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Effects of Storage Structure Type and Pesticide Type on The Physico-Chemical Properties of Cowpea (*Vigna Unguiculatus*) After Three Months' Storage: The Case of Daffiama Bussie Issa District

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ABSTRACT

Cowpea is an important grain legume widely used as food in Ghana and the world at large. It is a significant protein source used by many people in several countries. However, its postharvest management, especially storage, can be problematic because it is easily attached by storage pest insects, particularly Callosobruchus maculatus. Cowpea storage is crucial as the product is protected against damage and deterioration. Also, it is preserved until such a time that market prices are reasonable before they are marketed, enhancing food security. Cowpea grains that are predisposed to insects often attack significantly reduce the quantity and quality, which renders the product unwholesome for human consumption. A survey will be conducted in Daffiama Bussie Issa District in the Upper West Region of Ghana to identify storage structures and storage protectants used by stakeholders to store cowpea. The cowpea variety to be used for the experiment is called 'songotra' and is considered the people's choice. At the end of the storage period, the physical and chemical properties of the cowpea grains were assessed to confirm whether there is a significant effect on them. Test on the viability of seeds will be conducted. The findings will show which storage structure and protectants proved to be more effective by killing the cowpea weevil and unearth the treatment that will offer the highest and lowest protection. Pairwise Statistical Package for Social Scientists (SPSS) Version 9.0 was used to analyse the survey data. It is recommended that further research is conducted on the quantity of cowpea used for storage with an extended storage period.

KEYWORDS: Effects, Pesticide Physico-chemical, Cowpea and treatment

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INTRODUCTION

Cowpea, *Vigna unguiculata (L.) Walp* is one of the five most essential legumes in the tropics and provides protein for most people in the region and nitrogen to the soil (Duke, 1990). As stated by Hall, Sulaiman, Clark, and Yoganand (2003), cowpeas perform well even when produced in marginal soils due to their ability to fix nitrogen in the soil. It plays an integral part in crop rotation and can be used as green manure.Ocran, Delimini, Asuboah, and Asieku (1998) noted that cowpea is the most widely grown legume in Ghana and the most widely consumed legume (MOFA, 2010)

It plays a critical role in the lives of millions of people in Africa and other parts of the developing world, a significant source of dietary protein (IITA, 2007). It is clear that cowpea is grown throughout Ghana, but then the bulk of production occurs in the northern part of Ghana (Golob, Moss, Devereau, Goodland, Andan, Atarigya, and Tran, 1999). Consumption of cowpea per capita in Ghana is estimated at 5 kg (MOFA, 2008), and this is because cowpea grain contains about 23 to 25% protein, making it extremely valuable where many people cannot afford protein foods such as meat and fish (IITA, 2009). West Africa is the critical cowpea producing zone, mainly in the dry savannah and semi-arid agro-ecological zones. The principal cowpea producing countries are Nigeria, Niger, Senegal, Ghana, Mali, and Burkina Faso (FAOSTAT, 2000).

Daffiama Bussie Issa District is located in Ghana's Upper West Region. It is located between latitude 11' 30' and latitude 10' 20' north, and longitude 3' 10' and 2'10' west. Wa Municipal borders it on the south, Nadowli-Kaleo on the west, Sissala West District on the north, and Wa East District on the east. It stretches from the Billi Bridge (4km from Wa) to the Dapuori Bridge (nearly 28km from Nadowli) on the major Wa – Tumu route, and also from West to East from the Black Volta to Daffiama. The distance between the District and the regional capital is approximately 57 kilometres. The District's position encourages international trade between the District and neighbouring Burkina Faso.

Agriculture is the District's backbone, employing around 85 percent of the population. This sector's food crop production is primarily subsistence, with low output levels. Food and cash crop farming, as well as animal raising, are the major activities practised. The market is expected to grow at a rate of 2.1 percent per year, which is less than the national objective of 6 percent per year. Despite efforts to expand the industry, output remains subsistence, as there are no big plantations in the District.

METHODOLOGY

The study adopted a descriptive survey. In the study, the population comprised 50 consumers, 25 retailers and 25producers. The researcher used a simple random sampling technique to select one hundred (100) respondents from the district to respond to the test items on a questionnaire.

