STUDIES ON THREE STORAGE STRUCTURES FOR SWEETPOTATO (*IPOMEA BATATAS* L.) IN GHANA

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ABSTRACT

The effectiveness of the three storage structures for sweetpotato in Ghana was studied. Sweetpotato roots initially cured for 7days (Batch 1) and 14 days (Batch 2) were stored in the local, pit and clamp storage structures for approximately 3 months. The decrease in percentage wholesome roots corresponded to an increase in percentage fungi infected roots from 0 to 84 days of storage in all the different storage structures. Clamp storage structure recorded the highest percentage wholesome roots (20.0%) as compared to pit (16.3%) and local (0%) after 84 days of storage when roots were cured for 7 days. However for 14 days cured roots stored for 84 days, local storage structure recorded the highest percentage wholesome roots (20.0%), pit (0%) and clamp (10.0%). Highest incidence of fungi (100.0%) was recorded in the local storage structure for 7 days cured roots. However pit storage structure recoded the highest incidence of fungi (100,0%) when roots were cured for 14 days. Percentage sprouted roots were significantly higher in clamp storage structure as compared to local and pit. Percentage insects, rodents infested roots were also significantly low in all the three storage structures.

STUDIES ON THREE STORAGE STRUCTURES FOR SWEETPOTATO IN GHANA

1.0 INTRODUCTION

Sweetpotato (*Ipomea batatas* L.) is a root crop that belongs to the family Convolulaceae. It is a perennial that is grown as an annual especially in the Tropics including Ghana where it is a starchy staple. The largest producers outside the Tropics are China, Japan, USA and New Zealand. Sweetpotato ranks seventh from the point of total production on the list of world crops (Harton, 1987). It ranks eighth in the world in the provision of energy and protein (FAO, 1987). The crop tops the list of eight important crops in developing world in terms of the quantity of energy per hectare per day. It has a high energy efficiency ratio than the cereals when produced in a non-mechanized situation (Norman et al., 1984). In monetary terms, it is thirteenth globally in the production value of agriculture commodities and fifth on the list of developing counties most valuable food crops (FAO, 1987).

Sweetpotato do not normally require high level of inputs. Few weeks after planting, vines cover the entire field so that the necessity for weeding or the use of herbicides can be kept to a minimum. Insect damage is cosmetic and not yield reducing and fungal diseases are not usually a problem in the growing crop (Bouwkamp, 1987).

Yields of most crops are higher in temperate than in the topical areas, but sweet potato yields are relatively better in the tropics than do most other major crops (Bouwkamp, 1987).

1.1 Storage Losses

It is estimated, that in the tropics each year between 25% and 40% of shared agricultural products is lost because of inadequate farm and village - level storage (Hayma, 1982). Quantitative and qualitative losses or a combination of both arising from post-harvest storage result from physical, physiological or pathological factors or various combinations of these factors (Boot, 1974). When sweetpotato roots are left in the hot sun after harvest or during uncontrolled conditions of storage they are exposed to high temperatures, moisture losses and susceptibility to decay may increase. There is a natural loss of dry matter during storage as well as a transpiratory loss of water (or wilting). Sweetpotato stored under controlled conditions have been shown to produce carbon dioxide (CO_2) and loss water in such a way that the dry matter/water ratio changes little (Kushman and Wright, 1969).

In Ghana, farmers' investments in terms of land, energy etc on sweetpotato cultivation can be wasted due to improper post harvest handling and storage structures. Sweetpotato is thus either sold at the farm gate at reduced price, or stored in traditional storage structures that do not provide the right environment for storage. Some of these traditional methods protect the product reasonably well and need at most slight improvements. On the other land, it is possible that some traditional methods are unsatisfactory, and lead to high losses. Heavy storage losses in the traditional storage methods occurs due to rot, sprouting, rodent destruction, pest and disease damage. These losses do not motivate the farmer to grow more because he is unable to store his or her harvest or part thereof in a safe way for any long period of time. There is the need for an improved storage method to reduce post harvest losses and increase economic returns of farmers.

1.2 Curing

Curing allows injured fruits marked by a high water content to heal themselves. The process was first tested on potatoes and sweetpotato (Demeaux and Vivere 1984). Noticeable changes to occur are desiccation of several layers of the outermost parenchyma cell exposed to air on wounding. It has been shown (Walter and Schadel, 1982 and 1983) that beneath the dissociated cells is a subsequent deposition of a polymeric material in the parenchyma cells. Studies by Thompson (1972) showed that the percentage weight loss during 113 days of storage of cured and uncured roots in the West Indies was 17% and 43% respectively.

1.3 Traditional Methods.

Storage of sweetpotato is not a recent innovation. Ancient methods practised by the Marvis of New Zealand for hundreds of years have been described (Cooley, 1951, Kelery, 1965). Lancaster and Courtesy, (1984) reported on the Pit storage of sweetpotato in Zimbabwe and Malawi where the roots are placed in pits with alternative layers of wood ash. In Papua New Guinea roots are alternated with layers of grass and grass - lined hole and sprinkled with wood ash and are finally covered with dry leaves or grass (Numtor and Lyonga, 1987).

In Ghana a similar storage method is available. A hole is dug in the ground and lined with grass at the floor. It may be cylindrical or rectangular depending on the choice of the farmer and normally placed on raised ground under trees to prevent flooding and sunshine. Freshly harvested roots are heaped in the hole closed and sealed with grass and soil up to normal ground level.

