International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 4 Issue 7, July 2017

ISSN: 2394-4404

An Evaluation Of Postharvest Practices Used By Cowpea Marketers And Their Effect On Cowpea Grain Quality In Ghana

Osei Boahen Melkisedek

Department of Horticulture, Kwame Nkrumah University of Science & Technology, Kumasi, Ghana

Germain Kofi Acka

Oppong David

Antoinette Acka

Apex Community Foundation, Kumasi Ghana

Abstract: ***This survey was carried out in Ghana (Dormaa Ahenkro District) of Brong Ahafo Region in Ghana to evaluate the postharvest practices used by cowpea marketers and their effect on the quality of cowpea (Vigna unguiculata) grains of Nhyria, Tona and Soronko. The respondents were made up of fifty (50) cowpea marketers. Proximate composition was carried out on the cowpea varieties before and after storage. Weevil infestation was also assessed during the three (3) month of storage. The storage methods; drum (with no chemical), drum with phosphine tablet and hermetic bag. Majority of the cowpea marketers were 20-29 years. The field survey revealed five cowpea varieties under sales by the marketers. 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%), Jute sack (10%) 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. (32%) of the marketers (wholesalers and retailers) adopt good sanitation measures to prevent disease and pest infestation. However, (68%) of the marketers (wholesalers and retailers) use actellic whereas (8%) use phosphine tablet. 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 weevil infestation for the three varieties ranged from (0.74– 0.82). The crude fibre, fat and carbohydrate content showed no significant difference when compared with the control sample (before storage) and after storage. The high crude protein, crude fibre, moisture and ash content before storage and after storage suggest that the differences observed are mainly genetic. The low level of reduction in cowpea grain quality in terms of weevil infestation was mainly affected by the extent of minimal infestation and activities of the cowpea storage weevil Callosobruchus maculatus.***

I. INTRODUCTION

Cowpea is a food grain legume that plays an important role in the lives of millions of people in Africa and other parts of the developing world. The major season for cowpea cultivation is from May to August. Ghana is among the lowest in the world in terms of yield, averaging 310 kg/ha [16]. Hence, efforts have been made to improve cowpea production in Ghana through various means including the introduction of new varieties. 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. Recently, 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. World cowpea production was estimated at 3 319 375 MT and 75% of that production is from Africa [14]. Principal pest is the cowpea bruchid, *Callosobruchus maculatus* (F.), but other bruchids cause losses as well. The losses have been attributed to improper method to poor postharvest handling operations and practices among others. 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 handling practices, postharvest operations and storage

methods can help protect the grain to an acceptable level that would not cause economic losses. As a result of these uncertainties further research is needed to confirm an acceptable postharvest operation and establish the possible effects of the various factors on the quality of cowpea grains. The various stakeholders involved in the distribution chain therefore needs information on the various postharvest operations and how they impact the quality of the grains after storage especially Nhyira, Soronko and Tona varieties which is the most preferred varieties and highly nutritious in Ghana and also mostly sold by the cowpea marketers in the study area. The main objective of this research therefore was to determine the effect of postharvest practices carried out by the cowpea marketers on the quality characteristics of cowpea grains.

The specific objectives were;

- ✓ To determine the various postharvest practices used by cowpea dealers in the Dormaa Ahenkro district
- ✓ To determine the storage method that best preserves cowpea grains quality during storage.
- ✓ To determine the effect of the various storage methods used by the marketers on the proximate composition of cowpea grains after storage

II. MATERIALS AND METHODS

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.

SAMPLE COLLECTION

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

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).

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 Fifty (50) cowpea marketers (wholesellers and retailors)

RESEARCH MATERIAL/CROP

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

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

Determination of Weevil Infestation: This was done by taking samples of one kilogram from each treatment, and by using a sieve the numbers of live insects was counted manually and recorded [11].

DETERMINATION OF PROXIMATE COMPOSITION

The proximate composition was carried out on samples before storage and after three months of storage using the approved methods by [3].

