Special Conference Edition, June, 2023

http://dx.doi.org/10.4314/bajopas.v14i1.25S

Bayero Journal of Pure and Applied Sciences, 14(1):160 - 164
ISSN 2006 – 6996

EFFECTS OF WOOD ASH, ORANGE PEEL AND PEPPER ON THE CONTROL OF *Callosobruchus maculatus* INFESTATION OF LOCAL AND IMPROVED VARIETIES OF COWPEA (*Vigna unguiculata* L. Walp.)

Rabiu, Halima Musa
Department of Biological Science, Bayero University, Kano State, Nigeria
Email address: hmrabiu.bio@buk.edu.ng; Phone number: +2348060851382

ABSTRACT
Cowpea (Vigna unguiculata L. Walp.) is an important source of protein for the rural populace in Nigeria. Callosobruchus maculatus infest cowpea pods in the field and continue to grow and multiply in storage causing more hardship on already poor resourced farmers. This research was aimed at assessing the effects of orange peel, pepper and wood ash on control of weevils on improved (IT99k-573-1-1 and IT90K-277-2) and local (Achishiru) cowpea varieties. Pieces of wood, excluding bark, pepper and orange peel were separately washed, dried, milled and sieved. Survival was assessed by introduction of six males and six female healthy weevils in jars containing fifty grams of surface sterilized and uninfested seeds mixed with 2.5g of the respective powders. Survival of the introduced insects was recorded at Days After Infestation (DAI), namely, 5DAI, 10DAI and 15DAI. Emergence from treated seeds as above was recorded after 30, 60 and 90 days. All setups were replicated four times. Data were analysed with General Linear Model (GLM) ANOVA to determine significant differences in treatments at P<0.05. Highest mean survival (12.00) was observed in Achishiru followed by the means of 11.750 in 573-1- 1 and 11.25 for 277-2 at 5DAI in control treatments. Generally, treatments with wood ash was more effective against the weevils than orange peel and pepper. Least survival was recorded at 15DAI in all the varieties treated with wood ash (0.500 in 573-1-1; 0.750 in 277-2 and 1.250 in Achishiru). Significantly higher number of weevils emerged in control of Achishiru (17.75 at 90DAI; 14.00 at 60DAI); 573-1-1(16.50 at 90DAI). Least emergence was from seeds of 277-2 (0.00 at 30DAI), 573-1-1(1.25 at 30DAI). The local variety Achishiru appeared to be more susceptible to the bruchid infestation and improved variety 277-2 was more resistant. Wood ash offered more protection against the weevils than pepper and orange peel. It is recommended that these natural methods of cowpea infestation control methods to be explored with different storage material and for longer durations .
Keywords: Cowpea, Weevil, Wood Ash, Orange Peel, Pepper

INTRODUCTION

Food production for the needs of most of the rural sub-Saharan Africa is carried out by poor resourced smallholders. In northern Nigeria, such farmers face natural challenges such as poor soil fertility, draught, pests and diseases (Rabiu, 2015). Cowpea (*Vigna unguiculata* (L. Walp.), also known as black-eye pea, bean and 'wake' in the local language (Hausa), is a favourite staple in both rural and urban households in Nigeria. In the north western parts of the country, it is the most common delicacy in the mornings as a fried paste (Kosai) eaten with millet porridge (Koko). Cowpea seeds are prepared in numerous ways, aptly supplementing the more expensive forms of animal protein consisting of, on average 24.8%, protein (Aremu*et al.*, 2015). Other parts of the crops are consumed as vegetables or used as livestock fodder. Nigeria is the largest producer with an output of 2.9 million metric tons cultivated in 4.5million hectares annually, representing over 60% of total world production (Adelusi *et al.*, 2021). The production of cowpea is restricted by a number of biotic and abiotic factors both in the field and the seed in storage (Swella and Mushobozy, 2007). The constraining biotic factors are; insect pests, diseases and weeds, imposing serious threats to the crop production in Nigeria (Samaila *et al.,* 2019). The primary insect causing losses to stored cowpeas in West Africa is the cowpea weevil, *Callosobruchus maculatus,* a cosmopolitan pest whose infestation begins in the field and continues in storage (Omoigui *et al.*, 2018; Ilesanmi and Gungula, 2010). The damage caused by these weevils, also known as bruchids adds, constraints food production. Farmers incur economic losses due to loss of weight, nutritional value and viability of the stored grains (Swella and Mushobozy, 2007). Severe infestation can lead to total grain loss after three to six months of storage (Harshani and Karunaratne, 2019).

