



COMPARATIVE STUDY OF THE INSECTICIDAL EFFICACY OF *POLYALTHIA LONGIFOLIA* (SONN.) THWAITES AND *ACALYPHA WILKESIANA* (MUELL ARG) POWDER ON *CALLOSOBRUCHUS MACULATUS* (F.) (COLEOPTERA: BRUCHIDAE)

ISHADO, S. A., NDOR-ODOK, P. O., OGAR, E. O., AMADES, B., NSHABUM, T. G. AND OKANG, P. I.
Email: ishadostephen86@gmail.com

(Received 17 February 2025 Revision Accepted 24 March 2025)

ABSTRACT

Concerns over the environmental impact of synthetic pesticides have shifted attention toward bioactive plant products for the control of stored-product insect pests. This laboratory study evaluated the insecticidal efficacy of *Polyalthia longifolia* and *Acalypha wilkesiana* leaf powders against the cowpea weevil (*Callosobruchus maculatus*). The study aimed to assess mortality effects, damage reduction and emergence inhibition. Four treatment concentrations (0%, 1%, 2%, and 3%) of each plant leaf powder were tested in a completely randomized design, with three replicates per treatment. Each replicate consisted of 100 g of sterilized cowpea grains. Results showed that *A. wilkesiana* caused the highest mortality rates of 30.23% at 3%, 23.35% at 2%, and 20.76% at 1%. *P. longifolia* exhibited mortality rates of 25.46% at 3%, 21.65% at 2%, and 16.65% at 1%. Both plant powders significantly increased mortality compared to the control ($P < 0.05$). Damage reduction was also significant, with *A. wilkesiana* reducing damage to 25.80% at 3% and *P. longifolia* to 32.35% at 3%. Additionally, emergence inhibition was notable, with *A. wilkesiana* suppressing F_1 progeny emergence by 78.74% at 3% and *P. longifolia* by 71.15% at 3%. The study concludes that both plants possess insecticidal properties capable of suppressing cowpea weevils, with *A. wilkesiana* demonstrating greater efficacy than *P. longifolia*. These findings highlight the potential of these plant-based powders for sustainable pest management, contributing to food security and environmental safety.

KEYWORDS: Environmental Safety, Synthetic Pesticides, Insect Pest, Food Security, Sustainable pest Management

INTRODUCTION

Cowpea (*Vigna unguiculata*) is a crucial pulse crop, particularly in the semi-arid and sub-humid regions of Africa, where it serves as both a dietary staple and an economic asset for rural communities (Kabeh & Lale, 2004). Beyond its market value, cowpea offers exceptional nutritional benefits, making it an essential component of food security, especially in regions where animal protein is scarce (Ito & Ighere, 2017). Widely consumed in West and East Africa, Latin America, and the Caribbean, cowpea is deeply integrated into local cuisines and sustains millions of households (Langyintuo *et al.*, 2003).

Despite significant efforts to enhance agricultural productivity, post-harvest losses remain a major challenge, threatening food security in many developing nations. An efficient post-harvest system is critical in ensuring that harvested produce reaches consumers while maintaining its quality and nutritional value (Oni *et al.*, 2019). Among the key contributors to post-harvest losses are insect pests, which cause extensive damage, particularly during storage. The ability of a country to store large quantities of food effectively is fundamental to achieving long-term food security (Adamu, 2015).

Ishado, S. A., Department of Zoology and Environmental Biology, University of Calabar, Calabar, Nigeria
Ndor-Odok, P. O., Department of Global Healthcare Management, Coventry University, Coventry, UK
Ogar, E. O., Department of Animal Science, University of Calabar, Calabar, Nigeria
Amades, B., Department of Animal and Environmental Biology, Rivers State University of Technology, Port Harcourt, Nigeria
Nshabum, T. G., Department of Zoology and Environmental Biology, University of Calabar, Calabar, Nigeria
Okang, P. I., Department of Zoology and Environmental Biology, University of Calabar, Calabar, Nigeria

