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Efficacy of some Plants Extract in the Control of Cowpea (*Vigna unguiculata*) Stored Weevil (*Callosobruchus maculatus*)

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ABSTRACT

Recent revelations have shown that synthetic insecticides were found to penetrate into grains and may be toxic and hazard to human health. Therefore, it is of important to seek for cheapest and non-hazard means of controlling stored cowpea insects as such a study was conducted to examine the efficacy of *Anogeissus leiocarpus* and *Annona senegalensis* extracts in the control of stored cowpea weevil (*Callosobruchus maculatus*) at Shelterbelt research station Kano, Forestry Research Institute of Nigeria. The study was highly significant considering some years back European countries banned the exportation of Nigerian cowpea to their countries due to hazardous effect of the chemicals that were used in the control of the weevils. The experiment consists of ten treatments including control laid out in complete randomized design (CRD); *Anogeissus leiocarpus* leaf powder 100%, *Anogeissus leiocarpus* bark powder 100%, *Annona senegalensis* leaf powder 100%, *Annona senegalensis* bark powder 100%, actellic dust as control, 50% bark of *Anogeissus leiocarpus* and *Annona senegalensis* each, 50% leaf of *Anogeissus leiocarpus* and *Annona senegalensis* each, 50% leaf of *Anogeissus leiocarpus* and 50% bark of *Annona senegalensis*, 50% bark of *Anogeissus leiocarpus* and 50% leaf of *Annona senegalensis*, 25% of each of the materials. Each treatment was replicated three times. Data were collected on weevil's adult mortality, number of eggs laid, numbers of egg hatched, number of seeds attacked and percentage germination of the seeds at end of the trial. The data collected were subjected to analysis of variance (AVONA. Mean separations was carried out using Fisher's LSD where significance difference was declared. The result indicated that, there were significant differences between the treatments throughout the period of the experiment (2 to 8 weeks). However, among the various treatment of the plant products used, 100% *Annona* leaf powder proved to be most effective in controlling number of eggs laid at 2, 4, 6 and 8 weeks, actellic dust has the least number of hatched eggs at week 2 but no significant difference at the rest of the weeks, also 50% *A. Leiocarpus* and 50% *A. senegalensis* each proved to be most effective on less number of seed attacked at week 2, 4, 6 and 8 weeks of storage. No significant difference among all the treatments in controlling the mortality rate of adult *C. maculatus*. Actellic dust has the highest percentage germination followed by 100% *Annona senegalensis* leaf and then the rest of the treatments.

Keywords: Extracts, Cowpea, Weevil and Store

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) belongs to the family of crops Fabaceae, genus *Vigna*. It is known as black eye peas or southern peas and constitutes one of the most important food legumes in the tropics and sub-tropical countries (Yusuf *et al.*, 2011). According to African Agricultural Technology Foundation (AATF), (2011), cowpea is categorized as main grain legume which can be cultivated in tropical Africa. The crop is commonly consumed in the form of dry grains or young pods (Adenakan *et al.*, 2013). Dried grains are prepared into Moi-Moi, Akara (Kosai) or eaten in combination with other crops such as rice, yam, sorghum etc and can be used as forage also (Muhammad *et al.*, 2017). Nearly 200 million people of Africa consume the crop (AATF, 2011). It is a cheap source of protein and thus serves as sources of plant protein to low income peasant farmers that cannot afford animal protein such as meat and fish (Yusuf *et al.*, 2011; Ekeh *et al.*, 2013). According to FAO-STAT (2017), Nigeria leads other countries with production of over 3.4 million metric tons. FAO-STAT (2017) estimated that 7.4 million tons of dry cowpea grains were produced worldwide in 2017. Nigeria produced 3.4 million tons, making it the world's largest producer, followed by Niger and Mali. The grain contains 26.61 % protein, 3.99% lipid, 56.24 % carbohydrates, 8.60 % moisture, 3.84 % ash, 1.38% crude fiber, 1.51 % gross energy, and 54.85% nitrogen free extract (Owolabi *et al;* 2012). It is mostly grown as an intercrop with sorghum, maize and millet (Asiwe, 2006). Cowpea is usually preferred by farmers because of its role in increasing soil fertility through nitrogen-fixation (Blade *et al.*, 1997; Asiwe, 2006) and production of nutritious fodder for livestock. Under sole cropping, the potential grain yield is high (1.5 - 3.0 t ha^{-1}), especially, when insecticide was applied. However, the actual yields obtained by farmers in South Africa are much lower averaging less than 500 kg ha^{-1} (Asiwe, 2006; Asiwe *et al.*, 2009).

