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# Quality Attributes of Cowpea Seeds Stored with Neem and Moringa Seed Oils

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**Abstract:** The quality attributes of cowpea seeds stored with neem and moringa seed oils were investigated using various concentrations (0.5, 1.0 and 1.5 ml) of pure neem, pure moringa and mixtures of neem and moringa seed oils in ratios of 1:1, 1:2 and 1:3. The treated cowpea seeds were stored for a period of 180 days. During this period, data were collected monthly on insect mortality, number of emergence holes per seed and weight of cowpea seeds. At the end of the sixth month of storage, seed viability was determined. Data collected were subjected to Analysis of Variance (ANOVA) and least significant difference (LSD) test was used to compare means that were significantly different at $P \leq 0.05$. The treatments minimized weight loss in stored cowpea grains compared with the control samples. Number of emergence holes were fewer (<1.3) in all the treated samples compared with the emergence holes in control samples (16.33). The mixture of neem-moringa seed oils gave better cowpea seed preservation than the pure oils. The higher concentration of these oils used for cowpea storage, resulted in better preservation of seeds, however the less percentage germination was recorded. For cowpea grains stored for consumption, mixtures of neem-moringa oil at ratio of 1:2 or 1:3 is recommended but for cowpea seed meant for planting, storage with pure neem or mixture of neem-moringa oils at a concentration of 0.5 and 1.0 ml/200 g cowpea seed should be used.

**Key words:** Neem · Moringa · Seed oils · Bruchids · Emergence holes · Insect mortality · Cowpea seeds

## INTRODUCTION

Current forecasts predict that sub-Saharan Africa including Nigeria will need to double grain import to 50 million tonnes in a fiercely competitive world market to be able to meet up with the food demand of its population [1]. Added to this is the fact, Oyewole and Oloko [1] reported that since 1980, the population of Africa has risen by 53% but food production has risen by only 45%. More than 800 million people in developing countries were undernourished at the beginning of the 1990s and depended on food aid. These facts are issues of concern to all those directly connected with agricultural production. Research efforts towards ensuring sufficient food production for the increasing population has led to the realisation that losses of produce is perhaps one of the greatest problems confronting food production in Nigeria [1] and other sub-Saharan African countries. To reduce post harvest losses, harvesting, handling and storage methods must be matched by sudden increase in crop production.

The non-availability and high cost of synthetic pesticides, coupled with the potential hazards posed by these pesticides to the environment, human and livestock have necessitated the search for a more acceptable method of controlling insect pests of cowpea in storage. This study was therefore carried out in order to proffer an alternative cowpea preservative method that is cheap, available, affordable and has lasting preservative effect and which is indigenous to farmers, marketers and consumers of cowpea.

Neem (*Azadirachta indica, A. Juss*) is popularly known as village pharmacy as all parts of this plant are used for curing several types of diseases. Extracts of leaves and seeds exhibit the property of antibacterial, antifungal, antiviral and antimalaria. Leaf extracts are also known to inhibit the growth of plant pathogens [2]. Neem oil with the main constituent of Azadirachtin is used as insect repellent, feeding inhibitors, laying deterrents, growth retardants and sterilants among others. It has both contact and systemic actions on plants for controlling fungal diseases [2].

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*Moringa oleifera,* commonly referred to as moringa is the most widely cultivated variety of the genus Moringa. It is of the family Moringaceae. It is an exceptionally nutritious vegetable tree with a variety of potential uses. The moringa seeds yield 38-40% edible oil (also called Ben oil due to high concentration of behenic acid contained in the oil) that can be used in cooking, cosmetics and lubrication [3]. The refined oil is as clear as any other botanical oil. The seed cake remaining after oil extraction may be used as fertilizer [3].

## MATERIALS AND METHODS

The neem and moringa seeds from which oils were traditionally extracted for the preservation of cowpea seeds were obtained from the main campus of the Modibbo Adama University of Technology, Yola, Nigeria and Demsa Local Government Area of Adamawa State, Nigeria, respectively. The cowpea seeds (Ife brown) used for this work were harvested from a farm within the Modibbo Adama University of Technology, Yola. The plastic bowls for storage were purchased from the Jimeta Market, Yola, Adamawa State.

