MIDLANDS STATE UNIVERSITY

ASSESIMENT OF DIFFERENT TRADITIONAL TECHNIQUES OF STORING HARVESTED CORMS OF TANNIA (*Xanthosoma sagitifollia*) AND TARO (*Colocasia esculenta)* VARIETIES

By

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ABSTRACT

An experiment on the effect of different storage techniques on taro and tannia corms was carried out in a 2x5 factorial in a complete block design(CBD) replicated three times. Taro and tannia crops and the factors are different storage techniques. The techniques include refrigeration, heap covered with maize stalks, ash smeared corms, pit storage and corms stored under room temperature conditions. Taro and tannia corms were stored for 18 weeks after being cured using the same technique for 2 weeks. Then data on weight loss, pest damage, and corm rot and sprouting was measured. There was no significant differences ($P>0.001$) on the number of corms that were affected by pest during storage time. The corm weight was significantly different ($P<0.001$). There was a significant difference in the number of sprouted corms between taro and tannia corms ($P < 0.001$). This study concludes that refrigeration technique had less rots, less sprouting and no pest damage. The corms that were stored in pit lost less weight as compared to all other techniques. Farmers can use the pit method to store harvested corms if there are not bruised at harvesting

DECLARATION

I declare and certify that I have supervised this thesis and it is now ready for evaluation

Name of supervisor

....

Signature

....

Date

....

DECLARATION

I Nyikahadzoi Mugumo do hereby declare that this project is the result of my own assessment and research except to the extent indicated in the acknowledgements and references. This project has not been submitted in part or in full for any other degree for consideration by any other university. As such no part of this research in any form, electronic or photocopy may be produced for any other purposes other than academic without permission from the undersigned .Further declaration is made to the fact that this research was approved by the Department of Natural Resources Management and Agriculture at Midlands State University.

Nyikahadzoi Mugumo Reg No R12548Z Sig............................Date....................

DEDICATION

I dedicate to my wife Sheillah and my children Blessing, Donald and Anold.

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CHAPTER 1

1.1. INTRODUCTION

Taro is a common name for the corms and tubers of several plants in the Araceae. Of these *Colocasia esculenta* is the mostly widely cultivated .Taro is native to Southern India and South East Asia. It a perennial, tropical plant primarily grown as a root vegetable for its edible starchy corn and as a leaf vegetable. It is a staple food in Africa, oceanic and South Indian cultures.It is believed to have been one of the earliest cultivated plants. Taro is needed in Asia and the Caribbean for its fleshy corms and nutritious leaves. In addition to contributing to sustained food security in the domestic market, it brings in the export earnings in India (Revil et al, 2005).Taro is thought to have originated in the Indo-Malayan region moved to Egypt and the eastern Mediterranean then into East Africa and West Africa.

It is known by many local names and often referred to as “elephant ears” when grown as an ornamental plant. Taro can be grown in paddy fields where water is abundant or in upland situations where water is supplied by rainfall or supplemental irrigation .Taro is one of the few crops (along with rice and lotus) that can be grown under flooded conditions .This is due to air spaces in the petiole which permit under water gaseous exchange with the atmosphere. For a maximum dissolved oxygen supply the water should be cool and flowing .Warm stagnant water causes basal rotting .For maximum yield the water level should be controlled so that the base of the plant is always under water. Flooded cultivation has some advantages over dry-land cultivation it has higher yields (about double) out of season production (which may result in higher prices) and there is good weed control in flooding facilities. On the other hand in flooded production systems taro requires a larger maturation period investment in infrastructure and higher operational costs and monoculture is likely to take place.

Taro does well in deep moist or even swampy soils where the annual rainfall exceeds 2500mm per annum. The plant fit well into tree crop and agro forestry systems and some types are particularly well adapted to unfavourable land and soil conditions such as poor drainage. As such taro is grown under intensive cultivation as starch crop (Jianchu et al., 2001).