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

FIELD SURVEY

GENDER DYNAMICS OF COWPEA MARKETERS

Table 1 reveals the gender of respondents. All the respondents for the marketers (wholesalers and Retailers) were female, representing (100%) with (36%) been wholesalers and (64%) retailers.

Gender	Cowpea Marketers			
	Wholesalers		Retailers	
	Frequency	Percentage	Frequency	Percentage
Male	0	0	0	0
Female	18	36	32	64
Total	**18**	**36**	**32**	**64**

Source: Field Survey, 2014

Table 1: Gender distribution of cowpea marketers

AGE DYNAMICS OF COWPEA MARKETERS

The highest age range was within 20-29 years, with (40%) and (46%) from wholesalers and retailers respectively. It was

observed that 4% and 6% of the wholesalers and retailers were within the age ranged 30-40.

Gender	Cowpea Marketers			
	Wholesalers		Retailers	
	Frequency	Percentage	Frequency	Percentage
Below 20	0	0	2	4
20-29	20	40	23	46
30-40	2	4	3	6
Total	**22**	**44**	**28**	**56**

Source: Field Survey, 2014

Table 2: Age Dynamics of cowpea marketers

EDUCATIONAL BACKGROUND OF RESPONDENTS

With regards to the wholesalers and retailers, (8%) and (6%) were within the basic educational range respectively, (56%) and (10 %) for SHS/Commercial whiles 8% and 12% were Diplomat for wholesale and retailers respectively.

Education	Marketers			
	Wholesalers		Retailers	
	Frequency	Percentage	Frequency	Percentage
Basic	4	8	3	6
SHS/Commercial	28	56	5	10
Diploma	4	8	6	12
Total	**36**	**72**	**14**	**28**

Source: Field Survey, 2014

Table 3: Educational level of respondents

POSTHARVEST OPERATIONS AND PRACTICES OF COWPEA MARKETERS

MARKET PRODUCTION CHARACTERISTICS

It was observed that about (84%) of the marketers (wholesalers and retailers) had been in cowpea trading for 3-5 years, whereas 8% and 6% of the marketers (wholesalers and retailers) had been in the cowpea trading for 2-3year and 5-10 year respectively. Only 2% had 10 years and above. The major sources of cowpea were from farmers (84%), Farmers and marketers own backyard (4%) and Market (12%). Cowpea varieties usually purchased by the marketers were Soronko (24%), Tona (42%), Nhyira (16%), Uganda variety (8%) and Mallam adamu (10%).

Variable	Frequency	Percentage
Number of years in cowpea trading		
2-3years	4	8
3-5 years	42	84
5-10 years	3	6
10 years and above	1	2
Source of Produce		
Farmers	42	84
Farmers and Marketers own backyard	2	4
Market	6	12
Varieties Sold		
Soronko	12	24
Tona	21	42
Nhyira	8	16
Uganda (white with black eye)	4	8
Mallam adamu (red)	5	10

Source: Field Survey, 2014

Table 4: Market Production Characteristics

STORAGE OPERATIONS

According to Table 5, 100% of the cowpea marketers store their produce before sales. Besides, (36%) indicated that they store their produce in empty drums, jute sacks (10%), 40% in nylon bags, (10%) in their own storage room whiles (4%) use the hermetic bag.

Variable	Frequency	Percentage
Storage before sales		
Yes	50	100
No	0	0
Storage methods		
Storage rooms	5	10
Nylon bags	20	40
Empty drum	18	36
Hermetic bag	2	4
Jute sack	5	10

Source: Field Survey, 2014

Table 5: Storage Operations

PEST MANAGEMENT

Results in Table 6 indicated that, (92%) of marketers regularly spray their storage rooms whereas (32%) also adopt to good sanitation measures. Phosphine tablet (8%) and actellic (68%) are the major chemicals used.

