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Efficacy of some Selected Plant Products on the Storability Control of Cowpea Bruchid (*Callosobruchus maculatus* L. Walp) in North Eastern Nigeria

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Abstract
This study was aimed at controlling cowpea bruchid (*Callosobruchus maculatus* L. Walp) in storage using selected plant products, specifically, the best combination of the plant products for cowpea storage was determined. Plant materials such as Moringa seeds, cashew nut seeds, Bush mint leaves and Hot pepper were sourced in and around the Northeast region and were used in treatments for cowpea storage. 5kg of cowpea grains were randomly allotted to seven (7) treatments in a Completely Randomized Design (CRD), replicated three times. The data obtained were subjected to Analysis of Variance (ANOVA). Means were separated using Duncan Multiple Range Test (DMRT) at 5% level of significance. Non-inferential statistics such as Frequency tables, means and percentages were also used. Results after the period of storage revealed that some treatments had an increase in weight while some showed significant losses. There was increased ($p<0.05$) weight for cowpeas treated with bush mint and hot pepper BM+HP (0.50 g) compared to the control while that of cashew seed oil and moringa seed oil CS+MS (1.47 g) revealed a significant loss ($p<0.05$) after storage compared to the control. It was further observed that the control showed the least ($p<0.05$) number of live and dead insects (*C. maculatus*) followed by BM+HP (2.33 and 9.00, respectively) compared to the other treatments. A higher ($p<0.05$) value was observed in BM (251.33) for number of dead insects. It was further observed that the control showed the least ($p<0.05$) number of live and dead insects (*C. maculatus*) followed by BM+HP (2.33 and 9.00, respectively) compared to the other treatments. While the highest number of live insects recorded was similar ($p>0.05$) between BM (55.00) and cashew seed oil (CSO) (59.67) compared to the control. A higher ($p<0.05$) value was observed in BM compared to the control giving the highest rate of dead insects (251.33^a). This might be attributed to the presence of carvone which is usually extracted from bush mint and used commercially to kill insects. It was concluded that treatment of cowpeas in storage with BM+HP can significantly reduce insect population, grain damage and post-harvest loss of stored cowpea. Furthermore, cowpeas treated with HP only were observed to give the same result as BM+HP (clean grains with very negligible insect effect) although the colour turned to red. It is thus recommended that BM only, HP only or a combination BM+HP be used as most effective control measures (next to PICs) for cowpea storage in Northeastern Nigeria.

Keywords: Efficacy, Storability, Control, Cowpea, Small-scale farmers and Bruchid

Introduction

Cowpea "*Vigna Unguiculata"L.Walp* is a food legume of much economic importance worldwide especially in the dry tropical savannah. It is the most important indigenous legume covering 12.5 million hectares with annual production of about 3.0 million tons. Containing about 22-26% protein, it constitutes a major source of protein for majority of the poor rural and urban populace (FAO, 2012; FAOSTAT 2017).

Nigeria is the world's largest producer of cowpea with an average production rate of 2.123 million tons followed by Niger Republic with 1.10 million tons (Chibuzo *et al,* 2024). Northern Nigeria is top in cowpea production due to its vegetation, soil type and rainfall pattern. However, a large portion of the

harvests obtained is attacked by pests which reduce the quality and quantity of the product. This damage can be as high as 90% in cowpea (Oaya, 2019; Omoigui, *et al*, 2020).

The primary insect pest causing losses to stored cowpea in West Africa is the cowpea weevils, (*Callosobruchus maculatus*) with infestation beginning in the field at low level causing losses around harvest times and continues to reproduce in storage (Lale 2002 and Oaya *et al.*, 2011). Losses in cowpea yield due to pests are reported to occur at all stages of plant growth and up to 100% of grains may be infested and damaged in 3-4 months of storage; with substantial quantitative and qualitative losses manifested by grain perforation, reduction in weight, markets value and germination viability of seeds (Oluwafemi, 2012). A single female (*Callosobruchus maculatus*) can reproduce herself twenty fold every 3-4 weeks. Harvested cowpea grain with a very light infestation will be highly infested within 2-3 months. However, insecticides for grain preservation which are very harmful to human health are widely available (Yallappa, 2012).