One of the most destructive pests affecting stored cowpea is *Callosobruchus maculatus*, which can cause losses ranging from 50% to 90% (Ogunbite *et al.*, 2014; Ajayi *et al.*, 2015). While synthetic insecticides have traditionally been used for pest control, concerns over their environmental and health impacts have led to restrictions and bans in many countries. As a result, the search for alternative, eco-friendly solutions has intensified. Botanical pesticides, derived from plant extracts or powders, have emerged as promising, cost-effective alternatives that are both sustainable and environmentally safe (Isman, 2018). Several studies have demonstrated the insecticidal potential of various plant-derived products. For instance, leaf powders from *Aframomum melegueta*, *Dennettia tripetala*, and *Xylopia aethiopica* have shown effectiveness against *Cylas puncticollis*, a major sweet potato weevil (Nta *et al.*, 2018). Similarly, extracts from *Azadirachta indica*, *Lantana camara*, and *Tephrosia vogelii* have exhibited toxic effects on *Caryedon serratus*, a groundnut bruchid (Idoko *et al.*, 2016). Furthermore, studies on *Chenopodium ambrosioides* leaves and *Aframomum melegueta* seeds, both individually and in combination, have confirmed their efficacy in controlling *C. maculatus*, a primary pest of cowpea storage (Chougourou *et al.*, 2016).

The insecticidal properties of these plant-based materials are attributed to their bioactive compounds, such as tannins, saponins, alkaloids, and anthraquinones, which interfere with pest physiology and development (haieb, 2010; Chougourou *et al.*, 2015; Nta *et al.*, 2018; Oni, 2019).

This study aims to expand research on sustainable pest management by evaluating the effectiveness of *Acalypha wilkesiana* and *Polyalthia longifolia* leaf powders as environmentally friendly insecticides against *C. maculatus*. The findings could contribute to the development of safer and more sustainable pest control strategies, ultimately enhancing food security in vulnerable regions.

MATERIALS AND METHODS

Description of Study Area

The experiment was conducted at Room 249 in the department of Zoology and environmental Biology, University of Calabar, Calabar Municipality Cross River State (5°45'N 8°30'E) Nigeria, between June 2021 and August 2021. Calabar is 46 metres above sea level and its climate is classified as tropical. Rainfall is significant most months of the year and the short dry season has little effect. In Calabar, the average temperature (annually) is 25.8°C/78.5°F. The annual rainfall is 3306mm/130.2inch with an average relative humidity in the range 68-92%.

Cowpea Seeds Preparation

The cowpea seeds (*Vigna unguiculata*) used were purchased from Marian market (a local market within Calabar municipality) Calabar. The cowpea seeds were selected to ensure that none was perforated and

then disinfected in a freezer at 18°C for 48 hours and air dried in the open laboratory to prevent molding and kept in dry polythene bags prior bioassay.

Insect Rearing

The culturing of *C. maculatus* adults used for this study were obtained from an existing cowpea infested with weevils from a shop along Etagbor layout, Calabar municipality and reared at ZEB Room 249 in the department of Zoology and Environmental Biology, University of Calabar. Uninfested cowpeas were being added to culture at intervals to ensure the insect had enough to feed on so as to avoid starvation. The insects were reared in a perforated lid jar from where the stock was obtained and used for the experiment.

Collection of Test Plant Materials

The leaves of *A. wilkesiana* and *P. longifolia* used in the study were obtained from Ikot Ansa axis of Calabar Municipality and within the University of Calabar campus respectively. The leaves were air dried for two weeks in the laboratory before milling into fine powder with an electric blender and sieved through a mesh (250µm size).

Experimental Design

Laboratory-based assays were conducted in a completely randomized design using leaves powder of *Acalypha wilkesiana* and *Polyalthia longifolia* applied at three treatment doses (1%, 2% and 3%) for each plant and a control, giving a total of seven treatment groups. Each treatment was replicated three times giving a total of 21 treatment units as adopted by Nta *et al.* (2018).

Weevil Mortality

In a bid to determine the efficacy of *Acalypha wilkesiana* and *Polyalthia longifolia* powders on the mortality of *Callosobruchus maculatus* (insect pest pests of Cowpea), disinfected cowpea grains without feeding holes were weighed at 100g into a plastic container. Each container of 100g of cowpea was treated with various plant powders using different concentrations of the powder at (0%, 1%, 2% and 3%) and replicated three times each. The percentage concentrations of the powders were calculated using weight of test plant powder to weight of the cowpea while. The treatment with 0% concentration of the powder served as the control from which the comparison was made.