The objective of this study was to test the effectiveness of two improved storage structures and a traditional storage structure for sweetpotato storage under the Root and Tuber Improvement Programme (RTIP) at the Food Research Institute, Pilot Plant, Okponglo.

2.0 MATERIALS AND METHODS

2.1 Materials

2.1.0 Sweet Potato (*Ipomea batatas*)

Two batches, 600kg each of white variety sweetpotato were bought from Kumasi for the studies, Batch 1 (B1) went through 7 days curing process and Batch 2 (B2) went through 14 days curing process before storage in the 3 different storage structures.

2.1.1 Storage Structures

Two improved clamp storage structures, 2 improved pit storage structures and 2 traditional (local) storage structures from Asebu Ekroful were constructed on a suitable well - drained ground at the premises of Food Research Institute, Pilot Plant, Okpanglo.

2.1.2 Traditional (local) storage structure

The traditional storage structure consisted of a cylindrical hole (1m x 1m x 1m) dug in the ground and lined with grass at the floor.

2.1.3 Improved pit storage structure

The improved pit storage structure is an improvement of the local storage structure. It consisted of a cylindrical hole (1m x 1m x 1m) dug in the ground and lined thickly (about 20cm) with dry grass on the floor and walls to reduce roots damage in store and also reduce mould damage. A sloping thatched roof is constructed over the pit to prevent rain getting into the pit which could cause rotting. A narrow space is left between the base of the roof and the ground to allow for ventilation.

2.1.4 Improved clamp storage structure

It consisted of a circular bed of dry grass (20cm thickness) made on a raised flat mound of earth surrounded by a concrete wall 30cm above ground level. The dry grass is for cushioning and to absorb excess moisture. A hut is built on the concrete wall supported by wood and wire gauze that prevents rodents from entering. A thatched roof is provided to prevent too much exposure to sunshine or damage by heavy rains.

2.2 Methods

2.2.0 Curing

Two batches 580kg each of freshly harvested roots were piled and covered with jute sacks under an open garage after damaged roots have been removed. The roots were cured at temperature 35-40^{0}C and humidity 80-95%. Batch I (B1) was cured for 7days and Batch 2 (B2) was cured for 14 days.

2.2.1 Storage

After curing the roots were sorted out into wholesome roots, sprouted roots, fungi infected roots, insects/rodents infested roots and insect/ rodents sprouted roots.

From the wholesome roots 140kg were stored in each of the different storage structures as designated below.

B1L	-	Batch 1 roots after 7days curing in local storage structure
B1P	-	Batch 1 roots after 7 days curing in pit storage structure
B1C	-	Batch 1 roots after 7 days curing in clamp storage structure
B2L	-	Batch 2 roots after 14 days curing in local storage structure
B2P	-	Batch 2 roots after 14 days curing in pit storage structure
B2C	-	Batch 2 roots after 14 days curing in clamp storage structure.

2.2.2 Sampling

During storage samples (20kg) were randomly removed fortnightly from all the different storage structures and assessed for physiological deterioration, insect infestation and fungal damage. This procedure was followed for a period of 84 days.

3.0 RESULTS

It was observed that out of 580kg sweetpotato roots cured for 14 days, 76.5% were wholesome roots, 14.6% fungi infested roots, 2.5% sprouted roots, 4.1% insects and rodents infested roots. Completely spoilt roots that included squashed roots were 2.3% (Table 1).

After 28 days of storage no wholesome roots were recorded in storage structure B1L (Table 2 and Fig 1). Fungi infection increased tremendously after 28 days of storage, an increase of 50.5% on day 42, and 17.5% on day 70. The high incidence of fungi infection after day 28 corresponded to the unavailable wholesome roots after 28 days of storage.

A similar high fungi infection (51.5%) was recorded from the B1P on 84th day of storage (See Table 3 and Fig 2) whereas BIC recorded 32.5% on 84th day of storage (see Table 4 and Fig 3). The highest fungi infected roots were recorded in B1L (100%) on day 70 of storage (Table 2 and Fig 1). In addition B1C showed the highest wholesome roots (20.0%) on 84th day of storage (Table 4 and Fig 3).

Insects and rodents infested roots and insect infested sprouted roots recorded significantly low percentage in B1L, B1P and B1C (Table 2, 3 and 4).

Sprouted roots were considerable high, 0 - 37.0% in B1C (Table 4 and Fig 3). A similar pattern was observed in B1P, from 0 - 33.5% (Table 3 and Fig 2).

However in BIL sprouted roots were observed only on day 14 (24.0%) and day 28 (5.0%) (Table 2and Fig 1).

Data in Table 5 shows that wholesome roots in B2L decreased from 100% at day 0 to 20.0% at day 84 of storage (see Fig 4).

In Table 6 and Fig 5 wholesome roots recorded in B2P decreased from 100% at day 0 to 0% at day 84, similar to B2C from 100% at day 0 to 10.0% of day 84 (Table 7 and Fig 6).

Fungi infested roots recorded in B2L ranges from 10.0 - 40.5%, 5.0 - 100% B2P and 4.5 - 80.0% B2C (Tables 5, 6, 7, and figs 4, 5, 6). This indicates an increase in fungi incidence recorded in B2P followed by B2C and B2L showing the least.