Insect pests are considered to be largely responsible for this, as their attack can result in 90 - 100% yield reduction (Jackai and Daoust, 1996). More than 11 million hectares are harvested worldwide, 97% of which is in Africa. Nigeria cultivates 4.5million hectares annually representing over 60% of total production. The grain yield of cowpea in Nigeria is 700kg/ ha (FAO. STAT, 2011). The highest production of cowpea comes from the northern states of Nigeria (about 1.7 million tonnes from 4 million hectares).

However, in most parts of West Africa, insect pests are the most important constraint to cowpea production (Jackai and Daoust, 1996). Karungi *et al.* (2000) listed at least 20 major insect pest species in various cowpea producing regions of the world in which the number vary from region to region. The most damaging of all the insect pests are the flowering and post flowering insect pests. The major flowering and post flowering insect pest of cowpea in tropical Africa are the flower bud thrips, (*Megalurothrips sjostedti* Tryb.), cowpea pod borer (*Maruca vitrata* F.) and a complex of pod sucking bugs out of which *Clavigralla tomentosicollis* Stal is the dominant species (Jackai and Daoust, 1996). The most important storage pest of cowpea is bruchid (*Callosobruchus maculatus* F.) which cause reduction in the quantity and quality of the grains, and market value of the product.

The use of chemical insecticides is the best way of controlling *Callosobruchus maculatus*. Ekeh *et al*. (2013) stated that fumigation is appropriate to control the insects. Insecticides are having quick knock down action and are

persistent, efficient and effective means of control. However, their use has some negative consequences for instance, Suleiman and Yusuf (2011) reported that, chemicals are unavailable, expensive, poses hazard to man and livestock. Adebiyi and Tedela (2013) reported health issues and resistance of pest against chemicals. Recent revelations have shown that synthetic insecticides were found to penetrate into grains and may be toxic (Adebiyi and Tedela, 2013). Ekeh *et al*. (2013) reported residues of methyl bromide one of the fumigant used in dis-infestation of stored foods exhibiting carcinogenic effects in rats.

However, high cost and hazard effect of the chemical for the control of the insects is highly significant to the extent that some years back European countries banned the exportation of Nigerian cowpea to their countries (Anonymous 2015). In respect of the above mentioned, it is of important to seek for the cheapest and non-hazard means of controlling stored cowpea insects using some materials in order to boost the crop production and consumption without any threat to the health of consumers, (FAO-STAT, 2014) and some of the material that were proven to be effective insects repellent were obtained to be plant extracts. It is against this background that the experiment was conceived with objective of evaluating the efficacy of some plant extracts in the control of cowpea stored weevil (*Callosobruchus maculatus*).

Methodology

Experimental Site

The experiment was conducted at seed store of Shelterbelt Research Station Kano (Latitude 12° 1’ 42.20” to 12° 1’ 43.65” N and Longitude 8^{0} 30’, 9.06” to 8^{0} 30’ 29.07” E), Forestry Research Institute of Nigeria. The materials used were fresh leaves and barks of *Anogeissus leiocarpus* and *Annona senegalensis* which were locally obtained within the area of study and taken to the herbarium unit of Plant Biology Department, Bayero University, Kano, (BUK) for identification and authentication. These were air dried under shade and later pound into powder using pestle and mortar. The powdered form of the plant materials were used for the experiment. The weevil (*Callosobruchus maculatus)* were obtained from a highly infested cowpea grain at Dawanau grains market, Kano, while the cowpea grain (IT99K-573-1-1) variety used in the experiment was sourced from the International Institute of Tropical Agriculture (IITA), Kano office and was free from insect damage/infestation and was not sprayed with insecticide.