Variables	Frequency	Percentage
Pest management		
Regular spraying of storage rooms	46	92
Adoption of good sanitation measures	16	32
Chemicals used		
Phosphine tablet	4	8
Actellic	34	68

Source: Field Survey, 2014

Table 6: Pest Management Practices

CHALLENGES IN COWPEA TRADING

Pest and insect attack are the major problem confronting cowpea trading, as 72% of the respondent was in agreement. High transportation cost was the second (12%) major problem affecting cowpea trading. The least was from Grains with holes (8%) as well as theft (8%).

Variables	Frequency	Percentage
Challenges in cowpea trading		
Pest and insect attack	36	72
Theft	4	8
High transportation cost	6	12
Grains with holes	4	8

Source: Field Survey, 2014

Table 7: Challenges in cowpea trading

PROXIMATE COMPOSITION OF THE 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). 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%).

Varieties	Crude Protein	Crude Fibre	Moisture Content	Fat	Carbohyd rate	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

MONTHLY DATA READING DURING STORAGE

WEEVIL INFESTATION

Varieties: In the two cowpea varieties, weevil infestation were observed from the first month of storage, and throughout the third month of storage with no significant differences (p>0.01) occurring. The highest weevil infestation (0.82) was observed in Soronko cowpea variety during the third months of storage whiles the least was from Tona (0.75) and occurred on the third month of storage.

Varieties	Monthly Weevil Infestation Count		
	M1	M2	M3
Tona	0.77a	0.75a	0.75a
Nhyira	0.74a	0.76a	0.76a
Soronko	0.76a	0.77a	0.82a

Table 9: Effect of different cowpea varieties on live insect count during storage

STORAGE METHODS

No significant differences (p>0.01) were observed in the three storage methods used. The empty drum had the highest average weevil infestation (0.81) during the last month of storage whiles the least (0.20) was found in empty drum and phosphine on the second month of storage. Few live insect were found throughout the empty drum and phosphine storage method as shown in Table 10.

Storage Methods	Monthly Weevil Infestation Count		
	M1	M2	M3
Hermetic	0.75a	0.76a	0.77a
Drum (no chemical)	0.76a	0.77a	0.81a
Drum and Phosphine Tablet	0.40a	0.30b	0.20b

Table 10: Effect of different storage materials on the live insect count during storage

INTERACTIVE EFFECT OF VARIETY AND STORAGE METHODS

The interactive effect of the cowpea varieties and storage methods on live insect count is shown in Table 11 below. No significant difference (p<0.01) was observed in the interaction of variety and storage methods on weevil infestation count during the storage period. The highest average weevil infestation count (0.84) was found in the Soronko variety kept in hermetic bag on the third month storage. However, it was not significantly different from Nhyira variety stored in empty drum, Tona variety in empty drum as depicted in Table 11. On the contrary, Tona variety kept in empty drum and phosphine had the least average weevil infestation count (0.30) at the end of the storage period.

Interactive effect of variety and storage methods	Monthly Weevil Infestation Count		
	M1	M2	M3
Drum (no chemical) X Nhyira	0.75a	0.76a	0.78a
Drum and Phosphine Tablet X Nhyira	0.40b	0.40b	0.40b
Hermetic X Nhyira	0.76a	0.75a	0.74a
Drum (no chemical) X Tona	0.77a	0.76a	0.78a
Drum and Phosphine Tablet X Tona	0.76a	0.74a	0.30c
Hermetic X Tona	0.74a	0.70a	0.78a
Drum (no chemical) X Soronko	0.76a	0.74a	0.78a
Drum and Phosphine Tablet X Soronko	0.82a	0.60b	0.40c
Hermetic X Soronko	0.80a	0.82a	0.84a

Table 11: Effect of variety and storage methods on live insect count during storage

PROXIMATE COMPOSITION OF THE COWPEA VARIETIES AFTER STORAGE

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%).