Tannia (*xanthosoma sagittifolium*)) is a genus of flowering plants in the arum family, Araceae.The genus is native to tropical America but widely cultivated and naturalized in other tropical regions. Several are grown for their starchy corms an important food staple of regions known variously as malanga, cocoyam, yautia, dasheen and ape in Papua New Guinea. Some of its species are used as ornamental plants and in popular horticultural literature are known as ape or elephant ear The leaves of most tannia species are 40-200cm long sagitate (arrow head-shaped) or subdivided into three or as many as 18 segments .Unlike the leaves of taro those of tannia are usually not peltate the upper v-notch extends into the point of attachment of the leaf petiole to the blade.

Domestication of tannia species is thought to have originated in the northern lowland South America then spread to the Antiles and Mesoamerica. Today tannia is still grown in all those regions but is especially popular in Cuba and Puerto Rico where it is used in alcapurrias or boiled. It is grown in Trinidad and Tobago, Guyana and Jamaica to make the popular callaloo dish. It is also grown in West Africa, now a popular producer where it can be used as a replacement for yams in a popular regional dish called fufu .Taro is also grown as a crop in the Philippines. In Polynesia tannia was considered a famine food used only in the event of failure of the much preferred taro crop. The typical tannia has a growing cycle of 9 to 11 months, during which time it produces a large stem called a corm and will surrounded by smaller edible cormels about the size of potatoes. These cormels (like the corm) are rich in starch .Their taste has been described as earthy and nutty and they are a common ingredient in soups and stews. They may also be eaten grilled, fried or pureed. The young unfurled leaves of some varieties can be eaten as boiled leaf vegetables or used in soups and stews such as the Caribbean callaloo. (Garcia-Robledo et al 2005)

Taro and tannia are stored in a variety of traditional low-cost structures such as shade, hut and underground pits. Sometimes, the corms are placed in boxes before loading into the building while others are placed directly on the storage floor. Corms may also be stored in heaps in a shade and/or covered with straw or banana leaves. In parts of southern China, it is common practice to pile the corms in heaps and cover them with soil or seal them in leaf-lined pits in the ground (Plucknett and White, 1979).The main traditional storage systems which will be used in contacting this research are refrigeration, pit storage lined with banana leaves, covering them with maize stalks under shade, application of ash on taro and tannia then leave them under room temperature lastly storing them while heaped in a room.

1.2. Problem statement

Mhandarume ward 2 has smallholder farmers who cultivate taro and tannia mainly along Mvumvumvu flood plain. After maturity the crops are harvested but farmers face challenges when it comes to storage. Some of the corms will rot or sprout while some do not last for greater than 4 weeks before they lose weight.

The research will investigate the effectiveness of different traditional methods of storing harvested taro and tamia corms of different varieties. The research therefore seeks to assess the contribution of the different methods of storing taro and tamia corns of different varieties to the smallholder farmer. The research from the current research will form the basis for passing recommendation to the farmers in Mhandarume ward. Moreover the study could serve to draw national attention and support in addressing the poor storage of taro being experienced by smallholder farmer .The study is also important as it has potential to reduce post harvest loses which usually affects the availability of these products at the market when they are out of season. This will increase the production of taro and tamia on a larger scale as farmers will be able to store them for a long time after harvest and increase their availability when they are out of season. Most of the smallholder farmers do not have financial resources to purchase some of the chemicals needed to increase the shelf life of harvested taro and tamia, therefore this project intends to provide an alternative source of storage materials an d equipments which are cheap and readily available to farmers in communal areas .The farmers will be able to get a healthy diet as they will consume taro and tamia when they are out of season.

1.2. Justification

Mhandarume ward 2 is a communal area which comprise of smallholder farmers who cultivate taro and tannia along the Mvumvumvu River which meanders all the way from Cashel Valley and provides water all year round which keeps the banks and the flood plains wet. Some of the water is diverted into the flood plains to provide suitable moisture content needed for the growth of taro. When farmers try to store the crop after harvesting the crop is usually affected by post harvest losses such as rotting, sprouting, weight loss and hardness

1.3. Main objective

To determine the effectiveness of different storage techniques in storing taro and tannia

1.4. Specific objectives

To determine the effect of different storage techniques on weight loss of harvested taro and tannia corms.

To determine the effect of different storage technique on rotting of taro and tannia corms

To determine the effect of different storage techniques on sprouting of taro and tannia. corms.

