Current Trends in Technology and Science
ISSN: 2279-0535. Volume: VI, Issue: VI

Comparative Study of Cowpea Stored in Different Household Storage Materials

Falayi F.R.
Department of Agricultural Engineering,
The Federal University of Technology, Akure, Ondo State, Nigeria
frfalayi@futa.edu.ng, falayirichard@gmail.com

ABSTRACT - *Cowpea (Vigna unguiculata) is an important bean which serves as a major source of protein in the absence of sufficient animal protein for the human being. Studies have revealed that stored cowpea deteriorates very fast when kept in household storage materials and this study aimed to determine storability of cowpea using four household storage materials namely; jute bag, plastic container, polythene bag and hessian bag to determine the most appropriate material for the storage of the produce. Cowpea was stored in these materials for ten weeks and proximate composition of the stored cowpea was determined using standard AOAC methods. The amount of ash ranged between 4.53% and 5.08%, the crude fibre content ranged between 1.53% and 2.18%, the amount of fat was found to be 5.81%, 5.34%, 5.20%, and 5.67% for jute bag, plastic container, polythene bag and hessian bag respectively. The crude protein was found to be 23.24%, 22.70%, 25.08%, and 25.29% for jute bag, plastic container, polythene bag and hessian bag respectively. Relative humidity in jute bag, plastic container, polythene bag and hessian bag was found to be 85.71%, 85.28%, 84.80%, and 86.42% respectively. The moisture content in the stored products ranged between 12.05% and 13.69% with materials stored in polythene having the smallest value of moisture content. It was also observed that cowpea stored in polythene bags had the lowest case of weevil infestation. It was concluded that polythene bag appeared to be the best household storage material for cowpea and should be encouraged at household levels to increase the shelf life and prevent deterioration.*

Keywords:- Storage, Cowpea, Relative Humidity, Temperature, Deterioration

INTRODUCTION

Cowpea is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world, it is one of the most ancient crops known to man. The largest production is in Africa, with Nigeria and Niger predominating, but Brazil, Haiti, India, Myanmar, Sri Lanka, Australia, the U.S., Bosnia and Herzegovina all have significant production. Worldwide production of cowpeas is approximately 20 million acres [1].

According to Bawa et al [2], the storage structures for cowpea include Clay pots in which the grain is mixed with wood ash or Neem leaf extracts, and Storage containers such as Jute bags, Plastic containers, Hessian bags and Polythene bags. Other storage methods include barns on raised platforms using sticks and thatch for both the floor and roof (only cowpea in pod is stored with this method) and small containers using mud bricks for construction and using cement for plastering of the floor and walls, and of jute sacks.

Cowpeas are particularly susceptible to damage in storage, mainly by cowpea bruchids (Callosobruchus maculatus). A large number of pests and diseases attack cowpea at all growth stages. The pests and diseases constitute, without doubt, the most limiting factor affecting intensive cowpea production in Nigeria as they may cause total loss of the grain [3]. Stated that cowpea bruchids, Callosobruchus maculatus and Callosobruchus chinensis cause extensive damage to stored grain, infesting as much as 60% of it. Many researchers have observed the losses of the grain during the traditional post-harvest storage period are very high, thereby causing serious financial and nutritional losses of the grain to storage pests in the Nigeria. Bawa *et-al*. [2] and Singh *et-al.* [4] documented the loss of cowpea grain during traditional post-harvest storage in Nigeria. They concluded that Pods stored for eight months had 50% grain damage by bruchids, but when stored as grain 82% of the grain had one or more holes in them. A visit to any village market in this country will reveal that the cowpea grains offered for sale are usually damaged and when the damage exceeds one or two holes per seed, the price is usually lower than the grain without holes or with very few holes in them. Once the farmers' post-harvest storage methods are unable to prevent or even reduce the damage caused by pests to storage grain, most farmers have resorted to the use of very dangerous and unapproved synthetic chemicals such as organo-chlorine chemicals for cowpea grain storage [2]. These chemicals are not only expensive, but can cause serious environmental and health hazards or even death to livestock and human beings [5]. This research investigated the comparative study of the use of different household storage materials such as jute bags, hessian bags, polythene bags and plastic container for storage of cowpea and evaluated the best storage material that could prevent deterioration of the product at household level.