The increasing problems of residue and resistance to pesticides as well as contamination of the biosphere associated with large scale use of broad spectrum synthetic pesticides have led to calls for effective biodegradable pesticides with greater selectivity and creating worldwide interest in developing alternative pesticides. It was observed that the newer insecticides will have to meet entirely different standards. They must be pest-specific, phytotoxic, non-toxic to mammals, eco-friendly, less prone to pesticide resistance, relatively less expensive, and produced from locally available materials (Malgwi and Oaya, 2014). This necessitates the re-examination of the century's old practices of protecting stored products using plants derivatives (Talukder, 2006; Hermawan *et al.*, 1997). Additionally, plant derived materials are more readily biodegradable, do not contaminate the environment and may be less toxic to non-targeted organisms. Generally, postharvest management of cowpea pests relies heavily on the use of chemical insecticides. However, in the past, most of the small scale farmers in Africa employ a wide range of traditional methods such as use of ash, sand, dry whole pepper, ground pepper or other plant extracts such as aromatic plants which have both medicinal and aromatic properties. Some of the plants extracts also contain a variety of volatile oil which has insecticidal, anti-feeding and repellent effect on insect pest. The chemical repellence hypothesis states that the non-host plants orders repel herbivores by disrupting their ability to feed on the host plant (Park, *et al*., 2003; Yallappa et al., 2012).

Problem statement

The chemical pest control methods currently used on stored grains as practiced in North Eastern Nigeria seem to have adverse disadvantages that may be very harmful to living organisms which could lead to loss of human life and may also reduce the nutritional value of cowpea grains. The disadvantages are that: the methods are expensive and require trained personnel to use; repeated use of the same chemical leads to pest resistance; the chemicals tend to pose adverse effect on non-target organism causing negative effects on man and his environment. Furthermore, the chemicals are phytotoxic to plants when used wrongly; it affects soil fertility since useful soil microbes are killed and its involvement in food chain, contaminating water bodies and general environmental pollution (Oaya, 2021).

The loss of food grains (cowpea) during storage due to cowpea weevils in North Eastern Nigeria is a major community problem. Losses of grains during the post-harvest storage period are both in terms of quality and quantity of the stored produce, thus the farmers resort to the use of chemicals as post-harvest management strategy. Most of the chemicals are expensive and tend to have detrimental effects on the environment, non-target organisms and man, hence the urgent need to search for alternative and safer storage pests management methods that are non-detrimental, cheap and readily available in order to address the above mentioned problems which is not well documented in North Eastern Nigeria.

Objectives

The broad objective of this study is to assess the efficacy of the use of some selected plant products

(Bush mint powder (*Hyptis suaveolens)*, Hot pepper powder (*Capsicum frutescens*), Cashew seed oil (*Anacardium occidentale)*, and Moringa seed oil (*Moringa oleifera*)) as preservation resources for cowpea in the study area. Specifically, the study intends to:

i. Determine the best combination of the plant products for cowpea storage;
ii. Recommend the best combination to small-scale farmers in and around the study area.

Methodology

Study Area

This research work was conducted at the Teaching and Research Farm of Adamawa State University (ADSU) Mubi, North Eastern Nigeria. The area is located between latitudes 10^0 06'' and 10^0 29'' North of the Equator and between longitudes 13^0 07'' and 13^0 30'' East of the Greenwich Meridian. The zone has a tropical climate which is determined by the movement of the Inter Tropical Convergence Zone (ITCZ), as well as the effect of relief (Ray, 2017). The average annual rainfall of the area is 918mm while minimum and maximum average temperatures ranges between 16.7^{0}C and 30.2^{0}C. The dry season commences in October through April while the wet season begins in May, attains its peak between July and August, and then declines in September. The vegetation of the area is Sudan and Sahel Savannah which supports cowpea production, marketing and exports on a large scale thereby improving farm household income. However, post-harvest loses due to storage pests may pose as a hindrance (Adebayo *et al*., 2020).

Materials used

Purdue improved cowpea storage (PICS) bag; empty ordinary grain bags, weighting scale balance, 2mm sieve, syringe, 1 liter sized container and a refrigerator (freezer).

Preparation of Experimental Plant Materials

A 5kg sample each of shed dried bush mint and sun dried hot pepper were properly ground (milled) into powder ready to be used in the treatments for the experiments and similarly, the moringa and cashew nut seeds were cleaned from all impurities, washed, sundried and separately milled to extract the oils. A 1.0Liter sample each of moringa seed oil and cashew seed oil were then extracted and ready to be used in the treatments for the experiment. The cowpea grains were sterilized by freezing for 48 hours at -2^{0}C in order to kill any insect pests present. The grains were sieved with a 2mm sever to remove dead insects. The seeds were packed into ordinary grain bags and PICS bags; these were later used for the experiment.