Efforts at reducing the effects of bruchid attack on seeds involve the use of chemical pesticides such as methyl bromide and phosphine, among others (Omoigui*et al,* 2018). However, the use of synthetic insecticides in crop protection has so many known negative impacts on the environment. There is the need to continue exploring sustainable means for use in common cowpea varieties cultivated by local farmers using indigenous products. Therefore, this research sought to assess the effects of orange peel powder, pepper powder and wood ash on controlling *C. maculatus* infestation of cowpea seeds in storage.

MATERIALS AND METHODS

Collectionof Cowpea Seeds, *C. Maculatus* and Powders

Three cowpea varieties (IT99K-573-1-1, IT99K-277-2 and Achishiru) and bruchids known as cowpea weevils (*C. maculatus*) were collected from International Institute for Tropical Agriculture (IITA) Kano station (11.98º09'N; 8.55º78'5E). Dried fire wood of neem tree (*Azadaricta indica*), whole pods of chilli pepper and orange (*Citrus sinensis*) peels were all obtained from local sellers in Janguza Market located 11.96º69'N; 8.40º05'E in Ungogo local government of Kano State, Nigeria

Preparation of Test Materials

Wood pieces, excluding bark, pepper and orange peel were separately flushed under running water to remove dust and other impurities. They were then air dried in the laboratory for 30 days and oven dried at 60°C; pepper and orange peel for 24 hoursand, wood pieces for 48 hours. Wood pieces were burned over a gas cooker and allowed to ash in an earthen pot. Orange peel and pepper were separately milled in a clean electric blender. Wood ash and milled pepper and orange peels were passed through a 0.05mm sieve (Abdullahi *et al.,* 2016). The sieved powders were stored in airtight containers. The cowpea weevils were maintained in the laboratory in separate ventilated plastic jars containing cowpea seeds of 573-1-1, 277-2 and Achishiru.

Determination of Survival of *C. maculatus*

Seeds of the three varieties treated with wood ash, orange peel, and pepper were surface sterilized using hydrogen peroxide, thoroughly rinsed with sterile water, and oven dried at 60°C for 12 hours to kill any eggs. Fifty grams of seeds were measured in clean, ventilated containers and thoroughly mixed with 2.5g of the respective powders, equivalent to 5% of the Fifty grams of seeds were measured in clean, ventilated containers and thoroughly mixed with 2.5 g of the respective powders, equivalent to 5% of the seeds' weight. Controls were not mixed with any powder (Apuulit *et al.,* 1996). To check for survival, six male and six female healthy adult bruchids were carefully introduced into each jar. The setup was replicated four times. The survival of the introduced insects was recorded by manual counting at 5DAI, 10 DAI, and 15DAI.

Determination of Emergence of *C. maculatus* after Storage

Overall protocol followed modifications in Aboagye *et al.* (2017). Fifty grams of unsterilized, unbroken seeds were measured in well-ventilated plastic jars and treated as above. The number of adults who emerged was recorded after 30, 60, and 90 days after storage (DAS). The jars were placed in a completely random order in the laboratory. Afterwards, a mesh sieve of 4.80 mm diameter was used to remove all insects from the stored grains. The number of live weevils that fell through the sieve apertures was manually).

Statistical Analyses

Data were analysed using the General Linear Model (GLM) of ANOVA with determination of significant values set at P< 0.05 for weevils' survival in the different powders and seed varieties, as well as, emergence from uninfested seeds using Minitab software version 18. Mean comparison was conducted using Turkey test along rows.

RESULTS

The analysis of survival rates of *C. maculatus* by General Linear Model, GLM, ANOVA showed significant influence at P<0.001 of all three factors, namely the duration of the infestation, the variety of seeds and the treatment agent (Table 1). Further, both S (1.085) and adjusted R-Squared values (92.5%) showed the model as a good fit, and very little (less than 8%) of the outcome is accounted by other, unknown factors (Table 1)

Table 1: General Linear Model Analysis Showing the Effect of Time, Seed Variety and Control Method on the Survival of *Callosobruchus maculatus*

Factor	**Type**	**Levels**	**Values**		
Days after Infestation	Fixed	3	5, 10, 15		
Variety	Fixed	3	573-1-1, 573-2-1, Achishiru		
Treatments	Fixed	4	Control, Orange peel, Pepper, Wood ash		
Source	**DF**	**SS**	**MS**	**F**	**P**
Days after Infestation	2	140.29	70.146	59.58	0.000
Seed Variety	2	17.79	8.896	7.56	0.001
Treatments	3	1799.24	599.748	509.43	0.000
Error	136	160.11	1.177		
Total	143	2117.44			
Model Summary	**S**	**R-sq**	**R-sq(adj)**		
	1.08503	92.44%	92.05%		