Thirty plastic containers of 7cm long and 4.5cm in diameter and mesh sieve was used to cover the plastic containers containing the insects, cowpea and the plant materials to prevent the insects from escaping out of the containers and to allow air circulation (Aswallam, 2004)

Treatment and Experimental Design

The experiment was conducted using Complete Randomized Design (CRD) with ten treatments including control and three replicates. Ten grams of each of the plant materials were weighed into the sterilised plastic containers. Thirty apparently healthy seeds of cowpea and ten life adult *Callosobruchus maculatus* were introduced into each of the plastic containers. Each plastic container was covered with sterilised mesh sieve and tied with rubber band. The treatments were as follows:

Treatment	Plant materials and concentration
A	100% *Anogeissus leiocarpus* leaf powder
B	100% *Anogeissus leiocarpus* bark powder
C	100% *Annona senegalensis* leaf powder
D	100% *Annona senegalensis* bark powder
E	Actellic dust; Control
F	50% bark of *Anogeissus leiocarpus* and *Annona senegalensis* each
G	50% leaf of *Anogeissus leiocarpus* and *Annona senegalensis* each
H	50% leaf of *Anogeissus leiocarpus* and 50% bark of *Annona senegalensis*
I	0% bark of *Anogeissus leiocarpus* and 50% leaf of *Annona senegalensis*
J	25% each of the materials

Data collection

The data collection was carried at two weeks intervals and lasted for eight weeks, while the variables assessed were mortality rate of the weevils, number of seed attacked by the weevils, number of eggs lay by the weevil; number of eggs hatched, and seed viability Percentage.

Data analysis

The data collected were subjected to analysis of variance (AVONA) and significant mean differences were separated by the used of Fishher's Protected LSD.

Results

Effect of plant extracts on the number of eggs laid by *C. maculatus* on stored cowpea

The result presented in Table 1 shows the effects of different plants extracts on the number of eggs laid by the cowpea weevils on the stored cowpea. The plant extracts significantly affects eggs laid by *C. maculatus*. In all the sampling periods the result obtained showed that the number of eggs laid by the weevils was significantly higher in treatment B (100% *A. leiocarpus* bark powder) ($P<0.05$) compared to other treatment. But at 2 weeks after storage, treatments C and J had the lowest number of eggs laid followed by the remaining treatments that were statistically the same. At 4 weeks of storage treatments C and E were similar ($P>0.05$) but had the lowest number of eggs laid, followed by treatments D, G and H at par. However, at 6 weeks of storage same treatments C and E recorded significantly lowest number of eggs laid, while highest numbers of eggs laid were recorded with the rest of the treatments statistically similar. At 8 weeks of storage it was found to be only treatment C had the lowest number of eggs laid while high numbers of eggs laid by the weevil were recorded with rest of the treatments at par.

Table 1: The effect of different plant extract on the number of eggs laid on the stored cowpea

TREATMENTS		NUMBER OF EGGS LAID		
Plant Extracts	**2Weeks**	**4Weeeks**	**6Weeks**	**8Weeks**
A	41.67^{ab}	81.67^{abc}	98.00^{ab}	134.00^{a}
B	66.33^{a}	143.00^{a}	151.00^{a}	174.70^{a}
C	22.67^{b}	24.33^{c}	24.30^{c}	25.30^{c}

D	43.33^{ab}	88.00^{abc}	97.00^{ab}	138.70^{a}
E	24.33^{ab}	64.33^{bc}	70.30^{bc}	113.30^{a}
F	59.33^{ab}	119.67^{ab}	135.30^{ab}	145.30^{a}
G	38.67^{ab}	86.00^{abc}	100.70^{ab}	141.70l^{a}
H	41.67^{ab}	97.00^{abc}	116.30^{ab}	145.00^{a}
I	66.33^{a}	109.67^{ab}	122.30^{ab}	159.00^{a}
J	22.67^{b}	122.00^{ab}	121.00^{ab}	147.00^{a}
LSD	37.660	65.051	68.080	26.160

Means followed by the same letter(S) are not significantly different at 5% level of significance using Fisher's LSD.

A=100% *Anogeissusleiocarpus* leaf powder; B= 100% *A. leiocarpus* bark powder; C=100% *Annonasenegalensis* leaf powder; D=100% *A. senegalensis* bark powder; E=Actellic dust; F=50% bark of *A. leiocarpus* and *A. senegalensis* each; G=50% leaf of *A. leiocarpus* and *A. senegalensis* each; H=50% leaf of *A. leiocarpus* and 50% bark of *A.senegalensis*; I=50% bark of *A. leiocarpus* and 50% leaf of *A. senegalensis*; J= 25% each of the materials.