The extracted oils from neem and moringa seeds were used to treat the cowpea seeds so as to test the efficacy of the oils against infestation of *Callosobrucus maculatus* on the cowpea grains in storage. The test insects used for the experiment were adults of cowpea weevils *(Callosobruchus maculatus).* They were obtained from highly infested grains bought from Jimeta market in Adamawa State, Nigeria and reared on uninfested cowpea grains in a ventilated chamber. The containers used in rearing the insects were plastic containers measuring 17 cm by 17 cm in diameter and depth, respectively. Each container was covered with 10 mm mesh sieve to allow free air circulation and also to prevent insects from escaping. The experiment was carried out at ambient temperature of 28°C (±2) and relative humidity of between 70-75%. The containers were left for 10 days, after which the weevils in the cowpea were sieved out and then left for another 24 hours before they were harvested and used.

**Experimental Design:** The treatment which comprised of pure neem oil, pure moringa oil, neem-moringa in the ratios of 1:1, 1:2 and 1:3 all at concentrations of 0.5, 1.0 and 1.5 ml/200 g cowpea seeds were arranged in Randomized Complete Design (RCD) and replicated three times. About 200 grams of healthy, fresh, clean and unbroken cowpea seeds were weighed into conical flask and 0.5, 1.0 and 1.5 ml of the various oil types were pipetted into conical flasks containing the cowpea seeds and were shaken vigorously to ensure uniform exposure of seeds to the oils. These were then transferred into clean and dry plastic bowls measuring 5.5 cm deep by 8 cm wide. The control did not receive oil treatment. Ten male and ten female *Callosobruchus maculatus* (0-24 hours old) starved for 24 hours were added to each bowl of treated seeds and were covered with 10 mm-mesh muslin cloth to allow free air circulation and also to prevent the insects from escaping.

**Data Collection and Analysis:** Data collected include insect mortality, number of seeds with emergence holes, as well as weight of seeds taken at 30 days intervals for 180 days. Mortality was assessed based on the criterion that an insect with uncoordinated movement is dead [4]. Data collected were statistically analyzed using Analysis of Variance (ANOVA) to ascertain the differences between means and least significant difference was used to separate treatment means that were significantly different at $P \leq 0.05$.

## RESULTS

The weight of cowpea seeds steadily decreased with number of days storage (Table 1). Generally, pure neem oil treated samples had the highest seed weight all through the 180 days of storage. There was no significant difference ($P<0.05$) at the second month in the weight of cowpea but the remaining 120 days revealed that samples treated with pure moringa oil had the least grain weight when compared to samples treated with the other oil types. Pure neem oil seemed to be the most effective in minimising weight loss with 166.9 g weight at the end of six months, while pure moringa oil was the least effective having had the highest weight loss at the end of six months.

Table 2 shows that the various concentrations of the oil type significantly minimized weight loss in store cowpea compared with all the control samples. Oils at a concentration of 1.5 ml/200 g cowpea emerged the best with 198.7 g cowpea at the end of six months. The control samples recorded the highest weight loss having 71.4 g. Generally higher oil concentrations resulted in higher seed weight throughout the six months of storage period.

Table 3 shows the mean number of insect mortality in stored cowpea protected with various oil types. There were significant differences ($P<0.05$) in the effects of the oil types on *C. maculatus* in the first 3 months of storage, while there were no significant differences

Table 1: Effect of oil types on the weight of cowpea in storage

| | Period of storage in days | | | | | |
|---|---|---|---|---|---|---|
| Oil type | 30 | 60 | 90 | 120 | 150 | 180 |
| PN | 210.49 | 188.20 | 182.60 | 178.50 | 170.20 | 166.90 |
| PM | 211.29 | 189.70 | 159.80 | 147.80 | 132.60 | 127.90 |
| NM1:1 | 212.17 | 183.80 | 179.30 | 173.50 | 165.00 | 163.10 |
| NM1:2 | 212.00 | 183.40 | 179.20 | 173.00 | 166.60 | 165.10 |
| NM1:3 | 212.92 | 185.70 | 179.30 | 173.30 | 165.70 | 165.70 |
| Mean | 211.77 | 186.16 | 176.04 | 169.22 | 160.02 | 157.74 |
| LSD | 0.706 | 7.480 | 13.580 | 10.250 | 7.08 | 7.52 |
| Prob. of F | <0.001 | 0.364 | 0.011 | <0.001 | <0.001 | <0.001 |

PN = Pure Neem; PM = Pure Moringa; NM 1:1 = Neem – Moringa oil in ratio 1:1; NM 1:2 = Neem – Moringa oil in ratio 1:2; NM 1:3 = Neem – Moringa oil in ratio 1:3