1.5. Hypotheses

The different storage techniques have an effect on weight loss of taro and tannia corms

The different storage techniques have an effect on rotting of taro and tannia corms

To determine the effect of different storage technique of taro and tannia corms

CHAPTER 2

2 .0. LITERATURE REVIEW

Causes of storage losses of taro and tannia tubers include sprouting, transpiration, respiration, dormancy, rot due to mould and bacteriosis, and attack by insect, nematodes and mammals. Sprouting, transpiration and respiration are physiological activities which depend on the storage environment (mainly temperature and relative humidity).These physiological changes affect the internal composition of the tuber and result in destruction of edible material and changes nutritional quality. A number of treatments and techniques need to be developed to reduce these physiological activities and also to protect the tuber from post harvest diseases. These include treatment with chemicals, plant extracts and storage techniques used include cold storage, improved under storage and improved taro barns.

The possibility of storing fresh taro and tannia corms is decisively influenced by dormancy .Dormancy occurs shortly after physiological maturity of the corms during dormancy the metabolic functions of the corms are reduced to minimum .The duration of dormancy does not only depend on the plant but is also influenced by physical factors .A fall in temperature in temperature even if this is only a few degrees Celsius prolongs dormancy .Vice versa a rise in temperature reduces dormancy (Passam,1982)Relative humidity also has a similar effect .High humidity on the for example at the beginning of the rain season promotes germination .Low humidity on the other hand prolongs dormancy(Wickham,1984) .Taro and tannia have a water content of 60-80% depending with the variety. During storage the water content of taro and tannia reduces continually. Water vanes depending on the phase of storage during the first weeks after harvesting a reduction in the water content of the corms is hardly noticeable in some cases, water content will even rise slightly during this phase (Coursey, 1961)

During a storage period of five month the weight of the corms falls by up to 20% due to transpiration (Coursey and Walker, 1961).Data concerning the loss of weight due to transpiration show some difference. The reason for this is that the intensity of transpiration is considerably influenced by the predominant climatic conditions (temperature and relative humidity).Loss of weight due to transpiration has no influence on the nutritional value of the corms can even rise in relation due to transpiration. Despite this a great loss in weight from transpiration is not desired. Due to this the tubers lose their viability (germination), shrink become unattractive and undergo a change in flavor which is not wanted (Onwueme, 1978).As taro and tannia are mainly sold according to fresh weight and appearance, it is in the interest of the farmer to preserve the water content of the fresh corms as much as possible (Onwueme, 1978).The corm is a living organ. This is why metabolic functions continue during dormancy to preserve its viability .The energy essential for this is taken by the corm from its store of carbohydrates .Carbohydrates are burned to gain energy during which process CO_2 and H_2O are emitted to the environment as gases .In contrast to transpiration which only causes water loss in the corm, respiration involves the use of stored energy .This consequently is lost for human nourishment .During dormancy one kilogram of corms stored at 25^0c loses the equivalent of 3ml CO per hour (Passam and Moon,1977).

Germination marks the end of dormancy for the taro and tannia corms .Germination does not occur at the same time for all corms of one variety which are stored together .Germination is more dynamic process and takes place gradually .Environmental effects in particular relative humidity and temperature affect germination it was observed by Passam (1977) that corms of taro already germinated after 20 days at a humidity of 100% and a temperature of 25^oC.At the same temperature and a relative humidity of 60-70% germination began after 40 days and at 17^oc and a humidity of 100% after 30-40 days (Ibid 1978).Energy required to form the germ is taken from the carbohydrate reserves. During the process of germination the corms quickly loses nutrients dries out and rot pathogens penetrate it so that further storage becomes impossible (Passam and Noon,1977).Corm rot caused by various pathogens is one of the most significant causes of loss during the storage of fresh corms. The fungi causing rot are normally lesion pathogens. They can only actively penetrate the tuber through lesions, cuts, holes bored by nematodes or where rodents have bitten the tubers (Coursey 1967).

The types of storage structures are influenced by various factors .These include climate purpose of taro and tannia corms in storage and the socio-cultural aspects of storage. However the storage structures are also influenced by the type of building materials available and the resources of the farmer in particular the availability of labour and capital (FAO, 1990).

