Niger Agric. J. 31 (2000): 39-48

POTENTIALS OF *XYLOPIA AETHIOPICA* FOR SHORT-TERM PROTECTION OF COWPEA (VAR IT-81D-975) SEEDS IN NIGERIA

PHILIPPA C. OJIMELUKWE

Michael Okpara University of Agriculture Umudike
PMB 7267, Umuahia, Abia State, Nigeria
(Accepted July, 2000)

ABSTRACT

Seeds of a cowpea variety IT-81 D-975, improved for better insect resistance was used in the present study. Preliminary investigations were carried out to determine the optimal concentration of *Xylopia aethiopica* spice that possessed insecticidal properties against the cowpea bruchid, *Callosobruchus maculates*. Using 0.5% *X. aethiopica* dust, determined from this preliminary study, cowpea seeds were stored in four containers – white polyethylene bag (WPB), black polyethylene bag (BPB), plastic container (PC) and clay pot (CP), for six months. The moisture contents, seed viability, insect emergence hole, weight of seeds, bulk density, oil and water absorption capacities and reconstitution time of flour were monitored on a bi-weekly basis for 24 weeks. Moisture content and number of insect emergence holes of seeds increased with time of storage. Seed viability and weight of seeds decreased. Use of *X. aethiopica* as a protectant improved seed viability and reduced infestation of cowpea seeds by *C. maculatus*. Reconstitution time of flour increased with time of storage while water absorption capacity decreased. There was no significant change ($p \leq 0.05$) in the bulk density of flour samples. Because of reduced infestation, the reconstitution time of flour prepared from cowpeas stored with *aethiopica* was the reconstitution time of flour prepared from untreated cowpeas. PC and WPB were found to be better storage containers than BPB and CP.

Key words: Cowpea (IT-81-975 variety), insect infestation, *Xylopia aethiopica*, storage.

INRODUCTION

CALLOSOBRUCHUS MACULATUS (F) (Coleoptera, Bruchidae) is the most important cowpea storage pest in Africa (Singh, 1978). Up to 100% loss can be sustained within five months (Singh, 1978). *C. maculates* is susceptible to controlled atmospheres of 100 carbon dioxide (CO_2) or nitrogen (N_2). At temperatures of ≥ 30 °C, a 6-day exposure to CO_2 or N_2 achieves 100% mortality (Ofuya and Reichmuth, 1992; Mbata and Reichumuth, 1993). Synthetic insecticides and large-scale hermetic storage methods are also available for large-scale storage of cowpea. The general populace in developing countries, including small scale farmers and consumers, find many existing technologies for cowpea storage inappropriate and do not apply them due to limited available resources, environmental and social side effects and lack of technological expertise (Huignard, 1985, Egwuatu, 1987; Georghious, 1990; CTA, 1996). The resultant effect is that cowpea still suffers considerable damage in storage and alternative, more appropriate storage methods have to be sought. The present study investigates the potentials of a natural plant product, *X. aethiopica* for short-term cowpea storage, using up graded traditional methods. Similar studies had been conducted with the "Ife-brown" variety (Ojimelukwe and Okoronkwo, 1999).

MATERIALS AND METHODS

Samples of cowpea (IT 81D-975 variety) were obtained from International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria. Experimental insects were reared on cowpea seeds (Kano-white variety) obtained from commercial stock. Bruchids were reared at 27± 2 °C and 65± 10 RH with a 12 hour light dark cycle. Progenies were sorted into males and female according to the method of Halstead (1962). Ripe dried fruits of *X. aethiopica* were sundried to a moisture content of 10%, pulverized with an electric blender and sieved to pass 1 mm mesh sieve (to obtain the dust)

Five kilogram of cowpea seeds were packed in water tight containers (white polyethylene bags –13 mm thickness) and stored in a deep freezer for 2 weeks in order to achieve disinfestations. Subsequently, 10 portions of cowpea seeds were weighed into sterile petri-dishes and covered with cotton cloth, held tightly with rubber bands. Each petri dish was infested with *C. maculates progenies,* 2-3 days old (2 males and 3 females per 10 g seeds).