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 12: Proximate Composition of the three cowpea varieties after storage

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

EFFECT OF DIFFERENT 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 13 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.

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 13: Differences in the Storage Methods on the Proximate Composition

INTERACTIVE EFFECT OF THE STORAGE METHODS AND VARIETIES ONTHE PROXIMATE COMPOSITION

INTERACTIVE EFFECT OF STORAGE METHODS AND VARIETIES ON THE PROXIMATE COMPOSITION

Table 14 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 14. 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%).

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 14: Effect of Storage Methods and Varieties on the Proximate Composition

IV. DISCUSSION

DEMOGRAPHIC FEATURES OF RESPONDENTS

GENDER DYNAMICS OF RESPONDENTS

The results on the gender dynamics showed that (36%) and (64%) of the cowpea marketers were wholesalers and

retailors respectively with no male respondents. This suggests that the majority of farm lands are owned by males whereas cowpea marketing is dominated by the females. 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 [18]. It can be deduce that majority of farm holdings are male dominants.

AGE DYNAMICS OF RESPONDENTS

Majority of the cowpea marketers were 20-29 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.

EDUCATIONAL BACKGROUND OF RESPONDENTS

The result from this study suggests that most respondents in cowpea cultivation are mostly school dropout. 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.

POSTHARVEST OPERATIONS AND PRACTICES OF COWPEA MARKETERS

Majority of the marketers (wholesalers and retailers) not having a lot of experience in cowpea trading could be related to the age of the majority of the wholesalers and retailers which was below 30 years. Only (84%) of the marketers (wholesalers and retailers) had 3-5 years of experience with only (2%) having spent 10 years and above in cowpea trading. The least number of marketers (2%) with little trading experience could be due to professionals and other tertiary graduates with passion for trading. Farmers were the main sources marketers (wholesalers and retailers) got their produce from since they provided (84%) of the produce. This may be attributed to the fact that most of the farmers are closely related with the marketers (wholesalers and retailers). Some marketers also preferred to source their produce from local marketer's backyard and also from some huge market centres. This resulted in (4%) and (12%) respectively.

According to the field survey five major varieties were mostly traded. They were; "Uganda" (white with black-eye), "Mallam adamu" (red), "Soronko variety, Nhyira variety and Tona variety. These may be due to the fact there were the major varities that were cultivated by the farmers. It was observed that (100%) of the marketers (wholesalers and retailers) store their grains before sales. This suggests that large number of bags is bought and therefore some must be stored before sales. The major storage methods used were Storage rooms (10%), Nylon bags (40%), Empty drum (36%) and hermetic bag (4%). This may be due to the availability and the low price of nylon and empty drum as compared to the others. (92%) of those that store their produce in storage rooms do regular spraying to prevent disease and pest infestation. (32%) of the marketers (wholesalers and retailers) adopt good sanitation measures to prevent disease and pest infestation. However, (68%) of the marketers (wholesalers and retailers) use actellic whereas (8%) use phosphine tablet. The [14] reported that, in Ghana, cowpea is treated with Actellic 25EC or Actellic 2% dust at 1kg of Actellic 2% dust to 20 bags of threshed cowpea and 5ml of Actellic 25EC diluted with 195ml of water to treat 100kg of threshed cowpea. The high pest and disease attack is as result of not well dried cowpea grains during storage by the marketers. Cowpeas are mostly attack by both on the field and at storage. [23] stated that cowpea bruchids, *Callosobruchus maculatus* and *Callosobruchus chinensis* cause extensive damage to stored grain, infesting as much as 60% of it. The frequent increase in fuel prices and middle men involved in the transportation system might result in the high transportation cost. The activity of the pest and disease infestation might also lead to grains with holes as described by the cowpea marketers.