In respect to all seed varieties, treatment significantly affected the survival of the weevils compared to a lack of treatment (control). There were slightly different responses in the survival of the weevils among the varieties. From Table 2, the highest survival (12.00) was observed in Achishiru followed by 11.75 in 573-1- 1 and 11.25 for 277-2 at 5 DAI in control treatments. Generally, treatment with wood ash was more effective against the weevils than orange peel and pepper. Least survival was recorded at 15 DAI in all the varieties treated with wood ash, 0.50 in 573-1-1; 0.75 in 277-2 and 1.250 in Achishiru (Table 2).

Table 2: Survival of *Callosobruchus maculatus* in Seeds Treated with Wood Ash, Orange Peel and Pepper

Variety	5DAI				10DAI				15DAI			
	WA	OP	P	C	WA	OP	P	C	WA	OP	P	C
1	4.50 ±1.29 b	3.75 ±0.50 bc	3.75 ±1.78 bc	11.75 ±0.50^{a}	2.00 ±0.00 cd	2.75 ±0.96^{b} cd	2.50 ±1.29^{b} cd	11.00 ±0.81 a	0.50 ±0.50^{d}	1.75 ±0.50 cd	1.50 ±1.29 cd	9.75 ±0.96^{a}
2	3.50 ±0.57 bc	5.00 ±0.82 b	3.75 ±0.96 b	11.50 ±1.00^{a}	1.75 ±0.50 cd	4.75 ±0.96^{b}	3.75 ±0.96^{b} c	11.50 ±1.00 a	0.75 ±0.96^{d}	2.50 ±1.92 bcd	1.75 ±1.26 cd	11.25 ±0.96^{a}
3	4.00 ±0.82 bc	5.75 ±1.26 b	5.75 ±0.50 b	12.00 ±0.00^{a}	2.25 ±0.96 cd	3.00 ±0.82^{c} d	4.50 ±0.58^{b} c	11.00 ±1.16 a	1.25 ±1.50^{d}	2.25 ±1.25 cd	3.00 ±1.16 cd	10.50 ±1.50^{a}

Key: 1 = 573-1-1, 2 = 277-2, 3 = *Achishiru,* WA = Wood ash, OP = Orange peel, P = pepper, C = Control

Emergence of *C. maculatus* from Treated Stored Seeds

The results from the application of three treatments, namely wood ash, orange peel and pepper against emerging *C. maculatus* weevils on the three varieties of seeds(Table 3) showed and overal significant result over the control (Table 3). The variety of seed, and the number off days since storage also had significant effect on emergence (Table 3). Hence there was evidence of inhibitory effect against the emergence of the weevils. Additional details of mean values of emergence per each treatment, and comparisons of those values are given in Table 4.

Table 3: General Linear Model: Effects of Time, Seed Variety and Treatments on Emergence of *C. maculatus* weevils

Factor	Type	Levels	Values
Days After Storage	Fixed	3	30, 60, 90
Variety	Fixed	3	573-1-1, 573-2-1, Achishiru
Treatments	Fixed	4	Control, Orange peel, Pepper, Wood ash

Analysis of Variance

Source	DF	SS	MS	F-Value	P-Value
Days after Storage	2	779.34	389.670	69.58	0.000
Seed Variety	2	71.36	35.682	6.37	0.002
Treatments	3	1167.15	389.050	69.47	0.000
Error	136	761.62	5.600		
Lack-of-Fit	28	466.62	16.665	6.10	0.000
Pure Error	108	295.00	2.731		
Total	143	2775.83			

S	R-sq	R-sq(adj)	R-sq(pred)
2.36647	72.56%	71.15%	69.24%

The mean numer of weevils that emerged in 573-1-1 at 30, 60 and 90 DAS from seeds treated with wood ash was significantly lower than for all other treatments, except for treatments with orange peel (2.00) and pepper (2.25) at 30DAS (Table 3). Similarly, there was no emergence at 30DAS 277-2 in seeds treated with woodash. The highest emergence in 277-2 in was recorded in control (16.50) followed by orange peel (7.00) at 90DAS. Bruchids in local variety *Achishiru* were least affected by all treatments. A significantly higher number of bruchids emerged from control at 90 DAS (17. 75) and 60 DAS (14.00). Least number of emergence (2.00) was in pepper and woodash at 30 DAS.