X. aethiopica dust was thoroughly mixed with cowpea grains in petri dishes at five levels (0.1-0.5g per 10g of cowpea seeds). The petri dishes were checked daily for 30 days and dead insects were removed. Grains were also observed for evidence of feeding by *C. maculates* larvae. Each dosage level used for experiment was replicated five times.

Cowpeas were subsequently stored using 5% of *X. aethiopica* dust which was the optimal dosage level determined from earlier experiments. The seeds were stored in four packaging materials-white polyethylene bag (WAP), black polyethylene bag (BPB), plastic container (PC) and clay pot (CP). The clay pot was covered with fine mesh cloth held tightly with rubber band. Each treatment was replicated five times and had its own control. The first control consisted of cowpea seeds that did not contain *X. aethiopica* but contained bruchids. Cowpea seeds, neither treated with *X. aethiopica* nor containing bruchids were used as second experimental control for each storage container.

The following parameters were monitored for seeds stored in each container on a biweekly basis. Moisture content of pulverized seeds was determined by the air-oven method by drying 2g pulverized seed samples to constant weight in an air oven (AOAC, 1975). Moisture content determination for each treatment was carried out on triplicate samples. Seed viability/germination tests were conducted using 10 seeds selected at random from each treatment. The grains were placed on moist filter paper in petri dishes and observed for radicle and plumule emergence. For determination of seed damage, 10 seeds were selected at random (5times) from each experimental unit. The number of insect emergence holes on the seeds was counted and the average values were noted. Weight of seeds was determined by selecting 10 seeds at random from each seed lot and weighing them on a biweekly basis. Bulk density was determined by using 2g samples according to the method of Wang and Kinsella (1976). Oil and water absorption capacities were determined according to the method of Lin et al. (1974). Pure soybean oil and distilled water were used for the determination of oil and water absorption capacities respectively. Foam properties were determined according to the method of Coffman and Garcia (1977). The reconstitution time of flour was determined using the method of Wang and Kinsella (1976). All determinations in each of the experiments described above were carried out on 5 replicate samples except the determination of moisture content. Statistical analyses were carried out on obtained data.

RESULTS AND DISCUSSION

Table 1 shows the effect of preservation with *X. aethiopica* dust on the physicochemical properties of cowpeas (IT81D-975 variety). Seed damages (as indicated by the number of insect emergence holes) for cowpea seeds stored with *X. aethiopica* for six months, was significantly less ($p \geq 0.05$) than seed damage in the controls. Seeds stored with *X. aethiopica* were significantly more viable ($p \geq 0.05$) than the infested controls and comparable to the uninfested control. Also seeds stored with this plant product were easier to reconstitute. There were no significant differences ($p \geq 0.05$) in the moisture content, weight of seeds, bulk density, water absorption capacity and oil absorption capacity of cowpea seeds stored with or without *X. aethiopica*.

Table 1: Effect of Perservation with Xylopia aethiopica on some Physicochemical properties of Cowpea (IT. 81D-975) Seeds and sees flour.

	975	975C
Moisture content (%)	11.73	13.74
Seed viability (%)	53.04a	349.64b
Number of Insect Emergent Holes per 10 seeds	35.29b	53.44a
Weight of 10 seeds	2.32	2.34
Bulk Density of flour (g/cm^3)	0.89	0.88
Water Absorption Capacity of the flour	0.60	0.60
Oil Absorption Capacity of the flour	0.52	0.53
Reconstitution Time of flour (secs)	71.99b	82.80a

Values in the same rows followed by different letters indicate significant – tests 975 = control 975 = Treated seeds

Table 2 contains data on the change in physicochemical properties of cowpea seeds over a storage period of 24 weeks in WPB, BPB, PC and Cp. There were gradual increases in the moisture content and reconstitution time of stored cowpea seed flour. Seed viability declined as seed damage (indicated by the number of insect emergence holes) increased.

