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The Preservative Quality and Organoleptic Properties of Beans in Storage Containers Screened against Cowpea Seed Bruchid, Callosobruchus Maculatus (F)

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Abstract

The storage containers included polythene, plastic, metal, jute and sack bags were used as storage facilities to control *C. maculatus* (F.) and resultant effect on preservative quality of stored cowpea seed varieties was investigated. Five pairs of *C. maculatus* were introduced into each 30 g of cowpea seed variety contained in each of the storage containers, replicated four times and laid out in a completely randomized design using 5 x 3 x 4 factorial arrangement. Results indicated among the three beans varieties used, honey beans recorded significantly (P<0.05) higher number of undamaged seed and closely followed by iron bean variety with the exception of beans in sack bags. Consequently, there was an appreciable reduction in means seed damage and this contributed to high undamaged seed in Honey variety (0.00%)(100.00%). Observable weight loss was recorded in sack bag (0.00%) while other containers recorded percentage weight gain (2-8%). However, the cowpea seed stored in metal and sack containers developed foul odour, shrink and blue-greenish colour testa, which is an indication of growing mould. The panelists tend to prefer beans stored in polythene bag and by extension the Kampala bean variety. Though, the panellists had no objectionable taste to other varieties when cooked.

Keywords: Storage containers; Preservative quality; *Callosobruchus maculatus*; Cowpea; Variety

Introduction

It has been predicted that the World population will reach 9.1 billion by 2050 and this will require a 70% increase in food production and availability. Cowpea is paramount to the survival of low-income farmers in Africa and is consumed in many forms throughout the year Tchiagam et al. [1]. It is most likely contributing to decrease in poverty and reduction of food deficiency in Africa. In Nigeria, it is an important source of plant protein for humans and livestock Tchiagam et al. [1]; Akami et al. [2], and contributes to soil fertility Asiwe [3]; Ijarotimi et al. [4]; Thamaga-Chitja et al. [5] described storage as a way or process by which agricultural produce or products are kept for future use; it is a temporary and repeated phase during transit of agricultural produce from producers to processors and its products from processors to consumers. Grains need to be stored from one harvest to the next in order to maintain its constant supply all year round and to preserve its quality until required for use. However, 4 percent of total annual production of cowpea or about 30,000 tonnes valued over 30 million US dollars is lost annually to the cowpea bruchid in Nigeria alone Fakayode et al. [6]. Storage pests cause direct and indirect damages to stored agricultural products in Nigeria. Direct damages are in the form of weight loss, loss in grade of grains, lowering of harvests' market value, contamination and damage to storage structures. Indirect damages on crops include heating and moisture migration in silos and other storage structures like the traditional African silo: 'rhumbu' and cribs. Other indirect damages include the spreading of moulds and spores throughout the grain mass and monetary expenses in terms of having to purchase pest control chemicals. Damage and loss to stored grain, especially cowpea by insect pests is very severe.

Insecticides are widely available for use to reduce the population of these insects, though it requires expensive equipment and training for their use. They are expensive and nonbiodegradable thereby led to environmental pollution and became potentially dangerous to users. Consequently, many cowpea growers in Africa do not use insecticides because they cannot afford them; they do not have the necessary equipment, or they are not taught how to apply them properly. That is why conventional insecticides are not the answer to the insect problems Afolami [7]. Grains need to be stored from one harvest to the next in order to maintain its constant supply all year round and to preserve its quality until required for use. Peasant farmers were forced to sell pulses soon after harvest to traders for quick returns; the traders later take on the responsibilities of storing through the remaining period of the year. A wide variety of containers used for seed or grain storage include pots, tins and baskets, but the most common is the jute bags/sacks or polypropylene sacks. Sometimes, few farmers often store pulses before sale and can generally afford reasonable storage facilities as well as appropriate protective mechanisms Brice et al. [8]; Golob et al. [9]; Gudrups et al. [10]. Consequently, the storage sector needs to adopt appropriate structures and techniques that will help cut down postharvest losses. It is thus necessary for this study to show how various storage facilities affect both the quantity and quality of legumes in order to eliminate or reduce postharvest losses.

a) Objective of the study: Evaluate storage facilities effects on preservative and organoleptic properties of cowpea seed after storage.

Materials and Methods

The research was conducted at the Crop Protection Laboratory, Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt. The experiment was carried out under ambient temperature at 27 + 30c and relative humidity 65 + 5%, using thermometer and hygrometer.

Sample Collection

Three varieties of beans were used, the kampala, iron and honey beans, of which the kampala and the iron beans were bought from a market in Jos, Plateau state and the honey beans was obtained from Choba market, Rivers state. Storage containers, the metal, plastic, jute bags, sac bags and Ziploc were obtained from Choba market.