Table 2: Effect of various concentrations of oils on the weight of cowpea in storage

| Oil | Period of storage in days | | | | | |
|---|---|---|---|---|---|---|
| Concentration (ml) | 30 | 60 | 90 | 120 | 150 | 180 |
| 0.0 | 207.56 | 103.30 | 79.40 | 75.50 | 72.50 | 71.40 |
| 0.5 | 212.94 | 210.50 | 202.60 | 191.70 | 178.50 | 175.30 |
| 1.0 | 213.20 | 215.00 | 207.00 | 200.20 | 188.60 | 185.60 |
| 1.5 | 213.39 | 215.70 | 215.20 | 209.40 | 200.40 | 198.70 |
| Mean | 211.77 | 186.13 | 176.05 | 169.20 | 160.00 | 157.75 |
| LSD at 0.05 | 0.63 | 6.69 | 12.15 | 9.17 | 6.33 | 6.73 |
| Prob. of F | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

Table 3: Effect of oil types on mortality of *Callosobruchus maculatus* in stored cowpea storage

| | Period of storage in days | | | | | |
|---|---|---|---|---|---|---|
| Oil type | 30 | 60 | 90 | 120 | 150 | 180 |
| PN | 71.90 | 946.00 | 192.00 | 1.00 | 0.00 | 0.50 |
| PM | 55.90 | 522.00 | 443.00 | 95.00 | 41.80 | 28.30 |
| NM1:1 | 104.20 | 601.00 | 141.00 | 3.00 | 30.20 | 0.00 |
| NM1:2 | 109.70 | 655.00 | 95.00 | 0.00 | 0.00 | 0.00 |
| NM1:3 | 76.10 | 450.00 | 109.00 | 0.00 | 0.00 | 0.00 |
| Mean | 83.56 | 634.80 | 196.00 | 19.80 | 14.40 | 5.76 |
| LSD | 31.08 | 109.20 | 135.60 | 93.30 | 58.82 | 30.72 |
| Prob. of F | 0.005 | <0.001 | <0.001 | 0.176 | 0.440 | 0.258 |

PN = Pure Neem; PM = Pure Moringa; NM 1:1 = Neem – Moringa oil in ratio 1:1; NM 1:2 = Neem – Moringa oil in ratio 1:2; NM 1:3 = Neem – Moringa oil in ratio 1:3

Table 4: Effect of various concentrations of oils on mortality of *Callosobruchus maculatus* in stored cowpea

| Oil | Period of storage in days | | | | | |
|---|---|---|---|---|---|---|
| Concentration (ml) | 30 | 60 | 90 | 120 | 150 | 180 |
| 0.0 | 258.30 | 2463.00 | 598.00 | 1.00 | 0.00 | 0.00 |
| 0.5 | 28.60 | 63.00 | 123.00 | 70.00 | 29.90 | 3.50 |
| 1.0 | 24.10 | 11.00 | 62.00 | 9.00 | 27.70 | 19.60 |
| 1.5 | 23.30 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mean | 83.58 | 634.50 | 195.75 | 20.00 | 14.40 | 5.78 |
| LSD at 0.05 | 27.80 | 97.60 | 121.30 | 83.50 | 52.61 | 27.48 |
| Prob. of F | <0.001 | <0.001 | <0.001 | 0.277 | 0.490 | 0.425 |

Table 5: Mean number of cowpea grains that had various number of emergence holes after the first month of treatment with the various oils

| | Emergence holes | | | | | |
|---|---|---|---|---|---|---|
| Oil type | 1 | 2 | 3 | 4 | 5 | 6 |
| PN | 0.92 | 2.25 | 0.42 | 0.08 | 0.00 | 0.00 |
| PM | 5.75 | 0.50 | 0.00 | 0.00 | 0.08 | 0.00 |
| NM1:1 | 4.25 | 0.42 | 0.75 | 0.17 | 0.00 | 0.00 |
| NM1:2 | 4.58 | 1.92 | 0.58 | 0.33 | 0.00 | 0.00 |
| NM1:3 | 4.00 | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mean | 3.90 | 1.15 | 0.35 | 0.12 | 0.02 | 0.00 |
| LSD | 2.039 | 1.725 | 0.3008 | 0.2602 | 0.1067 | 0.00 |
| Prob. of F | <0.001 | 0.105 | <0.001 | 0.071 | 0.420 | 0.00 |