MATERIALS AND METHODS

The study was conducted in the Agricultural Engineering Department Laboratory of the Federal University of Technology, Akure in Ondo State, Nigeria. A local variety of cowpea called black-eye pea was obtained from Owena open market and used for the experiment. Plastic containers, small size Jute bags, medium size polythene bags and small size hessian bags were used to store cowpea for ten weeks. Each treatment has 5 replicates. Other materials used were weighing cans, sensitive weighing balance (mettler PC 440), sieves, oven (Towson and Mercer limited), muffle furnace (Gallen kamp), Soxhlet extractor, heater, water bath, titration set up, distillation set up, Kjeldahl apparatus, atomic absorption spectrophotometer, fume cupboard, hygrometer, digestion flask and desiccators were used. Boric acid, boric acid indicator, hydrochloric acid, sodium hydroxide, ethanol, Kjeldahl catalyst, concentrated nitric acid, concentrated sulphuric acid, petroleum ether, trichloroacetic acid and glacial acetic acid were also used.

Storage method

In the plastic containers, 1.6 kilograms of the cowpea was stored in each of the five plastic containers, without adding any chemical or giving any treatment, as that was the practice of most farmers. The five jute bags were each filled with 1.6 kg cowpea seed for storage. The five polythene bags were each filled with about 1.3 kg of cowpea seed while the five hessian bags were each filled with 1kg of cowpea seed. All the storage containers filled with cowpea were placed in a well-ventilated room for a period of ten weeks.

Collection of data

Seeds sample was taken weekly from the various storage materials.

I. Ambient and average temperature in each storage container was determined using digital thermometers 'MAX-MIN THERMO HYGRO'.
II. Relative humidity was also measured using the 'MAX-MIN THERMO HYGRO'
III. Weight of the stored cowpea was measured using sensitive digital weighing balance
IV. Moisture content of the stored cowpea was determined by oven dry method.
V. Number of damaged grains was done by randomly counting 100 grains from each sample and manually counting the number of holes in each grain, after sorting them out according to the number of holes.
VI. Percentage germination was done using method [6] by randomly counting 100 grains from each type of container. The samples were then planted, and germination percentage is taken after 7 days when all grains would have germinated.
VII. Proximate analysis was used to determine the nutritive composition of the stored cowpea such as dry matter, crude protein, fibre, fat and ash, as given by [6].

ANALYSIS OF DATA

Data collected were subjected to appropriate statistical analysis such as analysis of variance (ANOVA), descriptive statistics and Duncan multiple range using Statistical Package for the Social Sciences (SPSS). Differences were considered significant if Probability is less than 5% ($P < 0.05$) for both sets of data.

RESULTS AND DISCUSSION

Table 1 shows the result of the cowpea condition carried out before storage. The initial germination test indicated that 96% of the seed planted germinated which implied that the seeds were not dead. However, some degrees of insect infestation could be noticed.

Type of data	Results
Moisture content	11.85
Germination test	96%
Live insects	2
Dead insects	4
Zero hole	90
One hole	6
Two holes	3
Three holes	0

Table 1: Initial base-line data

The result of the proximate analysis on cowpea stored in different household materials is shown in Table 2. The proximate analysis revealed that the amount of ash of the cowpea has increased in storage from 2.30% (which was the initial i.e. control) to 5.08%, 2.30% to 4.71%, 2.30% to 5.35% and 2.30% to 4.53% for jute bag, plastic container, polythene bag and hessian bag respectively with the cowpea stored inside the polythene bag having the highest value of ash (5.35%) and cowpea stored inside hessian bag having the lowest value of ash (4.53%), at $p<0.05$, there is significant difference. This ash content is an indication of the level of inorganic elements in the sample.

Table 2: Proximate analysis of Cowpea stored in different household storage materials

	Control	Jute Bag	Plastic container	Polythene Bag	Hessian Bag
Moisture content	11.85±0.57^a	16.37±0.57^c	13.93±0.01^b	14.44±0.02^b	15.76±0.01^c
Ash	2.30±0.05^a	5.08±0.01^d	4.71±0.00^c	5.35±0.02^e	4.53±0.01^b
Crude Protein	25.86±1.17^b	23.24±0.02^a	22.70±0.11^a	25.08±0.04^b	25.29±0.11^b
Fat	8.45±0.57^b	5.81±0.00^a	5.34±0.02^a	5.20±0.11^a	5.67±0.01^a
Crude Fibre	2.92±0.01^a	1.91±0.00^c	1.53±0.01^a	2.18±0.01^d	1.77±0.01^b

Mean ± S.Ɛ with different superscript are significantly different from each other ($p<0.05$)