Experimental Procedure

5kg of cowpea grains were randomly allotted to seven (7) treatments in a Completely Randomized Design (CRD), replicated three times. The first treatment T_1 was 5kg of cowpea grains stored in a PICs bag, this served as the control. T_2 was 333.34g of bush mint powder mixed with 5kg of cowpea grains stored in an ordinary grain bag, while T_3 was 333.34g of hot pepper thoroughly mixed with 5kg grains of cowpea stored in an ordinary grain bag. The 4th treatment T_4 was 5kg cowpea seeds thoroughly mixed with 40ml of moringa seed oil while the 5th treatment T_5 was 5kg of cowpea grains properly mixed with 40ml of cashew seed oil. The 6th treatment T_6 was a mixture of 166.67g bush mint powder and 166.67g hot pepper powder thoroughly mixed with 5kg cowpea grains in an ordinary grain bag and finally, treatment seven (7) T_7 was a mixture of 250ml of moringa seed oil and 250ml of cashew seed oil properly mixed with 5kg of cowpea seeds stored in an ordinary grain bag.

Source of Experimental Materials

The materials used were sourced from the North East region of Nigeria, Cowpea grains were purchased from the open market in Mubi town, bush mint leaves were harvested from the surrounding bushes of Kaltungo, Gombe State, dry pepper was purchased from Biu local market of Borno State, Cashew seeds were sourced from Baisa, Taraba State and Moringa seeds were harvested in and around Mubi zone and processed into oil.

Experimental Procedure and Design
The experiment was laid out in a Completely Randomized Design (CRD) which was replicated thrice. The data obtained were subjected to Analysis of Variance (ANOVA). Means were separated using Duncan Multiple Range Test (DMRT) at 5% level of significance. Non-inferential statistics such as tables, Frequency tables, means and percentages were also used.

Data Collection and Statistical Analysis
Data were collected at the end of sixteen (16) weeks using the following parameters.

Mean Percentage Damaged Cowpea Grains
The mean percentage damaged grains was evaluated at the end of the experiment using the formular as reported by Oaya and Jada (2013).

$$\text{Percentage damaged seed}=\frac{number\ of\ damage\ \ seed}{total\ nuber\ of\ seed}\times 100 \quad (1)$$

Mean Percentage Undamaged Cowpea Grains
The main percentage number undamaged seed was determined suing the formula described by Oaya, *et al.* (2012).

$$\text{Percentage undamaged seed}=\frac{number\ of\ undamaged\ \ seed}{total\ nuber\ of\ seed}\times 100 \quad (2)$$

Mean Mortality Count
Mean percentage mortality will be determined using the formula as reported by Oaya and Malgwi (2014)

$$\text{Percentage mortality seed}=\frac{number\ of dead\ \ bruchids}{total\ nuber\ of\ bruchids\ alive\ and\ dead}\times 100 \quad (3)$$

Mean Weight of Cowpea Grains
The mean percentage of seed weight losses for each sample will be determined by using the following formula as reported by Malgwi and Oaya (2014)

$$\text{Percentage seed weight loses}=\frac{initial\ weight-final\ weight}{initial\ weight}\times 100 \quad (4)$$

Data Analysis
Data collected were subjected to Analysis of Variance (ANOVA) appropriate to completely randomized design (CRD). Mean separation was done using the Duncan Multiple Range Test (DMRT).

Table 1: Experimental design layout

T_1	T_2	T_3	T_4	T_5	T_6	T_7
T_6	T_5	T_4	T_7	T_2	T_1	T_3
T_7	T_3	T_5	T_1	T_4	T_2	T_6

Key
T_1= PICs bag control (5Kg cowpea grains); T_2=bush mint 333.34g/5kg cowpea grains;
T_4=bush mints and dry hot pepper 166.67g each/5kg cowpea grains; T_5= moringa seed oil 40ml/5kg cowpea grains
T_6= cashew seed oil 40ml/5kg cowpea grains; T_7= cashew seed oil and moringa seed oil 250ml each/5kg cowpea grains
Treatment T_1, T_2, T_3, T_4, T_5, T_6 and T_7 will contain 5kg cowpea grains each.

Results and Discussion

Table 2: Weight Changes and Insecticidal effects of some plant Products on stored Cowpea

Parameters	Control	BM	DHP	BM+HP	MSO	CSO	CS+MS	SEM
Weight before	5.00	5.00	5.00	5.00	5.00	5.00	5.00	-
Weight after	5.20^{b}	4.20^{c}	5.20^{b}	5.50^{a}	3.87^{d}	3.72^{e}	3.53^{f}	0.07
Weight gain/loss	0.20	0.80	0.47	0.50	1.13	1.28	1.47	-
Live insects	0.00^{d}	55.00^{a}	14.00^{c}	2.33^{c}	33.00^{b}	59.67^{a}	34.00^{b}	5.95
Dead insects	0.00^{e}	251.33^{a}	35.33^{de}	9.00^{de}	52.67^{d}	204.00^{b}	100.00^{c}	21.84