BASELINE DATA BEFORE STORAGE

PROXIMATE COMPOSITION OF THE COWPEA VARIETIES BEFORE STORAGE

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 4.12. 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 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. Butt *et al*., 2010, also reported

carbohydrate content of (57.42%) for cowpea variety. This was quite lower than those obtained in this study. Henshaw (2008) 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 [6]. [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]. [8], 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 the cowpea varieties varied between (2.43%, 2.56 and 2.58%) (Table 4.12). 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.

MONTHLY DATA READING DURING STORAGE

WEEVIL INFESTATION

From the results illustrated in Table 4.14, it can be inferred that the presence of weevil infestation is not dependent on the cowpea variety but may be due to other factors such as the state of the produce before storage. The type of storage methods used however had a significant impact had on the number of live insect count. The live insect count for the three varieties ranged from (0.74– 0.82) with no significant difference occurring among the varieties, however, Nhyira variety would be selected if live insect count is used as a major indicator for selection. This is as a result of Nhyira recording low average live insect counts (0.74-0.82) throughout the storage period. According to [11], timely harvesting of the cowpea varieties may have contributed to the low incidence of live insect count for the study. According to [21], cowpea weevils multiplies very fast in storage and gives rise to new generation every month. Most often cowpea weevils attack the pods on the field and at transit and oviposit through the pod before getting into storage. This might have resulted in the slight increase in the live insect count during the storage period.

The live insect count for the hermetic bag and empty drum ranged from (0.75-0.81) whiles the empty drum with phosphine was (0.20-0.40). The results imply, that low insect count was observed in empty drum with phosphine. The results obtained in this study were quite better than live insect count of (18) recorded for crib storage of cowpea by [17]. According to [11], several studies show that low-dosage phosphine (PH_3) fumigation for insect control, and consideration of grain quality is economical, practical, simple and safe. Phosphine released from metal phosphide preparations is currently the major fumigant in use for the protection of stored products. Phosphine is the preferred fumigant for routine treatment, especially in developing countries where other control techniques, including controlled atmosphere storage will be expensive and therefore cannot be readily adopted [11]. The application of the phosphine might have resulted in infestation of most of the insect during the three (3) months of storage.

One of the major life processes is respiration, the breakdown of substrates in the presence of oxygen to release carbon dioxide. Respiration of the cowpea grains in the hermetic bag and empty drum themselves and the insects used up the oxygen in the containers and produced carbon dioxide. Since insects cannot survive in the oxygen -depleted environment in the containers, their development was retarded and they eventually died off. This might have resulted in the low insect count. The presence of an appreciable amount of live insect (0.75-0.81) in the hermetic bag and empty drum storage may be due to oxygen diffusing into the package materials and permitting some survival [11]. According to [11], many researchers have revealed that, removal of oxygen by respiration is the main factor leading to death of insect in sealed container. In practice also there is some risk of oxygen diffusing into containers and permitting some survival. This might be the cause of the presence of some live insect count in the hermetic bag.

The interactive effect of variety and storage methods as illustrated in Table 4.16 showed no significant differences. The live insect count ranged from (0.3-0.84). Rahim, (2014), also reported no significant differences among storage containers in cowpea. The most effective storage methods were empty drum with phosphine tablet irrespective of the variety. Low insect count were reported at the end of the three (3) months of storage for all cowpea varieties kept in empty

drum with phosphine tablet. According to [11], several studies show that low-dosage phosphine (PH_3) fumigation for insect control, and consideration of grain quality is economical, practical, simple and safe. Cowpea varieties stored with hermetic and empty drum were not significantly different from each other. The presence of insects count in the hermetic bag may be due to the fact that it does not give much natural protection against insects, rodents and moisture [2]. In general, cowpea is highly prone to insect attack especially cowpea weevils that have high breeding at storage. It is confirmed by [21] that, cowpea weevils multiplies very fast in storage and gives rise to new generation every month. Most often cowpea weevils attack the pods on the field and at transit and oviposit through the pod before getting into storage.

