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A Survey On Postharvest Handling Practices And The Use Of Different Storage Methods By Cowpea Farmers And Their Effect On The Proximate Composition Of Cowpea (Vigna Unguiculata L.) Varieties (A Case Study In Dormaa Ahenkro District)

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Abstract: ***This survey was carried out in the Dormaa Ahenkro District of Brong Ahafo Region in Ghana to assess the postharvest handling practices and the use of different storage methods and their effect on the proximate composition of cowpea (Vigna unguiculata) grains of Nhyria, Tona and Soronko which were identified as the most popular cultivated varieties among several varieties. Purposive sampling was used in the selection of the five (5) communities from Dormah Ahenkro district to participate in the research. The communities selected were Kosane, Asikesu, Atesikrom, Besease and Badukrom. However, simple randomized sampling was used to select Ten (10) farmers from each community. The storage methods; drum (with no chemical), drum with phosphine tablet and hermetic bag. Majority (50%) of the active farmers was within the age ranged of 30 - 40 years. Majority (70%) of the farmers had SHS/Commercial education. Few (4%) of the farmers had basic education. The field survey revealed five varieties under cultivation by the farmers. They were; "Uganda" (white with black-eye), "Mallam adamu" (red), "Soronko variety, Nhyira variety and Tona variety. The major storage methods used were storage rooms (10%), Nylon bags (40%), Empty drum (36%) and hermetic bag (4%). It was observed that (92%) of those that store their produce in storage rooms do regular spraying to prevent disease and pest infestation. The ash content of the three cowpea varieties ranged between (2.00 and 2.50%). There was an increase in the ash and crude fibre content after storage for all the cowpea varieties. However, there was a decrease in the moisture, ash and carbohydrate content. The high crude protein, crude fibre, moisture and ash content before storage and after storage suggest that the differences observed are mainly genetic. It was recommended that other cowpea varieties should be sourced from research institutions to ascertain the findings from this study.***

Keywords: Cowpea, Postharvest Handling, Storage methods

I. INTRODUCTION

Cowpea is a valuable and dependable commodity that produces income for many small holder farmers and traders in Sub-Saharan Africa [18]. In West Africa, cowpea is grown mostly in subsistence farming systems and on a small scale in the lowland dry savanna and Sahelian regions. However, cowpea cropping systems are moving towards monocropping as the crop's economic importance increases. The cultivation of cowpea in Ghana is carried out mostly in the transitional zone of northern guinea savanna zone of Northern, Upper East and Upper West Regions. Ghana is among the lowest in the world in terms of yield, averaging 310 kg/ha [17]. Hence, efforts have been made to improve cowpea production in Ghana through various means including the introduction of new varieties.

In Africa, cowpea is the most popular legume and the largest part of the world production originates from this continent. Cowpea is adapted to stressful environments where other crops fail. It is a food security crop in the semiarid zone of West and Central Africa which ensures farm household subsistence food supply even in dry years. [13] estimated the world production area as 5.6 million hactre, of which at least 90% is in West and Central Africa, and the annual world grain production is estimated at 2.7 million tonnes. The principal cowpea producing countries are Nigeria, Niger, Senegal, Ghana, Mali, and Burkina Faso [13]. Among these countries, Nigeria and Niger are ahead with a production of 2 099 000 and 641 000 MT, respectively, in 1999 [14]. Nigeria, the largest cowpea producer in West Africa. Post-harvest insect pest of cowpeas (*Vigna unguiculata* (L.) Walp) in sub-Saharan Africa is one of the major factors that degrade the nutritional quality and economic value of the grain and cause producers, in anticipation of losses during storage, to sell at harvest when the price is lowest. Principal pest is the cowpea bruchid, *Callosobruchus maculatus* (F.), but other bruchids cause losses as well. The losses have been attributed to improper method use in grain storage. The high losses occurring after storage compels wholesalers, retailers, manufacturers not to buy in large quantities and store for future sale/usage. Many cowpea chain agents are not sure of what postharvest handling practices and storage method can help protect the grain to an acceptable level that would not cause nutritional losses. As a result of these uncertainties further research is needed to confirm an acceptable storage method and establish the possible effects of the various storage methods on the proximate composition of cowpea grains. The nutritional benefits associated with cowpea consumption are clear and cannot be over emphasized. Since cowpea is locally consumed in so many forms in Ghana, there is the need to derive maximum benefit from its production to boost the nutritional needs of the populace. The various stakeholders involved in the distribution chain therefore needs information on the various postharvest handling practices and storage methods and how they impact the proximate composition of the grains after storage especially Nhyira, Asomdwee, Adom, Soronko and Tona varieties which is the most preferred varieties and highly nutritious in Ghana. The main objective of this research therefore was to determine the postharvest handling practices and the use of different storage methods and their effect on the proximate composition of cowpea grains.