Twenty (20) adult *C. maculatus* were introduced into the transparent test containers uniformly to mate and oviposit for five days. The covers of the test containers were bored through and covered by nylon mesh (0.25mm mesh size) to ensure the weevils were confined within and secondly to ensure effective ventilation. Adult mortality count was carried out in four days at intervals of 24, 48, 72 and 96h after plant powders were applied. At each count, the numbers of dead weevils were noted and removed while those that were still alive were left to continue the experiment.

In order to ascertain if an insect was still alive or not, an insect under the study was pricked using an entomology needle and any insect which couldn't

respond after continuous pricking was considered dead and removed immediately.

From the data obtained, percentage weevil mortality at 24, 48, 72 and 96 succeeding treatment was calculated as:

$$\text{PWM} = \frac{\text{Number of dead weevils per treatment}}{\text{Total number of weevils introduced}} \times 100 \quad (\text{Nta et al., 2018})$$

Weevil Damage Test-

The degree of damage caused by the weevil was assessed based on the number of seeds perforated with one or more conspicuous exit holes at three weeks post treatment. Seeds examined were 30 sample seeds randomly selected from each treatment. Count data were taken on the number of seeds perforated. All biological assays were repeated three times and data obtained were pooled out and

subjected to analysis. The percentage damage caused by *C. maculatus* to seeds was computed following the method used by Adedire & Ajayi (1996) i.e.

(i) Percentage Damage (PD) = Number of treated perforated seeds sampled / Total number of sample seeds X 100

(ii) Weevils perforation index (WPI) was also calculated from the data obtained using the method by Fatope et al. (1995)

$$\text{WPI} = \frac{\text{Perforated seeds in treatment}}{\text{Perforated seeds in control} + \text{Perforated seeds in treatment}} \times 100$$

Adult Cowpea Weevils Emergence

The emergence and percentage reproductive potential inhibition test of adult *C. maculatus* were determined based on the emergence of the first filial generation (F1) progeny, five weeks following the removal of the weevil from the 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 powder on weevil's reproduction (reproductive Capacity inhibition test).

Emerged weevils were sieved out daily to prevent mating and subsequent oviposition by F1 progeny (Stathers et al., 2005).

The bioassay was concluded after seven weeks when there was no more emergence of adults and cumulative emergence for each unit was recorded accordingly. All data obtained for the RPI test were determined from the adult emergence using the formula:

$$\text{RPI} = \frac{\text{No. Of adult emerging in control} - \text{Adults emerging in treatment}}{\text{No. of adults emerging in control}} \times 100 \quad (\text{Nta et al., 2018})$$

Statistical analysis

Analysis of variance (ANOVA) was used to compare the mean mortality rates of beans weevils treated with different plant powders and the control group while the t-test was used to compare the efficacy of each plant powder against the control group. All data analyses were undertaken using SPSS version 17.0 software for windows, and conclusions drawn at 95% probability level.

RESULTS AND DISCUSSION

Weevil Mortality

After 96h of application of plant powder, significant differences ($P > 0.005$) were observed among the plant leaves powder of *Acalypha wilkesiana* and *Polyalthia longifolia* and control on cumulative mean mortality (%) of adult *C. maculatus*. It was observed that both powders had lethal contact effects on the insect at varying degrees and their effects were time dependent.

After 24h of exposure of the insects to both powders at 1% concentration, no mortality case was recorded but at 48h on exposure to same concentrations of the powders, mortality cases were noted with 3.35% mortality *C. maculatus* in cowpea treated with *Polyalthia longifolia* and 6.65% mortality of the weevils in the cowpea treated with *Acalypha wilkesiana* powder. Highest percentage mortality recorded in 1% concentration of both powders was recorded after 96h of treatment with *P. longifolia* at 16.65% and *A. wilkesiana* at 20.76%.