Effect of plant extracts on the number of hatched eggs of *C. maculatus*

The result presented in Table 2 shows the effects of plant extracts on numbers of hatched eggs of *C. maculatus* on stored cowpea. The result indicated that at 4 weeks of storage, treatment E recorded least number of hatched eggs of the insects followed by treatment D while highest number of hatched eggs was recorded with treatment B. At 6 and 8 weeks of storage there was no significant difference (P>0.05) between all the treatments with regard to numbers of hatched eggs by the weevil on the stored cowpea.

Table 2 : Effect of plant extracts on numbers of hatched eggs on the stored cowpea

TREATMENTS	**EGGS HATCHED**		
Plant Extracts	**4Weeeks**	**6Weeks**	**8Weeks**
A	16.33^{abc}	10.33^{a}	31.33^{a}
B	28.00^{a}	11.33^{a}	16.00^{a}
C	11.00^{bcd}	3.67^{a}	32.00^{a}
D	10.00^{cd}	6.33^{a}	26.00^{a}
E	1.00^{d}	1.00^{ab}	1.33^{ab}
F	17.33^{abc}	9.67^{a}	7.67^{ab}
G	18.33^{abc}	11.67^{a}	26.00^{a}
H	15.33^{abc}	12.00^{a}	11.33^{a}
I	17.67^{abc}	11.33^{a}	22.67^{a}
J	24.00^{ab}	15.00^{a}	23.67^{a}
LSD	12.111	16.161	29.060

Means followed by the same letter(S) are not significantly different at 5% level of significance using Fisher's LSD.

Effect of plant extracts on seed attacked on the stored cowpea

The result presented in Table 3 shows the effects of different plants extracts on the number of seed attacked of the stored cowpea by the cowpea weevils. Treatments of the plant extracts significantly affected the number of seed attacked by *C. maculatus*. In all the sampling periods the result obtained showed that, at 2 weeks of storage treatments D had the highest number of seed attacked at par with treatments B, C and H, while treatment Frecorded the lowest number of seed attacked. At 4 weeks of storage treatments F significantly had the lowest number of seed attacked, followed by treatments C, D, and E at par, while treatment A significantly recorded the highest number of seed attacked, though at par with the

remaining treatments. However, at 6 and 8 weeks of storage of the cowpea, treatments F recorded significantly lowest number of seed attacked, while highest number of seed attacked was recorded by the rest of the treatments statistically similar at the sampling period.

Table 3: Effect of plant extracts on seed attacked on the stored cowpea

TREATMENTS		NUMBER OF SEEDS		
Plant Extracts	**2Weeks**	**4Weeeks**	**6Weeks**	**8Weeks**
A	2.00^{bc}	25.00^{a}	19.00^{a}	30.00^{a}
B	3.33^{ab}	17.67^{ab}	26.67^{a}	30.00^{a}
C	3.33^{ab}	15.67^{b}	20.00^{a}	29.00^{a}
D	4.33^{a}	14.67^{b}	23.00^{a}	26.67^{a}
E	2.00^{bc}	12.67^{b}	22.33^{a}	26.33^{a}
F	1.00^{c}	1.00^{c}	0.33^{b}	0.33^{b}
G	2.33^{abc}	17.00^{ab}	21.33^{a}	29.67^{a}
H	3.67^{ab}	19.00^{ab}	20.00^{a}	30.00^{a}
I	3.00^{abc}	20.00^{ab}	21.33^{a}	30.00^{a}
J	2.00^{bc}	20.33^{ab}	23.67^{a}	29.33^{a}
LSD	1.961	8.234	10.050	4.625

Means followed by the same letter(S) are not significantly different at 5% level of significance using Fisher's LSD.

Effect of plant extracts on percentage mortality rate of adult *C. maculatus*

The result presented in Table 4 shows the effects of the different plant extract on percentage mortality of the adult weevils on the stored cowpea. The result revealed no significant difference among all the treatments on adult mortality of the stored cowpea throughout the period of the study. All the treatments were statistically similar (P>0.05).

Table 4 : Effect of plant extracts on percentage mortality of adult *C. maculatus*

Plant extracts	Initial no. of Adults *C. Maculates*	Adults mortality rates	Percentage(%) mortality
A	10.00	9.00	90
B	10.00	8.67	87
C	10.00	9.67	97
D	10.00	9.33	93
E	10.00	10.00	100
F	10.00	8.33	83
G	10.00	9.00	90
H	10.00	9.67	97
I	10.00	9.33	93
J	10.00	9.00	90

Effect of plant extracts on percentage seed germination of the stored cowpea

The result presented in Table 5 shows the effects of the different plant extract on percentage seed germination of stored cowpea. The result revealed that treatment E recorded the highest seed germination percentage, followed by treatments A, F, G, H, and I, at par while the lowest seed percentage germination was recorded with treatments B, D, and J at par.