The crude protein content of the cowpea stored inside jute bag, plastic container, polythene bag and hessian bag reduced from 25.86% (which was the initial i.e. control) to 23.24%, 25.86% to 22.70%, 25.86% to 25.08% and 25.86% to 25.29% respectively in the final proximate analysis with the cowpea inside the plastic container having the lowest value (22.70%) and that of hessian bag has the highest protein value (25.29%) closely followed by those inside the polythene bag (25.08%). At $p<0.05$, there is significant difference between the cowpeas stored in different storage materials. This range of values falls within the range given by [7] which is 15 to 30%. Cowpeas are rich sources of protein. Dietary proteins are needed for the synthesis of new cell, repair of worn out tissues, enzymes, hormones, antibodies and other substances required for healthy functioning and development of the body and its protection [8] and for the treatment of protein energy malnutrition [9]. Protein deficiency causes growth retardation, muscle wasting, oedema, abnormal swelling of the belly and collection of fluids in the body [10].

The crude fibre content of the cowpea stored in jute bag, plastic container, polythene bag and hessian bag analyzed reduced from 2.92% (which was the initial) to 1.91%, 2.92% to 1.53%, 2.92% to 2.18% and 2.92% to 1.77% respectively with the cowpea stored in hessian bag having the lowest value and the cowpea stored in the polythene bag has the highest value (2.18%). The cowpeas stored in jute bag, plastic container, polythene bag and hessian bag showed significant difference at $p<0.05$. Fibre normally influences the metabolism of the gastrointestinal tract (GIT) and its deficiency is linked to appendicitis, diverticular disease and hemorrhoids [11]. Crude fibre aids digestion, absorbs water and makes stool larger and softer, so preventing constipation [12]. Fibre also slows down the release of glucose into the blood and decreases inter-colonic pressure, hence, reduces the risk of colon cancer [11]. This value recorded for fibre in the cowpea is in line with submission of [13]. They reported that fibre is found only in plant foods, especially in whole grains, fruit and garden products. Vegetable fibre is a special kind of carbohydrate which does not go from the intestines to the blood, so that they act as an authentic broom in the intestines, absorbing toxins and carrying out harmful substances such as biliary acids, the precursors of cholesterol. Carbohydrate is a source of energy and it supports other metabolic activities within the body. Vegetable fibre swells with water, increasing its volume several times; this gives consistency to the faeces and facilitates its transit through the colon until it is expelled through the rectum. When the diet contains little fibre because of the lack of whole grains and vegetables, the faeces will be hard, dry and concentrated, thus obliging the intestine to make enormous effort to eliminate them. This causes or worsens several problems, such as diverticulum, hemorrhoids and even cancer of the colon [13].

The lipid (fat) content obtained from the final analysis of the cowpea also reduced from 8.45% (which was the initial) to 5.81%, 8.45% to 5.34%, 8.45% to 5.20% and 8.45% to 5.67% for jute bag, plastic container, polythene bag and hessian bag respectively with the cowpea stored in the polythene bag having the lowest value. Cowpeas have been shown to be low in their lipid content [14]. At $p>0.05$, there is no significant difference between the fat content of the cowpeas stored in different storage materials. Lipids provide strong energy and transports fat soluble vitamins like vitamins A, D, E and K [15]. Fat is needed for support of certain metabolic activities within the body of living organisms and equally a source of energy.

The moisture content was found to have increased (table 2), from 11.85% (which was the initial moisture content) to 16.37%, 11.85% to 13.93%, 11.85% to 14.44% and 11.85% to 15.76% for cowpea stored in jute bag, plastic container, polythene bag and hessian bag respectively. Cowpea stored in plastic has the lowest moisture content value (13.93%) closely followed by cowpea stored inside the polythene bag with 14.44% and Cowpea stored in jute bag has the highest moisture content value, this moisture content of the cowpea is still in the range of dried cowpea product of 15% [16], while that of cowpea stored in hessian bag and jute bag is slightly different from the range. At $p<0.05$, there is significant difference between moisture content of the cowpeas stored in different storage materials. Moisture content and water activity affect the progress of chemical and microbiological spoilage reactions in food. Moisture content is determined for long term storage. The result for moisture is in line with the findings of [16] that cowpea contains 11.5% moisture content and maximum moisture content

for safe storages is 15%. Hence, it must be properly dried to ensure long shelf life [17].

Table 3 shows the analysis of the environmental factors of the cowpea stored in different household storage materials (jute bag, plastic container, polythene bag and hessian bag). From table 3, it was revealed that the ambient temperature of all the storage materials is the same throughout (i.e. 29.31^{0}C), there is no significant difference at p>0.05 in the ambient temperature. This is due to the fact that they were kept in the same storage environment.