The specific objectives were;

- ✓ To determine the postharvest handling practices carried out by farmers in the Dormaa Ahenkro district
- ✓ To determine the various storage methods used by the farmers in the storage of cowpea in Dormaa Ahenkora District.
- ✓ To determine the effect of the various storage methods on the proximate composition of cowpea grains after storage

II. MATERIALS AND METHODS

A. LOCATION OF EXPERIMENT

The research was conducted at the Laboratory of the Department of Horticulture, KNUST, Kumasi and Crops and Soil Science Department, KNUST, Kumasi Ghana. The research period lasted from 5th December, 2013 to 20th June, 2014.

B. SAMPLE COLLECTION

Samples of cowpea stored under identified methods were randomly collected from farmers in the District under study. The seeds were sent to the Center for Scientific and Industrial Research - Crops Research Institute (CSIR-CRI) for identification.

C. EXPERIMENTAL DESIGN

The experimental design was laid in a 3x3 factorial in a completely randomized design with 3 treatments and replicated three times. However, with the hermetic treatment 27 small plastic containers were used and three containers were taken monthly for the data determination since, with hermetic, the containers could not be opened and sealed back without oxygen being taken in to the containers. Each treatment was made up of nine kilogram of grains (9 kg).

D. FIELD SURVEY

Purposive sampling was used in the selection of the five (5) communities from Dormah Ahenkro district to participate in the research. The communities selected were Kosane, Asikesu, Atesikrom, Besease and Badukrom. However, simple randomized sampling was used to select Ten (10) farmers from each community

E. RESEARCH MATERIAL/CROP

The research materials are Nhyira, Soronko and Tona cowpea seeds.

F. TREATMENTS

The treatments were:

- ✓ Traditional use of empty drum (control)
- ✓ The use of drum with phosphine tablet (0.04grammes) into each container
- ✓ Hermetic, where containers were tightly sealed to prevent the exchange of air between the environment inside the container and the environment outside the container

G. PROXIMATE COMPOSITION

Moisture content was determined by hot air oven drying overnight at 30°C [3]. Ash Content of flours were determined by ignition of flours for 2 hours at 600^0C. Crude fiber and fat (solvent extraction) were determined by the [3] methods. Crude protein content was determined by digestion and distillation of samples. The distillate was titrated against 0.1N hydrochloric acid (HCl) solution until the solution changed from bluish-green to pink [3]. Carbohydrate content was calculated by the difference methods.

H. ANALYSIS AND INTERPRETATION

The field survey was analyzed using statiscal package for social scientist (SPSS) and laboratory results were analyzed using Statistix 9 Students Version. Means were separated using HSD at 1% significance level.

III. RESULTS AND DISCUSSION

FIELD SURVEY

Gender	Farmers	
	Frequency	Percentage
Male	35	70
Female	15	30
Total	**50**	**100**

Source: Field Survey, 2014

Table 1: Gender Distribution of Cowpea farmers

GENDER DYNAMICS OF COWPEA FARMERS

Table 1 above reveals the gender of respondents. It was observed that (70%) of the farmers were male whiles (30%) were also female. This suggests that the majority of farm lands are owned by males. The findings on the gender dynamics was quite similar to (73%) of male farmers and (27%) of female farmers involved in cowpea production in Sekyedumase District by [19]. It can be deduce that majority of farm holdings are male dominants.