Also, it was noticed that the highest percentage mortality recorded in the control was 8.35% after 96 h and was similar to the result recorded in 24h with weevils treated with *A. wilkesiana* and 72h with *P. longifolia* powder. It was also noticed that the percentage mortality (25.46) recorded in 3% of *P. longifolia* at 96h post treatment observation was less than that at the same concentration with *A. wilkesiana* at 72h.

From the overall mortality test, the highest rate of *C. maculatus* mortality to both powders was each recorded at 3% concentration after 96h of treatment with *P. longifolia* recording 25.46% and *A. wilkesiana*

recording 30.23%. It is observed from the table that when compared to the control, both powders of *A. wilkesiana* and *P. longifolia* were potent but powder of *A. wilkesiana* proved to be more effective yielding significantly higher mortalities ($P>0.05$) than the powders of *P. longifolia*.

Table 2: Effects of *Polyalthia longifolia* and *Acalypha wilkesiana* leaves powder on mortality of *C. maculatus*

Plants	Conc % (w/w)	24hr	48hr	72hr	96hr
<i>Polyalthia longifolia</i>	1	0.00±0.00 ^a	3.35±0.33 ^b	8.35±0.33 ^b	16.65±0.67 ^b
	2	1.65±0.33 ^b	13.35±0.67 ^c	16.65±0.33 ^c	21.65±0.33 ^c
	3	6.65±0.67 ^c	18.35±0.33 ^d	21.65±0.88 ^d	25.46±0.58 ^d
<i>Acalypha wilkesiana</i>	1	0±0.00 ^a	6.65±0.67 ^{bc}	15.58±0.58 ^c	20.76±0.58 ^c
	2	8.35±0.33 ^c	13.35±0.67 ^c	20.75±0.58 ^d	23.35±0.33 ^{cd}
	3	15±0.58 ^d	18.30±1.20 ^d	26.65±0.33 ^e	30.23±1.00 ^e
Control	0	0.00±0.00 ^a	0.00±0.00 ^a	1.65±0.33 ^a	8.35±0.33 ^a

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

Weevil Damage and weevil perforation index

In assessing the effect of the test plant's powders on the grain damage by *C. maculatus*, the units that were treated with powders were compared to the control. All powders were discovered to have induced significantly lower ($P<0.05$) percentage seed damage. The control which was not applied any of either plant powders recorded the highest percentage of cowpea damage at 51.10% caused by the weevils. This was followed by the cowpea grains treated with *P. longifolia* powders which recorded 37.77%, 28.87% and 24.43% at 1%, 2% and 3% powder concentrations respectively. The lowest damage reports were recorded by the grains treated with powders of *A. wilkesiana* which were 32.23%, 24.43% and 17.77%

at 1%, 2% and 3% powder concentrations respectively. It was observed that at 3% concentration of *P. longifolia*, the damage recorded (24.43%) was the same as that recorded in the 2% powder concentration of *A. wilkesiana*.

The weevil perforation index was recorded highest in *P. longifolia* at 42.50% which was higher as compared to same concentration of *A. wilkesiana* powder which gave 38.68%. The lowest perforation index was recorded in 3% of *Acalypha wilkesiana* at 25.80% lower than at 3% of *P. longifolia* which was 32.25%. Both powders showed suppressive influence on weevil damage ability and perforation index but powder of *A. wilkesiana* proved to be more effective than *P. longifolia*. Both plants have been reported to contain Alkaloids, Saponins, Tannins and phenolic acids which may have been the reason for their suppressive ability (Lara *et al.*, 2010; Ogbeide *et al.*, 2021; Oso, 2020)

Table 3: Effects of powders of *Acalypha wilkesiana* and *Polyalthia longifolia* on *C. maculatus* damage and weevil perforation index of cowpea seeds.