Emergence of bruchids in control at 90DAS was significantly higher in Achishiru and 277-2 indicating better resistance by 573-1-1. However, orange peel provided significantly lower resistance (9.75) in 573-1-1 than pepper and wood ash in all varieties at 90DAS. At 60DAS emergence was significantly higher in control of Achishiru (14.00) than all others. There were also significant differences at 30DAS in control of Achishiru (5.50) and 573-1-1(5.00) with 573-2-1treated with wood ash (0.00).

Table 4 Mean Number (and Comparisons) of Weevil Emergence per Variety of Seeds in Days after Storage

Variety	30DAS				60DAS				90DAS			
	Wood ash	Orange peel	Pepper	Control	Wood ash	Orange peel	Pepper	Control	Wood ash	Orange peel	Pepper	Control
573-1-1	1.25 ±0.95^{f}	2.00 ±0.82^{f}	2.25 ±0.50^{ef}	5.00 ±0.82^{d}	1.25 ±0.96^{f}	6.50 ±1.22^{cd}	4.75 ±0.96^{de}	8.50 ±1.00^{bc}	1.25 ±0.96^{f}	9.75 ±1.71^{ab}	7.00 ±1.16^{cd}	12.25 ±0.50^{a}
277-2	0.00 ±0.00^{d}	2.50 ±1.00^{cd}	2.00 ±0.82^{cd}	4.25 ±1.26^{bc}	2.75 ±1.50^{cd}	4.00 ±0.00^{bc}	2.50 ±1.71^{cd}	6.75 ±1.50^{b}	3.00 ±2.45^{cd}	7.00 ±1.16^{b}	6.50 ±1.00^{b}	16.50 ±1.92^{a}
Achishiru	2.00 ±1.63^{b}	3.50 ±1.92^{b}	2.00 ±1.63^{b}	5.50 ±1.92^{b}	3.00 ±1.16^{b}	6.00 ±2.31^{b}	4.00 ±1.63^{b}	14.00 ±5.16^{a}	6.75 ±1.71^{b}	6.00 ±0.82^{b}	6.75 ±0.95^{b}	17.75 ±3.10^{a}

Values with common letters were not statistically significantly different.

DISCUSSION

The results from this research demonstrate the potentials of natural products in the control of *C. maculatus.* Effective measures of cowpea weevil had been reported using neem extract solution, moringa oils, common salts, wood ash and using finger pepper (Ilesanmi and Gungula, 2010; Abdullahi *et al.,* 2016). All of our three powders had insecticidal properties against the weevil. Similar to this work, many researchers report varying degrees of effectiveness of the natural product against the weevil. Tiroesele *et al.*(2016) found that chopped up small pieces of chilies and garlic had negative effects on cowpea weevils compared to peppermint pieces. Outer peel of citrus fruits is known to possess oil with some insecticidal properties as reported by Fawki *et al.* (2014) and Harshani and Karunaratne (2019).

In the present research, wood ash proved to be more potent than orange peel and pepper powders. This could be due to variations in the chemical compositions as well as the physical properties of the three products after preparation. Orange peel and pepper powders were mechanically processed by grinding, thereby likely retaining their bio-compounds, which the weevils may be more tolerant to. Wood ash, on the other hand, had undergone much more chemical alteration due to the burning, perhaps leading to the production of intolerable by-products for the weevils. Another possible explanation for the better effectiveness of wood ash is that it also had a finer texture even though it was sieved through the same mesh size. It therefore offered a better coating of the seeds to prevent infestation. Observations showed that ash protected the seed by providing mechanical protection and restricting the movement of insects among the seeds, hampering oviposition directly onto the seed (Apuuli and Villet, 1996).

The improved varieties fared better than the local variety. This is because both 573-1-1 and 277-2 were bred for insect resistance as well as other advantages. Amusa et *al.* (2014) investigated the tolerance of some elite cowpea varieties to *C. maculatus* and found the majority showed a high percentages seed damage. Mogbo *et al.* (2014) reported varying natural resistance of local Nigerian cowpea varieties to adult *C. maculatus* attacks without the application of insecticides after 6 weeks of storage.

CONCLUSION

Generally, treatment with wood ash was more effective against the weevils than orange peel and pepper. Significantly higher number of weevils emerged in control of Achishiru (17.75 at 90DAS) than in all treatments. Least emergence was from seeds of 277-2 (0.00 at 30DAS).The local variety Achishiru appeared to be more susceptible to the bruchid infestation and improved variety277-2 was more resistant. It is recommended that these natural methods of cowpea infestation control methods be explored with different storage material and methods of preparation and for longer durations.