Instrument

The main instrument was quality questionnaires developed by the researcher to identify protectant chemicals used in treating cowpea seeds destined for storage purposes, some storage structures,

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pests that attack their stored grains, and some challenges faced by stakeholders. In all 25 producers, 25retailers and 50 consumers were contacted and interviewed. Several questions were asked to elicit responses from respondents. The questions also sought information on a wide range of issues regarding cowpea storage in the district.

Validity and reliability of the instrument

The test items in the questionnaires were constructed by qualified personnel in agriculture in the study area and moderated by two PhD holders. They were mainly meant for Cowpea producers, retailers and consumers. The idea was to obtain direct first-hand information from these stakeholders. The test was administered within four weeks interval. The instrument was found to be reliable, with a reliability coefficient of 0.7.

Background information on cowpea producers

Table 1.1 gives the demographic information about cowpea producers. Most (84%) of the producers were males, while 16% were females. For the age distribution, 4% were between 21-30 years, 20% were between 31-40 years, 44% were between 41-50 years, and 32% were between 51 and 60 years. The majority of the respondents had no formal education (40%), 8% had primary education, 36% had middle/Junior high school education, 8% had secondary education, while 8% had tertiary education. For farming experience, 44% had 1-5 years of experience, 12% has 6-10 years' experience, and 28% had 11-15 years' experience while 16% had above 16 years' experience.

TABLE 1.1: Background and information on cowpea producers

DESCRIPTION		PERCENTAGES (%)
Gender	Male	84
	Female	16
Age	21-30 years	04
	31-40 years	20
	41-50 years	44
	51-60 years	32
Education	Non-formal education	40
	Primary	08
	Middle school/JHS	36
	Secondary	08
	Tertiary	08
Farming experience	1-5 years	44
	6-10 years	12
	11-15 years	28
	Above 16 years	16

Type of Storage Materials for Cowpea

The type of storage structures used by farmers was barn (36%), pot (28%), fertiliser sack (28%) and others such as drum (8%) (Figure 1.1).

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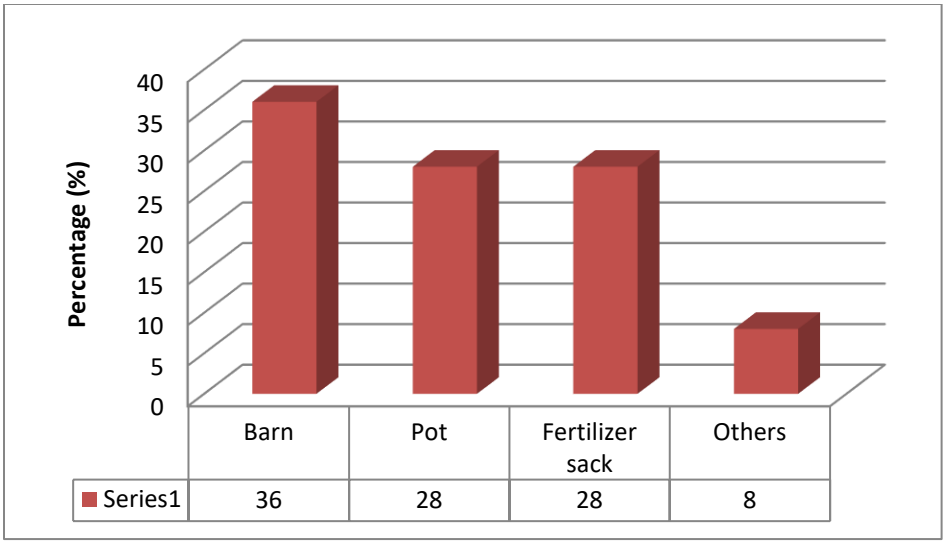

Figure1.1: Type of storage structure used by producers

Type of Pesticide used to treat cowpea

From figure 1.2, pesticides used by farmers to treat cowpea before storage included wood ash (36%), betallic super EC (44%) and phostoxin tablets (20%).