Gender	Farmers	
	Frequency	Percentage
Below 20	20	40
20-29	5	10
30-40	25	50
Total	**50**	**100**

Source: Field Survey, 2014

Table 2: Age Dynamics of Cowpea Farmers

AGE DYNAMICS OF COWPEA FARMERS

From Table 2 it could be inferred that, majority of the farmers were above 30 years representing (50%) of the respondents. The lowest (10%) age group for the farmers was within the age range of 20-29 years whereas farmers below 20 were (40%). Majority (50%) of the active farmers was within the age ranged of 30 - 40 years. The most economic working age group were those aged from 20 to 40 years for all the respondents and hence, show a mixed aged grouped (youthful and adult class) are the major producers and marketers of the pulses at the study areas This suggest most of the respondents in their active age are involved in either cowpea production or marketing. This may be attributed to the tedious nature of work involved especially in planting, weeding, harvesting, transportation, distribution among others. This also shows that the cowpea as a crop has a future in terms of production yields in the study area

Education	Farmers	
	Frequency	Percentage
Basic	2	4
SHS/Commercial	35	70
Diploma	13	26
Total	**50**	**100**

Source: Field Survey, 2014

Table 3: Educational level of respondents

EDUCATIONAL BACKGROUND OF RESPONDENTS

Table 3 shows the educational level of respondents. Four (4%) percent of the farmers had up to basic level of education, (70%) of the farmers were made of SHS/Commercial and (26%) were diplomat. Majority (70%) of the farmers had SHS/Commercial education. Few (4%) of the farmers had basic education. The result from this study suggests that most respondents in cowpea cultivation are mostly school dropout, thus could not further their education after the SHS education. Cowpea cultivation was their second source of income generation as most of the male farmers interviewed were either into driving or store operation and the female farmers were also into pitty trading. Also, Income generation, food and employment are the main benefits that drive majority of the respondents into cowpea cultivation and trading.

AGRONOMIC AND POSTHARVEST PRACTICES OF COWPEA FARMERS

Variable	Frequency	Percentage
Number of years in farming		
1-5 years	40	80
6-10 years	8	18
10 and above	2	4
Acreage of land		
1-3 acres	42	84
4-7 acres	8	16
Crops under cultivation		
Cowpea, Maize and cassava	10	20
cowpea and maize	5	10
cowpea only	35	70

Source: Field Survey, 2014

Varieties	Frequency	Percentage
"Uganda" (white with black eye)	2	4
"Mallam adamu" (red)	3	6
Soronko	15	30
Nhyira	20	40
Tona	8	16
More than one variety	4	8

Source: Field Survey, 2014

Table 4: Farm Production Characteristics

FARM PRODUCTION CHARACTERISTICS

Majority (80%) of the cowpea farmers had no good experience in farming having spent from 1 to 5 years in farming (Table 4). Just (18%) of the farmers had little experience in farming. A sizable number of farmers (84 %) had land size ranging from 1-3 acres. Those with land ranging

from 4 – 7 acres were 16 % (Table 4.4). Most of the farmers cultivated sole cowpea (70%), cowpea and maize (10%) and cowpea, maize and cassava (20%). Cowpea varieties under cultivation were; "Uganda" (white with black-eye) (4%), "Mallam adamu" (red) (6%), "Soronko (30%), Nhyira (40%) and Tona (16%) variety. It was revealed from the field survey that (80%) of the farmers had between 1 to 5 years of farming experience. (18%) of the farmers had between 6 to 10 years of farming experience. (4%) of the farmers having more than 10 years of farming experience clearly shows that those who have had experience in cowpea production are few. This may be due to the combined nature of work in the District. Therefore most of the farmers do not want to go into large scale production. Few (16%) of the farmers having 4-7 acres of land clearly suggest that cowpea farming is not the major crop under cultivation. The land tenure system in Ghana which poses difficulties for land acquisition explains why only few farmers had farming lands of more than 7 acres. The limitation on land for farming partly accounts for the low annual yields of most agricultural crops.