The bulk density of flour from cowpea seeds did not change significantly ($p \geq 0.05$) within the storage period. Oil and water absorption capacities reduced with storage period. Average weight of the seeds also decreased. Cowpea seeds stored with *X. aethiopica* were quite wholesome for at least 12 weeks (containing < 0.2 insect emergence holes per seed).

Table 2: Effects of storage period on some Physicochemical Properties of Cowpea Seeds (PT 81D-975) and seed flour

Storage period (wks)	Moisture Content (%)		Numbers of Insect Emergent holes per 10 seeds		Seed viability (%)		Average Weight of 10 seeds		Bulk Density of flour g/cm -3		Oil Absorption capacity of flour		Water Absorption Capacity of flour		Reconstitution Time of flour (secs)	
	975	975c	975	975	975	975c	975	975c	975	975c	975	975c	975	975c	975	975c
0	7.2f	7.2f	0.0d	0.0d	89.1a	87.6b	2.4e	2.4e	0.8	0.8	0.6a	0.6a	1.0a	1.0a	53.0de	53.0d
2	7.2f	7.2f	0.0d	0.0d	89.0a	87.5b	2.4e	2.4e	0.8	0.8	0.6	0.6	1.0a	1.0a	53.0de	53.0de
4	7.5f	7.5f	0.0d	0.0d	88.0b	87.5b	2.4e	2.4e	0.8	0.8	0.6a	0.6a	1.0a	1.0a	53.0de	53.0de
6	9.3e	10.5e	0.5d	0.5d	79.0d	78.3e	2.5d	2.5d	0.9	0.9	0.6a	0.6a	0.9b	0.9b	53.3de	46.8
8	9.6e	10.8e	3.5d	2.5d	80.5c	77.5f	2.7b	2.8a	0.9	0.9	0.6a	0.6a	0.6c	0.6c	64.5	66.3c
10	10.5e	11.3d	8.3d	8.5d	75.0g	70.8h	2.5d	2.3f	0.9	0.9	0.5a	0.6a	0.5d	0.5c	56.5c	57.9c
12	11.0d	11.4d	13.5d	12.8d	54.3j	49.5k	2.6c	2.5d	0.9	0.9	0.6a	0.6b	0.5d	0.6c	57.5c	54.0c
14	12.9cd	14.4b	16.3	44.5c	58.3i	54.0j	2.3f	2.3f	0.9	0.9	0.5b	0.5b	0.5d	0.5d	54.3c	53.8d
16	15.4Bc	18.3a	52.5c	49.3c	32.5l	23.3m	2.4e	2.3f	0.9	0.9	0.5b	0.5b	0.5d	0.5d	57.0c	55.9c
18	13.8c	18.2a	70.5bc	88.3bc	25.5m	22.5o	2.2g	2.2g	0.9	0.9	0.4c	0.5b	0.4e	0.4e	99.3b	123.3a
20	15.0b	17.5	77.5bc	107.5a	18.8p	17.5q	2.1h	2.2g	0.9	0.9	0.5b	0.5b	0.5d	0.4e	94.3b	130.8a
22	15.5b	18.6a	87.3b	95.3a	17.5q	18.0q	2.1h	2.1h	0.9	0.9	0.6a	0.5b	0.5d	0.5d	93.3b	117.3b
24	15.8b	18.9a	89.0b	114.5a	18.0q	16.3r	2.1h	2.1h	0.9	0.9	0.5b	0.5b	0.5d	0.6c	98.0b	107.8b
FLSD	2.0		18.7	117.5a	0.7		0.1		-		.04		09		12.4	
0.05																

Lines in the same column followed by the different letters are significantly different (p> 0.05) from one another

975 = Cowpea treatment with X acthopica

975c = Infested Control

Table 3 shows the effects of storage with various containers on the physicochemical properties of cowpea seeds and cowpea seed flours. Seeds contained in CP imbibed the highest amount of moisture. Increase in moisture content was lowest for seeds stored in PC. Seeds stored in PC with *X. aethiopica* as an admixture were significantly more viable ($p < 0.05$) than seeds stored in the same container without this plant product. There were no significant difference ($p < 0.05$) in seed damage, weight of seeds, bulk density and oil and water absorption capacities of seed stored in the various containers. Cowpea flour from seeds stored in BPB and CP showed poorer reconstitutability than flour from seeds stored in other containers.