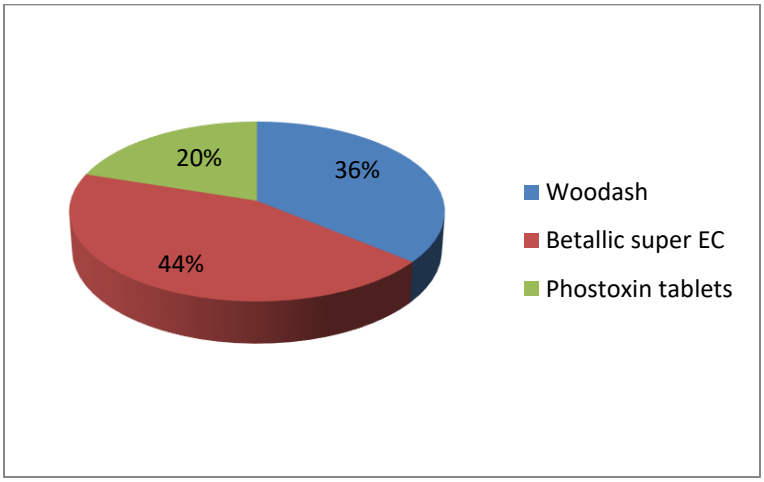

Figure 1.2: Type of pesticide used to treat cowpea before storage

Storage structure, duration and quality of cowpea

Table 1.2 gives storage information about cowpea. A majority (52%) of the producers stored the cowpea produce for more than three months, 8% stored the produce for a month, and 28% stored the produce for two months, while 12% stored the produce for three months. Bagged cowpeas were stored in rooms (76%), warehouses (8%) and storerooms (16%) on bare floors (72%), pallets (16%) and raised platforms (12%). Most farmers (64%) indicated storage adds value to the

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cowpea, while 36% indicated it did not. Cowpea was stored to maintain supply (72%), while 32% reported it was not.

The majority of the farmers (68%) reported the quality of cowpea was affected after storage, while 32% reported it was not. Problems encountered by farmers during storage of cowpea included pest infestation (56%), moldiness of cowpea (20%) and change in colour of cowpea (24%). However, problems encountered after storage were germination problems (36%), colour change of cowpea (12%) and holes in grains (24%), while 28% of the farmers had no challenges after storage.

Table 1.2: Structure, duration and quality of cowpea

DESCRIPTION		PERCENTAGES (%)
Storage duration of produce	I month	08
	Two months	28
	Three months	12
	More than three months	52
Where bagged cowpea are stored	Rooms	76
	Warehouse	08
	Storeroom	16
How bagged cowpea are stored	Bare floor	72
	Pallets	16
	Raised Platforms	12
Does storage add value to cowpea?	Yes	64
	No	36
Do you store cowpea to maintain supply	Yes	72
	No	28
Is cowpea quality affected after storage	Yes	68
	No	32
Problems encountered during storage of cowpea.	Pest infestation	56
	Moldiness	20
	Change of colour	24
Problems encountered after storage of cowpea	Germination problems	36
	Colour change	12
	Holed grains	24
	No challenges	28

Pest type and problems encountered

Table 1.3 gives pest information about stored cowpea. The majority of the producers (52%) indicated pest and disease as the most critical impediment in cowpea storage, while 48% did not agree.

Type of pest that affected cowpea in storage was weevils (64%), ants (20%) and rodents (16%). Pest problems were managed by selling produce immediately (16%), consuming produce (24%),

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treating produce with chemicals (48%) and sun drying (8%). However, 4% of the farmers did nothing to manage pest infestation during cowpea storage.

Table 1.3: Pest type and problems encountered

DESCRIPTION		PERCENTAGES (%)
Pest and disease are the most critical impediment in cowpea storage	Yes No	52 48
Type of pest that affects cowpea in storage	Weevils Ants Rodents	64 20 16
How to manage pest problems of cowpea in storage	Sell produce immediately Consume produce Treat produce with chemicals. Sundry Do nothing	16 24 48 08 04

Respondents' access to training in Postharvest Management of Cowpea

From the results (Figure 1.3), 24% of the farmers had training in postharvest management of cowpea, while 76% did not.