Insects and rodents infested roots observed from B2L, B2P and B2C were significantly low, 5.0 - 17.5% B2L, 0 - 10.0% B2P and 0 – 18.0% B2C. Similar pattern was observed in insect infested sprouted roots (Figs 4, 5 and 6).

Table 1

Categories of sweetpotato (*Ipomea batatas*) roots from Kumasi after 14 days of curing.

Sweetpotato roots	Quantity (kg)	Percentage (%)
Wholesome	443.5	76.5
Sprouted	14.5	2.5
Fungi Infested	85.0	14.6
Insects, rodents infested	23.5	4.1
Completely spoilt	13.5	2.3
Total	580	100

Table 2

Percentage of sweetpotato roots sampled from storage structure BIL on various days of storage after 7 days curing.

Sweetpotato	Days of storage						
roots	0	14	28	42	56	70	84
Wholesome	100	48.0	39.0	0	0	0	0
Sprouted	0	24.0	5.0	0	0	0	0
Fungi infected	0	12.5	31.0	81.5	82.5	100	100
Insects, rodents infested	0	10.5	18.0	18.5	17.5	0	0
Insects, rodents infested sprouted	0	5.~~5~~0	7.0	0	0	0	0

Percentage of sweetpotato roots from storage structure B1L on various days of storage after 7 days curing before storage.

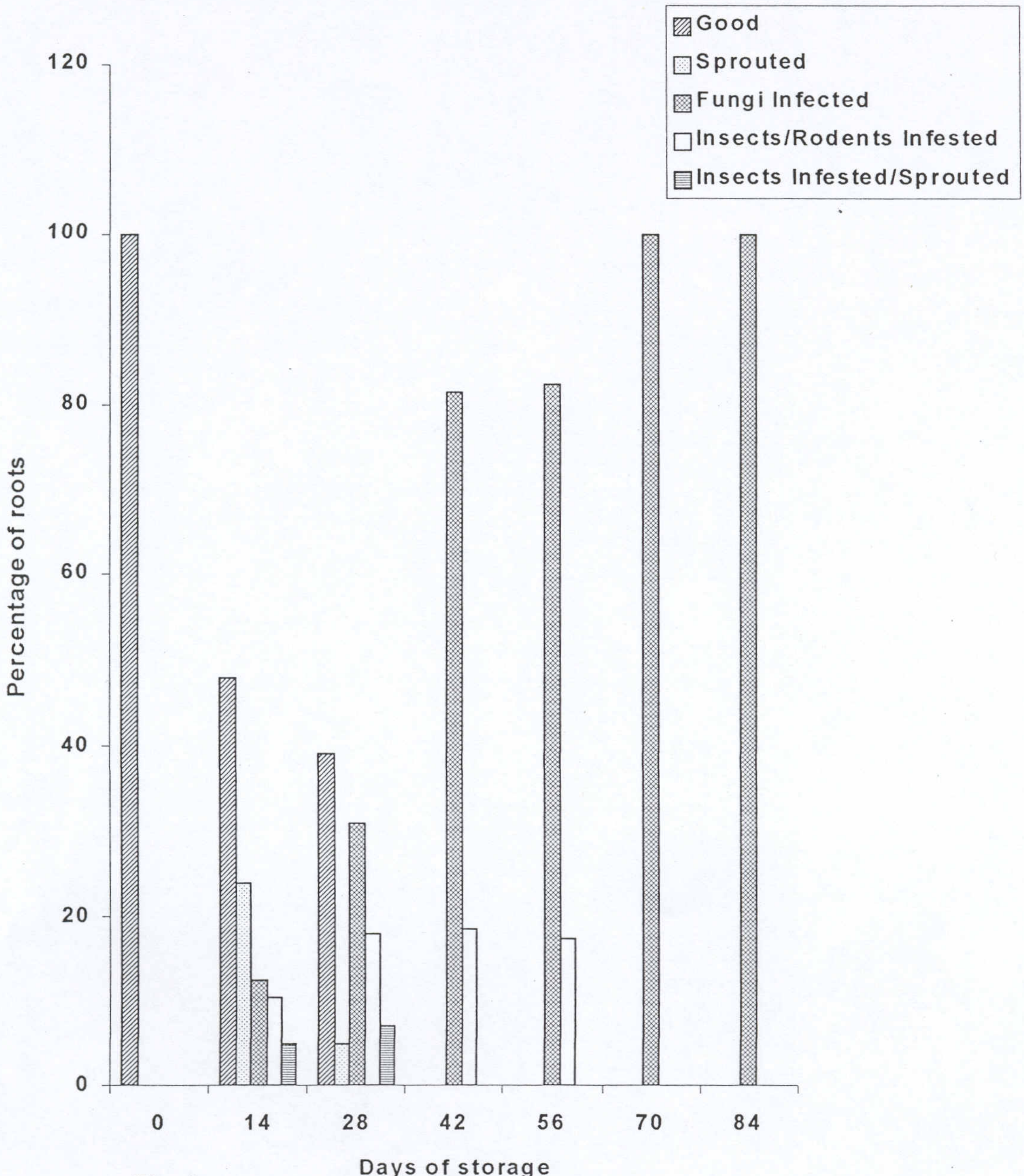

Fig. 1

Table 3

Percentage of sweetpotato roots sampled from storage structure BIP on various days of storage after 7 days curing.