PN = Pure Neem; PM = Pure Moringa; NM 1:1 = Neem – Moringa oil in ratio 1:1; NM 1:2 = Neem – Moringa oil in ratio 1:2; NM 1:3 = Neem – Moringa oil in ratio 1:3

Table 6: Mean number of cowpea grains that had various number of emergence holes one month after treatment with various concentrations of oils

| Oil | Emergence holes | | | | | |
|---|---|---|---|---|---|---|
| Concentration (ml) | 1 | 2 | 3 | 4 | 5 | 6 |
| 0.0 | 12.80 | 4.40 | 1.40 | 0.47 | 0.07 | 0.00 |
| 0.5 | 1.33 | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.0 | 0.80 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.5 | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mean | 3.90 | 1.15 | 0.35 | 0.12 | 0.00 | 0.00 |
| LSD | 1.823 | 1.543 | 0.269 | 0.2327 | 0.0984 | 0.00 |
| Prob. of F | <0.001 | <0.001 | <0.001 | <0.001 | 0.403 | 0.00 |

(P<0.05) in the succeeding 3 months. In the last 3 months, there were few or no weevil mortality recorded. Neem-moringa 1:3 oil with 0 weevil mortality proved to be the most effective in preventing adult weevil emergence therefore less weevil mortality, while pure moringa oil was the least effective in preventing adult weevil emergence having recorded the highest (above 28) number of weevil mortality.

The mean effects of various concentrations of the oils on insect mortality is shown on Table 4, which revealed significant differences (P<0.05) in the activities of various concentrations of the oil types on insects mortality in the first 3 month compared with the control. There was no significant difference (P<0.05) in the activities of the various concentrations of the oils in the remaining 3 months. In the last 3 months, most of the cowpea seeds in the control had been reduced to powder having been consumed by the cowpea weevil. Oils at a concentration of 1.5 ml/200 g cowpea were the best in reducing adult emergence, thereby giving the least number of insect mortality of 0 insect in the last four months of storage. The highest insect mortality of 598 insects was observed in the control samples.

**Effects of Oils on the Number of Emergence Holes on Cowpea Seeds Made by Callosobruchus Maculatus:** The results presented in Table 5 indicated that the oil types used in treating the cowpea samples significantly differed (P<0.05) in their effects on the number of emergence holes made by *C. maculatus.* Generally, all the treated samples had either one or two holes on the seeds but the mixture of neem-moringa oils in the ratio of 1:3 had the lowest number of holes and not more than two holes per seed whereas all other oil treated samples had more than two holes per seed. No seed had more than 5 holes on it.

Table 6 shows that the various concentrations of oils used had significant effects on the number of emergence holes produced by *C. maculatus* compared with the control samples. There were no treated seeds that had more than 2 emergence holes, while only a few seeds treated with 1.5 ml of oil had 1 hole but none had 2 holes.

**Effects of Treatment Oils on the Percentage Viability of Cowpea Seeds Stored for Six Months:** The results of viability of the seeds after six month of storage with the application of various rates of the oils is shown in Table 7. There were higher germination percentage in untreated seeds compared to treated seeds. The higher concentration of the oils resulted in lower germination percentage, except pure moringa oil that had higher germination percentage with higher oil concentration. Generally, the lowest germination percentage was

Table 7: Interaction of oil types and various concentrations of the oils on the germination percentage of cowpea seeds after 6 months of storage period

| | Oil types | | | | |
|---|---|---|---|---|---|
| Concentration | PN | PM | NM1:1 | NM1:2 | NM1:3 |
| 0.0 ml | 100 | 100 | 100 | 100 | 100 |
| 0.5 ml | 90 | 0 | 76.7 | 85 | 90 |
| 1.0 ml | 76.7 | 5 | 71.7 | 63.3 | 90 |
| 1.5 ml | 71.7 | 35 | 66.7 | 76.7 | 73.3 |
| Prob of F | 0.001 | | | | |
| LSD | 13.35 | | | | |

PN = Pure Neem; PM = Pure Moringa; NM 1:1 = Neem – Moringa oil in ratio 1:1; NM 1:2 = Neem – Moringa oil in ratio 1:2; NM 1:3 = Neem – Moringa oil in ratio 1:3

observed with the pure moringa treated samples. The results also showed that even at the concentration of 1.0 ml/200 g cowpea, neem:moringa oil in ratio 1:3 had 90% germination capacity (being the highest at this concentration).

