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Full Length Research Paper

Effects of Neem and Moringa seed oil on cookability and palatability of cowpea grains stored for six months

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This study was carried out to determine the effects of neem *(Azadirachta indica A. Juss)* and Moringa *(Moringa oleifera)* seed oils treatment on the cooking and organoleptic properties of cowpea grains at the end of 180 days of storage, and to formulate a standard mixture of neem and moringa seed oil in appropriate ratio for better consumer acceptability of the cowpea preserved with this oils in 2009 at the Federal University of Technology, Yola, Adamawa State, Nigeria. Data collected which include cooking time, leached solids, soaking time, swelling capacity and flavour, taste, texture, colour and overall acceptability were analysed using analysis of variance (ANOVA) to ascertain the significant differences between means and least significant difference was used to compare the means that were significantly different ($p<0.05$). The results showed that there was no significant differences ($p<0.05$) between the cooking properties of the various oil treated samples and the control. The cooking time of control samples of 55 min was significantly lower ($p<0.05$) than the cooking time of 60 min for treated samples. The sensory evaluation test showed that neem: moringa ratio 1:3 oil treated samples were the most preferred in terms of colour, texture, taste, flavour and overall acceptability followed by neem: moringa ratio 1:2 oil treated samples. The study recommends mixtures of neem: moringa oils in the ratios 1:2 and 1:3 for the preservation of cowpea meant for consumption.

Key words: Cookability, palatability, organoleptic properties.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp], one of the grains that suffer from post harvest losses, is a warm season, annual, herbaceous legume. Cowpea suffers heavily from insects, both in the field as well as when stored after harvest. FAO (1988) reported that 30 to 50% cowpea lose was recorded during storage. Yield reductions caused by insect infestation can reach as high as 95%, depending on location, year and cultivar (Carlos, 2004).

Cowpeas are an important source of protein in developing countries, especially in West Africa where they are eaten in a variety of ways (Philip et al., 1987). Like other legumes, cowpeas contribute to the level of dietary protein in starchy tuber-based diets through their relatively high protein content and to the quality of dietary protein by forming complementary mixtures with staple cereals. It contains about 23 to 38% proteins, 60 to 66% carbohydrates mostly as oligosaccharides, 5 to 6% fibre, 3.4 to 3.7% ash and 1 to 1.3% oil (Bressani, 1985). Apart from being a major staple food of man, it also provides a good source of fodder for livestock as well as cover crop and green manure (Quin, 1997). Nigeria is a major producer of cowpea in the world, which makes it an important grain legume crop.

Neem oil with the main constituent of Azadirachtin is used as insect repellent, feeding inhibitors, egg laying deterrents, growth retardants and sterilants among others. It has both contact and systemic action on plants for controlling fungal diseases (Rao, 1990).

Moringa oleifera, (Moringaceae) commonly referred to as moringa is the most widely cultivated species of the

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genus Moringa. It belongs to the family Moringaceae. Moringa is an exceptionally nutritious vegetable tree with a variety of potential uses, such as medicinal use, nutritional use, industrial use, etc. The Moringa seeds yield 38 to 40% edible oil (called Ben oil from the high concentration of behenic acid contained in the oil) that can be used in cooking, cosmetics and lubrication. The refined oil is as clear as any other botanical oil (FAO, 1999). It is pale yellow in colour with a flavour often described as mild and nutty. It is resistant to rancidity, which may be because it contains powerful antioxidants that act as natural preservatives.

The concept of using neem oil for preservation of cowpea is not new but the fact still remains that it lacks consumer acceptability especially in terms of taste, when used as preservative. Deutsche Gesellschat fur Technische Zusammenarbeit (1988) affirmed that the informal investigations carried out in the framework of the extension programme in Benin opined that the bitter taste of neem oil discourages many farmers from adopting its use for the preservation of cowpea grains meant for direct human consumption. This study tried to determine the cooking properties and acceptability of cowpea samples preserved with pure neem seed oil, pure moringa seed oil, and their mixtures. Therefore, the present study was undertaken to formulate a standard mixture of neem seed oil and moringa seed oil in appropriate ratio to have a desired organoleptic properties of preserved cowpea grains after been cooked and to have better consumer acceptability.