Insect culture

Identified *Callosobruchus maculatus* was collected from infested beans in the laboratory. The devoured seeds were replaced continuously with fresh un-infested seeds. Only newly emerged adult bruchids were used for the experiment.

Sterilization of the Beans: The different varieties of the beans was tied in a nylon which was doubled and stored in the refrigerator at -40c in order to kill all pathogens and insects pest for about a week and then after they were sun dried.

Weighing of Cowpea: 30 grams of cowpea seed was weighed using a weighing balance and introduced into each of the different storage containers (metals, Plastic, Jute bags, sack bags, and polythene bags) and kept in the laboratory.

Identification of Insect: Examination of bruchids was done with a light microscope of high resolution to correctly identify adult *C. maculatus* that was used for cultures. Thus, the teneral adult females were easily recognized by their strong markings on the elytra consisting of two large marginal dark patches mid-way along the elytra and smaller patches at the anterior and posterior ends, leaving a light grey-brown cross-shaped area covering the rest Dobie et al. [11]. The teneral adult males are much less distinctly marked and smaller Hill [12]; Delobel & Tran [13].

Bioassay: Five pairs of *C. maculatus* were introduced into each container containing 30 g cowpea seeds without adding chemical substances or any other protecting materials. The bruchids were immobilized in the freezer for about three minutes before introducing them into the different containers. Each treatment was replicated four times and left on work bench for three months. The experimental design was a completely randomized design using a 5x3x4 factorial arrangement. Percentage weight loss and percentage damage respectively were calculated using the formulae, according to several workers Baba-Tierto [14]; Osipitan & Mohammed [15].

% Grain weight loss = Weight of control sample – final weight of grain x 100

Weight of control sample

% Grain damage = Number of damaged grains x100

Total number of grains

Preference Taste: Cowpea seeds stored in different containers were washed and cooked in clean water for 65 min Ojiako & Adesiyun [16]. No extraneous flavour was added while cooking. The cooked seeds were served to a panel of ten judges in a comfortable offices and boardroom devoid of environmental interferences of odour and noise. To eliminate subconscious bias of the judges, samples were cryptically labelled A – N (15 places). All samples were presented to the judges at the room temperature Larmond [17]. A structured questionnaire was designed and administered to both lecturers and students in the department of Crop and Soil Science. Then ten questionnaires were administered to thirty (30) randomly selected lecturers and students. However, Morphological feature test (i.e. Modal observation) and Preference taste were carried out.

A five-point hedonic scale was used to rate the cooked cowpea seeds for odour, taste, texture and appearance. Where; 1 – Poor; 2 – Fair; 3 – Good; 4 – Very good, and 5 – Excellent.

Stastical Analysis: Data collected were subjected to Analysis of variance using GENSAT 3.5 and SPSS 20.0 version while mean separation was accomplished by LSD at 5% probability.

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Results

Result indicated that despite different storage containers used for the storage, the cowpea seeds stored in sack bag recorded the least percentage weight loss (0.00%) whereas other cowpea varieties across the storage containers had percentage weight gain range between (2 – 8%)(Table 1). Perhaps the source of water could be attributed to metabolic water produced by the activities of bruchids. There was appreciable reduction in percentage seed damage and undamaged seed in honey variety (0.00) (100.00) irrespective of the containers used. It was observed that iron and honey varieties were more susceptible to the attack of the bruchids mainly in sack and jute bags. Table 2 showed the quality of cowpea seeds of three high yielding varieties of beans exposed to *C. maculatus* in different containers after 90 days of storage. The sensory evaluation test implicated only cowpea seeds variety stored in metal container of not measured up to normal quality standard. It was observed that contents had foul odour and changed in appearance (damp, soft, shrink and light greenish blue to greenish blue testa; thus, an indication of secondary infection). The mouldiness would have been caused by fungal disease. However, other cowpea varieties irrespective of containers used showed normal colour, odourless, intact appearance and mild or no sign of secondary infection. Therefore, it was observed no sign of mould infection in beans stored in polythene container recorded (Table 2). Panelists assessed acceptability of the cooked seeds of cowpea on taste characteristics on a rating scale from 1 – 4. 1 = Poor; 2 = Fair; 3 = Good; 4 = Very good and 5 = Excellent. According to the judgement of the thirty (30) panelists, the storage containers left no flavour strongly objectionable enough to influence acceptance of cooked seeds that had been stored over two months in metal, plastic, jute, sack and polythene bags. Though the panel tend to prefer beans stored in polythene bag by extension the kampala variety (Figure 1).