Also, only (70%) of the farmers were into only cowpea cultivation. Majority of the farmers were into two or more crops in combination with cowpea. Crops such as maize and cassava are also highly cultivated in the district. The field survey revealed five varieties under cultivation by the farmers. They were; "Uganda" (white with black-eye), "Mallam adamu" (red), "Soronko variety, Nhyira variety and Tona variety. Majority of the farmers (40%, 30% and 16%) cultivate Soronko, Nhyira and Tona varieties. Only (4%) of the farmers cultivate more than one variety during the cropping season. Majority of the farmers cultivating the under study cowpea variety suggests that it is the varieties of economic importance to the farmers in the District.

Variable	Frequency	Percentage
Storage of produce before sales		
Yes	35	70
No	15	30
Storage Methods		
Traditional silos	1	2
Applying chemicals treatment before bagging	7	14
Nylon sacks	5	10
Own storage room	2	4
Hermetic bags	10	20
Empty drums	25	50
Challenges during storage		
Diseases and Pest attack	40	80
Theft	8	16
Not well dried beans	1	2

Source: Field Survey, 2014

Table 6: Storage Operations

STORAGE OPERATIONS

Most (70%) of the farmers stored their produce before using them whiles (30%) do not store their produce (Table 6). Majority of the farmers (50%) stored their produce in empty drum for future use whiles some (14%) farmers apply chemical treatment before bagging, (4%) use their own storage room and (2%) uses traditional silos. It was observed that (20%) of the farmers use hermetic bag for storage purposes. Only (4%) also stated the use of chemical insecticide/ fumigants as a preservative for proper storage. The major challenges farmer's encounters during storage are Diseases and Pest attack (80%), theft (16%) and not well dried beans (4%). Storage methods adopted by the farmers were traditional silos, the use of hermetic bags, empty drum, treatment with chemicals before bagging, nylon bags and the use of storage rooms. The most dominant storage method was the use of empty drum (50%). This was followed by use of hermetic bag (20%) and treatment with chemicals before bagging (14%). The low cost of empty drum, storage rooms and the traditional silos propels some of the farmers in their use despite the dangers involved. Majority of the farmers using empty drum in storing their cowpea grains suggest that there is the need for community extension education on proper storage methods. Storing cowpea with Phostoxin in any storage container will preserve the seeds. Studies have shown that indoor storage of bag-stacks of rice, maize and soyabeans within sealed plastic enclosures under high CO_2 atmosphere can control pest infestation effectively and prevent quality deterioration of grains when done correctly [11].

A greater number of farmers, (70%) storing their produce before usage gave an indication that majority of the farmers had available storage facilities. This implied that, the country as a whole needed major storage structures to properly store such produce for emergency use. It could also be deduced that these farmers were capable of producing enough to feed their families and store the extra produce for sale in an anticipation of higher prices. The major challenges during storage are disease and pest attack (80%), theft (16%) and not well dried cowpea grains (4%). Deterioration in grain quality is not just a problem faced by farmers. Traders at all levels within the system also suffer storage losses as a result of insect pest damage [2]. Insect pests' infestation and their damage is one major problem that affects grains at storage and account for a high percentage of losses prior to and at storage. Level of infestation and damage is often observed and reported to be greatly high in cowpeas.

Variables	Frequency	Percentage
Pest management		
Grain moisture assessment	6	12
Regular spraying with chemicals	37	74
Use of wood ash	2	4
Re-drying /Spraying with chemicals	5	10

Source: Field Survey, 2014

Table 7: Pest Management and Other Chemical Usage

PEST MANAGEMENT AND OTHER CHEMICAL USAGE

Results in Table 7 shows that, 74% of farmers regularly spray their grains with chemicals to control pest and diseases. 12%, 10% and 4% of the farmers respectively re-check their grains moisture levels in order to prevent storage, re-drying /spraying with chemicals lastly the use of wood ash as a means of controlling pest. Pest management practices identified were regular checking on grain moisture content (12%), regular

spraying with recommended chemicals (74%), re-drying of grains and spraying with recommended chemicals (10%) and the use of wood ash (14%). This suggest that majority of the farmers are aware of the use of recommended chemicals. The use of botanical ashes to protect the grain from post-harvest losses caused by insect weevils is highly significant and contributes significantly to the uniqueness and success of this system [15]. The use of these management practices will improve grain quality and a longer storage period will also benefit consumers by improving the supply of grain legumes and hence food security during the dry season.