A typical storage facility made in the fields is the trench silo .To make this a pit approximately corresponding to the expected volume of taro and tannia to be harvested is excavated. The pit is lined with straw or similar material such as banana leaves (Nwankiti and

Makurdi,1989).The corms are then stored on the layer of straw either horizontally on top of each other or with the tip vertically downwards beside each other so far it is not known whether the method of storing horizontally or vertically influences storage behavior.

Storage of taro and tannia in heaps on the ground, according to this method of storage the corms are piled maize stalks. This normally happens under a tree providing shade and the heap is covered with maize or millet stalks or similar materials (FAO, 1990).This method can be erected without any costs. The shady tree somewhat balances out the temperatures occurring throughout the day and provides certain protection against overheating of the produce. This storage is badly ventilated .As it is closed the produce cannot be checked regularly .This promotes rapid spreading of rot which means that storage duration is strictly limited. The stored produce is also damaged by insects and rodents which can hide themselves very well in the store (Nwankiti and Makurdi, 1989)

Even within the same environmental conditions, storage stability varies among and between root species. For instance, under high storage temperatures of 25o C and above and relative humidity of 85% and above, it has been found that more sprouting and decay occurred with Taro than another variety Tannia cormels (Agbo-Egbe and Rickard, 1991). Soil type condition conducive for successful underground storage is a well drained sandy soil profile. In parts of Southern China, it is common practice to pile the corms in heaps and cover them with soil or seal them in leaf-lined pits in the ground (Plucknett and White, 1979).

Fungal infection is also reduced. Storage losses can be reduced by minimising the occurrence mechanical damage and leaving the corms untrimmed during storage (Cooke et al., 1988). Taro can be stored in shaded pits for about 4 months without significant losses in quality and quantity, and satisfactory storage has been achieved for up 3 months under a variety of tropical conditions. In general, tannia keeps better in traditional pit storage better than ventilated room or barn storage. Mature tannia corms do not deteriorate if left in the ground and it is also common practice to harvest corms for immediate utilisation as required.

The corms were still edible after 9 weeks storage (Thompson, 1996). Other studies showed that tannia corms may be stored in well ventilated conditions for up to 6 months (Kay, 1987), although loss of eating quality was observed after 8 weeks. Ventilated storage of corms in the dark at 24°C resulted in 30% decay after 1-3 weeks (Kay, 1987). Factors such as corm maturity, environmental condition, agro-climatology, degree of physical damage, and a host of pre-harvest factors contribute to the variability of results reported.

There is considerable evidence that corm storage life is improved under refrigerated storage conditions. It must be noted though, that refrigeration technology cost more than traditional and ventilated storage methods, and investments in capital equipment, packaging, technical skill, and power supply are necessary. Storage life is generally improved at conditions of lower temperature and high humidity. If storage environment can be maintained at 11-13°C and 85-90% relative humidity, the length of storage of taro can be extended to about 150 days. At low temperature (15°C) and high humidity (85%), both taro and tannia were successfully stored for 5-6 weeks (Agbo-Egbe and Rickard, 1991). For tannia, storage at 7°C and 80% relative humidity was found to maintain corms in good condition and good eating quality for about 120-130 days (Tindall, 1983).

2.1 ORIGIN AND DISTRIBUTION

Various lines of ethno-botanical evidence suggest that taro originated in South Central Asia, probably in India or Malay Peninsula .Wild forms occur in various parts of South Eastern Asia(Purseglove,1972).From its centre of origin ,taro spread eastwards to the rest of South East Asia ,and to China ,Japan and the Pacific Islands (some authors have suggested that the island of New Guinea may have been another centre of origin for taro ,quite distinct from the Asia centre).From Asia, taro spread westward to Arabia and the Mediterranean region. By 100 B.C. it was being grown in China and in Egypt .It arrived on the coast of Africa over 2000 years ago ,it was taken by voyagers ,first across the continent to West Africa ,and later on slave ships to the Caribbean .Today ,taro is pan –tropical in its distribution and cultivation .The greatest intensity of its cultivation and its highest percentage contribution to the diet ,occurs in the Pacific Islands. However the largest area of cultivation is in West Africa, which therefore accounts for the greatest quantity of production.Significant quantity of taro are also grown in the Caribbean and virtually all humid parts of Asia .It has been suggested that the eddoe type of taro was developed and selected from cultivated taro in China and Japan several centuries ago and it was later introduced to the West Indies and other parts of the world (Purseglove, 1972)

