably changed the behavior of the insects through the chemoreceptors present in the antennae. These semio-chemicals probably provided a vapour barrier preventing *C. puncticollis* from touching tubers surfaces [25]. These observations also correspond with the reports of Tapondjou*et al.,* [26],Ukeh*et al.,* [27], Talukdar and Howse [28], Javid and Poswal [29] and Egwunyenga*et al.,* [30] who separately reported that n-hexane or ethanolic extract of *D. tripetalla*, *A. melegueta* and *X. aethiopica* could individually cause 40.1% to 100% repellence when used to protect grains or dry fish from storage coleopterans (beetles).

From these investigations, *A. melegueta*had100% repellence effect on *C. puncticollis* at 5% treatment dose. Ukeh&Umoetok [31] reported that ®–linalool is the major component in

essential oils of *A. melegueta* conferring repellent activity against *Triboliumcasternum* and *Rhyzoperthadominica*. Linalool, Citral and Cineole are familiar reversible competitive inhibitors of acetylcholinesterase[32], the principal enzyme that ends nerve impulses through speed up of the hydrolysis of the neurotransmitter acetylcholine (ACH) to cholin and acetate in the nervous system of insects [33]. Therefore the action of monoterpenoids (C-® Linalool, citral and cineole) on insects is thought to include: repellent, neurotoxicity, paralysis and death. It is not surprising therefore, that these plants extracts especially at 3 and 5% exhibited significant inhibition of reproductive potential, as well as reduced F_1 cumulative progeny emergence, in *C. puncticollis*.

This study also revealed that all treatments with n-hexane extract from all test plants parts and at all concentrations resulted in more weevil death and reproductive potential inhibition than the control. The reason for this could be that extract action are often target specific and have unique modes of action [34] [35]. More so, organic solvents such as n-hexane have been reported as being very effective in extracting active ingredients from plant parts[36]. Arannilewa*et al.*, [37] also reported that extracts are potent against all insects and their developmental stages and have been reported to have higher capacity to penetrate into the vascular bundles of tubers thus suppressing oviposition and any larval development and so resulting in complete failure of embryonic development.

The efficacy of these test plants extracts in the laboratory was dependent on dosage, with higher doses providing better protection with significantly fewer adults emerging and attacking sweet potato.

5. CONCLUSION

Results obtained from this research revealed that though *A. melegueta, X.aethiopica*and *D. tripetalla*fruits and leaves extracts were effective in controlling sweet potato weevil, *C. puncticollis;* the most effective was*A. melegueta* fruit extract. These plants could be incorporated in integrated pest management practices by local farmers. The plant extracts exerted considerable repellent, anti-reproductive and anti-feedant effects which ultimately led to significant reduction in tuber damage.To the resource-poor farmers in Nigeria, this research forms the basis for the use of these plant products in crop protection so as to reduce the application of synthetic insecticides.

6. REFERENCES

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