Evaluation of Some Plant Materials for the Control of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) on Stored Cowpea Seeds (A Review).

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ABSTRACT

Effect of Coffee senna (*Cassia occidentalis)* and Shea butter (*Vittallaria paradoxa)*, Neem (*Azadirachta indica)*, Cashew (*Anacardium occidentale* (L)), *Pipper guineense* Schum, compared with Actellic dust (Pirimiphos methyl) on the control of cowpea bruchid, *Callosobruchus maculatus* (Fab.) under prevailing laboratory conditions were reviewed. The results of the review revealed that the effect of *A. indica* and *P. guineense* powders have a comparative effect to synthetic insecticide (Pirimiphos methyl). Similarly the mixture of *C. Occidentalis* and *V. paradoxa* leaf powders in the ratios of 50%:50% applied at the rate of 2.5.5.0, 7.5 and 10.0w/w into 20g of cowpea seeds caused mortality of adult bruchid at different time intervals. Also Cashew kernels oil extract completely prevented infestation and damage of cowpea seeds for a period of three months. The results of the review clearly revealed the potentials of *A. indica* and *P. guineense* seeds powders and the mixed powders of leaves of *C.occidentalis* and *V. paradoxa* and cashew kernel oil as plant derived grain protectants against *C. maculatus* and could serve as an alternative to synthetic insecticides for the protection of stored cowpeas against the bruchid.

Keywords: *Callosobruchus maculatus;* grain protectants; synthetic insecticides; infestation; cowpea.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp. is one of the most nutritious grain legumes (Ehlers and Hala, 1997) where it is valuable as a source of dietary protein as well as vitamins and minerals (Singh *et al*., 2003). The bean weevil is considered as one of the most serious stored bean pests worldwide. Like many other food crops a wide spectrum of insect pest attack cowpea both in the field and in the storage, among them is the Cowpea beetle *Callasobruchus maculatus* (F) which is a cosmopolitan and most important storage insect pest of cowpea Linnaeus (Walpers) (Southgate,1979.,Jackai and Daoust,1986:Deborah *et al* ;2003) that can render the unprotected

grain unsuitable for food or seed in 4-6month(Sec *et al* 1991). The cowpea bruchid, *Callosobruchus maculatus*, is a major insect pest of cowpea in the tropics (Ofuya, 1992), causes great loss of stored cowpea seeds in Nigeria (Caswell. 1970; Taylor, 1971). Synthetic insecticides have been widely developed and are extensively used for the control of agricultural insect pest because of their effectiveness and easy application and storage. However, the problems of many synthetic insecticides which include high persistence, poor knowledge of application, cost, non-availability, genetic resistance and hazard to health have necessitated the search for humanly safe, ecologically tolerable and relatively cheap control measures (Sighamony *et al.* 1986, Knaham *et al*. 1990, Adedire & Ajayi 1996, Akinkurolere *et al*. 2006). Evaluating and using botanical pesticides, either as crude or formulated extracts, is an alternative strategy. The study was undertaken to review the effectiveness of different plant materials used as bean seeds protectants against the cowpea bruchid *Callosobruchus maculatus* (F.). Some plants of worldwide distribution had shown, in previous observations, toxic, antifeedant and repellent effects on insects. Among these plants, effect of Coffee senna (*Cassia occidentalis)*, Shea butter (*Vittallaria paradoxa)*, Neem (*Azadirachta indica)*, Cashew (*Anacardium occidentale* (L)) and *Pipper guineense* Schum were compared with Actellic dust (Pirimiphos methyl) on the control of cowpea bruchid, *Callosobruchus maculatus* (Fab.) was highlighted. The international literature on the biological properties of crude extracts and isolated secondary substances of plants against different insects and other organisms is abundant. Jilani & Su (1983) and Jilani *et al.* (1988) conducted insect repellency assays using extracts of different plants on stored-product pests. Boeke *et al.* (2004) evaluated the efficiency of 23 different plant extracts on *Callosobruchus maculatus* and found repellency of volatile oils. Abdullahi, N., (2011) evaluated the efficacy of different concentrations of mixed leaf powders of *Vittallaria Paradoxa and Cassia occidentalis* against *Callosobruchus Maculatus* (F.) (Coleoptera: Bruchidae) on stored cowpea seeds. Ileke, K. D. *et al*., (2012), evaluated the contact toxicity and fumigant effect of *Azadirachta indica*, *Anacardium occidentale*, *Pipper guineense*, and Pirimiphos Methyl Powders against Cowpea Bruchid, *Callosobruchus maculatus* (Fab.) [Coleoptera: Chrysomelidae] in stored cowpea seeds. Chris O. *et al,* (2011) study the response of *Callosobruchus maculatus* (Coleoptera: Chrysomelidae: Bruchinae) to extracts of cashew kernels. Thorayia F.K. *et al,* (2012) study the efficiency of peppermint oil fumigant on controlling *Callosobruchus Maculatus* F. infesting cowpea seeds.