Varieties	Crude Protein	Crude Fibre	Moisture Content	Fat	Carbohydrate	Ash
Nhyira	27.96a	4.60a	2.43a	4.33a	58.16b	2.50a
Soronko	26.04b	4.33a	2.56a	4.25a	60.79a	2.00b
Tona	25.13c	4.30a	2.58a	4.36a	61.31a	2.30ab

CP- Crude protein, CF- Crude fibre, FA- Fat, MC-Moisture content, CHO-Carbohydrate, ASH-ash, Values not followed by the same alphabet in the same row are significantly different (P<0.01)

Table 8: Proximate Composition before storage

PROXIMATE COMPOSITION OF THE COWPEA VARIETIES BEFORE STORAGE

Table 8 shows the proximate composition of the three cowpea varieties before storage. The proximate analysis results showed significant differences (P<0.01) in the crude protein content between the three cowpea varieties. The results show that the varieties with highest crude protein contents were Nhyira (27.9%) and Soronko (26.04%). The variety with the lowest crude protein was Tona (25.13%). No significant differences (P>0.01) in the crude fibre and fat contents were observed for the different cowpea varieties. The results showed no significant differences (P>0.01) in the moisture content between Soronko and Tona. However, it was observed that the moisture of Soronko and Tona significantly differed from that of Nhyira variety (P<0.01) with the moisture contents of Soronko (11.25%) and Tona (10.36%) being higher than that of Nhyira (8.33%). The highest carbohydrate content was observed in Tona variety (55.31%) followed by Nhyira (54.16%) with the lowest carbohydrate content observed in Soronko variety (53.79%). However, these observed differences were not significantly different from each other (P>0.01). Among the three cowpea varieties, significant difference (P<0.01) in the ash content was observed between Nhyira and Soronko varieties with the ash content of Nhyira (2.50%) being higher than that of Soronko (2.00%).

The observed differences in proximate composition in the cowpea varieties under study could be attributed to soil type, environmental conditions, cultural practices and inherit genetic factors [9]. Since the cowpea varieties were grown under similar conditions, their differences could be mainly due to the genetic makeup. Significant differences were only observed in the crude protein, carbohydrate and ash content as shown in Table 8. The crude protein content of the three varieties were generally higher (25.13- 27.96%) compared to other findings from other cowpea varieties. The differences in the crude protein content can be attributed to the geographical location [7]. This therefore suggests that soils from the districts in which the crops were cultivated had higher nitrogen levels. The higher crude protein content (27.96%) for Nhyira variety, suggests that it could be a superior source of protein than the rest. The higher crude protein content observed for the three varieties is indicative that the varieties could be used to reduce protein deficiency conditions such as Kwashiokor. The crude protein content of (26.04) obtained in this study were found to be higher than (22.33%) and (22.98%) reported on Asontem variety by [10] and [6].The crude protein content of obtained in this study was also higher than (23.09%) reported on Soronko variety [6]. However, the crude protein content of (29.00% and 26.55%) reported on Nhyira and Tona varieties by [12] were all higher than that reported for the same variety in this study. Higher carbohydrate content was observed in this study when compared with various studies on some selected cowpea varieties. [8], also reported carbohydrate content of (57.42%) for cowpea variety. This was quite lower than those obtained in this study. [16] reported (57 – 62%) carbohydrate content on twenty-eight varieties of cowpea seeds. The carbohydrate content of the flours in this study was comparable to Asontem and Soronko cowpea variety (52.41% to 56.14), [6]. Carbohydrates are good sources of energy and that a high concentration of it is desirable in breakfast meals and weaning formulas.