MATERIALS AND METHODS

The neem seeds used in this study were handpicked within the main campus of the Federal University of Technology, Yola (FUTY). The *M. oleifera* seeds were obtained partly from FUTY premises and also from Demsa Local Government area of Adamawa State, Nigeria, where it is commonly found and sold. The cowpea sample (Ife brown) used for this work was harvested from a farm within the University. The plastic bowls for storage were purchased from the open market. The test insects used for the experiment were adults of cowpea weevils *(Callosobruchus maculatus).* They were obtained from highly infested grain bought from the market in Adamawa State, Nigeria and reared on uninfested cowpea grains in a ventilated chamber.

Rearing of the experimental insects *(Callosobrucus maculatus)*

The containers used in rearing the insects were plastic containers measuring 17 by 17 cm diameter and depth respectively and were purchased from Jimeta market in Adamawa State, Nigeria. The weevils harvested from the infested cowpea grains were introduced into the plastic containers containing 500 g each of uninfested cowpea grains. Each container was covered with 10 mm mesh sieve to allow free air circulation and also to prevent insects from escaping. This was carried out at ambient temperature of 2± 28°C and relative humidity of between 70 to 75% (Aliyu and Ahmed, 2006). This was left for 10 days, after which the weevils in the cowpea were sieved out and then discarded. The infested cowpea grains were left for another 24 h and the newly emerged weevils within this 24 h were harvested and used to infest the treated cowpea.

Extraction of neem oil

The processing of neem seed involved cleaning, dehulling and oil extraction. The cleaning process was dry cleaning. The seeds were dehulled with a mortar and pestle and then winnowed. The dehulled seeds were milled using hammer mill and 500 g of the resultant powder was used for the extraction. The oil was extracted manually using hand to knead the paste with occasional addition of cold water until the oil started coming out. 175 ml (representing 35%) of oil was obtained this was then sieved to remove impurity. The oil obtained was yellow in colour with characteristics neem seed flavour.

Extraction of moringa oil

The dried moringa seeds were dehulled using mortar and pestle while the kernels were milled using harmer mill. 500 g of the powder thus obtained was used for the oil extraction. 125 ml (representing 25%) oil was extracted manually by kneading the moringa paste with hands with occasional addition of cold water, the pale yellow with characteristic moringa seed flavour oil extracted was then sieved to remove impurity and was finally packaged.

Treatment of cowpea grains

The extracted oils from neem and moringa seeds were used to treat the cowpea grains so as to test the efficacy of the oils against *C. maculatus* on the cowpea grains in storage.

The experiment was designed such that there were 5 treatments and each treatment was replicated 3 times, the untreated sample was used as control.

For each treatment, 200 g of healthy, clean and unbroken cowpea grains with a moisture content of 10% were placed in four clean, dry plastic bowls measuring 5.5 cm deep by 8 cm wide. The cowpea grains in 3 of the 4 plastic bowls were treated with 0.5, 1.0 and 1.5 ml of pure moringa oil as follows: The oil was pipetted into a conical flask containing the cowpea and was shaken vigorously to ensure uniform exposure of grains to the oil. This was then transferred into the bowl according to the method of Singh et al. (1989). Ten male and ten female *C. maculatus* (0 to 24 h old) starved for 24 h were added to each set of the treated grain. Each container was covered with 10 mm-mesh muslin cloth to allow for air circulation and also to prevent the insects from escaping. The control group was left untreated. Each treatment was replicated three times. All these were kept at ambient temperature (28± 2.5°C) for 180 days. The above treatment was repeated for pure neem oil and mixtures of neem and moringa oils in ratio 1:1, 1:2 and 1:3 of neem and moringa oils respectively. At the end of the storage period, cooking properties, palatability test and other parameters were determined

Effect of the oils on cooking properties and palatability of the stored cowpea grains

Cooking properties comprised the following parameters;

1. Cooking time
2. Leached solids
3. Soaking time
4. Swelling capacity. Were determined.

Cooking time

The cooking time of each of the treated cowpea sample was determined following the procedure of Akinyele et al. (1986). Twenty grams of the treated cowpea grains were added to 450 ml of boiling water in milk-tins placed in stainless cooking pot on an electric stove maintaining the level of water by adding more water intermittently. The cooking time was determined by noting the time in minutes required for soft cooking by pressing the cooked seeds between two fingers until no hard material was found. Untreated cowpea grains were treated in the same manner.