RESULTS AND DISCUSSION

Effectiveness of Plants and Pirimiphos methyl Powders as Contact Insecticides

The contact toxicity of the combined formulation of *C. occidentalis* and *V. paradoxa* leaf powders and *A. indica, A. occidentale, P. guineense* and pirimiphos methyl powders against *C.maculatus we*re shown in (Table 1 and 2). Highest mortality count (100%) of *C.maculatus* adult was observed on seed treated with the combination of the leaf powders applied at the concentration of 7.5 and 10.0%w/w after 24hours of treatment and this was found to be similar with that recorded on seed treated with the chemical pesticide(Actellic dust) with the higher concentration of the mixed leaf powders (Table1).The lowest mortality of the insect was noted on the seeds treated with lower application level of the combination of the leaf powders(2.5%w/w and 5.0%w/w) which recorded 100%mortality after 120 hours of treatment and this was found to be better than the mortality recorded on the untreated control seeds of 100% mortality at 216 hours after exposure to treatment. The result obtained in the study has demonstrated the insecticidal activity of the combined formulation of *C. occidentalis* and *V.*

paradoxa leaf powder against *C. maculates* similar to the chemical pesticide (Actellic dust). These was in agreement with the findings of Ogunwolu and Idowu (1994) who reported that 2.5% powdered seed of *A. indica* were toxic to *C. maculates*. Similarly Mulatu and Gebremedhin (2000) reported that eucalyptus seed powder treatment caused the death of emerging adult of *Callosobruchus*. The effectiveness of this leaf powder may be attributed to the presence of different bioactive agents such as steroid, flavonoid, anthraquinone e.t.c in the extracts of the powders.