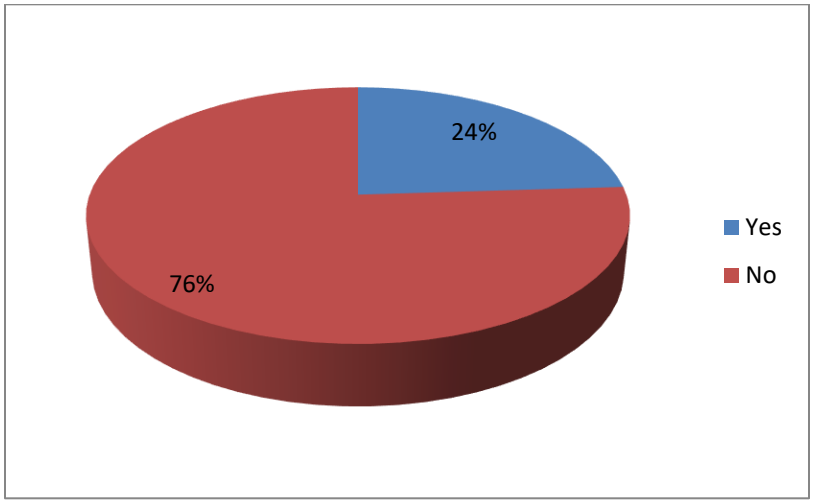

Figure 1.3: Respondents' access to training in postharvest management of cowpea

Storage place of cowpea during retail

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Figure 1.4 showed that 4% of the retailers stored their cowpea in pots while 96% stored them in fertiliser sacks.

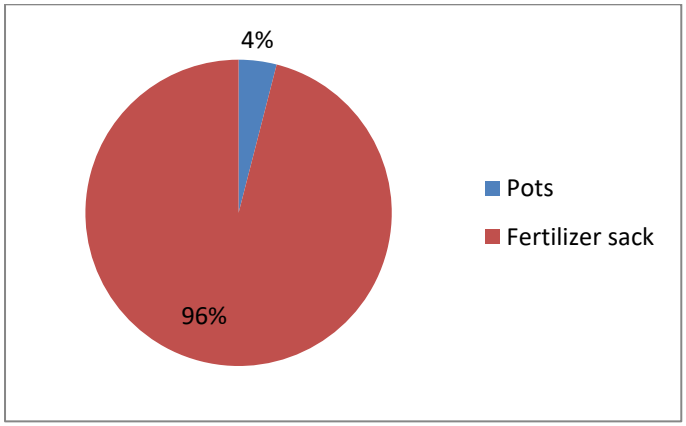

Figure 1.4: Storage place of cowpea during retail

Response of Retailers to Postharvest losses of cowpea

Retailers were asked if they had encountered postharvest loss of cowpea during retail (Figure 4.8). The majority (60%) responded they had encountered losses, while 40% responded they had not.

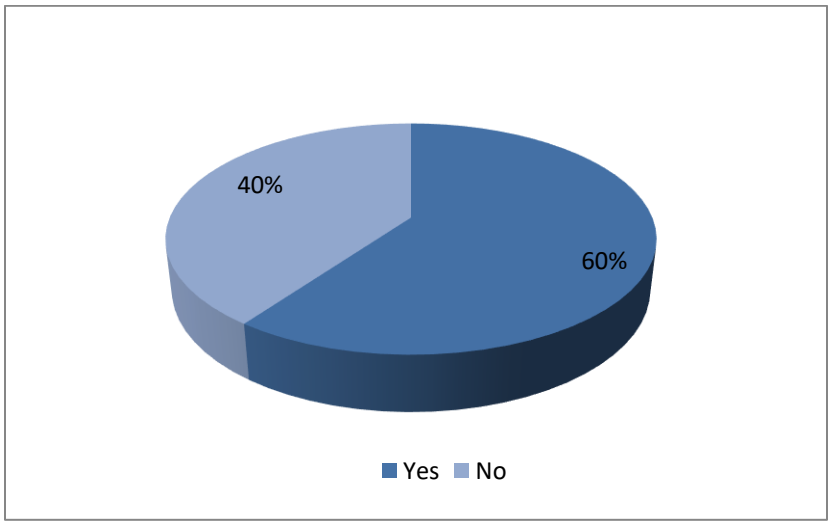

Figure 1.5: Respondents take on postharvest losses of cowpea during retail

Background information on cowpea consumers

Table 1.4 gives demographic information about cowpea consumers. From the interview, 52% of the cowpea consumers were males, while 48% were females. Few (8%) of the consumers were between the age range of 10- 20 years, 34% were between 21-30 years, 30% were between 31-40 years, 20% were between 41-50 years, while 8% were between 51-60 years old. The table showed that 2% had primary education, 26% had middle school/Junior high school education, 26% had

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Senior High School (SHS) education, and 34% had Tertiary education, while 12% had no formal education.