^{abc}: Means with different superscripts on the same row are statistically ($p<0.05$) different, BM: bush mint, DHP: dry hot pepper, BM+HP: bush mint and dry hot pepper, MSO: moringa seed oil, CSO: cashew seed oil, CS+MS: cashew seed oil and moringa seed oil, SEM: standard error of means

Source: Field Experiment, 2024

Table 2 above present's data on the effects of plant products on weight changes and insecticidal properties observed after cowpea storage. Significant ($p<0.05$) effects were observed in most measured parameters. After the period of storage, some of the treatments presented an increase in weight while some showed significant losses. There was increased ($p<0.05$) weight observed for cowpeas treated with bush mint and hot pepper BM+HP (0.50 g) compared to the control while that of cashew seed oil and moringa seed oil CS+MS (1.47 g) revealed a significant loss ($p<0.05$) after the period of storage compared to the control. The increase observed in cowpeas treated with BM+HP might be attributed to the segregation of foreign matter (Aremo *et al.*, 2015). Cowpeas stored with foreign matter can accumulate over time which could contribute to its additional weight. It could also be due to its hygroscopic nature, where it picks up moisture from the air if they are not stored in airtight containers, the authors added. The increase in weight conflicts with the findings of Olunloyo *et al.* (2022) who reported a loss of weight in cowpea grains after four months of storage. However, the loss of weight observed in CS+MS coincided with the findings of Bakoye *et al.* (2020) who stored cowpeas using various technologies for eight months. The loss of weight, they added, might be attributed to insect infestation (caused mostly by *Callosobrucus maculatus*) which is the major cause of pot-harvest loss in cowpea. It contributes to about 30-40% loss of cowpeas in storage (Elhefny and Abdelfattah, 2022).

It was further observed that the control showed the least ($p<0.05$) number of live and dead insects (*C. maculatus*) followed by BM+HP (2.33 and 9.00, respectively) compared to the other treatments. While the highest number of live insects recorded was similar ($p>0.05$) between BM (55.00) and cashew seed oil (CSO) (59.67) compared to the control. For the number of dead insects, a higher ($p<0.05$) value was observed in BM (251.33) compared to the control. The decrease in insect populations in grain stored in PICS/control bags observed here corroborates the findings of previous studies in which cowpea was stored in several different countries in sub-Saharan Africa (Aremu *et al.*, 2015; Bakoye *et al.*, 2020; Olunloyo *et al*., 2022). As a follow-up to the control, the smaller number of both live and dead insects in the cowpea treated with BM+HP might be attributed to the combined insecticidal properties of the plants that reduced the infestation and survival of the insects (Aliyu *et al.*, 2022) in the cowpea during the storage period which produced very clean seeds. Bush mint and hot pepper have been reported to have insect-repellent properties because they contain chemicals such as Capsaicin (CABI, 2023; Shim *et al.*, 2023) and essential oils (Saıfı *et al.*, 2023) that have toxic and repellent effects on cowpea insects. Even though *C. maculatus* can withstand harsh/extreme environmental conditions (Bakoye *et al.*, 2020), but it was unable to survive and thrive well in stored cowpeas treated with BM+HP. This study was able to establish that treatment of cowpeas with BM+HP significantly reduced insect population and damage to grains for 16 weeks. Furthermore, the

colour of cowpea seeds treated with HP only was observed to change to red and the seeds were undamaged and very clean However, the use of cashew seed oil to treat cowpea grains in this study revealed a higher number of live insects. This might be attributed to the quantity of the oil used not being optimum to provide insecticidal action or the oil extraction being adulterated. Meanwhile, treatment of cowpeas with BM revealed the highest rate of dead insects (251.33[a]). This might be attributed to the presence of carvone which is usually extracted from bush mint and used commercially to kill insects (Singh and Pandey, 2018). This implies that bush mint can produce a lethal effect on *C. maculatus* more than the other treatments used in this study.

Conclusion

From the results obtained in this study, it was concluded that treatment of cowpeas in storage with BM+HP can significantly reduce insect population, grain damage and post-harvest loss of stored cowpea. Furthermore, cowpeas treated with HP only were observed to give the same result as above (clean grains with very negligible insect effect) although the colour of the stored cowpea grains eventually turned to red. However, cowpeas treated with BM only revealed the highest rate of dead insects. It is thus recommended that BM only, HP only or a combination BM+HP be used by small scale farmers as the most efficient control measures (next to PICs) for cowpea storage in Northeastern Nigeria.

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