EFFECT OF STORAGE ON THE PROXIMATE COMPOSITION OF THE COWPEA VARIETIES

Generally, the proximate composition of the three cowpea varieties was not significantly affected after storage as showed in (Table 4.12 and Table 4.23). 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 4.23. 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 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

EFFECT OF DIFFERENT STORAGE METHODS ON THE PROXIMATE COMPOSITION

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].

With regards to the carbohydrate retention, (56.71 - 59.73%) were observed for all the storage methods. This was slightly greater than (56.24 - 60.06%) reported on five varieties of cowpea by [22]. There was an increase in the ash content in cowpea grains stored in empty drum and also in hermetic bag as shown in Table 4.16. [18] 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.

EFFECT OF STORAGE METHODS AND VARIETIES ON THE PROXIMATE COMPOSITION

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 4.26. [24] 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 [18]. The interactive effect of the storage methods and varieties had no significant impact on the mineral composition, as no regular pattern was observed.

VII. CONCLUSION AND RECOMMENDATION

A. CONCLUSION

The following conclusions were made from the findings of the study:

- ✓ It was observed that (36%) and (64%) of the cowpea marketers were wholesalers and retailors respectively with no male respondents.
- ✓ The field survey revealed five cowpea varieties under sale by the cowpea marketers. They were; "Uganda" (white

with black-eye), "Mallam adamu" (red), "Soronko variety, Nhyira variety and Tona variety.

- ✓ Storage methods adopted by the cowpea marketers were the use of storage room, nylon bag, empty drum, hermetic bag and jute sacks.
- ✓ 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.
- ✓ The live insect count for the three varieties ranged from (0.74– 0.82) with no significant difference occurring among the varieties. Mortality rate was higher in the Nhyira cowpea variety during the three (3) month of storage period. However, based on the findings, any of the variety can be selected for storage when dead insect count is used as a major indicator.
- ✓ The interactive effect of storage methods and cowpea varieties had no significant difference in the crude fibre, fat and moisture content.

B. RECOMMENDATION

- ✓ Cowpea dealers should adopt the empty drum with phosphine tablet and the hermetic bag for storing cowpea for a better keeping quality.
- ✓ 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 and mineral composition.
- ✓ For high retention of proximate composition the use of hermetic bag and empty drum will be appropriate.

Cowpea grains from a reputable research institutions should be used in order to assess if the handling practices carried out by the farmers had a significant effect on the quality of seeds used.

REFERENCES

[1] Aiyesanmi, A. F. and Oguntokun, M. O. (1996). Nutrient composition of Dioclea reflexa seed–an underutilized edible legume. Rivista Italiana delle Sostanze Grasse. 73:521–523. Aiyesanmi, A. F. and Oguntokun, M. O. (1996). Nutrient composition of Dioclea reflexa seed–an underutilized edible legume. Rivista Italiana delle Sostanze Grasse. 73:521–523.

[2] Ali, I. (2008). Storage systems of Cowpea and their implications for pests' management in the Tamale Metropolis, BSc. Dissertation, UDS, Tamale; pp. 43-49.

[3] AOAC, (2000) Official methods AOAC, Official Methods of Analysis (15th edn). Association of Official Analytical Chemists, Washington, DC (1990).

[4] Arawande .J.Olalekan and Borokini .F. Bosede (2010). Comparative Study on Chemical Composition andFunctional Properties of Three Nigerian Legumes (Jack Beans, Pigeon Pea and Cowpea). Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 1 (1): 89-95 © Scholarlink Research Institute Journals

[5] Asare, T. A., Agbemafle, R., Adukpo, G. E., Diabor, E. and Adamtey, K.A. (2013). Assessment of Functional Properties and Nutritional Composition of Some Cowpea (Vigna Unguiculata L.) Genotypes in Ghana. Department of Molecular Biology and Biotechnology, School of Biological Sciences, University of Cape Coast, Cape Coast, Ghana

[6] Bayssah Nataline Sonnie (2013). Assessing the Effect of Seed Quality Characteristics on the Growth and Yield of Four Cowpea (Vigna unguiculata (L) Walp) Varieties