Table 1.4: Background information on cowpea consumers

DESCRIPTION		PERCENTAGES (%)
Gender	Male	52
	Female	48
Age	10-20 years	08
	21-30 years	34
	31-40 years	30
	41-50 years	20
	51-60 years	08
Education	Non-formal education	12
	Primary	02
	Middle school/JHS	26
	Secondary	26
	Tertiary	34

How often cowpea is included in the diet

From figure 1.6, 16% of consumers incorporated cowpea in their diet daily, 54% did weekly, and 22% did monthly, while 8% did yearly.

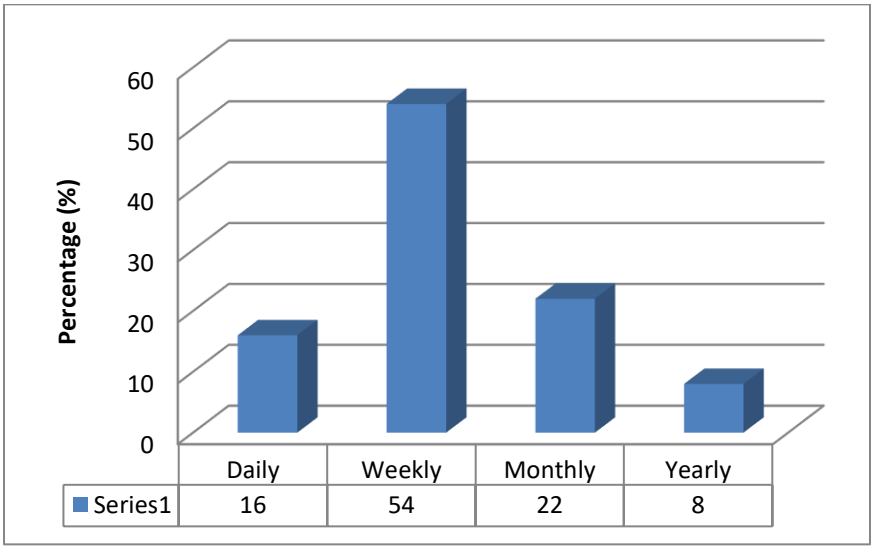

Figure 1.6: How often cowpea is included in the diet.

Response to the storage of cowpea after/ on purchase by consumers

Figure 1.7 showed that 68% of consumers stored cowpea when they purchased it while 32% did not. Storage facilities used were plastic rubber (58%), pots (26%) and drums (26%) (Figure 1.8).

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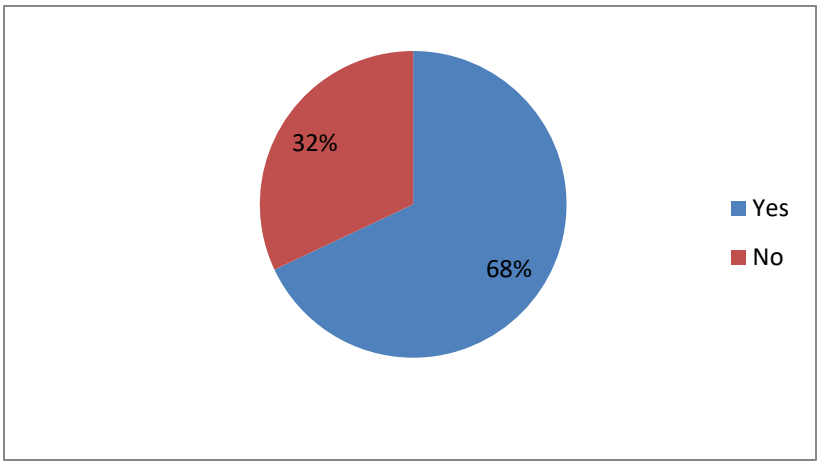