Neem, *A. indica* powder caused 50% mortality of adult cowpea bruchid, *C.maculatus* at rate of 0.8g/20g within 24 hours of post treatment (Table 2). The corresponding value for *P. guineense* was 47.7% mortality. These were significantly lower ($P<0.05$) than that of pirimiphos methyl dust which caused 77.7% mortality of adult cowpea bruchid, *C. maculatus* at rate of 0.8g/20g of cowpea seeds within 24 hours of application. At three days post treatment, *A. indica*, *A. occidentale* and *P. guineense* caused 93.3%, 43.3% and 90% mortality of adult cowpea bruchid, *C. maculatus* at rate of 0.8g/20g of cowpea seeds compared with pirimiphos methyl who were able to evoked 100% adult mortality of *C. maculatus* at all the concentrations tested. However at seven days post application, *A. indica*, *P. guineense* and pirimiphos methyl powders caused 100% mortality of adult bruchid at all tested concentrations (Table 2). Neem, *A. indica* powder when used as contact insecticides caused 100% mortality of adult bruchid within 7 days of treatment, an effect that have earlier been reported by Ofuya (1992); Onu and Baba (2003); Mainia and Lale (2004); Mbailao *et al*. (2006). The insecticidal potential of *A. indica* could be attributed to the presence of azadiratins, which is toxic to stored product insect pests (Onu and Baba, 2003; Mainia and Lale, 2004; Mbailao *et al*., 2006). Black pepper, *P. guineense* powder also had contact toxicity of comparable effect to that of pirimiphos methyl dust causing 100% adult mortality of bruchid within 7 days of application (Table 2), an effect that is similar to the report of Ofuya and Dawodu (2002) that reported the effectiveness of *P.guineense* powder against *C. maculatus*. This result also validated the reports of Asawalam and Emosairue (2006); Ashamo (2007) that *P. guineense* and Pirimiphos methyl powders caused 100% mortality of adult maize weevil within 7 days of application. These authors established that the biological activity of *P. guineense* could be attributed to the presence of chavin and piperine, an unsaturated amide (Lale, 1992). Cashew seed powder could be very effective against stored product insects if applied at high concentrations (Table 2). Oparaeke and Bunmi (2006) reported that *A. occidentale* nut shell was highly toxic to *C. subinnotatus* and achieved 100% insect mortality within 48 hours at 7.5% and 100% mortality within 72 hours at 2.5% and 5.0% concentrations. Adedire *et al*. (2011) also reported that cashew kernel extracted with water, methanol, ethanol, acetone, pet- ether and n-hexane caused 85% to 100% adult mortality of *C. maculatus*. They attributed these insecticidal activities to the presence of secondary plant compounds such as anacardic acid and cardinal (Rehn and Espig, 1991). Others are quercetin and kampferol glycosides (Oliver- Bever, 1986). The lethal effect of these powders on cowpea bruchid In this study could be as a result of contact toxicity.

Fumigant Effect of Plant and Pirimiphos Methyl Powders

Table 3 shows the fumigant effect of *A. indica*, *A. occidentale*, *P. guineense* and pirimiphos methyl powders against *C. maculatus*. At three days of application, powders of *A. indica*, *A. occidentale* and *P. guineense* causedmortality of adult cowpea bruchid at all tested concentrations. However pirimiphos methyl powder caused 100% mortality of adult *C. maculatus* at all tested concentrations. The plants powders were not effective as fumigants with

the highest mortality of 23.3% and 20% caused by *A.indica* and *P. guineense* powders respectively. This result validated the report of Ashamo (2007) who recorded that *P. guineense* powders tested for fumigant effect could only caused 28.4% adult mortality of maize weevil.

Effect of cashew kernel oil extracts on mortality of adult *C. maculatus*

Bruchid mortality in cowpea seeds treated with cashew kernel oil extracts differed significantly ($F_{6, 21} = 148.63$, $P = .001$) from bruchid mortality in the untreated (control) (Table 4). All extracts showed bruchid mortality ranging from 85.5%– 100%. Adult mortality increased with length of exposure. Cashew kernel extract of steam distillate and n-hexane were most effective against *C. maculatus* evoking 100% and 98.75% mortality, respectively, after 72 h of exposure. Ethanol extract was least toxic causing 85.50% bruchid mortality after 96 h of exposure. Th results obtained from this study showed that extracts of cashew nut seeds caused high mortality of adult *C. maculates* in treated cowpea seeds with steam distillate being the most toxic of all the extracts tested. This corroborated the findings of Oparaeke *et al.* 2001, Oparaeke & Bunmi 2006, who had earlier evaluated plant oils as botanical insecticides and grain protectants and found them effective against storage beetles. The results is also similar to the observations of Onolemhemhem & Oigiangbe (1991), who obtained 100% mortality of adult *C. maculatus* in cowpea seeds treated with groundnut oil at the rate of 5 ml and 6 ml of oil kg–1. Osisiogu & Agbakwuru (1978) had also reported the effective protection of cowpea against *C. maculatus* with *Dennetia tripetala* oil. In this study, the lethal effect of cashew kernel oil extracts on the beetle could be as a result of contact toxicity.