Sweetpotato roots	Days of storage 0	14	28	42	56	70	84
Wholesome	100	54.0	46.0	50.0	15.0	17.0	16.3
Sprouted	0	26.0	19.0	15.0	33.5	24.5	17.0
Fungi infected	0	10.0	10.0	21.0	30.0	45.0	51.5
Insects, rodents Infested	0	5.0	10.0	12.0	6.5	13.5	9.5
Insects infested sprouted	0	5.0	15.0	2.0	15.0	~~8.0~~ 2.0	5.5

Table 4

Percentage of sweetpotato roots sampled from storage structure BIC on various days of storage after 7 days curing.

Sweetpotato roots	Days of storage 0	14	28	42	56	70	84
Wholesome	100	57.5	21.5	43.5	25.0	22.5	20.0
Sprouted	0	29.0	37.0	21.0	35.0	27.5	25.5
Fungi infected	0	5.0	9.0	14.5	20.0	40.0	32.5
Insects, rodent infested	0	5.0	16.0	17.5	5.0	5.0	15.5
Insects, rodents infested sprouted	0	3.5	16.5	3.5	15.0	5.0	6.5

Percentage of sweetpotato roots from storage structure B1P on various days of storage after 7 days curing before storage.

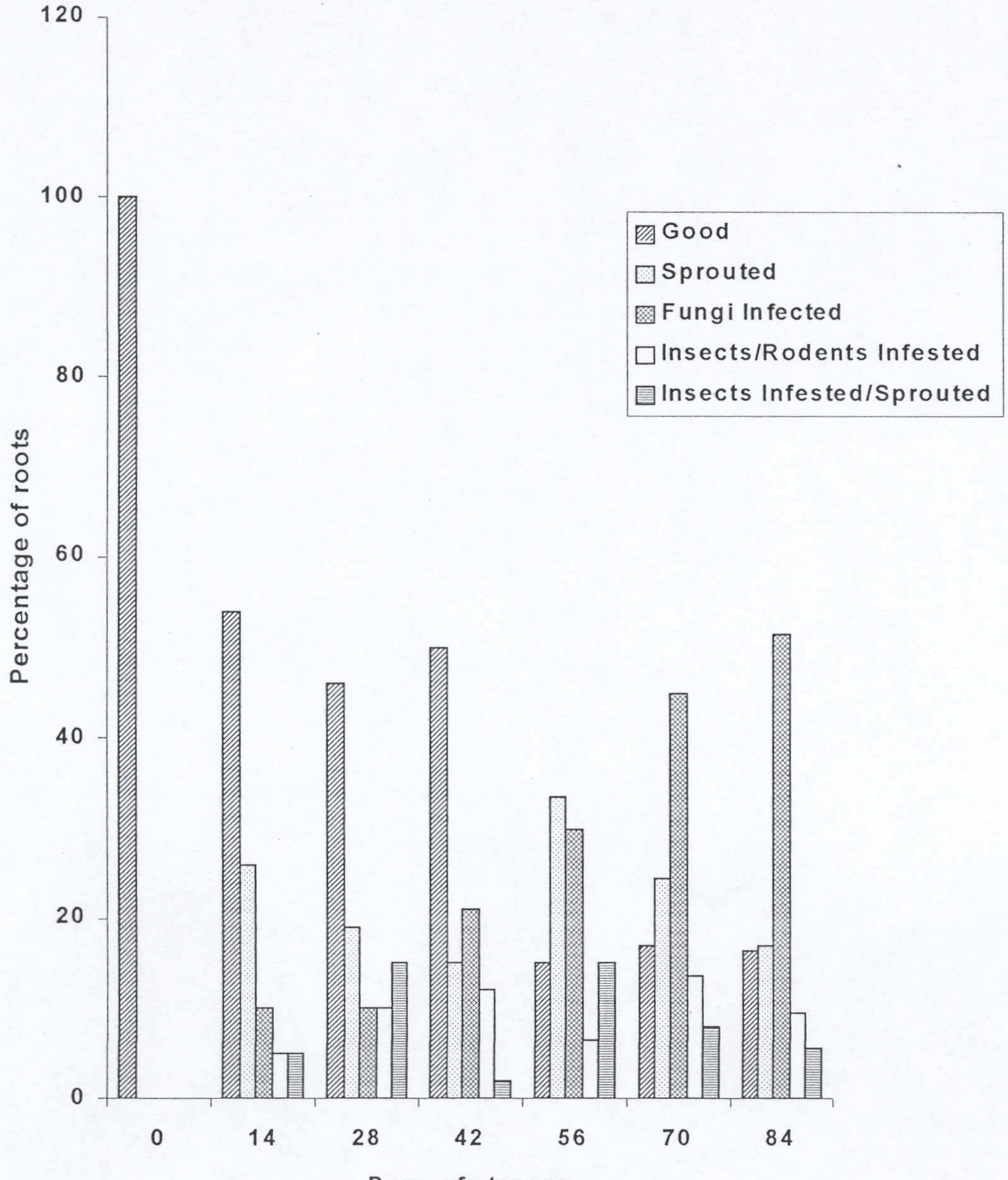

Fig. 2

Percentage of sweetpotato roots from storage structure B1C on various days of storage after 7 days curing before storage.