Taro–also called Dasheen–is a perennial tropical or subtropical plant commonly grown for its starchy but sweet flavored tuber. Taro is always served cooked, not raw. The taro tuber is cooked like a potato, has a doughy texture, and can be used to make flour. Young taro leaves and stems can be eaten after boiling twice to remove the acrid flavor. Cook taro leaves like spinach. A paste called poi is made from the taro root.

Taro grows to 3 feet tall (1m) or taller and has light green, elongated, heart-shaped leaves on long stalks. Taro tubers are rounded, about the size of a tennis ball; each plant grows one large tuber often surrounded by several smaller tubers.

2.2Botany

Taro is a tropical or subtropical plant that requires very warm temperatures–77° to 95°F (25-35°C)–and consistent moisture to thrive. Taro can be grown for its tubers only where summers are long–at least 200 frost-free, warm days. Taro can be grown for its leaves in a greenhouse.

Taro is a perennial herbaceous plant that grows from 1.2 m tall. Its leaves are light green, elongated, and heart shaped similar to an elephant's ear. Tubers are spherical and about the size of a tennis ball often covered with brownish skin and hairs; the flesh is pinkish purple, beige or white. Taro requires seven months of hot weather to mature.

2.3 Varieties.

There are various cultivars and forms of taro; some with purple leaves or purple veins in the leaves, some for growing in wet conditions and some for growing in dry conditions. Taro cultivars are often grouped by the color of their flesh–ranging from pink to yellow to white. Trinidad dasheen grows well in most areas in the world.

2.4 Area cultivated.

Taro corms can be planted in dry or wet settings. Taro requires rich, moist, well-drained soil to moisture-retentive soil. In Asia taro is often planted in wet paddy. In dry setting, taro corms are planted in furrows or trenches about 15cm deep and covered by 5-8cm of soil. Taro grown for its leaves can be grown in temperatures as low as 59°F, outdoors or in a greenhouse. Taro grows best in a soil pH between 5.5 and 6.5.

2.5 Planting time.

Plant taro when the weather and soil has warmed in spring. Taro requires at least 200 frost-free days to reach maturity.

2.6 Planting and spacing.

Taro is grown from small sections of tuber, small tubers, or suckers. Plant taro in furrows 15cm deep and cover corms with 5-8 cm of soil; space plants 30-60 cm apart in rows about 40 cm apart. Plants grow to about 1.2 m tall and about 10-20 cm across depending with variety.

2.7 Water and fertilizer apllication.

Taro plants should be watered well and the soil should be consistently moist. Water taro often in dry weather. Feed taro with rich organic fertilizer, compost, or compost tea. Taro prefers a high-potassium fertilizer.

2.8 Companion planting.

A second crop of taro can be planted between taro rows about 12 weeks before the main crop is harvested.

2.9Pests.

Aphids and Red spider mites may attack taro grown indoors.

2.10Diseases.

Taro leaf blight will cause circular water-soaked spots on leaves. Downy mildew may attack taro.

2.11Harvesting.

Taro tubers are harvested about 200 days after planting when leaves turn yellow and start to die. Lift taro roots like sweet potatoes before the first frost in autumn. Taro leaves can be picked as soon as the first leaf has opened; harvest taro leaves cut-and-come-again, never stripping the plant of all its leaves. Taro tubers can be boiled or fried like potatoes; taro leaves can be boiled like spinach.

When the taro reaches maturity, frequently at the beginning of the dry season, vegetative growth stops, the leaves turn yellow and most of the dry matter of the taro vine is translocated into the tuber which then enters a resting or dormant stage. This stage of physiological maturity normally takes place some 8 to 11 months after planting and the taro are then ready for harvesting. Traditionally taro are harvested manually using wooden spades or digging sticks and with great care to avoid damaging the tubers. Exceptionally, the short-term variety D. rotundata can be double-harvested, the first harvest being 5-6 months after planting and the second 3-4 months later (Onwueme 1978). During the first harvest great care is taken to remove the tuber or tubers by cutting below the head and leaving the top to grow again and produce a further tuber.