Protectant ability of cashew kernel oil extract on cowpea seeds damage

In this study, the cashew kernel oil extract of, acetone, n-hexane, pet-ether and steam distillate completely prevented infestation and damage of the treated cowpea seeds (Table 5). There was neither seed damage nor weight loss recorded in the treated cowpea seeds and WPI was zero for the above solvent extracts except in seeds treated with cashew kernel oil extract of acetone and methanol. However, the WPI of 12.76 and 26.89 obtained for extracts of acetone and methanol, respectively, were significantly different from WPI of the control. In the untreated cowpea seeds, 75.02% damage occurred as revealed by emergent holes of the bruchids. As a result of the feeding activity of *C. maculatus* larvae on the cowpea seeds, the weight of the untreated cowpea seeds was significantly reduced compared with the treated seeds. This is in agreement with the findings of Pereira (1983) and Shaaya *et al.* (1997) who reported that oils extracted from crude palm kernel and rice bran at the rate of 1.5 g and 3 g kg–1 cowpea seeds offered full protection from *C. maculatus* for a period of 4 to 5 months. The insecticidal activity of cashew kernel oil could be linked to the presence of secondary plant compounds such as anacardic acid and cardinol (Rehm & Espig 1991). Others are quercetin and kaempferol glycosides (Oliver-Bever 1986). Some of these compounds had been implicated in their immunomodulatory, haemolytic, allelopathic and insecticidal activities (Echendu 1991, Golob *et al.* 1999).

Effect of cashew kernel oil extracts on seed viability

Percentage germination of all treated seeds after 7th day was generally high (Table 6). Almost all the treated seeds germinated. The untreated cowpea seeds had the highest germination of 100%, followed by seeds treated with methanol, ethanol, acetone, n-hexane, pet-ether extracts and steam distillate in that order. Grains treated with the steam distillate had the lowest percentage germination of 82.5%. There were no marked differences between the percentage germination in

treated cowpea seeds compared with the untreated (control). This shows that plant extracts have no adverse effect on germination.

SUMMARY AND CONCLUSION

The results obtained from the review confirmed that cashew kernel oil extracts, most especially that of the steam distillate and probably those of non-polar solvents are effective in controlling *C. maculatus*. It could serve as a better alternative to synthetic insecticides. It could also save cost as regards the purchase of solvents such as n-hexane, pet-ether, acetone etc. which are expensive and may not be accessible to small holder farmers. Since cashew kernels are edible, the oil extract is not toxic to humans and their livestock, thereby giving advantage over other bioactive compounds from non edible plant sources. The results also revealed the potentials of *A. indica* and *P. guineense* seeds powders and the mixed powders of leaves of *C.occidentalis* and *V. paradoxa* as plant derived grain protectants against cowpea bruchid, *C. maculatus*. The availability, biodegradable, low costs rate and potential as biopesticide make them good candidates in upgrading traditional crop protection practices in sub-Saharan Africa.

The plants powders were not effective as fumigants with the highest mortality of 23.3% and 20% caused by *A.indica* and *P. guineense* powders respectively.

Table 1: Mortality among adult *Callasobruchus maculatus* (In Hours) reared on Cowpea grains treated with combination of plants leaf powders.

		(Each observation is based on three replicates)							
Combined leaf powder	Amount applied/20g (Conc. In %)	Mortality after infestation(in hours) 24	48	72	96	144	168	192	216
Cass+Vitt(50:50)	0.5(2.5)	53.33	55.00	60.00	76.66	100	-	-	-
	1.0(5.0)	60.00	61.66	65.00	78.33	100	-	-	-
	1.5(7.5)	100	-	-	-	-	-	-	-
	2.0(10.0)	100	-	-	-	-	-	-	-
Control (untreate	0	0	0	0	0	0	0	0	100
Cowpea treated With Actellic du	0.5(2.5)	100	-	-	-	-	-	-	-
	1.0(5.0)	100	-	-	-	-	-	-	-
	1.5(7.5)	100	-	-	-	-	-	-	-
	2.0(10.0)	100	-	-	-	-	-	-	-

Key: Cass=Cassia occidentalis leaf powder, Vitt=Vittallaria paradoxa leaf powder.