The ash content of the three cowpea varieties ranged between (2.00 and 2.50%). The ash content observe was quite low compared with (4.47- 4.72%) by [5] for three cowpea varieties. Higher ash content of (3.50%) was also reported by [10] for Asontem cowpea variety. This was also quite higher than that obtained for the cowpea varieties in this study. The crude fibre content of the cowpea varieties ranged from (4.30-4.60%). [8] also reported crude fiber content of (9.58%) for cowpea. Crude fibre content of (6.14%) was found in Asontem variety whiles (6.13%) was reported on Soronko variety (Baysah, 2013). [8] also reported crude fibre content of (9.58%) for cowpea in Pakistan. These findings were all higher than that found in this study. The crude fibre content obtained in this study was however higher than (0.97%) reported on cowpea in Nigeria by [4]. Crude fibre helps in the prevention of heart diseases, colon cancer, diabetes etc. High fiber intake has been linked with decreased chances of colon cancer and associated with reducing constipation. The crude fat content of the three varieties were (4.33%), (4.25%) and (4.36%) for Nhyira, Soronko and Tona respectively. [4] also reported fat content of (4.37%) for cowpea seed flours found in Nigeria. Crude fat content of (1.77%) and (1.78%) were also reported on Asontem and Soronko variety by [6]. [6], also reported fat content of (1.27%) for cowpea in Pakistan. These were all lower than that reported for this study. Differences in fat content may be due to varietal differences [20]. Fats are essential in diets as they increase the palatability of foods by absorbing and retaining their flavours [1], in addition to being vital in the structural and biological functioning of cells and in the transport of nutritionally essential fat-soluble vitamins. Diets high in fat contribute significantly to the energy requirement for humans. Consequently, the high fat content of Tona variety would

make it a better source of fat than Soronko variety. The moisture content of Tona variety was the highest (2.58%) but was not significantly (P>0.01) different from the others. The moisture content of Asontem (13.67%) obtained in this study was lower than the (14.33%) reported on Asontem variety by [10]. High moisture content of (9.22%) was also recorded on Asontem variety by [6]. The lower moisture levels in this study are suggestive of longer shelf life for the cowpea flours.

Variety	Crude Protein	Crude Fibre	Moisture Content	Fat	Carbohydrate	Ash
Nhyira	27.33a	4.62a	2.23ab	4.38a	54.95b	2.67a
Soronko	25.22b	4.35a	1.61b	4.68a	59.66a	2.05b
Tona	24.00b	4.42a	2.42a	4.25a	59.23a	2.48a

Table 9: Proximate Composition of the three cowpea varieties after storage

PROXIMATE COMPOSITION OF THE COWPEA VARIETIES AFTER STORAGE

Table 9 displays the Proximate composition of the three cowpea varieties after storage. The proximate analysis of the crude protein content showed significant differences (P<0.01) among the different varieties of cowpea. Nhyira recorded the highest crude protein content (27.33%), ahead of Soronko (25.22%) and Tona (24.00%). However, there were no significant differences (P>0.01) regarding crude fibre and fat contents among cowpea, though Nhyira yielded the greatest crude fibre proportion (4.62%), compared to Tona (4.42%) and Soronko (4.35%). With fat, it was observed that Tona (2.42%) and Nhyira (2.23%) yielded the greatest percentage, while Soronko came in a distant third (1.61%). Similarly, analysis of the moisture contents of the three cowpea varieties revealed no significant differences (P>0.01). Soronko, as figures reveal, recorded the greatest moisture content (11.68%), followed by Tona (10.71%) and Nhyira (8.58%). On the contrary, significant differences (P<0.01) in cowpea carbohydrate and ash contents were observed. For carbohydrates, these significant differences were noted between Nhyira and the other varieties (Tona and Soronko), despite Tona's carbohydrate amount being greatest (52.77%), and that of Soronko (52.66%) being ahead of Nhyira's (50.75%). With Ash content, the significant differences (P<0.01) observed were between Soronko and the two others, Nhyira and Tona. While the results show that Nhyira contained the highest amount of Ash (2.677%), Soronko had the least (2.05%).

