THE EFFECTS OF STORAGE PERIOD ON THE NUTRITIONAL VALUES OF FRUITS AND VEGETABLES (ORANGE AND OKRA)

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BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN AGRICULTURAL & BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

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DECLARATION

I hereby declare that this work is a record of a research work that was undertaken and written by me. It has not been presented before any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

Akinola Sadiat Yetunde

25/02/2010

Date

CERTIFICATION

This project entitled "The Effect of Storage Period on the Nutritional Value of Fruits and Vegetables (orange and okra)" by Akinola, Sadiat Yetunde, meets the regulations governing the Award of the degree of Bachelor of Engineering (B.Eng.) of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is dedicated to Almighty God, the renewal of my strength to whom I give all the thanks and also to my mother Mrs Bola Akinola and my lovely family.

ABSTRACT

These research work is to determine the effect of storage period on the nutritional values of two varieties of orange and okra, using two different storage structures, namely the pot –in-pot (ECS) and the open shelf (floor) for a period of 2 weeks. Temperature readings were taken within the range of 27.8 and 30 and a relative humidity of 70-75%, nutrients tested for include; moisture content, ash content, crude fibre, fat content, protein, carbohydrate and vitamin C content. The samples had their highest values in moisture content and vitamin C. Moisture content for the orange stored in the pot (84.00)% and the floor (81.77)%, The vitamin C value for the okra stored in the pot is (23.00)% and for the floor (22.00)%. The result of the experiment indicated there was a difference in the nutrients between the pot-in-pot and on the floor . The pot-in-pot serves as a better means of storage method because it still retains most of its nutritional contents during and after storage.

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CHAPTER ONE

1.0 INTRODUCTION

Fruits and vegetables are part of highly perishable food commodities which is collectively known as horticultural food products. They compromise of approximately 25% of the major food commodities in our country, as other less developed countries. They are very important components of our diet for their excellence contributions of vitamins, minerals, carbohydrates, dietary fibre and protein. Thus, their contributions to human nutrition and health, the growing awareness as important raw materials for food and agro-industries and their potentials as sources of foreign exchange, are well known. (Oyenuga and Fetuga 1988). Food production is rising slowly while hunger and malnutrition is on the fast increase. It is observed that increased food production cannot satisfy the increasing food demand unless attention is focused on reducing post harvest losses: thus, the reduction of post harvest losses will create an opportunity for providing a substantive amount of food for consumption and other uses. Fruits and vegetables are liable to losses at every stage from production to consumption. Their perishable nature had instigated the study of the technology of handling, preservation, storage, processing, distribution and marketing. (Booth and Coursey, 1992). On the basis of land area, production volume and value, the leading fruits and vegetables in the Nigerian fresh markets include; citrus, mango, plantain and banana fruits with some indigenous fruits such as leafy vegetables, tomatoes, peppers. Onions, okra, peas etc. The term storage means the holding of produce (cereals, grains, legumes, fresh fruits, leafy vegetables, root and tubers) under controlled atmosphere i.e. avoiding deterioration of produce while in store. The purpose of storage is to meet a regular continuous demand of the commodity and to provide a degree of price

stabilization. The extent to which deterioration and loss of produce occur in storage is dependent on physical and production factors, the storage environment and biological factors. Notable amongst the production factors are pre-harvest and post-harvest factors. The main perishable staples are cassava, yam, potatoes, banana, plantain; the major vegetables are onions, amaranths and fruits e.g. citrus, pineapple, tomato, paw-paw, mango. (Olorunda Taylor,1995). According to Food and Agriculture Organization.(1977) these vegetables crops constitute over 39% of food crops consumed in the developing countries. Also in Food and Agriculture Organization publications losses have been estimated to be very high for fruits and vegetables in the tropical areas. 50% is known between rural production and town consumption (Food and Agriculture Organization,1994).