The average temperature of the cowpea stored in jute bag, plastic container, polythene bag and hessian bag are 29.00^{0}C, 28.90^{0}C, 28.78^{0}C, and 28.72^{0}C respectively. At p>0.05, there is no significant difference between the average temperature of the cowpeas stored in different household storage materials.

Table 3: Analysis of Environmental Factors

	Jute Bag	Plastic container	Polythene Bag	Hessian Bag
Average temperature (^{0}C)	29.00±0.27^a	28.90±0.27^a	28.78±0.26^a	28.72±0.27^a
Ambient temperature (^{0}C)	29.31±0.33^a	29.31±0.33^a	29.31±0.33^a	29.31±0.33^a
Relative humidity (%)	85.71±1.36^a	85.28±1.43^a	84.80±1.27^a	86.42±1.13^a
Weight (kg)	6.69±0.03^b	8.18±0.03^c	6.68±0.02^b	6.11±0.01^a
Moisture content (%)	13.58±0.42^b	12.22±0.15^a	12.05±0.20^a	13.69±0.31^b

Mean ± S.Ɛ with different superscript are significantly different from each other (p<0.05)

There was also increase in weight compared to the initial stage of storage, the weight differ from each other because quantity stored in each type of household storage material is not the same due to their storage capacity, there is significant difference at p<0.05.

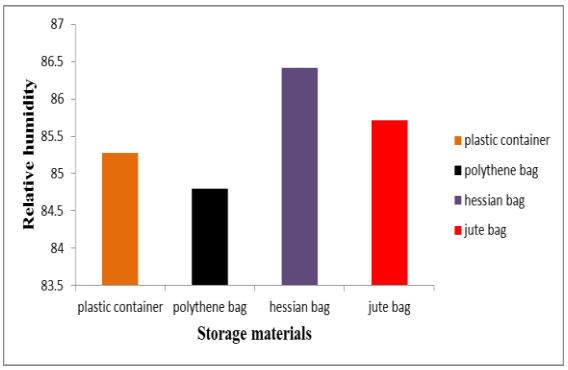

Fig.1 Bar chart of Relative Humidity of Cowpea stored in different household storage materials

The relative humidity of the cowpea stored inside the jute bag, plastic container, polythene bag and hessian bag ranged from 84.80% to 86.42% with the Cowpea stored in polythene bag having the lowest relative humidity value (84.80%) and those stored in hessian bag has the highest value (86.42%) as shown in figure 1. At p>0.05, there is no significant difference between the relative humidity of the cowpeas stored in different storage materials because they fell in the same range.

The moisture content in storage has increased (table 3), with the cowpea stored in hessian bag having the highest value 13.69% and cowpea stored in polythene bag has the lowest moisture content value of 12.05% as shown in figure 2, compared to the initial (control) moisture content of 11.85%.

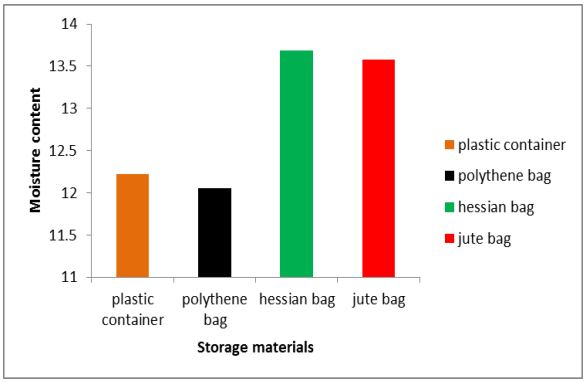

Fig. 2 Bar chart of moisture content of cowpea stored in different household storage materials

This shows that polythene bag will be preferable for cowpea storage. At p<0.05, there is significant difference between the moisture content of the cowpeas stored in different household storage materials (i.e. jute bag, plastic container, polythene bag and hessian bag). This result for moisture content is in line with the finding of [16], that cowpea contains 11.50% moisture content and maximum moisture content for a safe storage is 15%. Moisture content and water activity affect the progress of chemical and microbiological spoilage reactions in food. Moisture content is determined for long term storage. Hence, it must be properly dried to ensure long shelf life [17].

CONCLUSION

From the analysis, there were significant differences between the protein, fibre, lipid, ash and moisture content of the cowpea stored in different household storage materials at p<0.05.