Plants	Conc % (w/w)	Weevil Damage (%)	WPI (%)
<i>Polyalthia longifolia</i>	1	37.77±0.33 ^c	42.50±0.33 ^d
	2	28.87±0.33 ^b	36.10±0.33 ^{bc}
	3	24.43±0.33 ^{ab}	32.35±0.33 ^b
<i>Acalypha wilkesiana</i>	1	32.23±0.33 ^b	38.68±0.88 ^c
	2	24.43±0.33 ^{ab}	32.35±0.33 ^b
	3	17.77±0.88 ^a	25.80±0.33 ^a
Control	0	51.10±1.23 ^d	54.23±1.02 ^e

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

Cumulative Adult Emergence

Both test plants powders used for the experiment individually showed significant effects ($P < 0.05$) on progeny emergence when compared with the control. In the control, it was observed that the highest cumulative mean of emerged progeny of *C. maculatus* (45.66) was significantly higher ($P > 0.05$) than emerged progeny in all experimental units. With the treatments, the lowest mean of emerged adults and highest reproduction potential inhibition were 3% with *A. wilkesiana* (12.34, RPI = 78.74); 2% with *A.*

wilkesiana (23.02, RPI = 72.40) and 3% with *P. longifolia* (23.51, RPI = 71.15).

The result showed that the cumulative emergence in 3% powder concentration of *P. longifolia* (23.51) was not significantly different from that 2% concentration of *A. wilkesiana*. The reproductive inhibition was very high in *A. wilkesiana* treatments as compared to *P. longifolia* and the control. In all the treatments, the highest emergence and lowest reproductive potential inhibition was 1% with *P. longifolia* (37.25, RPI = 18.46%). While the highest reproductive inhibition and lowest emergence (12.34, RPI = 78.74%) was recorded in *A. wilkesiana*. This goes to show that both plants have reproductive potential inhibition properties on *C. maculatus*, *A. wilkesiana* has a higher effect than *P. longifolia*.

Table 4: Effect of Powders of *Polyalthia longifolia* and *Acalypha wilkesiana* on progeny emergence and reproductive potential inhibition (RPI) of *C. maculatus*.

Plants	Conc. % (w/w)	Cumulative emergence	RPI
<i>Polyalthia longifolia</i>	1	37.25±0.09 ^c	18.46±0.12 ^b
	2	28.89±2.70 ^{bc}	61.40±0.14 ^{cd}
	3	23.51±2.59 ^b	71.15±0.18 ^d
<i>Acalypha wilkesiana</i>	1	29.70±2.46 ^{bc}	38.57±0.26 ^c
	2	23.02±2.62 ^b	72.40±0.26 ^d
	3	12.34±1.64 ^a	78.74±0.15 ^e
Control	0	45.66±0.09 ^d	0.00±0.00 ^a

Values are presented as Mean \pm Standard Error. Values in each column having similar superscript are not significantly different based on Waller-Duncan post hoc test.

The results obtained from this research reveals that the leaves of *Polyalthia longifolia* and *Acalypha wilkesiana* had insecticidal activities against *Callosobruchus maculatus* and can be used in the control of the bruchid.

When compared to the control, all the test plants' powders were effective in reducing insect population under laboratory conditions however; their effectiveness was directly proportional to concentration and exposure periods. This was evidenced by highest mortality recorded at highest concentration of 3% and at 96h post treatment by *A. wilkesiana* and though slightly lower but significantly different mortality recorded by 3% if *P. longifolia* at the same post treatment time. Earlier authors had also reported dose-related mortalities in similar treatments (Ukeh *et al.* 2012; Nta *et al.* 2018). *P. longifolia* and *A. wilkesiana* have been reported by different researchers to contain different phytochemicals such as Tannins, Saponins, phenolic acids etc which acts as chemical defenses against herbivores and other organisms in the environment (Ogunwenmo *et al.* 2007; Lara *et al.*, 2010; Oso, 2020; Ogbeide *et al.*, 2021). 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 (Lee *et al.* 2001; Kouninki *et al.* 2007).

The bioactivities of these plants may have been due to contact toxicity of the plants powders to the insect or stomach poisoning during feeding (Oso, 2020; Ogbeide *et al.*, 2021). Furthermore, at higher concentrations, the powder may have blocked the insect's spiracles resulting in suffocation and death. This probable action was also reported by Oparaeke & Kuhiep (2006). This study thus confirms the reports of Rayapakse (2006) and Asawalem *et al.* (2012) who reported that these tropical plants (*A. wilkesiana* and *P. longifolia*) have strong anti-feedant and anti - survival effects on different storage pest species including Coleopterans such as *C. maculatus*. *Callosobruchus maculatus* on exposure to 1% of *A. wilkesiana*, there was no record of mortality which contradicts reports by Oni (2009) where it was reported that there was significant loss at 24h post treatment. This could be due to the fact that oil had more phytochemicals present in larger volume as compared to the powder used in this study.