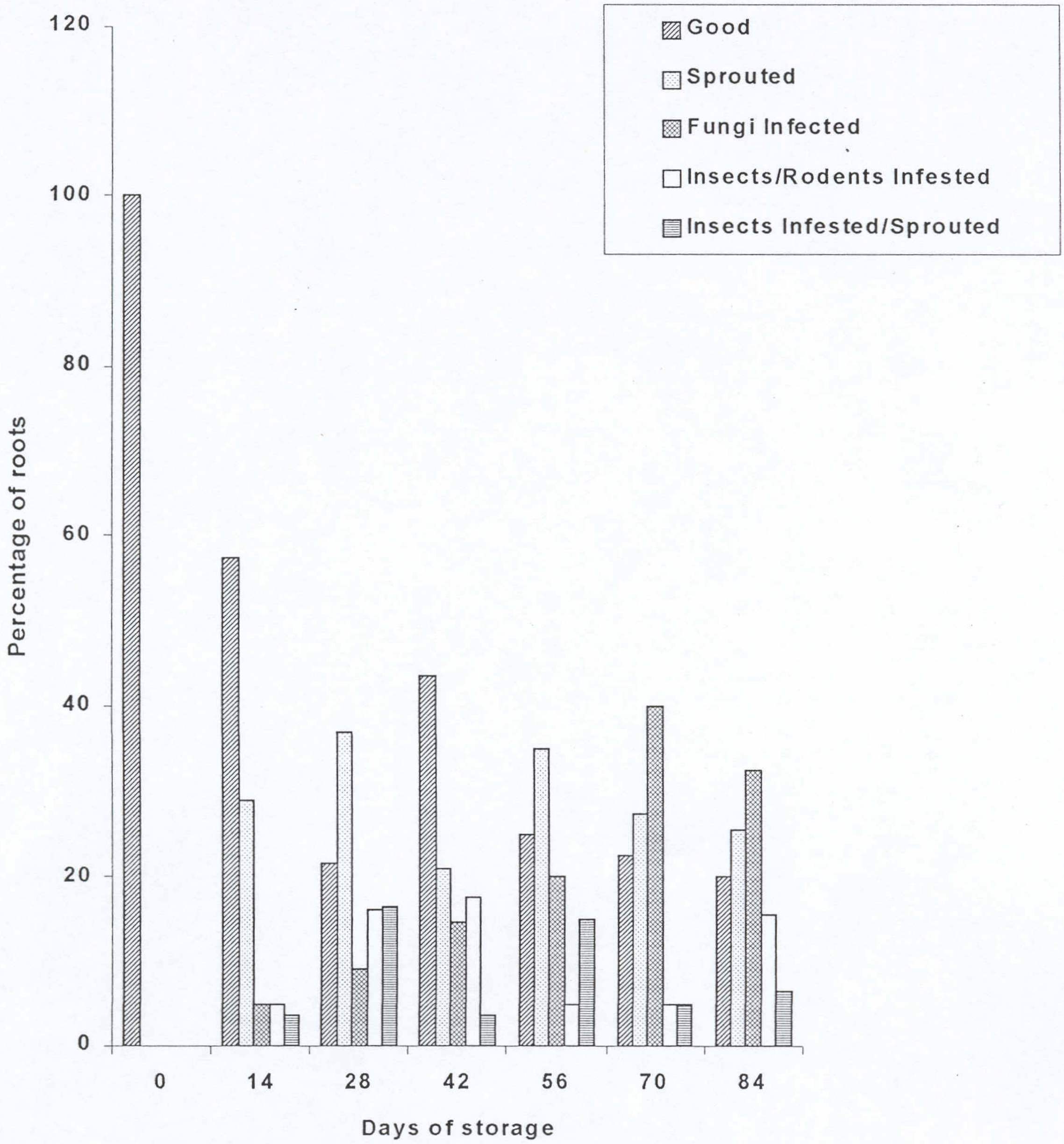

Fig. 3

Table 5.

Percentage of sweetpotato roots sampled from storage structure B2L on various days of storage after 14 days curing.

Sweetpotato roots	Days of storage 0	14	28	42	56	70	84
Wholesome	100	72.5	62.0	32.5	38.5	21.5	20.0
Sprouted	0	0	0	18.0	8.0	28.0	24.0
Fungi infected	0	10.0	31.5	28.5	31.0	29.0	40.5
Insects, rodent infested	0	17.5	6.3	16.0	16.5	5.0	5.5
Insects, rodent infested sprouted	0	~~10.0~~ 0	~~0~~ 0.2	5.0	6.0	16.5	10.0

Table 6

Percentage of sweetpotato roots sampled from storage structure B2P on various days of storage after 14 days curing.

Sweetpotato roots	Days of storage 0	14	28	42	56	70	84
Wholesome	100	85.0	59.0	36.0	27.5	0	0
Sprouted	0	0	0	10.0	3.0	0	0
Fungi infected	0	5	33.5	45.0	57.5	100	100
Insects, rodent infested	0	10.0	7.5	5.0	5.0	0	0
Insects, rodents Infested sprouted	0	0	0	~~5.0~~ 4	7.0	0	0

Percentage of sweetpotato roots from storage structure B2L on various days of storage after 14 days curing before storage.tubers under storage - B2L