Table 3: Effect of Storage Containers on some Physicochemical Characteristics of Cowpea (IT81D –975) seeds and seed flour

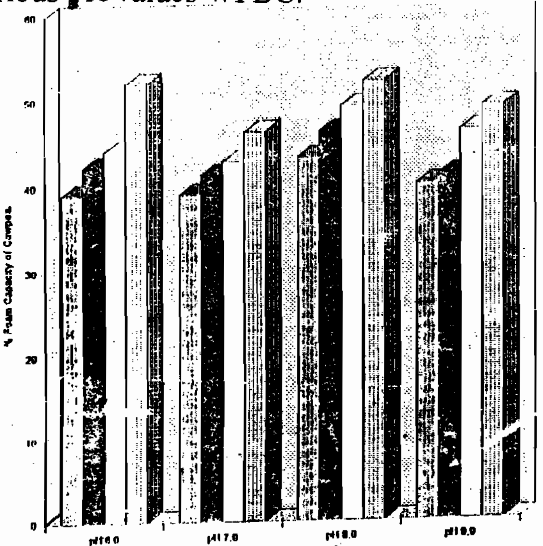
	WPB		BPB		PC		CP		FLSD
	975	975c	975	975c	975	975c	975	975c	0.05
Moisture Contents (%)	11.7d	14.7b	10.5c	13.6c	9.8c	9.5cf	15.0b	16.7	1.0
Seed Viability (%)	50.4c	44.0c	47.3d	38.7f	79.1a	76.8b	35.4g	24.0g	2.3
Number of Insect Emergent Holes per 10 Seeds	30.7	49.4	36.5	57.3	25.0	45.9	49.0	61.2	-
Weight of 10 Seeds (g)	2.4	2.3	2.4	2.5	2.4	2.4	2.2	2.2	-
Bulk Density of flour (g/cm 3)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	-
Oil Absorption Capacity	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.5a	-
Water Absorption Capacity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Reconstitution Time	67.7b	77.4a	69.7b	80.9a	52.0b	54.1b	96.5a	118.88a	44.3

Values followed by the same letter in rows are not scientifically different from one another ($p > 0.05$) at 95% confidence

WPB = White polyethylene bag
BPB = Black polyethylene bag
PC = Plastic container
PC = Clay pot

The foam properties of stored cowpea seeds are shown in Fig. 1 Infestation and seed damage decreased the foam stability rendering cowpea seeds unsuitable in certain cowpea food systems. Storage in PC and WPB, led to better retention of initial foam properties of the cowpea seed flour and better retention of good foam properties in the cowpea seeds. Obtained results highlight the beneficial effects of storage of cowpea seeds with *X. aethiopica* dust. Higher rates of seed damage in the control (not treated with (*X. aethiopica*) plant product reduced infestation rate. Similar studies with "Ife-brown" Cowpea variety (Ojimelukwe and Okoronkwo, 1999) indicated that the initiation of seed damage in "Ife-brown" cowpea was more than in IT 81D-975 variety. However, as storage time increased, both varieties deteriorated in quality because of infestation (especially the untreated controls). IT81D-975 is an improved cowpea variety for insect resistance, developed genetically from "Ife-brown" cowpea variety.

Fig. 1. Foam capacities of cowpea seed flour stored for weeks in different containers at various PH values WPBC.