Plant products including essential oils and powders are a mixture of biologically active substances or secondary metabolites of defensive nature that have been broadly studied for pest management purposes (Isman, 2006; Pavela, 2011). Botanic powders, similar to essential oils, are intricate blends of terpenes, their oxygenated derivatives and other aromatic

compounds. Their chemical composition often varies significantly depending on factors such as species, chemotype, climate, soil conditions, geographical location and extraction method. (Nerio *et al.*, 2010; Zapata and Smaghe, 2010). The mechanism of activity of plants powders and their chemical component could affect the biochemical process and disrupt the endocrine balance of insects (Rattan, 2010). The action of botanics and its chemical constituent may also produce neurotoxicity in insects giving symptoms similar to those produce by organophosphate and carbamate insecticides (Ukeh and Umoetok 2011), which are often characterized by hyperexcitation leading to rapid knock-down and immobilization (Rattan, 2010).

The phytochemicals screening of *A. wilkesiana* leaves conducted showed the presence of Tannin, phenol, Saponin, flavonoid, Cardiac Glycoside, Phytate, Anthraquinones, Terpenoids, Oxalate and Alkaloids (Madziga *et al.* (2010). The physico - chemical and phytochemical evaluation of leaves powder of *P. longifolia* also showed the presence of Alkaloids, steroids, tannins, phenols and flavonoids (Jayaveera *et al.* 2010). The presence of Saponins in the Copper leaf may have been the major reasons behind the higher mortality recorded from the experiment (Chaieb, 2010).

Significant reproductive inhibition of *C. maculatus* due to the plant powders was exhibited by the significantly lower cumulative progeny emergence but higher reproductive potential inhibition in treated experiments, unlike the control which recorded up to 45.66 progeny emergence and a low RPI of 0.00

Polyalthia longifolia has earlier been reported to have to have demonstrated larvicidal and repellent activities on mosquito (Sosan *et al.* 2001; Lara *et al.* 2010) while research has also proven the inhibitory effects of *A. wilkesiana* oil extract on the antioxidant, detoxifying and neurotransmitter enzymes in *C. maculatus*. The Alkaloid present in the powder from qualitative phytochemical analysis may have been the major reason behind the potency of the plant in the control of *C. maculatus* (Oni, 2019).

Finally, this study indicates that *A. wilkesiana* and *Polyalthia longifolia* powder elicited direct adult mortality, reduced level of weevil damage and perforation index of the insect (*C. maculatus*) as well as exert an inhibition on the emergence of a new generation. This therefore proves the efficacy of the plants in control of insect infestation.

CONCLUSION AND RECOMMENDATION

The findings from this study showed that mortality increased as concentration and exposure time increased. The study also revealed mortality, controlled damage effect and reproduction inhibition potentials against *C. maculatus*. *Acalypha wilkesiana* caused the highest mortality rate followed by the second test plant *P. longifolia* in all concentrations evaluated.

Unlike the mortality case, the damage effects on the cowpea seeds treated with *A. wilkesiana* by *C. maculatus* was lesser and there was an obvious reduction in damage as the plant powder concentration increased. Inhibition rate was found to be higher in cowpea seeds treated with plant powders when compared with the control. It can be concluded that these local plants can be advertised to replace synthetic chemicals used in insect pest control in stored grains which may likely pose serious health threats to humans and damage to the environment.

It is recommended that due to their availability and environmental friendliness, plant powders should replace synthetic pesticides in the control of insect pests. Furthermore, since all test plants exhibited insecticidal properties, a similar study should also be carried out by combining powders of both plants to know the combined effects in the control of pests.