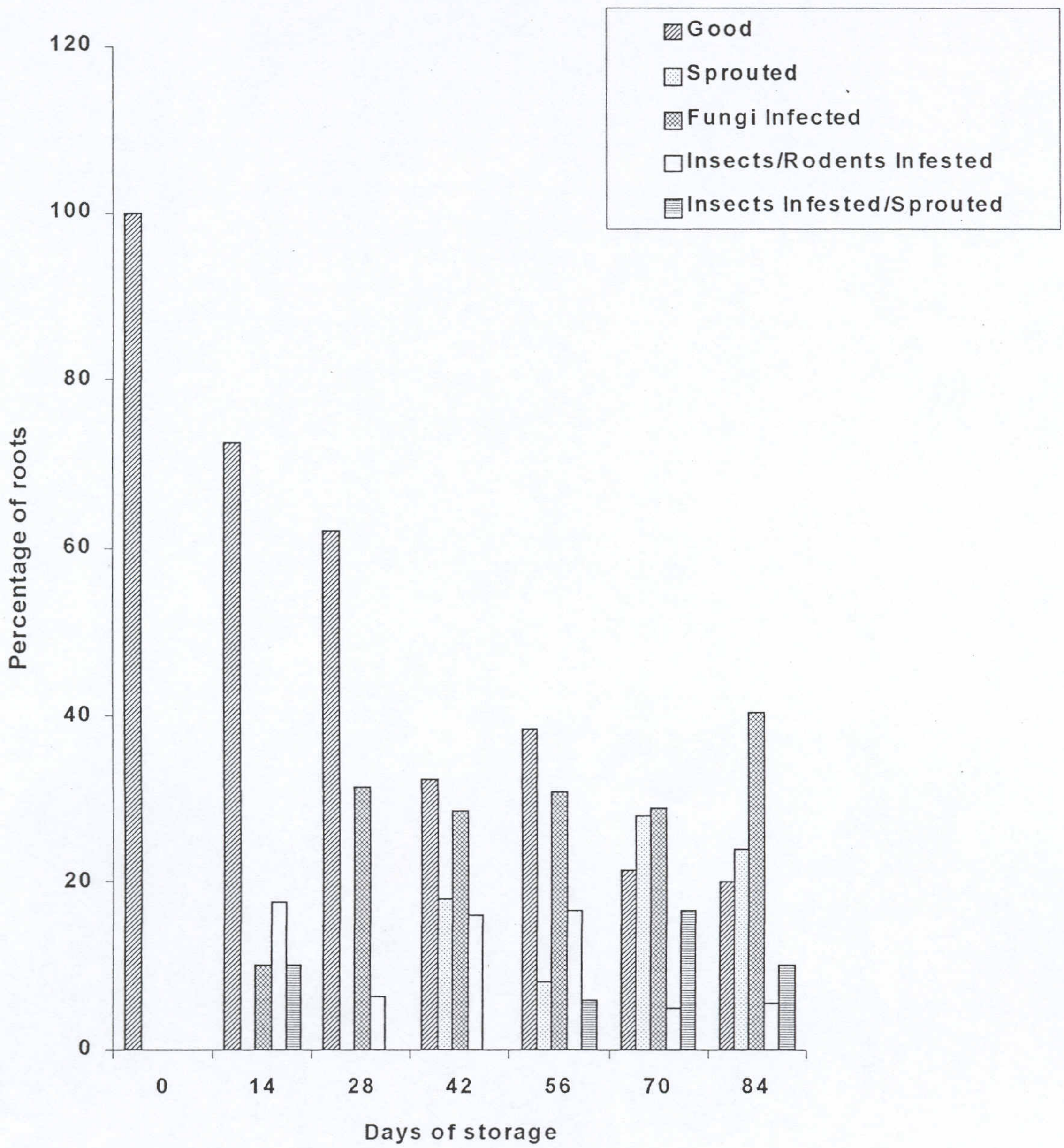

Fig. 4

Percentage of sweetpotato roots from storage structure B2P on various days of storage after 14 days curing before storage.