2.12 Storing and preserving.

Taro tubers can be left in the ground after maturing as long as the ground does not freeze. Lifted taro tubers should be stored in a cool, dry place. Clean and store taro tubers like sweet potatoes. Use the largest corms first as they do not keep as well as smaller tubers.

2.13Toxicity

The plant is inedible when raw and considered toxic due to the presents of calcium oxalate crystals typically as raphides .The toxin is minimized by cooking especially with a pinch of backing soda .It can also be reduced by steeping taro roots in cold water overnight .Calcium oxalate is highly insoluble and contributes to kidney stones .It has been recommended to consume milk or other calcium rich foods together with taro.

2.14 Common names.

Taro; cocoyam; dasheen; edo; elephant ear plant; yu, yu tou (Chinese); woo, wu choi (Cantonese); sato-imo, kimo (Japanese) yams (Nigeria), madhumbe (Zimbabwe).The cultivated varieties of tannia have been allocated to four species, *Xanthosoma atrovirens*, *Xanthosma caracu*, *Xanthosoma nigrum Xanthosoma violaceum*) and *X.sagittifolium*, but some cultivars are not assignable to any of these. They display a wide diversity of habit, leaf shape and colour and cormels. This variation just like taro is also envisaged in the varieties found in Zimbabwe, named *Magogoya* and *Madhumbe,* which are believed to have striking morphological differences, even though the names may be used inter-changeably according to Mujaju,(2004).

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 SITE AND DISCRIPTION

The experiment was carried out in Mandarume ward 2, Chimanimani District, Manicaland Province in the winter season of 2014.The area is located in agro ecological region four with an average annual rainfall of 450-650 mm and an average minimum temperature of 22^{o}c and maximum temperature of 30^{o}c .Mhandarume ward 2 consists of soils which are generally sandy and sandy loam.

3.2 Experimental design

The experiment was a randomized complete block design (RCBD) with three blocks which acted as replications and variety was used as a blocking factor. Each variety was subjected to three different storage systems

3.3 Preparing taro and tannia for storage

By tradition and upbringing taro farmers understand that only sound, healthy tubers were suitable for storage. For this reason taro and tannia was harvested with great care but, because of the varying sizes and shapes of taro and tannia tubers, some damage inevitably occurs. Farmers are known to reject unhealthy or damaged tubers which are then used for immediate consumption or processing. A bruise or abrasion is more likely to lead to decay in storage than a clean cut and it is traditional practice to cut away any bruised or decayed flesh and often to rub the clean wound with alkaline material such as lime or wood ash to discourage reinfection.

3.4 Curing of taro and tannia

Taro corms need to be properly cured as soon as possible after harvest to promote the formation of a hard cork layer. Curing was carried out near the place where the tubers were stored to minimize handling after curing. The process was carried out for 4 to 7 days at temperatures of 32° to 40°C and a relative humidity of 85% to 95% (FAO, 1989).this can be achieved in two ways:

3.4.1 Curing.

The taro and tannia tubers were placed on a thin layer of dry grass and then covered with a thin layer of soil. The treatment took about two weeks after which the tubers were removed for storage. After curing the tubers were handled with care to avoid new injuries.

3.4.2 Pit storage

When taro and tannia were cured all the tubers of the two varieties were stored in pits lined with banana leaves. Each variety in its own pit measuring 1 m x 1 m x 1m and the quantity was the same in each pit that is ten kilogrammes per variety .After placing the taro and tannia tubers in the pit the corms were then covered with a layer of banana leaves to avoid soil contact. Then there were pit was covered with soil. Then the tubers were left for six months.

3.4.3 Heaping

All the two varieties were stored in a shade and covered with maize stalks to prevent direct sunlight. Same amount of stalks were used to cover the tubers and they were placed at different positions on the same shade .Each position having the same quantity of taro tubers that was 10 kg.