1.1 Justification

Fresh fruits and vegetables being essential component of the human diet have necessitated the increase in commerce of these commodities. The fruits and vegetables have turned into commercial fruits and vegetable business and are important sectors of the agricultural industry. Man has been able to maintain and eat these in his diet as they provide variety, taste, interest and aesthetic appeal to meet certain essential nutritional requirement. Nigeria blessed with tropical climate which favours the production of fruits and vegetables, foods, majority of which are staple foods of the people. Fruits are form of the food and the food is any material taken from the outside environment into the body to provide nourishment to the body organ and to ensure proper growth and maintenance of physiological integrity. Food occurs in many forms, red meat, cereals, milk, poultry products, fruits, vegetable, fish and sea food, sugar and sugar product. It can be said that man main source of food are

plant and animal origin. It is therefore essential to know the microbial floral associated with plant and animal in the natural habitat. Also during storage, it is essential to know what happens to the nutritional values and its desirable possible subsequent effects on human dietary needs. (Marion and Jay,1999). Hence, quantifying such nutritional losses or otherwise in stored produce is of great importance to both handlers and consumers alike. For it is noted that the ultimate in food supply chain is not just the increase in the production, but how to get what is produced to the consumers in the form that is desired. Generation of such information will guide the handlers and consumers as how to long such fruits and vegetables could be stored without losing completely the essential nutrients. (Olorunda and Aworh, 1993).

1.2. Objectives

1. To determine the effect of storage period on the nutritional values on orange and okra.

2. To provide vital information that will help handlers and consumers in increasing proper preservation techniques.

1.3. Scope of Work

The work is centered on two crops (orange & okra), to determine the effect of storage period on some of the nutritional values using the ECS (pot-in pot) method and the open shelf (ground).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Fresh Fruits and Vegetables.

These include the leafy green vegetables such as mango, citrus, banana, plantain and Modified flower parts (pineapple). The edible parts of most fruits and vegetables are not the seeds (which are often discarded) but fleshy tissues whose natural function is to support the germination and growth of the seed when the fruit falls or to serve the purpose of dispersal by attracting birds or other agents of dispersal including man. The edible tissue is meant to perform these functions when ripe and fresh and serve as food in dry condition. The storage life, therefore, may be only days even under ambient conditions. They quickly deteriorate because of their fast respiration rates, which causes rapid heat build-up and depletion of their high moisture content. (Hobson,2001).

2.2 Fruit

Fruit refers to the seed bearing structures of flowering plants. This broad definition, however, refers to such a heterogeneous group of plant products such as cereals, legumes, bananas, and spices. The botanists' definition encompasses the fleshy fruits that arises from expansion of the ovary of the flower and does not include fleshy fruit that arises from the growth of structures other than the ovary, such as the receptacle (apple, strawberry), bract and peduncle (pineapple). Some of the common fruits in Nigeria are pineapple (*ananas comosus*), pawpaw (*carica papaya*), mango (*magnifera indica)*, and orange (citrus). (Moore, 2001).

2.2.1 Orange

The exact location of origin of citrus fruit is not clearly identified, although most researchers place it in south-east Asia, at least 4000 years BC. It is believed that word' orange'' originates from Sanskrit. Citrus fruit belong to the rutaceae family. Citrus trees are evergreen trees that give fruits of different forms and sizes (from round to oblong), which are full of fragrance, flavor and juice. A section of these fruits allows to identify different layers. A rough, robust and bright color (from yellow to orange) skin or rind, known as epicarp or flavedo, which covers the fruit and protects it from damage. Its glands contain the essential oils that give the fruit its typical citrus fragrance. A white, thick and spongy mesocarp or albedo, which together with the epicarp forms the pericarp or peel of the fruit. The internal part that makes the pulp. Citrus is a large genes with many different cultivated species, the major ones being citrus sinesis L. (sweet orange). C. reticula blanco(mandarin). C lemon (L.) swingle (lime), C, medica L. (citron), and C. paradise Maef (grapefruit). Some authors refer to sweet orange, lemon, lime, and grapefruit as natural hybrids rather than wild species (Moore,2001). Citrus fruits have several beneficial health and nutritive properties. They are rich in vitamin C or ascorbic acid and folic acid, as well as good source of fiber. They are fat free, sodium free and cholesterol free. In addition they contain potassium, calcium, foliate, thiamin, niacin, vitamin B6. Phosphorus, magnesium and copper. They may help to reduce the risk of heart diseases and some types of cancer. They are also helpful to reduce the risk of pregnant women to have children with birth diseases.(Federica et al, 1998).

2.2.2 Diseases of citrus

2.2.3 *Anthracnose Rot: Collectotrichum gloeosporioides*

Acid lime and sweet orange are susceptible to this disease. It initiates at the stem end as a small brown area. As the area enlarges, a soft pliable rot develops; it is dark brown in colour. (Hobson, 2001).