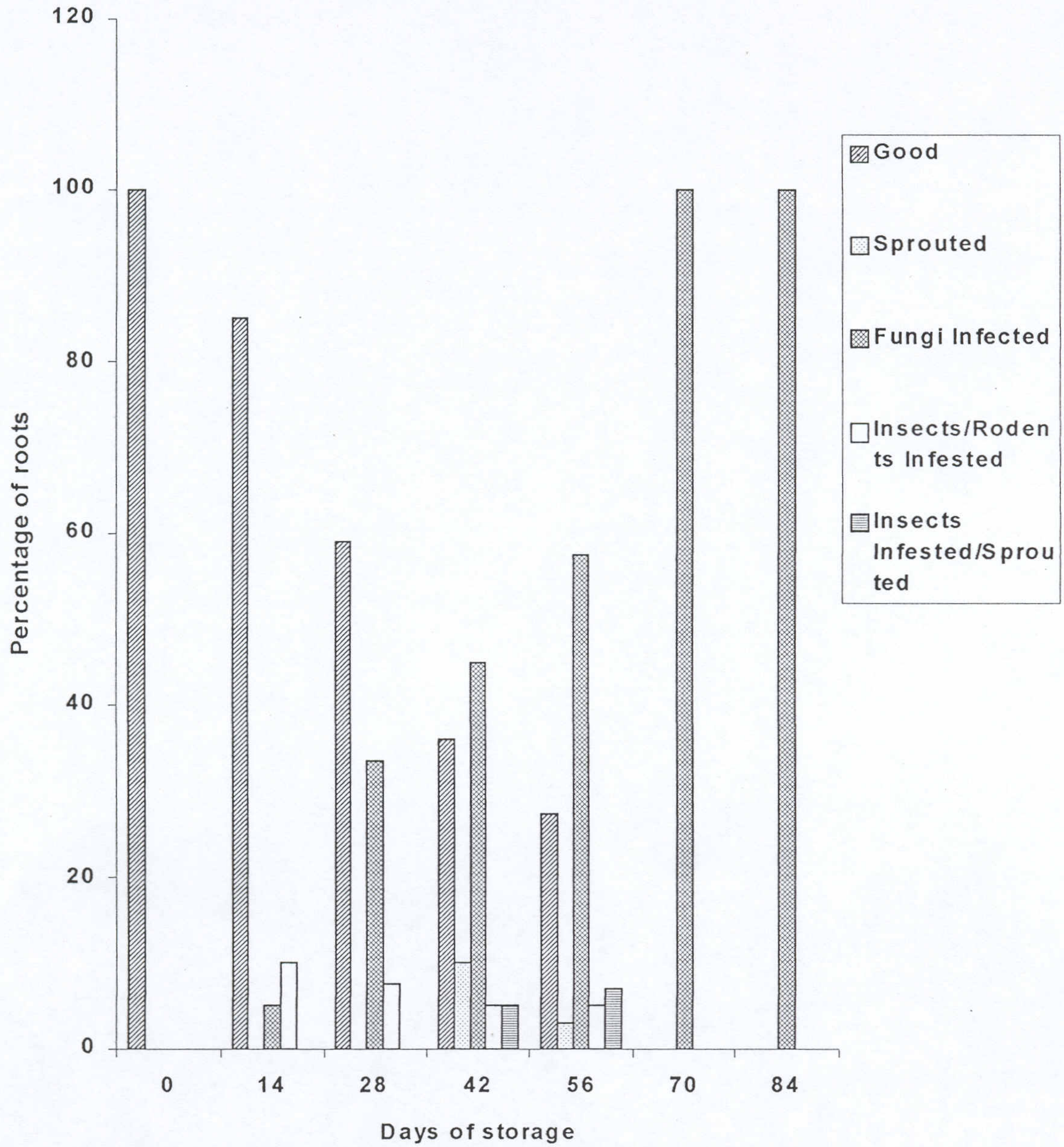

Fig. 5

Table 7

Percentage of sweetpotato roots sampled from storage structure B2C on various days of storage after 14 days curing.

Sweetpotato roots	Days of storage 0	14	28	42	56	70	84
Wholesome	100	91.5	58.0	38.5	22.5	14.0	10.0
Sprouted	0	0	0	30.0	3.5	0	0
Fungi infected	0	4.5	29.0	15.0	69.0	68.0	80.0
Insects, rodent infested	0	4.0	8.0	5.0	5.0	18.0	10.0
Insects, rodent infested, sprouted	0	0	5.0	11.5	~~5.0~~ 0	0	0

Percentage of sweetpotato roots from storage structure B2C on various days of storage after 14 days curing before storage.