Table 5: The effect of different plant extract on the Percentage (%) seed germination of stored cowpea

Plant Extracts	Number of seed sown	No of seed Germinated	Percentage (%) germination
A	5	3	60
B	5	2	40
C	5	4	80
D	5	2	40
E	5	5	100
F	5	3	60
G	5	3	60
H	5	3	60
I	5	3	60
J	5	2	40

Discussion

The finding of the research shows that there was significant difference among the treatments of the plant extracts. 100% *Annona senegalensis* leaf powder was the treatment with lowest number of eggs laid throughout the study period. Ajayi and Lale, (2001); observed that, the volatile constituents present in the plant materials are responsible for the ovipositor deterrence of *C. Maculatus* due to dying of the adult females before laying eggs in contact with the plant materials. This clearly indicated that the extract contained some organic material that were capable of stopping the multiplications of the weevils as reported by Bekele *et al*. (1997)

The finding of the research shows that there was significant difference between the treatments on number of eggs hatched. Actellic dust recorded least numbers of hatched eggs of the insects followed by treatment D (100% *A. senegalensis* bark powder) The result agrees with the findings of (Bekele *et al*., 1997) who reported that, the toxic properties of plants products compiled with the growth and development of eggs decreased the number of progeny that emerged in treated cowpea grains. Also, (Abd El-Salam, 2010) reported that, the botanicals affect the physiological and biochemical processes associated with the embryonic development after diffusing into the eggs.

The plant extracts significantly reduced the number of seed attacked by *C. maculatus*. The result obtained showed that in all the sampling period, treatment with 50% bark of *Annona senegalensis* and *Anogeissus leiocarpus* each had lowest number of seed attacked. The result agrees with the findings of (Ketoh *et al*., 2005; Shukla *et al*., 2011) who tested on the activity of plant materials on different life stages (larva, pupa) of *C. maculatus* which are responsible for damaging seeds by boring into the seeds.

The result of this study shows significant high rate of adult mortality in all the treatments. This result was in conformity with the findings of Rajapakse *et al*., (1998), which showed that there was significant high rate in adult mortality of *C. maculatus* when treated with *Annona senegalensis* seed powder. This indicated that *Annona senegalensis* seed contain properties that can inhibit insect activities. This was in line with the report of Mann *et al*., (2010) who stated that the flora of savannah consist of plant species that possesses insecticidal properties and plant product treatment acted either as stomach or contact poison or both because they were all found to be effective in suppressing the growth of the bruchids. *Anogeissus leiocarpus*

seed powder proved to be most effective in controlling of *C. Maculatus* because it provided good protection to cowpea grain against damage and loss on the grain weight Muhammad *et al*., (2017) they further reported that the use of plant powders has been reported to produce higher death of insects because of physical barrier with the tendency of blocking the spiracles of the insects, thus impairing respiration leading to death of the insects.

The result showed that seed viability of treated and control cowpea were all significantly influenced by the plant products. The result showed high percentage germination with the control. The result conformed to the findings of Emmanuel, (2013) that showed that a large difference can be observed between germination percentages of the control treated and infested seed of cowpea grains. According Ibrahim and Garba, (2011), even slight bruchids feeding damage the embryo impairs germination feeding in the cotyledon will not affect germination but the vigour of the young plant can be reduced.

Conclusion and Recommendations

Based on the findings of the research work, it can be concluded that, the plant materials had significant effects on the stored cowpea weevils in terms of the number of eggs laid by the adult weevils, seeds attacked, eggs hatched and adult mortality. The results indicated that, cowpea seeds treated with the plant materials showed significant effect on the percentage germination also. Therefore it is recommended, for health safety in storage of cowpea for a period of 2 to 8 weeks, 100% *Annona senegalensis* leaf powder or 50% each of the bark of *Anogeissus leiocarpus* and *Annona senegalensis* should be used.

In addition, there is need to investigate the shelf life of the powders to find out if repeated application is needed after a given period.

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