Leached solids of treated cowpea grains

The amount of leached solids during cooking was determined using the procedure of Akinyele et al. (1986). The 20 g of raw cowpea was cooked, the liquid after draining the cooked cowpea was evaporated to dryness in a hot air oven at 80°C overnight. The weight of the residue was taken and expressed in gram percent of the initial weight of the cowpea grains before cooking. Untreated cowpea grains were used as control.

Soaking time of treated cowpea grains

The soaking time was determined following the procedure of AOAC (1984). Ten grams of whole raw cowpea was weighed and soaked in 50 ml distilled water at room temperature (28±2.5°C). The grains were then removed, drained, and reweighed after 20 min. This process was repeated until constant weight was attained for each treatment. Untreated cowpea grains were used as control.

Swelling capacity

The swelling capacity of each treated cowpea was determined by the method of Akinyele et al. (1986). It involved weighing fifty grains of the cowpea and cooking in boiling water for 50 min. The grains were drained and re-weighed. The final weight plus the leached solids in grams were taken as the cooked weight. The swelling capacity was the difference between the raw weight and the cooked weight per 100 g grains. Untreated cowpea grains were cooked in a similar manner.

Palatability test of treated cowpea grains

Sensory evaluation of each cooked treated cowpea samples was determined for flavour, colour, texture, taste, and overall acceptability by ten trained judges as described by Ihekoronye and Ngoddy (1985). The sample was evaluated on a 7–point hedonic scale (1 = disliked very much, 2 = disliked much, 3 = disliked moderately, 4 = neither liked nor disliked, 5 = like moderately, 6 = like and 7 = like very much) in the mid morning (11.00 a.m.) in a sensory evaluation laboratory under white light. The ten (10) panel members consisted of staff and students that were randomly selected from Federal University of Technology, Yola community. Samples were presented in 3 digits code in plates. The order of presentation of the sample to the judges was randomized. Untreated cooked cowpea grains were used as control.

Statistical analysis

Analysis of variance was used to ascertain the significant differences between means. Least significant differences (LSD) test was used to compare means that were significantly different at $p<0.05$ (Statsoft Inc., 1984-2008).

RESULTS

Effects of treatment oils on cooking properties of cowpea stored for 180 days

The results of the cooking time of the treated samples are shown in Table 1. The cooking time of various samples treated with pure neem, neem – moringa oil in ratio 1:1, neem – moringa oil in ratio 1:2 and neem – moringa oil in ratio 1:3 was 60 min. The control sample also took 60 min to get cooked. The cooking time (65 min) of pure moringa oil at 0.5 and 1.0 ml per 200 g cowpea treated samples was significantly higher than all other concentrations of the various oil types and mixtures. The shortest cooking time (55 min) was recorded from samples treated with 1.5 ml of pure moringa oil.

The amount of solids leached into the water after boiling cowpea grains that were treated with various concentrations of those oils are presented in Table 1. While pure neem, neem – moringa in ratio 1:1, neem – moringa oil in ratio 1:2 and neem – moringa oil in ratio 1:3 treated sample had leached solids in the range of 0.15 - 0.23 g, pure moringa oil treated samples at lower concentrations (0.5 to 1.0 ml) leached most into the water (0.38 g). There were therefore significant differences between samples treated with pure moringa oil at lower rates and other oils treated samples, however, the remaining oil treated samples showed no significant difference in their leaching ability when compared with the control.

Table 1 shows the time taken by the various cowpea samples treated with the different oil types and stored for six months to soak. The results showed no significant difference between the soaking time of the control samples and the treated samples at various concentrations except for pure moringa oil treated samples at 0.5 and 1.0 ml which took a longer time of 28 and 24 min respectively to soak compared to the various concentrations of the other oil types which took shorter time to soak.