Response on whether cowpea is stored at home on purchase by consumers

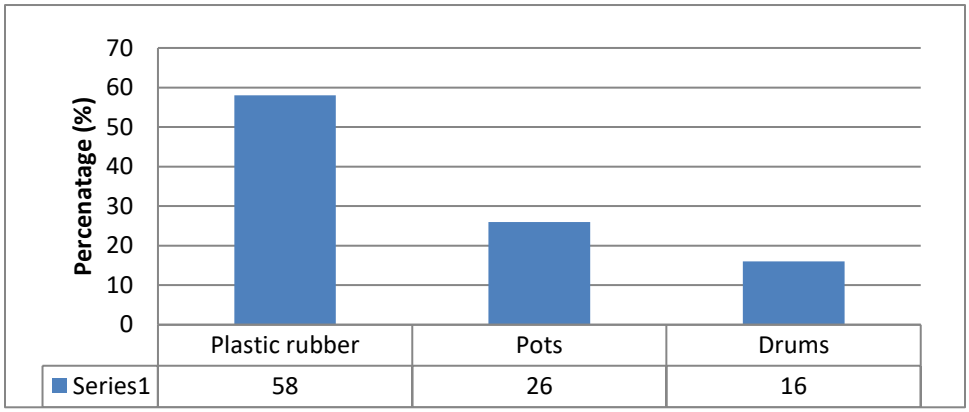

Figure 1.8: Storage facilities used at home by consumers

Respondents take on home storage and management of pest

The pest that affects cowpea during storage at home included weevils (72%), ants (16%) and rodents (12%). Consumers protected cowpea against pests by treating with chemicals (32%), sun drying (58%) and without doing anything (10%) (Table 1.5)

Table 1.5: Respondents' take on home storage and management of pests

DESCRIPTION		PERCENTAGES (%)
The pest that affects cowpea during storage at home	Weevils	72
	Ants	16
	Rodents	12
	Treat with chemicals	32

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How to protect cowpea against pests at home	Sundry	58
	Do nothing	10

Respondents' perception of the hazards confronted by cowpea treated with chemicals

From Table 1.6, 82% of the consumers thought it was risky to eat cowpea treated with chemicals, while 18% thought it was not. The majority (54%) indicated cooking length does not reduce the chemical in cowpea, while 46% indicated it did. However, few (24%) reported stomach problems after eating cowpea treated with chemicals, while 76% did not have stomach problems.

Table 1.6: Knowledge about cowpea treated with chemicals

DESCRIPTION		PERCENTAGES (%)
It is risky consuming cowpea treated with chemicals	Yes	82
	No	18
Cooking length does not reduce chemicals in cowpea	Yes	46
	No	54
Encounter stomach problems after eating cowpea	Yes	24
	No	76

Effects of storage materials and pesticide treatment on the viability of seeds after the storage period

Table 1.7 shows the effect of pesticides and storage materials on the viability of seeds after storage. Significant differences ($P<0.01$) were observed among the individual means. Rubber can (75.25%) recorded the highest percentage viability of seeds. This was followed by fertiliser sack (72.25%) which has similar percentage viability with polythene bag (72.25%). Pot (71.50%) recorded the least viability of seeds after the storage period among the individual means.

Cowpea treated with wood ash recorded 73.00%, phostoxin tablet recorded 73.75%, betallic super EC recorded 73.75%, and control (no addition of pesticides) recorded 70.75% of viable seeds after storage.

Effect of storage materials and pesticide application on the viability of cowpea seeds showed significance ($P<0.01$). Cowpea grains stored in rubber can with betallic super EC treatment of pesticide recorded the highest percentage viability of seeds (76.00%), while the least percentage viability of seeds was recorded in cowpea seeds stored in a pot with no application of pesticide (70.00%). Cowpea seeds stored in a polythene bag, as well as fertiliser sack with no application of pesticide (control), recorded similar percentage viability of seeds as grains stored in a pot with wood ash treatment (70.00%).

Table 1.7: Effects of storage materials and pesticide treatment on the viability of seeds after the storage period.

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Storage materials	Pesticides(protectants)				Mean
	Wood ash	Phostoxin T	BsuperEc	Control	
Pot	70.000c	73.000b	73.000b	70.000c	71.500a
Polythene bag	73.000b	73.000b	73.000b	70.000c	72.250b
Fertiliser sack	73.000b	73.000b	73.000b	70.000c	72.250b
Rubber can	76.000a	76.000a	76.000a	73.000b	75.250b
Mean	73.000a	73.750a	73.750a	70.750b	
CV=1.7235					

Effect of storage materials and pesticide treatment on damaged cowpea grains in storage.