REFERENCES

Abdullahi, A., Usman, I. S., Girei, A.A., Isma'il, G. (2016) Examinationsof Indigenous Storage Methods of Cowpea (*Vigna unguiculata*) In Mubi South Local Government Area, Adamawa State,Nigeria. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development* **16** (2):9-15

Aboagye, D., Darko. J. O., and Banadda, N. (2017) Comparative study of hermetic and non-hermetic storage on quality of cowpea in Ghana *Chem. Biol. Technol. Agric* **4**(10):1-6

Adelusi, S. M., Barau, B., Adams, A., Allimi, H. M., Bamishaiye, O. M., and Ajayi, S. A. (2021) Cowpea infestation and effects of crop-storage relationship at Dawanau International Market, Kano State, Nigeria *J Agric Food Sci*: **9:** 204-211

Amusa, O.D.,Ogunkanmi, L.A., Adetunbi, J.A., Akinyosoye, S.T., Bolarinwa, K.A., Ogundipe, O.T. (2014) Assessment of Bruchid (*Callosobruchus maculatus*) Tolerance of Some Elite Cowpea (*Vigna unguiculata*) Varieties *Journal of Agricultural Sustainability* **6**(2): 164-178

Apuuli't, U.K. K. and Villet, M.H. (1996) The use of wood ash for the protection of stored cowpea seed *(Vigna unguiculata*(L) Walp.) against Bruchidae **(**Coleoptera**)***African Entomologist* **4**(1): 1-3

Aremu, D. O., Babajide, N. A., Ogunlade, C. A., Oyeniran, T. and Kadiri, A. O. (2015) Effects ofStorage Media and Duration on Nutritional Qualities of Cowpea (*Vigna unguiculata* L Walp) *IOSR Journal of Agriculture and Veterinary Science* **8** (2 Ver I): 60-65

Fawki, S., Abdel Fattah, H.M., Hussein, M.A., Ibrahim M.M., Soliman, A.K., Salem, D.A.M. (2014) The use of solar energy and citrus peel powder to control cowpea beetle *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae**)** 11th International Working Conference on Stored Product Protection 1-13DOI: 10.14455/DOA.res.2014.168

Harshani, H.S. and Karunaratne, S. (2019)Chemical composition and insecticidal effect of fruit peel powders of two citrus species against *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in stored cowpea (*Vigna unguiculata*) *International Journal of Pest Management*1-1https://doi.org/10.1080/09670874.2019.1698788

Ilesanmi1, J. O. andGungula, D. T. (2010) Preservation of Cowpea (*Vigna unguiculata* (L.) Walp) Grains against Cowpea Bruchids (*Callosobruchus maculatus*) Using Neem and Moringa Seed Oils *International Journal ofAgronomy.* 2010, Article ID 235280, 8 pages doi:10.1155/2010/235280Hindawi Publishing Corporation.

Mogbo T. C., Okeke T. E., Akunne C. E. (2014) Studies on the Resistance of Cowpea Seeds (*Vigna unguiculata)* to Weevil *(Callosobruchus maculatus)* Infestations *American Journal Zoology Research* ***2***(2): 37-40

Rabiu, H. M. (2015) Sub-Saharan Smallholder Perspectives on the Challenges and Prospects of Food Production in the Dryland published in the Proceedings of the 1st International Conference on Drylands held at the Centre for Dryland Agriculture, Bayero University, Kano. 8th-12th December, 2014. ISBN 978-978-8203-57-3:77-80

Omoigui, L.O., Kamara, A.Y., Batieno, J., Iorlamen, T., Kouyate, Z., Yirzagla, J., Garba, U. and Diallo. S. (2018) Guide to cowpea production in West Africa. IITA, Ibadan, Nigeria 60 pp

Samaila, A. E., Degri, M. M. and Mshelia, J. S. (2019) Assessment of Field Insect Pests Damage on Cowpea in Gombe State, Nigeria *International Journal of Entomology andNematology Research* **4** (1):10-23

Swella, G.B. and Mushobozy, D.M.K. (2007) Evaluation of the Efficacy of Protectants against Cowpea Bruchids (*Callosobruchus maculatus*(F) on Cowpea Seeds **(***Vigna unguiculata*(L.) Walp.**)***Plant Protect. Sci*. **43**(2): 68–72

Tiroesele, B., Thoma, K., and SeipatiSeketeme, S. (2015) Control of Cowpea Weevil, *Callosobruchus maculatus* (F) (Coleoptera: Bruchidae), Using Natural Plant Products *Insects* **6:** 77-84; doi: 10.3390/insects6010077