Loss of nutrients due to feeding activities of *C. maculates* larvae in the grain could reduce the nutritive value of the seed. Loss of germinative capacity is indicative of infestation and grain damage. It may result from direct consumption of the germ by developing insects. The feeding activities of developing insects would also impair germinability. The change in reconstitution time of flour implies that seed damage caused by infestation alters the rehydration properties of cowpea seed flour-a functional property that is very important in cowpea food systems. *X. aethiopica* appears to lose its potency as a protectant after 2-3 months. Adult cowpea bruchids also seem to be more vulnerable to this plant product than the larvae. However, a more detailed study needs to be carried out to determine its effects on specific target groups within the life cycle of *C. maculates.* The containers used in the present study possessed enough moisture barrier properties to conserve the weight of cowpea seeds stored in them. The average weight loss of seeds (about 12,5%) was less than estimated values by earlier researchers – about 30% (IITA, 1984). Porous earthernware pot (CP) however enhanced moisture inbibition and rate of deterioration of cowpea seeds. PC and WPB were found to be good storage containers for cowpeas. In conclusion, *X. aethiopica* is effective for short-term storage of cowpea. It does not offer complete protection but reduces infestation rates. Further studies to determine the effect in specific target groups within the life cycle of bruchids might highlight the best utilization method for this plant product. Studies about its synergistic effect with other plant products or stored product protection chemicals may also enhance its efficacy.

ACKNOWLEDGEMENT

I am sincerely grateful to International Foundation for Science (IFS) for supporting this research

REFERENCES

A.O.A.C (1975) Official Methods of Analysis 12th edn. Association of Official Analytical Chemists, Washington, DC.

CTA (1996) Risks and consequences of the misuse of pesticides in the Treatment of Stored Products. Technical Centre for Agricultural and Rural Cooperation. Leaflet No2

Coffman C. W and Garcia V. V (1977) Functional properties and amino acid content of a protein isolate from mung beans flour J. Food Technol 12:473-484.

Egwuatu R. I. (1987) Current status of conventional insecticides in the management of stored products insect pest in the tropics. Insect Sci Appl 8:695-701.

Georghious P. G. (1990) Overview of Insecticide Resistance. Green MB, Lebanon HM, Moberg NK (eds.) ACS Symposium Series 421. 19-41. Amer Chem Soc Washington DC.

Halstead D. G. N. (1962) External sex difference in stored products insects. Coleoptera Bull Entomol Res 5: 119-134.

Huignard J. (1985) Importance des pertes des aux insects ravageurs des grainers: Problem's pose par la conservacion des legumineuses alimentaires sources des proteins vegetates. Cahiers du nutrition et de dietetique xx: 193-199.

IITA (1984). Grain legume Improvement programme International Institute for Tropical Agriculture, Research highlight 1981-1984, IITA Publications, Ibadan, Nigeria.

Lin M. J., Humbert E. S. and Sosulski F. N. (1978) Certain functional properties of sunflower meal products. J Food Sci. 19: 368-379.

Mbata G. N. and Reichumuth CH (1993) Toxicity of inert atmospheres to various stages of *Callosobruchus subinnotatus* (PIC) Coleoptera: Bruchidae Medlingen an der Faculteit Landbouwkundige Universitiet Gent. 58/2b: 593-598.

Ofuya T L and Reichmuth CH (1992) Mortality of the cowpea bruchid *Callosobruchus maculates* (Fabricus) in a highly elevated carbon dioxide atmosphere. Proceedings of the First European Conference on Grain Legumes, Angera, France. Pp 365-366

Ojimelukwe P. C. and Okoronkwo S (1999) Effect of Preservation with *Xylopia aethiopica* the Shelf life of Cowpea Seeds. J. Food Sci. Technol 36, (2): 170-172.

Singh S. R and Taylor, T. A. (1978) Pests of grain legumes and their control in Nigera. In: Pests of Grain Lrgumes: Ecology and Control. (Singh S. R, Van Embem H. F, Taylor T. A. (eds) Acad Press London. Pp: 267-279.

Wang JC and Kinsella JE (1976) Functional properties of novel proteins. J. Food Sci. 41: 286-292.