3.4.4 Refrigeration

The two varieties were cleaned and stored under refrigeration conditions to prolong the life of the corms. They were kept under same temperatures and these were checked and controlled to maintain taste and avoid freezing.

3.4.5 Covering with Ash

The corms of taro and tannia were smeared with wood ash then stored under room temperature. The quantity was 10 kg of each crop.

3.4.6 Open Air

The two varieties were weighed and the quantity was 10 kg and nothing was applied on the corms. These were heaped in a room and kept under room temperature.

3.5 Data collection

The following data was collected after 18 weeks of storage:

Weight was measured

Number of sprouting corms was counted

Number of rotting corms was counted

Number of corms affected by insect and pest damage in storage was also counted

3.6 Data analysis

The collected data was subjected to analysis of variance (ANOVA) using Gens tat version 3 Release 7.2D.DE software package .Treatment means were separated using LSD at 5% confidence level.

CHAPTER 4

4.0 RESULTS AND DISCUSSION

4.1 Effect of different storage techniques on weight of taro and tannia after 18weeks in storage.

Storage of cocoyams reduced weight loss in this study (Table 4.1). The results indicate that the weight loss in the traditional system (tubers heaped inside a shed) could be reduced in the thatched-roof pit by 65% if yams were treated with a mixture of fungicides and insecticides (Fiagan, 1995). The comparatively favourable temperatures and relative humidities within the ventilated pit contributed to a significant reduction of storage losses (Table 4.1).

Table 4.1 Weight of taro and tannia after 18 weeks in storage

Crop			Treatment		
	Ash smear	Maize stalk	Pit	Refrigeration	Room T^{o}c
Taro	6.300	7.567	7.900	8.333	6.133
Tannia	6.700	8.233	9.433	8.633	5.700
LSD	0.511				
Cv%	4.0 %				
PV	<0.001				

4.2 Effect of different storage techniques on pest damage of taro and tannia corms

Maize stalk technique had more number of corms damaged by pests. This suggest that there were damaged by rodents (Table 4.2).

Table 4.2 Number of taro and tannia corms damaged by pest in storage

Crop			Treatment		
	Ash smear	Maize stalk	Pit	Refrigeration	Room T^{o}c
Taro	2.00	6.00	0.67	0.67	2.00
Tannia	2.00	7.33	1.00	0.33	3.00
LSD	1.121				
Cv%	26.3%				
PV	<0.001				

4.3Effect of different storage techniques on rotting of taro and tannia corms

Corms stored at room temperature had more rots followed the corms smeared with ash. This suggests that corms were infected by fungi (Table4.3). These conditions also favour the development of fungi and bacteria it is advised (Demeaux and Vivier 1984) that prior to curing the tubers should be treated with lime wash or wood ash, or if available, an appropriate fungicide such as thiabendazole or benomyl.

Table 4.3 Number of rotting corms of taro and tannia in storage after 18 weeks of storage

Crop			Treatment		
	Ash smear	Maize stalk	Pit	Refrigeration	Room T^{o}c
Taro	7.33	9.33	3.67	2.33	15.33
Tannia	6.67	7.67	3.33	1.00	9.67
LSD	1.319				
Cv%	11.7%				
PV	<0.001				

According to trials in Nigeria, taro tubers were treated for two weeks by this method and showed only 40% rotted tubers after 4 months of storage, compared to 100% of untreated tubers. Both of these curing methods were dependent on high temperature and high relative humidity.

4.4Effect of different storage techniques on sprouting of taro and tannia corms

Sprouting was noticed in Pit storage technique, the corms produced more vigorous sprouts. This could be to availability of soil moisture.

Table 4.4 Number of sprouting corms of taro and tannia in storage after 18 weeks

Crop			Treatment		
	Ash smear	Maize stalk	Pit	Refrigeration	Room T^{o}c
Taro	10.33	11.33	18.33	3.67	13.33
Tannia	8.00	9.00	12.00	2.00	10.67
LSD	1.425				
Cv%	8.5				
PV	<0.001				

CHAPTER 5

5.0 Conclusion and Recommendation

5.1 Conclusion

Pit storage lost less weight compared to all other techniques. Refrigeration technique had neither rots nor pest damage.