## DISCUSSION

The study has shown that pure neem and moringa oils and their mixtures in ratio 1:1, 1:2, 1:3 adequately protected un-infested cowpea grains from *C. maculatus* infestation. This result is consistent with those reported by Aliyu and Ahmed [4] who used groundnut oil at the rates of 2-8 ml/kg of cowpea to treat cowpea for storage. Also, Schoonhoven [5] and Pereira [6] used industrially refined palm oil and groundnut oil for cowpea storage. Efficacy of vegetable oil against *C. maculatus* has been attributed to ovicidal effect of the oils [7], reduced oviposition [5] and reduced adult longevity.

Though the quantity of cowpea used was 200 g per treatment, in the first month, there was a weight gain observed due to the high relative humidity (from between 64-82% in June to 84-92% in July) during the period. This explains why the weight of all the samples exceeded 200 g at the end of the first month.

It is clear from the study that pure neem, pure moringa and the mixtures of neem-moringa seed oil at 1.5 ml/200 g were more potent in protecting stored grains of cowpea against infestation and damage by *C. maculatus* as the oils drastically reduced number of emergence holes and did not significantly reduce the weight of cowpea samples throughout the study period. This shows that the concentration of the oil is critical in the preservation of the cowpea as higher concentrations leads to better preservation of the seeds. The above results affirmed the reports of Lale [8] and RMRDC [9] that neem oil has more than 12-15 complex constituents that have repellent, anti-feedant, insect growth regulatory and pesticidal properties. Perhaps this gives the reason why the preservation effect of these oils was so glaring in this study. Lale [8] stated that some essential oils are highly lipophilic and therefore have the ability to penetrate the curticle of the insect or mite and that fatty vegetable oils kill insects by flooding their spiracles thus causing asphyxiation. Fatty vegetable oils are mainly active against eggs and so a uniform spread of the oil is necessary to maximise effectiveness. This result compares favourably with the findings of other workers [10-13] who used various essential oils to protect cowpea. They reported that oil extracted from *P. guineense* seed powder was effective in protecting stored cowpea seeds against infestation and damage by *C. maculates.* They further reported that adult weevils were rapidly killed while oviposition and subsequent adult emergence were completely prevented.

Mixture of neem-moringa seed oil at 1:3 was found to be the best in protecting the cowpea seeds probably because the mixture of these two oils might have supplied additional constituents that could be found in individual oils thus giving more effective protection against the insect than the constituents of the individual oils.

Low percentage (0-35%) of germination from pure moringa oil may probably be due to serious seed damage by *C. maculatus* recorded from seeds treated with pure moringa oil which was not very effective in preserving the stored cowpea hence the bruchid damaged bean seed suffered a decline in germination related to each emergence holes [14]. Some level of viability of the seeds recorded on damaged seeds shows that farmers can still plant damaged seeds if the seeds do not have more than two bruchid emergence holes. The lower rate of oils application on the cowpea seeds, resulted in the higher percentage viability. This is in agreement with the findings of Aliyu and Ahmed [4] who reported similar effect from their experiment when they use groundnut oil to preserve cowpea. They also found that the higher rate of groundnut oil recorded the less percentage germination. This shows that for cowpea intended to be used as grains, higher concentration of oil can be used but where the cowpea is intended to be used for seeds, lower concentration of the oil should be used to treat the seeds. This study shows that pure neem oil and mixtures of the two oils may be used to protect

stored cowpea bruchid damage without risk to seed quality, an effect that has also been observed elsewhere by Pereira [6] that quality of cowpea seeds was not adversely affected by treatments oils.

## CONCLUSION

Pure neem oil, mixture of neem and moringa oils (neem-moringa 1:2 and 1:3 at 1:5 ml /200 g cowpea) were successfully used for the preservation of cowpea grains for a period of 180 days. The research shows that if only moringa oil is to be used, the concentration should not be less than 1.5 ml/200 g cowpea. For cowpea grains stored for consumption, mixtures of neem-moringa oil at ratio of 1:2 or 1:3 should be used for better preservation. For cowpea seed meant to be used for planting, storage with pure neem or mixture of neem-moringa oils at a concentration of 0.5 and 1.0 ml/200 g cowpea seed should be used. These will give protection to the seeds in store and also ensure higher percentage germination when planted.

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