REFERENCES

- Adamu, A., 2015. Role of food security in achieving national security. The Punch newspaper, 39: 24.
- Adedire, C. O. and Ajayi, T. S., 1996. Assessment of the insecticidal properties of some plant extracts as grain protectants against the maize weevil, *Sitophilus zeamais* Motschulsky. Nigerian Journal of Entomology, 13(1):93-101
- Ajayi, O. E. Balusa, R. Morawo, T.O. Zebelo, S. and Fadamiro, H., 2015. Semio chemical modulation of host preference of *Callosobruchus maculatus* on legume seeds. Journal of stored products research, 63: 31-37.
- Asawalam, E. F., Emosairue, S. O., Ekeleme, F. and Wokocha, R. C., 2006. Insecticidal effects of powdered parts of eight Nigerian plant species against maize weevil, *Sitophilus zeamais* Motsch. (Coleoptera: Curculionidae). Nigerian Agricultural Journal 3: 106–113.
- Chaieb, I., 2010. Saponins as insecticides, A review. Tunisia J. Plant protect. 5: 39-50.
- Chougourou C. D., Zoclanclounon, Y. A., Agbaka, A. and Togola, A., 2015. Toxicity of two plant powders as biopesticides in the management of *Callosobruchus maculatus* F. (Coleoptera: Chrysomelidae, Bruchidae) on two stored grain legumes. Journal of Applied Bioscience, 86: 7900-7908.
- Fatope, M. O., Nuhu, A. M., Mann, A. and Takeda, Y., 1995. Cowpea weevil bioassay: A simple prescreen for plants with grain protectant effects. International Journal of Pest Management, 41: 2, 84-86
- Idoko, S. O., Bassey, S. U. and Ukatu, P., 2016. Comparative efficiency of insecticidal plants on the management of groundnut Bruchid (*caryedon serratus*). Journal of Agricultural studies 4(3): 47
- Isman, M. B., 2006. Botanical insecticides, deterrent and repellents in modern Agriculture and an increasing regulated world, Annual Review of Entomology. 51: 45-46
- Isman, M. B., 2008. Percept botanical insecticides for richer, for poorer. Journal of Pest management science, 64: 8-11.
- Ito, E. E and Ighere, E. J., 2017. Bio-insecticidal potency of five plants extracts against cowpea weevil, *Callosobruchus maculatus*, on stored cowpea, *Vigna unguiculata*. JORDAN Journal of Biological sciences. 104:317-322.
- Jayaveera, K. N. Sridhar, C. Kumanan, R. Yogananda, R. K., 2010. Phytochemical, antibacterial and anti-helminthic potential of flowers of *Polyalthia longifolia* Var. Pendula. Natural product communications 4(3):327-330.
- Kabeh, J. D. and Lale, N. E., 2004. Effects of pre-harvest sprays of Neem, *Azadirachta indica* seed products and pirimiphos-Methyl and harvest time modification on infestation by storage Bruchids in the field and store in Maiduguri, Nigeria. Nigerian journal of Entomology 22: 104 – 116
- Kouninki, H., Haubruge, E., Noudjou, F. C., Lognnay, G., Malaisse, F., Ngassoum, M. B., Goudoum, A., Mapongmetsem, P. M., Ngamo, L. S. and Hance, T., 2007. Toxicity of some terpenoids of essential oils of *Xylopia aethiopica* from Cameroon against *Sitophilus zeamais* Motschulsky. Journal of Applied Entomology 13(4): 269–274.
- Langyintuo, A. S., Lowenberg-Deboer, J., Faye, M., Lambert, D., 2003. Cowpea demand and supply in West and Central Africa. Field Crops Research 82: 215-231