5.2 Recommendation

Curing method may need further studies in order to define more precisely the parameters of the operation, particularly in considering the optimum duration of the curing period combined with an appropriate fungicide.

A further research can be done with extended time of storage.

The pit technique is recommended to smallholder farmers as they cannot afford refrigeration.

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APPENDICIES

Analysis of variance

Variate: Roting_atwk18

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Vegetables	1	28.0333	28.0333	46.72	<.001
Storag_technque	4	435.1333	108.7833	181.31	<.001
Vegetables.Storag_technque					
	4	27.8000	6.9500	11.58	<.001
Residual	20	12.0000	0.6000		
Total	29	502.9667			

Tables of means

Variate: Roting_atwk18

Grand mean 6.63

Vegetables	tannia	taro
	7.60	5.67

Storag_technque	ash smear	maize stalk	pit	refregiration
	7.00	8.50	3.50	1.67

Storag_technque	Room t°c
	12.50

Vegetables	Storag_technque	ash smear	maize stalk	pit
tannia		7.33	9.33	3.67
taro		6.67	7.67	3.33

Vegetables	Storag_technque	refregiration	Room t°c
tannia		2.33	15.33
taro		1.00	9.67

Standard errors of means

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
e.s.e.	0.200	0.316	0.447

Standard errors of differences of means

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
s.e.d.	0.283	0.447	0.632

Least significant differences of means (5% level)

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
l.s.d.	0.590	0.933	1.319

Analysis of variance

Variate: Sprouting_atwk18

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Vegetables	1	64.5333	64.5333	92.19	<.001
Storag_technque	4	496.1333	124.0333	177.19	<.001
Vegetables.Storag_technque	4	14.8000	3.7000	5.29	0.005
Residual	20	14.0000	0.7000		
Total	29	589.4667			

Tables of means

Variate: Sprouting_atwk18

Grand mean 9.87

Vegetables	tannia	taro
	8.40	11.33

Storag_technque	ash smear	maize stalk	pit	refregiration
	9.17	10.17	15.17	2.83

Storag_technque	Room t°c
	12.00

Vegetables	Storag_technque	ash smear	maize stalk	pit
tannia		8.00	9.00	12.33
taro		10.33	11.33	18.00

Vegetables	Storag_technque	refregiration	Room t°c
tannia		2.00	10.67
taro		3.67	13.33

Standard errors of means

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3

d.f.	20	20	20
e.s.e.	0.216	0.342	0.483

Standard errors of differences of means

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
s.e.d.	0.306	0.483	0.683

Least significant differences of means (5% level)

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
l.s.d.	0.637	1.008	1.425

Variate: Sprouting_atwk18

d.f.	s.e.	cv%
20	0.837	8.5

Analysis of variance

Variate: Weight_atwk18

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Vegetables	1	1.82533	1.82533	20.28	<.001
Storag_technque	4	35.96867	8.99217	99.91	<.001
Vegetables.Storag_technque	4	3.02467	0.75617	8.40	<.001
Residual	20	1.80000	0.09000		
Total	29	42.61867			

Message: the following units have large residuals.

units 6	0.567	s.e. 0.245
units 16	-0.833	s.e. 0.245
units 27	0.500	s.e. 0.245

Tables of means

Variate: Weight_atwk18

Grand mean 7.493

Vegetables	tannia	taro
	7.247	7.740

Storag_technque	ash smear	maize stalk	pit	refregiration
	6.500	7.900	8.667	8.483

Storag_technque	Room t°c
	5.917

Vegetables	Storag_technque	ash smear	maize stalk	pit
tannia		6.300	7.567	7.900
taro		6.700	8.233	9.433

Vegetables	Storag_technque	refregiration	Room t°c
tannia		8.333	6.133
taro		8.633	5.700

Standard errors of means

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
e.s.e.	0.0775	0.1225	0.1732

Standard errors of differences of means

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
s.e.d.	0.1095	0.1732	0.2449

Least significant differences of means (5% level)

Table	Vegetables	Storag_technque	Vegetables Storag_technque
rep.	15	6	3
d.f.	20	20	20
l.s.d.	0.2285	0.3613	0.5110