Source: Abdullahi, N., (2010) Evaluation Of The Efficacy Of Different Concentrations Of Mixed Leaf Powders Of Vittallaria Paradoxa Andcassia Occidentalis Against *C.Maculatus* (F.).

Table 2. Comparison of percentage mortality of adult *C. maculatus* in cowpea seeds treated w plant powders and Pirimiphos methyl dust for contact toxicity.

Plant powder	Conc. g/20g Cowpea	Mean % Mortality at days Post treatment + S.E.			
		1	2	3	7
A. indica	0.1	10.0+0.0ab	30.0+0.0b	67.7+0.3d	100.0+0.0d
	0.2	14.7+0.6b	46.3+0.6c	70.0+0.0d	100.0+0.0d
	0.4	20.0+0.0b	54.7+0.3c	84.4+0.2e	100.0+0.0d
	0.8	50.0+0.0c	79.3+0.4d	93.3+0.6ef	100.0+0.0d
A. occidentale	0.1	0.0+0.0a	0.0+0.0a	20.0+0.0b	47.3+0.6b
	0.2	0.0+0.0a	0.0+0.0a	27.3+0.6bc	53.3+0.6bc
	0.4	0.0+0.0a	0.0+0.0a	33.7+0.3c	60.0+0.0c
	0.8	0.0+0.0a	0.0+0.0a	43.3+0.6c	63.3+0.6c
P. guineense	0.1	10.0+0.0ab	30.0+0.0b	63.3+0.6d	100.0+0.0d
	0.2	12.3+0.6b	44.2+0.2c	67.7+0.3d	100.0+0.0d
	0.4	19.7+0.3b	50.0+0.0c	83.3+0.6e	100.0+0.0d
	0.8	46.7+0.3c	76.7+0.3d	90.0+0.0ef	100.0+0.0d
Pirimiphos methyl	0.1	63.3+0.6d	80.0+0.0d	100.0+0.0f	100.0+0.0d
	0.2	67.7+0.3de	83.3+0.6de	100.0+0.0f	100.0+0.0d
	0.4	70.0+0.0de	87.7+0.3e	100.0+0.0f	100.0+0.0d
	0.8	77. 7+0.3e	90.0+0.0e	100.0+0.0f	100.0+0.0d
Control	0.0	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a

Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other using New Duncan Multiple Range Test.

Source: Ileke . K. D., *et al*., (2012) Evaluation Of Contact Toxicity And Fumigant Effect Of Some Medicinal Plant And Pirimiphos Methyl Powders Against Cowpea Bruchid, *Callosobruchus Maculatus* (Fab.)

Table 3. Comparison of percentage mortality of adult *C. maculatus* in cowpea seeds treated with plants powders and Pirimiphos methyl dust for fumigant effect

Plant powder	Conc. g/20g Cowpea	Mean % Mortality at days Post treatment + S.E.			
		1	2	3	7
A. indica	0.1	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
	0.2	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
	0.4	0.0+0.0a	0.0+0.0a	0.0+0.0a	10.0+0.0a
	0.8	0.0+0.0a	0.0+0.0a	0.0+0.0a	23.3+0.6b
A. occidentale	0.1	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
	0.2	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
	0.4	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
	0.8	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
P. guineense	0.1	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
	0.2	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a

	0.4	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a
	0.8	0.0+0.0a	0.0+0.0a	0.0+0.0a	20.0+0.0b
Pirimiphos methyl	0.1	10.0 +0,0a	53.3+0.6b	100.0+0.0b	100.0+0.0c
	0.2	23.3+0.6b	60.0+0.0bc	100.0+0.0b	100.0+0.0c
	0.4	30.0+0.0bc	67.7+0.3cd	100.0+0.0b	100.0+0.0c
	0.8	37.7+0.3c	77.7+0.3d	100.0+0.0b	100.0+0.0c
Control	0.0	0.0+0.0a	0.0+0.0a	0.0+0.0a	0.0+0.0a

Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other using New Duncan Multiple Range Test.