The swelling capacity of the treated cowpea and untreated cowpea grains stored for six months (180 days) of treatment is shown on Table 1. The result revealed that there were significant differences ($P<0.05$) between the swelling capacities of cowpea grains treated with pure moringa oil at a concentration of 0.5 and 1.0 ml and samples treated with various concentrations of other oil types. Neem-moringa in ratios of 1:2 and 1:1 oil at concentration of 1.0 ml and 1.5 ml/ 200 g cowpea treated samples respectively had the highest swelling capacity of 29.78 and 29.72 g respectively, representing 218 and 187% increase after the control samples which had 30.22 g. There was no much difference in swelling capacity of other oils treated samples. Pure moringa oil at 0.5 ml per 200 g treated samples, however, recorded the least swelling capacity (20.95 g) representing only 121% increase in swelling capacity. The results show that the

Table 1. Mean cooking properties of cowpea grains after treated with various concentrations of neem and moringa seed oils after 180 days of storage.

TRT	Concentration				l. s. d.	s. e. d.
	0.0 ml control	0.5 ml	1.0 ml	1.5 ml		
Cooking time (min)						
PN	50.00	60.00	60.00	60.00		
PM	50.00	65.00	65.00	55.00		
NM1:1	50.00	60.00	60.00	60.00	0.00	0.00
NM1:2	50.00	60.00	60.00	60.00		
NM1:3	50.00	60.00	60.00	60.00		
Leached solid (g)						
PN	0.1700	0.2367	0.2300	0.2233		
PM	0.1700	0.3800	0.3533	0.1533		
NM1:1	0.1700	0.2400	0.1700	0.1800	0.04530	0.02238
NM1:2	0.1700	0.1567	0.1533	0.1467		
NM1:3	0.1700	0.1600	0.1567	0.1500		
Soaking time (min)						
PN	20.00	19.73	19.77	19.47		
PM	20.00	27.67	24.40	19.50		
NM1:1	20.00	19.73	19.87	19.83	1.460	0.721
NM1:2	20.00	19.60	19.47	19.23		
NM1:3	20.00	19.27	19.20	19.03		
Swelling capacity (g)						
PN	30.22	29.61	29.33	29.44		
PM	30.22	20.95	22.43	26.20		
NM1:1	30.22	29.00	29.03	29.72	2.065	1.020
NM1:2	30.22	29.04	29.78	28.20		
NM1:3	30.22	28.46	27.92	29.20		

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.

treatments did not have significant difference ($P<0.05$) in the swelling capacity of samples treated with various concentrations of the oils compare to the control samples. Pure Neem and neem-moringa 1:1 however appeared to be the best in terms of swelling capacity of the treated cowpea grains next to the control sample.

Table 2 represents the results of the sensory acceptability in terms of colour, taste, flavour, texture, and overall acceptability of cowpea samples cooked six month after treatment with different concentrations of neem and moringa seed oils. The lowest colour ratings of 2.30 and 2.90 were recorded from samples treated with 0.5 and 1.0 ml of pure moringa oil respectively. The panellist preferred the colour of those samples treated with various concentrations of the oils to the control moringa in ratio of 1:2 and 1.5 ml neem-moringa in the ratio of 1:3 however appeared to be the most acceptable in terms of colour having recorded the score of 5.90 and 5.90 respectively.

The result of the panellists ratings in terms of taste reveals that the lowest ratings of 2.00 and 2.80 were from the samples treated with pure moringa oil at the rate of 0.5 and 1.0 ml. This was closely followed by the control samples. The best ratings of 5.80 and 5.60 were recorded from samples treated with 0.5 and 1.0 ml neem-moringa oil in ratio 1.2 and 1:3 respectively.

The acceptability in terms of flavour of the cowpea samples treated with various oils and cooked after having been stored for 180 days were rated and presented in Table 2. The lowest flavour ratings of 1.90 and 2.40 were sample. Cowpea samples treated with 1.0 ml Neem-recorded for samples treated with pure moringa at the rate of 0.5 and 1.0 ml. The best ratings of 5.80 were recorded from samples treated with the mixture of neem-moringa oils in the ratio 1:3 irrespective of the oil concentration. These ratings were comparable with the ratings from the control.