The effect of pesticides and storage materials on the percentage of damaged cowpea grains in storage is presented in Table 1.8. For the individual means, significant differences (P<0.01) were observed among the pesticides and storage materials. Pot (122.67%) recorded the highest damaged cowpea grains, followed by polythene bag (117.58%) and then fertiliser sack (105.42%) with rubber can recording the least (90.08%). Cowpea treated with wood ash recorded 108.25%, phostoxin tablet recorded 104.92%, betallic super EC recorded 100.58%, and control (no addition of pesticides) recorded 122.0% of damaged cowpea grains.

Effect of storage materials and pesticide application on damaged cowpea grains also showed significance (P<0.01). Cowpea grains stored in a pot with no application of pesticide (control) recorded the highest damaged cowpea grains (134.0%), while the least damaged was recorded in cowpea grains applied with betallic super EC and stored in a rubber can (79.33%).

Table 1.8: Effect of storage materials and pesticide treatment on damaged cowpea grains in storage

Storage materials	Pesticides(protectants)				Mean
	Wood ash	Phostoxin T	Betallic super EC	Control	
Pot	121.67bc	119.00cd	116.00de	134.00a	122.67a
Polythene bag	118.00cd	116.00de	111.00f	125.33b	117.58b
Fertiliser sack	106.67g	102.67g	96.00h	116.33de	105.42c
Rubber can	86.67i	82.00j	79.33j	112.33ef	90.08d
Mean	108.25b	104.92c	100.58d	122.00a	
CV= 4.3158					

Effect of storage materials and pesticide treatment on undamaged cowpea grains

The effect of pesticides and storage materials on the percentage of undamaged cowpea grains is shown in Table 1.9 Rubber can (909.25%) significantly (P<0.01) recorded the highest entire cowpea grains, followed by fertiliser sack (894.75%) and then polythene bag (882.42%) with pot (877.33%) recording the least. Cowpea treated with wood ash, phostoxin tablet, betallic super EC and control (no addition of pesticides) recorded 891.75%, 895.08%, 6899.58% and 877.33% of undamaged cowpea grains, respectively.

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Effect of storage materials and pesticide application on undamaged cowpea grains showed significance (P<0.01). Cowpea grains stored in rubber can with betallic super EC pesticide treatment recorded more of the undamaged cowpea grains (920.67%) while cowpea grains stored in a pot with control (no pesticide treatment) recorded more of the damaged cowpea grains (866.0%).

Table 1.9: Effect of storage materials and pesticide treatment on undamaged cowpea grains

Storage materials	**Pesticides (protectants**				**Mean**
	Wood ash	PhostoxinT	Betallic super EC	Control	
Pot	878.33hi	881.00gh	884.00g	866.00j	877.33d
Polythene bag	882.00gh	884.00g	889.00ef	874.67i	882.42c
Fertiliser sack	893.33d	904.67c	904.67c	883.67g	894.75b
Rubber can	913.33b	918.00ab	920.67a	885.00fg	909.25a
Mean	891.75c	895.08b	899.58a	877.33d	
CV= 4.8822					

CONCLUSION

The storage structures as applied by stakeholders in agriculture, including polythene bags, clay pots and fertiliser sacks, were inferior in maintaining the quality of the cowpea beans compared to the 'rubber can technology' in the district. This was attributable to the application of inappropriate structures. To control storage pest infestation, farmers, retailers, and consumers must embrace the rubber can technology with betallic super EC pesticide treatments. The premium price is rewarded when cowpea is held and sold off the bumper season, and as such, farmers, retailers and consumers are encouraged to store their cowpea for above three months. However, the long storage period went with its challenges such as holed grains, colour change, moldiness and low germination percentage (when used as seed) due to inappropriate storage technologies. The findings of the study showed that betallic super EC as a protectant was efficacious and superior in protecting against bruchid infestation, colour, taste loss, as well as loss of germination ability compared to phostoxin fumigation, wood ash and untreated control in the Daffiama Bussie Issa district and hence farmers, retailers and consumers, are enhanced to go in for betallic super FC as a better storage option.

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