Source: Ileke . K. D., *et al*., (2012) Evaluation Of Contact Toxicity And Fumigant Effect Of Some Medicinal Plant And Pirimiphos Methyl Powders Against Cowpea Bruchid, *Callosobruchus Maculatus* (Fab.)

Table 4: Mortality of adult *Callosobruchus maculatus* in cowpea seeds treated with different solvent of cashew kernel

	Percentage mortality at hours post-treatment			
Cashew extract	24	48	72	96
Untreated	0.00 ±0.00a	0.00 ±0.00a	2.50 ±1.44a	2.50 ±1.44an
Hexane	25.00±4.05cd	61.25 ±2.39cd	98.75±5.20d	100.00±0.00d
Pet-ether	21.25±2.39cd	52.50 ±3.15cd	88.75 ±1.25bc	96.25 ±1.20d
Acetone	20.00 ±4.56cd	45.00 ±2.04bc	77.50 ±1.44bc	97.50 ±4.56d
Steam distillate	31.25 ±2.39c	73.25±3.23c	100.00 ±1.25d	100.00 ±1.25d
Methanol	12.50 ±1.44bc	31.25±1.44b	60.00 ±1.25b	93.75±1.25c
Ethanol	8.75 ±1.25bc	26.25±1.44b	52.75 ±1.25b	85.50 ±1.44c

Means within the same column followed by the same letter(s) are not significantly different at P > 0.05 using Tukey's b test.

Source: Adedire *et al* (2011): Toxicity of cashew kernel extracts against *Callosobruchus maculatus*

Table 5: Effect of cashew kernel oil on long term storage of cowpea seeds.

0.4% v/w cashew kernel extract	Mean total number of seeds	Mean number of damaged seeds	Mean percentage seed damage	Mean weight loss	Weevil Perforation Index (WPI)
Untreated	186.25	142.00 ±2.20	75.02 ±2.03d	20.21 ±1.45c	50.00d±0.00d
n-hexane	187.25	0.00±0.00	0.00±0.00a	0.00±0.00a	0.00 ±0.00a
Pet-ether	186.00	0.00±0.00	0.00±0.00a	0.00 ±0.00a	0.00 ±0.00a
Acetone	186.00	0.00±0.00	0.00±0.00a	0.00±0.00a	0.00±0.00a
Steam distillate	187.00	0.00 ± 0.00	0.00±0.00a	0.00±0.00a	0.00 ±0.00a
Methanol	187.00	37.75 ±3.21	20.17±1.73c	11.26±1.04b	26.89 ±2.30c
Ethanol	186.00	18.25±3.21	9.76 ±1.39b	3.10 ±0.52a	12.76±1.92b

Each value is a mean ± standard error of four replicates. Means within the same column followed by the same letter(s) are not significantly different at P > 0.05 using Tukey's b test.

Source: Adedire *et al* (2011): Toxicity of cashew kernel extracts against *Callosobruchus maculatus*

Table 6: Percentage germination of cowpea seeds previously protected for 90 days with 0.5% cashew kernel extracts.

Cashew extracts	Mean percentage germination
Untreated	100.00 ± 0.00d
n-hexane	80.00 ± 2.04a
Pet-ether	86.50 ± 3.15abc
Acetone	88.75 ± 1.25bc
Steam distillate	78.75 ± 2.39a
Methanol	92.50 ± 1.44cd
Ethanol	90.00 ± 2.04c

Each value is a mean ± standard error of four replicates. Means within the same column followed by the same letter(s) are not significantly different at $P > 0.05$ using Tukey's b test.

Source: Adedire *et al* (2011): Toxicity of cashew kernel extracts against *Callosobruchus maculatus*

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