Generally, the proximate composition of the three cowpea varieties was not significantly affected after storage as showed in (Table 9). The crude fibre, fat and carbohydrate content showed no significant difference when compared with the control sample (before storage). The ash content for all the cowpea varieties increased after storage as depicted in Table 9. Nhyira variety increased from 2.50% to 2.67%, Soronko increased from 2.00% to 2.05% and also Tona increased from 2.30% to 2.48% with no significant differences. Increase in Fat content was observed only in Nhyira and Soronko variety, with no significant differences. All the other proximate parameters decreased after storage with no significant differences. The results from the study suggest that storage of cowpeas does not significantly affect the proximate composition of cowpea varieties. The high crude protein, crude fibre, moisture and ash content before storage and after storage suggest that the differences observed are genetic. According to [9], differences in proximate composition in cowpea varieties are mainly genetic factors.

EFFECT OF DIFFERENT STORAGE METHODS ON THE PROXIMATE COMPOSITION OF THE COWPEA VARIETIES AFTER STORAGE

Storage Methods	Crude Protein	Crude Fibre	Moisture Content	Fat	Carbohydrate	Ash
Empty drum and Phosphine tablet	24.77a	4.46a	1.97b	4.34a	56.71b	2.43a
Empty drum	25.88a	4.38a	2.06a	4.42a	57.75b	2.43a
Hermetic	25.88a	4.54a	2.22a	4.22a	59.73a	2.35a

Table 11: Differences in the Storage Methods on the Proximate Composition

The effects of different storage methods on the proximate composition of the three cowpea varieties are provided in Table 11. The storage methods used were empty drums, empty drums with phosphine, and hermetic bags. There were no statistical differences (P>0.01) among the three storage methods with respect to crude protein content. Storage of cowpea in hermetic bags and empty drums each yielded the highest crude protein values (25.88%), greater than what was observed with storage in empty drums and phosphine (24.77%). There were no significant differences (P>0.01) for the effects of cowpea storage methods on crude fibre, fat, moisture content, carbohydrates and ash content. But with crude fibre content, storage with hermetic bags gave the greatest figure (4.54%), while the empty drum provided the least (4.38%). It was also observed that storing cowpea under hermetic conditions produced the most fat (2.22%), greater than the empty drum (2.06%) and the empty drum and phosphine (1.97%) methods. Regarding moisture content, the results again showed that cowpea in hermetic storage recorded the greatest value (12.22%); storing cowpea in an empty drum gave a better result (9.42%) than doing so in an empty drum and phosphine (9.34%). The empty drum method returned the best results in relation to carbohydrate storage (52.75%) compared to the hermetic and empty drum and phosphine methods (51.73% and 51.71% respectively). Both the empty drum only and empty drum and phosphine storage methods yielded the highest results (2.43%) for ash content.

The proximate composition of the stored cowpea grains were analysed on the basis of carbohydrate, protein, ash, moisture content, fibre, and fat content retained after storage. Whereas hermetic bag yield the highest crude protein, crude fibre, moisture and ash content, empty drum had the highest retention in terms of fat content. There were some minimal differences in the levels of some nutrients retained by the different storage methods, all the storage methods proved very effective in retaining more than (60%) of the parameters studied.

The percentage crude protein retained by the different storage methods ranged between (24.77 to 25.88%). [5], also reported crude protein of (21.63 -25.28%) for four advanced

lines of cowpea seeds. This was quite lesser than that obtain from this study. The results from this study was also higher than (22.33%) and (22.98%) reported on Asontem variety by [10] and [6].

With regards to the carbohydrate retention, (56.71 - 59.73%) were observed for all the storage methods. The results were also higher than the (50.95% to 53.98%) reported on Nhyira, Tona and Adom cowpea varieties by [12]. There was an increase in the ash content in cowpea grains stored in empty drum and also in hermetic bag as shown in Table 12. [19] also reported an increase in mean values of percentage ash content of cowpea "Uganda" after storage irrespective of the storage method used. This may be attributed to contamination from insect excreta, thus generating much residue. The feeding activities of *Callosobruchus maculatus* (weevil) may have resulted in the increase in the ash content [19]. Although, hermetic bag was able to retained most of the proximate components, the other storage methods were capable of retaining amounts which showed no significant differences. To improve on the proximate composition of cowpea after storage producers and marketers need to consider the use of hermetic storage methods.