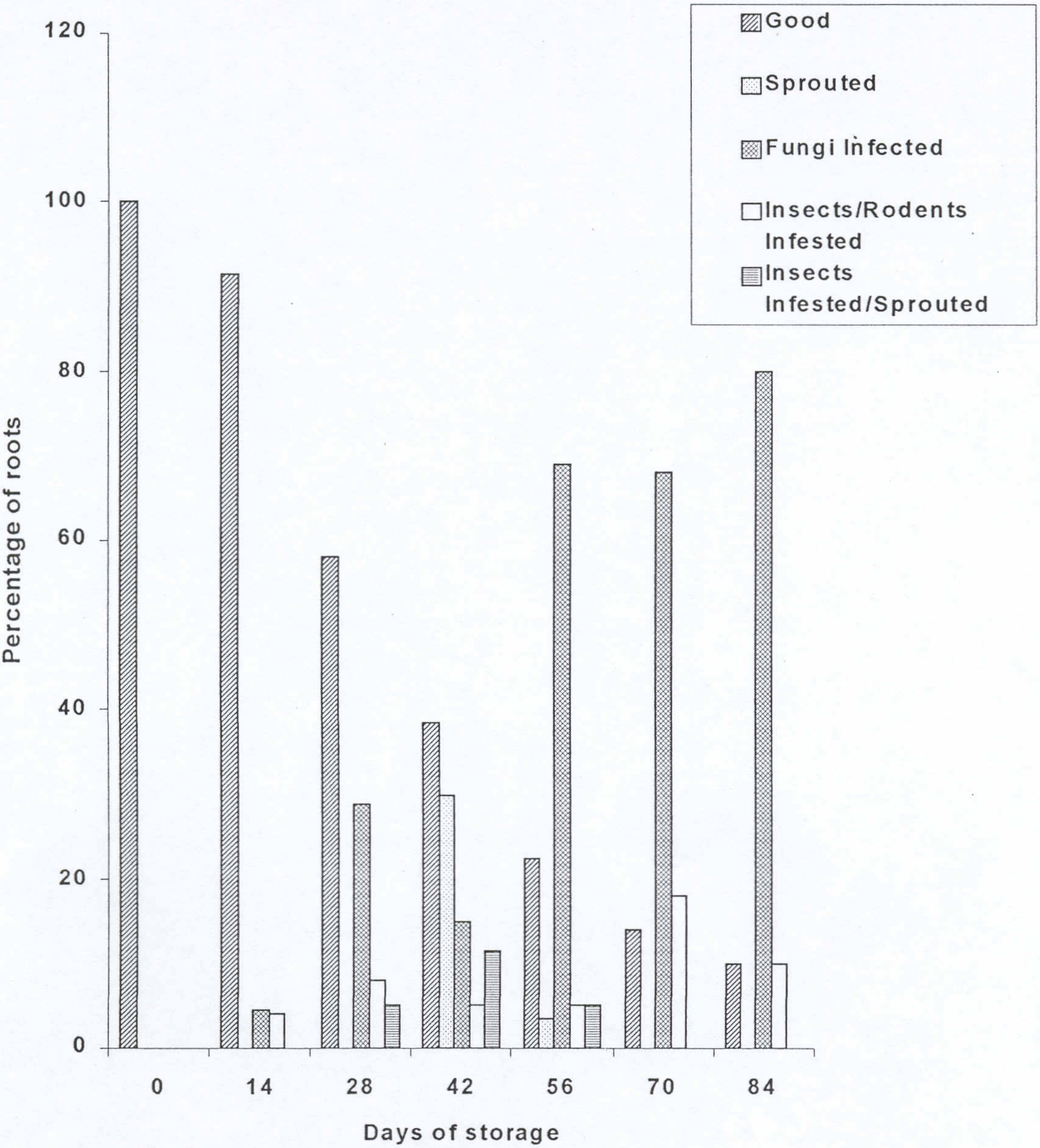

Fig 6

4.0 DISCUSIONS

Sweetpotato has a high moisture content and a relatively delicate skin. It remains metabolically active after harvest and is easily damaged. The energy essential for this metabolic function is taken by the root from its stores of carbohydrates. Carbohydrates are burned to gain energy during which process CO_2 and H_2O are emitted to the environment as gases. Studies by Jenkins (1982) showed that respiratory losses are much higher and greater under tropical temperatures. High temperatures also encourage sprouting with frequent increase in water and respiratory losses. The high incidence of sprouting in B1C, B2C, B1P and B2P was caused by excessive heat and carbon dioxide built up in the storage structure during the day. Low sprouted roots recorded in B1L and B2L was due to the air stream through the sweetpotato that carry off the heat and carbon dioxide produced by the roots in the storage structure. Sprouts recorded in B1C, B2C, B1P and B2P ranges from 0 - 25 cm in length whereas in B1L and B2L it ranges from 0 - 16.0cm in length.

The high incidence of fungi infected roots recorded in B1L corresponded to the reduced percentage of wholesome roots. Fungi easily attack sweetpotato roots due to the high water activity available as a result of the high moisture content of sweetpotato. The fungi causing rot are normally lesion pathogens. They actively penetrate the roots through lesions, cuts, holes bored by nematodes or where rodents have bitten the roots. Rot was observed on only parts or the complete root and was either "dry" or "soft" rot (Centre for Overseas Pest Research 1978). Rots effects changes in consistency and flavour frequently making the roots no longer suitable for consumption or causing considerable loss in market value.

Roots stored in B1L are easily attacked by soil fungi and air fungi (through their spores) as compared to B1P and B1C which are provided with a hut and raised above the ground in the case of B1C. This is however contradicted in B2C and B2P which recorded high fungi incidence and the least recorded in B2L. This could probably due to the 14 days of curing process. Among the most significant species are *Penicilium* sp. and *Aspergillus* sp.

Insects, rodents infested roots in all the different storage structures were significantly low as compared to fungi infected roots. However the potato weevil (*Cylas formicarius*) causes additional losses to stored sweetpotato. Roots may be initially attacked during storage or may be contaminated with eggs or larvae of the pest from the field. Such contamination may not be visible to the eye and apparently healthy roots may be stored only to be attacked when the eggs hatch and larvae begin to feed. Weevil damage produced quantitative losses on aesthetically unappealing roots which may be discoloured and bitter lasting.

5.0 **SUMMARY**

1. A decrease in wholesome roots corresponded to an increase in fungi infested roots as the storage days increases from O to 84 in all the different storage structures.

2. Storage structure B1L recorded the highest incidence of fungi infested roots when roots were cured for 7 days.

3. Storage structure B2P recorded the highest incidence of fungi infested roots when roots were cured for 14 days.

4. Wholesome roots recorded in B1C were the highest when roots were cured for 7 days.

5. Wholesome roots recorded in B2L was the highest when roots were cured for 14 days.

6. Sprouted roots were significantly higher in B1C and B2C.

7. Storage structure B2L, B2P and B2C recorded sprouted roots after 48 days of storage.

8. Insects, rodent infested roots were significantly low in all the different storage structures.

9. In addition, insects infested sprouted roots recorded in all the different storage structures were significantly low.

6.0 CONCLUSION

This studies shows that the improved clamp storage structure is the most efficient based on wholesome and fungi infected roots. This is followed by the improved pit and the least been the local structure. In addition curing of roots should not exceed 7 days since roots cured more than 7 days rots faster in storage.

7.0 RECOMMENDATION

1. More trails should be conducted using different varieties of sweetpotato. It is suspected that varieties will store differently.

2. Studies on the process of curing should be conducted in terms of weight loss or gain over a period of 3-21 days using different varieties of sweetpotato.

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