- Lara, O. O., Kaloustian, J., Agbani, E. O., Portugal, H., Adewoyin, F. B., Fagbola, E. O., 2010. Pesticidal and antimicrobial profile of the sesquiterpenrich leaf essential oil of *Polyalthia longifolia*, Sonn. Thwaites. <https://www.researchgate.net/publication/287235334>
- Lee, S. E., Lee, B. H., Choi, W. S., Park, B. S., Kim, J. G. and Campbell, B. C., 2001. Fumigant toxicity of volatile natural products from Korean spices and medicinal plants towards the rice weevil *Sitophilus oryzae* (L.). *Pest Management Science* 57: 548–553.
- Madziga, H. A., Sanni, S. and Sandabe, U. K., 2010. Phytochemical and elemental analysis of *Acalypha wilkesiana* leaf. *Journal of American Science*. 6(11): 510-514
- Nerio, L. S., Olivero, J and Stashenko, E., 2011. Repellent activities of essential oils: A Review *Bio Resources Technology* 101: 372 - 378.
- Nta, A. I., Okweche, S. I., and Umoetok, S. B., 2018. Efficacy of three plants powders in the control of *Cylas puncticollis*_(Boheman) (coleopteran: curculionidae) on sweet potato during storage. *Journal of African Entomology* 26(1):141-149.
- Ogbeide, O. S., Unuigbo, C. A., Unula, C. F., Aiwonegbe, A., Uadia, J. O., 2021. Bioactive chemical constituents, acute toxicity and 1,1-diphenyl-2-picrylhydrazyl radical scavenging activity of *Polyalthia longifolia* root. *GSC Biological and Pharmaceutical Sciences*, 14(01): 18-26
- Ogungbite, O. C., Odeyemi, O.O. and Ashamo, M. O., 2014. Powders of *Newbouldia laevis* as protectants of cowpea seeds against infestation by *callosobruchus maculatus* (Fab) for poor resource farmers. *Octa journal of Bioscience* 2(1): 40-48
- Ogunwemmo, K. O. Idowa, O. A., Innocent, C, Essan, E. B. and Oyelana, O. A., 2007. Cultivation of *codium variegatum* Blume (Euphorbiaceae) show variability in phytochemical and cytological characteristics. *African journal of biotechnology* 6(2): 2400-2405.
- Oni, M.O., 2019. Efficiency of *Acalypha wilkesiana* leaf oil extract applied as a biocide against *Callosobruchus maculatus*. *Brazilian journal of biological science*, 6(12): 171-180.
- Oni, M. O., Ogungbite, O. C., Oguntuase, S. O., Bamidele, O. S. and Ofuya, T. I., 2019. Inhibitory effects of oil extract of green *Acalypha* (*Acalypha wilkesiana*) on antioxidant and neurotransmitter enzymes in *Callosobruchus maculatus*. *The journal of Basis and Applied Zoology*. 80: 47
- Oparaeke, A. M. And Kuhiep, G. C., 2006. Toxicity of powders from indigenous plants against *Sitophilus zeamais* Motsch. on stored grains. *Journal of Entomology* 3: 216–221.
- Oso, A. A., 2020. *Acalypha wilkesiana*: prospects as an agricultural biocide. *World Journal of Advanced Research and Reviews* 6(1): 166-172
- Pavela, R., 2011. Insecticidal and repellent activity of selected essential oils against the pollen beetle, *Mengethes aeneus* (Fabricius) adults. *Industrial Crops and product* 34: 888-892
- Rattan, R. S., 2010 Mechanism of action of insecticidal secondary metabolites of plant origin, *Crop protection* 29: 913-920
- Rayapaske, R. H., 2006. The potential of plants and plant products in stored insect pests' management. *Journal of Agricultural Sciences* 2(1): 11–21.
- Sosan, M. B, Adewoyin, F. B, Adewunmi, C.O., 2001. Larvicidal properties of three indigenous plants oil on the mosquito *Aedes aegypti*. *Nig. J. Nat. And med* 05: 30-31.
- Stathers, T., Namaanda, S., Mwanga, R. M., Khisa, A. and Kaporga, R., 2005. Manual for Sweet Potato integrated production and pest management. Farmers field school in Sub-Sahara Africa, International Potato Centre, Kampala, Uganada.
- Ukeh, D.A., 2009. Repellent effects of five monoterpenoid odors against two stored products insects' pest. *Nigerian Journal of Entomology* 26: 11-19.
- Ukeh, D. A. and Umoetok, S. B., 2011. Repellent effects of five monoterpenoid odours against *Tribolium castaneum* (F) in Calabar, Nigeria. *Crop protection*, 30: 1351-1355
- Zapata, N. and Smagghe, G., 2010. Repellency and toxicity of essential oils from the leaves and bark of *Laurelia sempervirens* and *Drinys winteri* against *Tribolium castaneum*. *Scientific Journal of Biosciences* 32: 405-410.