From the elemental analysis, there were significant differences between the average temperature, weight, relative humidity and the moisture content of the cowpea stored in the four household storage materials at p<0.05, but no significant difference in the ambient temperature at p>0.05.

From the result, Cowpea stored in the hessian bag has the highest moisture content value while those stored inside the polythene bag has the

lowest moisture content value closely followed by those stored in the plastic container. Also, the Cowpea stored in the polythene bag has the lowest relative humidity value while those stored inside the hessian bag has the highest relative humidity value.

In conclusion, among the four household cowpea storage materials examined in this study (i.e. jute bag, plastic container, polythene bag and hessian bag), plastic container and the polythene bag can be used as household storage material for storing cowpea but the polythene bag is the best among the four household storage materials because it gives the lowest relative humidity and moisture content value which means that it does not give room for moisture absorption for the cowpea stored inside and thereby giving no room for the breeding of cowpea weevils also called bruchids (Callosobruchus maculatus) because it occurs in the presence of too much moisture. It also conserve the fibre, ash, fat and the protein content of the cowpea stored inside it, making the best household cowpea storage material among the four household storage materials (i.e. jute bag, plastic container, polythene bag and hessian bag) so far considered.

REFERENCES

[1]. Food and Agriculture Organization (FAO), 2007. "Core Production Data, "http://faostat.fao.org/site/340/default.aspx (accessed June 25, 2017).

[2]. 2 Bawa L. Y., Oparaeke A. M., and Ainika J. N (2012). Cowpea (Vigna unguiculata) Pest Control Methods in Storage and Recommended Practices for Efficiency: A Review. Journal of Biology, Agriculture and Healthcare www.iiste.org ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) Vol 2, No.2

[3]. 3. Raemaeker, 2001 (Crop Production in Tropical Africa – pp 372).

[4]. 4 Singh, B.B., D.R. Mohan-Raj, K.E. Dashiel and L.E.N. Jackai, 1997. Advances in Cowpea Research-Post Harvest Storage of Cowpea in Sub-Saharan African. I.I.T.A/JIRCA Publication, I.I.T.A Ibadan, Nigeria 1[I]P 302-312

[5]. 5 European Union. 2002. Strategic evaluation of the agro-industrial sector, Niger. Report of SOFRESCO Consultants. 5 pp.

[6]. 6. AOAC, 1995. Official methods of analysis. Association of Official Analytical Chemists methods, AOAC 16th Edition. Washington, D.C. 1995.

[7]. 7. Tobin G, Carpenter KJ (1978). The nutritional value of dry bean (Phaseolus vulgaris); a literature review nutrition abstract Rev. Ser. A human Exp. 48: 919-936. www.abc.net.au www.WHfoods.com.

[8]. 8. Cheesebrough M (1987). Medical laboratory manual for tropical countries (2nd edition). Cambridge bulterworth. Heiemann Ltd. p. 605.

[9]. 9. Omoruyi F, Osagie A.U, and Adamson I., (1994). Blood protein and tissue enzymes in malnourished rats rehabilitated with corn-crayfish protein diets. Biosci. Res. Commun. 6(1): 1-6.

[10]. 10. Mounts, T.L. (2000). The Chemistry of Components.2ndEdn. Royal Society of Chemistry. Natural Resources Institute, 1999 (Grain Storage Management (PG/MSC Computer Mediated Distance Learning Course – pp 109).

[11]. 11. Gibney M.J., (1989). Nutrition diet and health, New York, Chester Melbourne Sydney, Cambridge, Cambridge University Press. p. 168.

[12]. Ayoola, P.B and Adeyeye, A., (2009).Proximate Analysis and Nutrient Evaluation of Some Nigerian Pawpaw Seeds Varieties. Science Focus. 14(4) pp: 554-558

[13]. George and Pamplona-Roger, 2003. Enjoy it! Foods for healing and prevention, Ibergraphi. 2002-E-28830 San Fernando de Heneres (Madrid).

[14]. Davidson S, Passmore R, Brock JF, Truswell AS (1975). Human nutrition and diabetes (6th edition), New York. The English language book society and church living stone. p. 756.

[15]. Ologhobo A.D, Fetuga B.L., (1988). Energy values in differently processed cowpeas. Nig. Food J. 4(1): 34-44.

[16]. Ihekoronye A.J., and P.O. Ngoddy, 1985. Integrated Food Science and Technology for the Tropics, Macmillan London.

[17]. Warner, K.I. (2002). Food Chemistry. Aspen Publisher Inc. Gaithersburg Maryland. Pp: 90-93.