Table 2 also shows the panellists acceptance of the

Table 2. Mean sensory ratings for consumer acceptance of cowpea grains treated with various concentrations of neem and moringa seed oils after 180 days of storage.

Sample	Concentration	Colour	Flavour	Taste	Texture	Overall acceptability
Control	0.00	3.40	5.30	5.50	5.40	4.90
PN	0.50	4.90	4.80	5.20	4.80	5.20
PM	0.50	2.30	1.90	2.00	3.20	2.00
1:1 NM	0.50	5.20	5.00	5.10	5.00	5.10
1:2 NM	0.50	5.70	4.80	5.80	5.30	5.60
1:3 NM	0.50	5.90	5.80	5.50	5.80	5.80
Control	0.00	3.40	5.30	5.50	5.40	4.90
PN	1.00	5.10	3.90	4.40	3.90	4.30
PM	1.00	2.90	2.40	2.80	3.00	2.70
1:1 NM	1.00	5.30	4.50	4.80	4.60	2.70
1:2 NM	1.00	5.90	5.30	5.10	5.20	5.70
1:3 NM	1.00	5.20	5.80	5.60	5.10	5.30
Control	0.00	3.40	5.30	5.50	5.40	4.90
PN	1.50	4.80	3.60	4.00	4.20	4.20
PM	1.50	4.90	3.90	4.40	4.20	4.30
1:1 NM	1.50	5.00	3.70	3.30	4.70	4.00
1:2 NM	1.50	5.40	4.40	5.10	4.40	5.30
1:3 NM	1.50	5.90	5.40	5.20	5.00	5.60
LSD		0.941	1.290	1.216	1.210	1.244

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.

texture of cooked cowpea samples affected by treatment with various oil types and concentrations and after having been stored for 180 days. The lowest ($p<0.05$) texture ratings were recorded from samples treated with pure moringa oil at 0.5 and 1.0 ml and pure neem oil at 1.0 ml per 200 g cowpea. The panellists rated the texture of those samples preserved with 0.5 ml neem – moringa oil in ratio 1:3 as the best although this was at par statistically with the ratings of the control samples.

Finally the result of the overall acceptability in terms of sensory attributes of the treated cowpea samples stored for 180 days shows that the overall acceptability ratings of samples treated with pure moringa oil at 0.5 and 1.0 ml per 200 g and neem – moringa oil in ratio 1:1 at 1.0 ml per 200 g were the lowest ($p<0.05$) compared to the other oil types and rates. The panellist rated neem – moringa oil in ratio 1:3 treated sample at a concentration of 0.5 ml/200 g cowpea as the best in overall acceptability. This was however not statistically different from samples treated with various concentrations of neem – moringa oil in ratio 1:2.

DISCUSSION

Effect of treatment oils on cooking properties of cowpea stored for 180 days

The samples that cooked at shorter period of time were more acceptable to consumers. Pure moringa oil at 1.5 ml/200 g samples cooked at 55 min, Pure Neem, Neem-Moringa 1:1, Neem-Moringa 1:2, Neem-Moringa 1:3 treated samples (cooked at 60 min) they were more acceptable in this regard while pure moringa oil at lower rates had exceptionally longer cooking time of 65 min, hence consumers especially the urban working class will not accept this sample because of its longer cooking time.

The leached solids in range of 0.15 to 0.23 g were observed in all rates of pure neem, neem– moringa in ratios 1:1, 1:2 and 1:3 oils treated samples and 0.38 g leached solid was observed in pure moringa oil (at lower rates) treated samples. This indicates that very minute quantity of each of the cowpea constituents will leached into the cooking water. This means that the treatment may not have much significant effect on the chemical constituents of the stored cowpea. The higher soaking time of 27.67 and 24.37 min observed from Pure Moringa oil at 0.5 and 1.0 ml per 200 g cowpea could be due to excrete from the weevils that infested the cowpea grains that made it damp and later became hardened after drying (Lale, 2002).