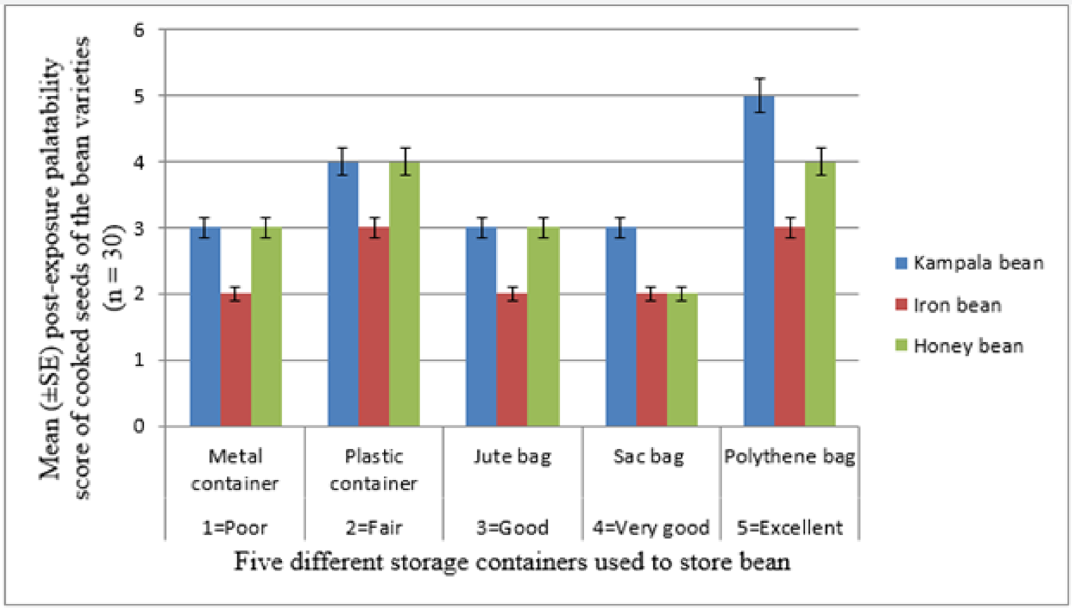

Figure 1: Consumer palatability-preference for seeds of three varieties of bean cooked after exposure to Callosobruchus maculatus and storage with commercially available containers.

Table 1: Effect of storage containers on the development of *Callosobruchus maculatus* in stored cowpea seeds.

Variety	Storage	Mean no. of undamaged seed ± SE	Mean no. of damaged seed ± SE	Mean of weight gained ± SE
Kampala	Metal	30.38 ± 42.5	92.35 ± 9.73	8.00 ± 5.42
	Plastic	70.08 ± 40.3	8.53 ± 1.56	5.08 ± 0.59
	Jute	92.58 ± 4.31	7.38 ± 4.33	4.08 ± 0.70
	Sac	88.50 ± 1.15	12.75 ± 2.87	3.50 ± 2.05
	Polythene	97.80 ± 0.91	2.20 ± 0.91	2.45 ± 0.17
Iron	Metal	70.40 ± 47.0	51.48 ± 53.30	5.00 ± 3.38
	Plastic	94.00 ± 2.53	6.00 ± 2.53	5.40 ± 0.92
	Jute	89.30 ± 3.21	10.83 ± 3.02	6.65 ± 1.19

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	Sac	25.45 ± 9.71	74.55 ± 49.7	0.00 ± 0.00
	Polythene	98.80 ± 1.17	0.93 ± 1.32	3.33 ± 0.64
Honey	Metal	96.33 ± 2.14	3.65 ± 2.09	6.48 ± 0.89
	Plastic	84.63 ± 30.8	15.38 ± 30.75	4.58 ± 3.15
	Jute	91.45 ± 6.38	8.53 ± 6.38	6.08 ± 1.88
	Sac	25.83 ± 49.47	74.18 ± 49.47	2.65 ± 3.17
	Polythene	100.00 v 0.00	0.00 ± 0.00	3.23 ± 0.59
Mean		77.03 ±36.00	24.58 ±37.38	4.43 ± 2.75
SE		7.99	7.22	0.6
CV		9.80%	12.4	9.2
LSD (0.05) (Variety)		NS ±	NS	NS
LSD (0.05) (Storage)		22.8	20.6	1.85

Table 2: Quality assessment of seeds of three high-selling varieties of bean exposed to *C. maculatus* insect pest and stored for 60 days using commercially available storage containers.