INTERACTIVE EFFECT OF THE STORAGE METHODS AND VARIETIES ON THE PROXIMATE COMPOSITION

SOURCE	CP	CF	FA	MC	CHO	ASH
Storage Methods X Varieties						
Empty Drum X Nhyira	27.00a	-	-	-	50.93ab	2.60b
Empty Drum and Phosphine X Nhyira	26.00ab	-	-	-	50.80ab	2.73b
Hermetic X Nhyira	25.00a	-	-	-	50.53b	2.70b
Empty Drum X Tona	24.33ab	-	-	-	53.66a	2.60ab
Empty Drum and Phosphine X Tona	23.33b	-	-	-	52.66ab	2.73b
Hermetic X Tona	24.33ab	-	-	-	52.00ab	2.52ab
Empty Drum X Soronko	25.33ab	-	-	-	53.66a	2.80b
Empty Drum and Phosphine X Soronko	25.00ab	-	-	-	51.66ab	2.52b
Hermetic X Soronko	25.33ab	-	-	-	52.66ab	2.90a

Table 12: Effect of Storage Methods and Varieties on the Proximate Composition

Table 12 reveals the interaction between the storage methods and varieties after storage with regards to Proximate composition. It can be revealed from the results that the interactive effect of the two factors had no significant impact on the crude fibre, fat and moisture content. The highest (27.00%) crude protein was observed in Nhyira variety stored in empty drum with the least (23.33) coming from Tona variety stored in empty drum and phosphine as illustrated in Table 4.18. The carbohydrate content was however higher in Tona variety stored in empty drum and also in Soronko variety stored in empty drum. The ash content of the interactive effect ranged from (1.83-2.73%).

The interactive effect of storage methods and cowpea varieties had no significant difference in the crude fibre, fat and moisture content. There was a general decrease in the crude protein and carbohydrate content, however, the ash content increased among the treatment combinations as shown in Table 12. [21] also reported a slight decrease in crude protein content of stored cowpea. The crude protein content of the cowpea varieties ranged from (25.13 -27.96%) whiles the crude protein ranged after the interactive effect was from (23.33 - 27.00%). The carbohydrate content before storage was from (58.16 - 60.79%) and decreased to (50.53 -53.60%) after the interactive effect. The decrease in the crude protein and carbohydrate content can be attributed to insect infestation during storage. Results on monthly data reading illustrated in Figures 4.8 shows that almost all the grains had some form of insect infestation irrespective of the storage method. The decrease in protein could be as a result of insects feeding on the grain as a source of energy for their survival. The general increase in the ash content could be due to contamination from insect excreta, thus generating much residue [19].

IV. CONCLUSION AND RECOMMENDATION

CONCLUSION

- ✓ The field survey revealed five cowpea varieties under cultivation by the farmers. They were; "Uganda" (white with black-eye), "Mallam adamu" (red), "Soronko variety, Nhyira variety and Tona variety. Majority of the farmers (40%, 30% and 16%) cultivate Soronko, Nhyira and Tona varieties respectively.
- ✓ Storage methods adopted by the farmers were traditional silos, the use of hermetic bags, empty drum, treatment with chemicals before bagging, nylon bags and the use of storage rooms. The most dominant storage method was the use of empty drum (50%). The major challenges during storage are disease and pest attack (80%), theft (16%) and not well dried cowpea grains (4%). Nhyira cowpea variety recorded the highest crude protein, crude fibre and ash content. Low ash and fat content was also recorded in the Soronko variety before storage.

RECOMMENDATION

- ✓ Farmers and cowpea dealers should adopt the empty drum with phosphine tablet and the hermetic bag for storing cowpea for a better keeping quality.
- ✓ It is recommended that Government, Non-governmental Organizations (NGOs) and other related Agencies should educate farmers and the general public on the different storage methods and the dangers of using chemicals in storing their cowpea grains.
- ✓ Since the proximate composition of the cowpea varieties before and after storage was within the recommended rate, farmers and cowpea marketers may rely on any of the storage methods on the basis of proximate composition.
- ✓ For high retention of proximate composition the use of hermetic bag and empty drum will be appropriate.

- ✓ Cowpea grains from research institutions should be used in order to assess if the handling practices carried out by the farmers had an impact on the quality of seeds used.

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