The soaking time of less than 20 min observed in other oils treated samples is even shorter than the soaking time of 20 min for the control samples. This period of time is considerably shorter than the time recorded by Fashakin and Fasanya (1988), Sanni et al. (2006) and Akinyele et

al. (1986) for other Nigerian cowpea varieties. This is likely due to the effect of the treatments. Apart from the pure moringa oil at lower rates, treated samples, there are no significant differences in the cooking properties of the treated samples compared to the control samples, signifying that the cooking properties of the control samples may be the same with the treated samples. Meaning that the oil does not have adverse effect on the cooking properties and this will enhance its acceptability in preserving cowpea grains.

The swelling capacity varied from 187 and 218% in pure moringa oil at 1.0 and 1.5 ml/200 g cowpea treated samples respectively. The samples that also suffered the highest level of insect infestation. The high swelling capacity observed in pure moringa oil treated samples could probably be due to the high level of weevil infestation which increased their water absorption capacity and the eventual high swelling capacity.

Effect of treatment oils on the organoleptic properties of cowpea

The panellists preferred the colour of the oils treated samples and rated the control sample's colour very low probably because the oil brightened the colour of the cowpea grains and made them more attractive even after cooking. In terms of flavour, the characteristic flavour of the oils was found in the treated samples, due to the absorption of the oils. And this was insignificant to alter the acceptability in terms of flavour of the treated samples. This report is in agreement with the report of Gayan et al. (2006) who reported that the characteristic odour of the essential oil was found in the treated cowpea due to the absorption of essential oil. Perhaps, the blend of these two oils might have given it better flavour.

The panelists seemed to prefer the taste of pure moringa oil treated samples. Their low rating of pure neem oil treated samples was consistent with the report of a research carried out by Deutsche Gesellschat fur Technische Zusammenarbeit (1988) where reasons were given for low adoption of pure neem oil treated samples by farmers as the bitter taste of the samples. It also affirm the informal investigation carried out in the frame work of extension programme in Benin which revealed that the bitter taste of neem oil might be due to bitter compound azadiracthin in neem which discourages farmers from applying it on cowpea meant for consumption. Deutsche Gesellschat fur Technische Zusammenarbeit (1988) also affirmed that the bitter taste can be completely removed if the treated cowpea is soaked for a long time in water. With the mixture of the two oils the rate of adoption increased as panellist have preference for neem–moringa in ratio 1:3 taste probably because the addition of moringa oil at higher ratio reduces the concentration of neem oil (thereby reducing the bitter taste to a level that is insignificant to be felt by the panellists while still having the preservation effect on the cowpea). And if soaked in water for sometime it will enhance the taste and would be more acceptable. This is because the bitter taste will be completely removed (Deutsche Gesellschat fur Technische Zusammenarbeit, 1988).

The texture of samples treated with neem–moringa in ratio 1:3 were rated highest by the panel members which indicates that the treatment especially with mixtures of the two oils might be better for preserving cowpea as it did not affect the texture but rather improved it. Neem–moringa in ratio 1:3 oil treated samples had higher score in colour, flavour, texture and was third in taste and the best in overall acceptability, thus suggesting that one could treat cowpea for consumption with Neem Moringa 1:3 oils without any fear of consumer rejection.

CONCLUSION AND RECOMMENDATIONS

The result of organoleptic test showed that cowpea samples treated with 0.5 ml/200 g neem moringa oils in ratios 1:3 is rated best and 1:2 is rated second in overall acceptability. Farmers should therefore dispel the fear of adopting the use of neem oil as preservative for cowpea as they can use the above mixture (that is, 1:2 and 1:3 neem: moringa oils) for preservation.

a. The results of the cookability and oganoleptic test suggest that a mixture of neem and moringa oils (neem-moringa 1:2 and 1:3 at 0.5 ml /200 g cowpea) could be used for the preservation of cowpea meant for consumption.

b. If only moringa oil is to be used, the concentration should not be less than 1.5ml /200 g cowpea. This is because cowpea treated with pure moringa oil at lower concentration of 0.5 and 1.0 ml /200 g cowpea, recorded very low overall acceptability of 2.00 and 2.70 respectively.

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