[7] Blumenthal, J., Baltensperger, D., Cassman, K. G., Mason, S. and Pavlista, A, (2008). Importance and Effect of Nitrogen on Crop Quality and Health. Agronomy -- Faculty Publications. Paper 200. http://digitalcommons.unl.edu/agronomyfacpub/200. Accessed September 1, 2012

[8] Butt and MS Batool R. (2010). Nutritional and Functional Properties of Some Promising Legumes Protein Isolates.Pak, J. Nutri. 9(4): 373-379.

[9] Chinma, C. E., Alemede, I. C., and Emelife, I. G. (2008). Physicochemical and functional properties of some Nigerian cowpea varieties. Pakistan Journal of Nutrition 7(1): 186-190.

[10] Darfour B. Wilson D, Ofosu D, Ocloo FCK (2012). Physical, proximate, functional and pasting properties of flow produced from gamma irradiated cowpea. Phys. Chem. 81 (4) :450-457

[11] Dramani K. (2010) Comparative study of cowpea storage in different storage structures. Project report submitted to the Department of Agricultural engineering.

[12] F. Appiah, J. Y. Asibuo and P. Kumah1, African Journal of Food Science Vol. 5(2), pp. 100 - 104 February 2011 IITA. 1993. Annual Report of the IITA. Ibadan, Nigeria. pp. 56-80.

[13] FAO, 2009. On-farm Post-harvest Management of Food Grains by P. Golob. A manual for extension workers with special reference to Africa. Rome, FAO.

[14] FAOSTAT. 2000. Site internet: http//www. Fao. org/statistics

[15] Henshaw, F.O. (2008). Varietal Differences in Physical Characteristics and Proximate Composition of Cowpea (Vigna unguiculata). Department of Food Science and Technology, University of Agriculture, Nigeria World Journal of Agricultural Sciences Vol. 4 (3), pp. 302-306, ISSN 1817-3047.

[16] IITA (2009). Cowpea http://www.iita.org/cowpea. International Institute of Tropical Agriculture

[17] Imoro Yakubu (2014) Effect Of Different Indigenous Storage Structures On The Quality Of Cowpea (Vigna Unguiculata) Grains During Five Months Storage In The Savelugu / Nanton Municipality Of The Northern Region

[18] Maalekuu, B. K1 and E. N. Kotey (2014). A survey on methods used in the storage of some varieties of cowpea (Vigna unguiculata L.) and their effect on quality (A case study in Ejura-Sekyedumase District)

[19] Mbah, C.E. and Silas, B., (2007). Nutrient composition of cowpeas infested with Callosobruchus Maculatus L. in

Zaria. NIGERIAN FOODJOURNAL, VOL. 25, No. 2, 2007 (www.ajol.info/journals/nifoj) ISSN0189-7241

[20] Moorthy, S. N., Rickard, J. and Blanshard, J. M. V. (1996). Influence of gelatinization characteristics of cassava starch and flour on the textural properties of some food products, Colombia, pp. 150-155.

[21] Ouedrago AP, Sou S, Sanon A (1996). Influence of temperature and humidity on population of C. maculatus (Coleoptera: Bruchidae) and its parasitoid Dinarmus basalis

[22] Owolabi, A.O., Ndidi, U.S., James, B.D. and Amune, F.A. (2012). Proximate, Anti nutrient and Mineral Composition of Five Varieties (Improved and Local) of Cowpea, Vigna unguiculata, commonly Consumed in Samaru Community, Zaria-Nigeria, Department of Biochemistry, Ahmadu Bello University, Zaria.

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

[24] Rubasinghege G.R.S., Abeywickrama K. and Paranagama, (2007). Effect of selected essential oils on physicochemical changes of stored cowpea, Vigna unguiculata, treated to control cowpea bruchib, Callosobruchus maculatus (F.). pp: 23-24