Storage containers	Quality indices considered			
	Colour	Odour	Appearance/ Texture	Mold infection
	Kampala bean variety			
Metal container	Normal	Foul	5 % shrunken, most intact and normal	Slight
Plastic container	Normal	Normal	Normal and intact	Slight
Jute bag	Normal	Normal	Normal and intact	Slight
Sac bag	Normal	Normal	Normal and intact	Slight
Polythene bag	Normal	Normal	Normal and intact	No
	Iron bean variety			
Metal container	Light greenish-blue	Foul	5 % shrunken, damp and soft	Moderate
Plastic container	Normal	Normal	Normal and intact	Slight
Jute bag	Normal	Normal	Normal and intact	No
Sac bag	Brownish-white	Foul	Normal and intact	Moderate
Polythene bag	Normal	Normal		No
	Honey bean variety			
Metal container	Greenish-blue	Foul	5 % shrunken, most intact	Slight
Plastic container	Normal	Normal	Normal and intact	Slight
Jute bag	Normal	Normal	Normal and intact	No
Sac bag	Brownish-white	Foul	Normal and intact	Moderate
Polythene bag	Normal	Normal	Normal and intact	No

Note: Inference was based on modal observation.

Discussion

According to Adejumo & Raji [18], who reported that air (Oxygen) is essential for the development and multiplication of stored produce insect pests, air-tight container deprives the pests of air leading to their death by asphyxiation and since no chemical treatment is required, the method is not hazardous. Consequently, the toxic effects of low oxygen concentration are much increased by the presence of relatively low level (10-35%) of CO_2 Ripp [19]. However, controlled atmosphere with elevated carbon dioxide (CO_2) or Nitrogen (N_2) and depleted Oxygen can be used to control insects and mites in stored grains Jayas et al. [20]. According to Dramani [21], control of cowpea storage pests and diseases can be achieved by using good storage facilities, In this trial, the results showed that there was appreciable reduction in percentage seed damage and undamaged seed in honey variety irrespective of the containers used. The implication is that the

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bruchid could only laid eggs, but other stage developments were inhibited by the storage facilities. Unlike when the bruchids would lay eggs, hatch and penetrate into the seed cotyledons Mazarin et al. [22], where the larvae and pupae develop and could completely damage seed viability and nutritive quality De Groot [23]; Oyeniyi et al. [24]. Also, the cowpea seeds stored in sack bag recorded the observable percentage weight loss, whereas other cowpea varieties paradoxically had high percentage weight gain. However, the increase in percentage weight gained across the bean varieties could be attributed to metabolic water produced during physiological process involved by the bruchid during storage. Haines [25] reported that heat and water which makes infested pocket of grain to become warmer and wetter was due to the metabolism of insect. Consequently, the rate of growth of insect thus increases and the infested region begins to expand as the insects disperse from its heavily infested centre.

In the judgement of 30 panelists, the different containers left no flavor or aroma strongly objectionable enough to influence acceptance of cooked seeds that had been stored over two months in various storage containers. Though panel of judges tend to prefer beans stored in polythene bags by extension the kampala beans variety. The consumer palatability-preference choice for kampala bean variety implied that the beans could be stored for long without losing the taste and nutritious quality. However, fewer or no damage was recorded by the *C. maculatus* on the honey bean compared to other variety. Findings also showed that the varieties of cowpea stored in the polythene bags (Ziploc) especially the kampala beans from the palatability test carried out was mostly preferred by the consumers. This is followed in that order by honey beans and iron beans. Moreover, the least preferred cowpea seeds were stored in the sac bags which was significantly different from the metals, plastic and jute bag container regards to the quality of cowpea seeds after storage. This is in accordance with Dramani [21], who reported that control of cowpea storage pests and diseases can be achieved by using good storage facilities. In the same vein, Akami [2] reported that approximately 50–80% of cowpea grains are lost during the storage stage due to insect pest attacks. In a similar finding, several workers reported annual grain losses of over 50% Abraham & Firdissa [26] in cereals and up to 100% Boeke & Sara [27] though the average loss remains at 20% Youdeowi & Service [28]; Philips & Throne [29].

Conclusion

i. Among the five storage containers screened for storage of cowpea seeds against damage caused by C. maculatus; polythene bag was determined to be most efficient and effective container in bruchid damage reduction [30].

ii. The sack bag pre-disposes stored cowpea seeds to bruchid damage, while metal container recorded foul odour and changed in appearance of stored beans

iii. Furthermore, honey variety was determined to be more suitable cowpea seed for storage

The panel of judges tend to prefer beans stored in polythene bag and by extension the kampala variety.

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