2.2.4 Alternaria *Rot: Alternaria citric*

This is common disease in sweet in Punjab. It also affects mandarin. Infection by Alternaria citric causes stylarend rot in sweet orange. Circular, brown spots develop at the stylar end of the fruit. These spots enlarge, coalesce and cause rotting of the fruits. In the mandarin, circular brown spots develop on the rind of the fruit which enlarge and cause rotting of the fruits in the infected area. (Hobson, 2001).

2.2.5 *Black Mould Rot (or) Aspergillus Rot: Aspergillus niger*

This rot develops as a light colored soft spot that can be punctured easily. It gradually turns pale yellow and orange in colour with the tissue becoming wrinkled. As the rot develops further, the decayed area sinks and mycelium and fruiting bodies of the fungus appear. This forms a black, Powderly layer of the affected surface. (Hobson, 2001).

2.2.6 *Citrus mosaic*

This disease is caused by a virus transmitted by diseased buds, aphids and the parasite cassytha. Affected leaves show irregular yellow or light-green patches alternating with normal green areas without reference to the veins. The fruit drop prematurely and the quality is reduced by rugged surface. (Hobson, 2001).

2.3 Vegetables.

The term 'vegetable' is frequently used to refer to the soft edible leafy plants which may be eaten raw as salads or cooked in stew. They may or may not be sweet and may thus need considerable seasoning and salting. In Nigeria, most of the commonly used vegetables are all leaves, seeds, fruits and roots which are the succulent plant parts eaten as complementary foods, side dishes (raw) or as soup with condiments with their main staples dishes. Vegetable is sub-divided into; Leaf vegetables; spinach, lettuce, cabbage, bitter leaf, amarathus, water leaf, pumpkin. Fruit vegetables; tomatoes, okra, chilli, pepper.Seed vegetables; melon, peas, beans, amarathus, grain.Root vegetables; potatoes, onions, carrots and garlic. (Olorunda Taylor,1995).

2.3.1 Okra

Okra is believed to originate from abyss man centre, on area that includes present day Ethiopia, the mountaineers or plateau portion of Eritrea and the Eastern, higher part of the Anglo-Egyptian Sudan. It is an annual crop best grown in warm, humid climates and respond to plenty water but will endure drought quite well. It attains height from 90m in dwarf varieties to 210 or 240cm in other with many short branches (Rice et al, 1993). Leaves are heart shaped and lobed or divided. The fruit is a long pod, generally ribbed and spindles in cultivated kind pods, the edible portion are harvested while still tender and immature. They attain length of 15- 20cm and up to 2.5cm or more diameters. First pods are ready for harvest at a proper early stage. Okra pods can be used in cooking in a variety of ways. Most commonly, okra is used in soups, stews 'gumbles' or 'Creole' dishes in a combination with other vegetables, especially tomatoes. It thickens and flavour soups and creoles in a unique way. It can be dipped

out in this area, the problem still remains, considering the Nigerian peculiar situation in the area of fruits and vegetables storage. There are little or no information on the depreciating quality of the necessary nutrient contained in fresh produce during storage. Such information is desirable so as to accordingly modify the storage system with a view to getting the desired result. Since it is noted that the ultimate desire in the food supply chain is not just the production, but how to get the food to the consumers in the form that is desired. Hence, this present work is to quantify how storage period actually affect some nutritional values of orange and okra. (Olorunda, Aworh, 1993).

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 Pot in Pot Evaporative Cooler

The method of pot in pot evaporative cooler was employed in this experiment. The evaporative cooler works on the principle of cooling resulting from evaporation of water from the surface of structures. The cooling achieved from this device also results in high relative humidity of the air in the chamber from which the evaporation takes place relative to ambient air. The atmosphere in the inner chamber therefore becomes more conducive for fruit and vegetable storage. (NISPRI).

3.2 Collection of Samples

Matured but unripe oranges of two different species (Never and Cipher) and okra of two different species were harvested by plucking from Abdulsalam farms orchard in Minna.

3.3 Physical Observations

A total of 40 oranges and 1kg of okra comprising about 40 pieces of okra were observed and screened through sorting for mechanical damage or injury during harvesting which included wounds and cuts. The good ones were stored, free from bruise and microbial contamination.

3.4 Storage of Samples

Four pot in pot evaporative cooler A, B, C, D were cleaned and dried to make them free from fungi and bacteria. It consists of small pot placed in a bigger pot, and the space in between was filled with river bed sand which was frequently watered to keep the sand moist at all times. Fruits were placed in the inner pot which was covered with a foam

board. This is to reduce the level of oxygen present in the pot so as to lower the respiration activities of the fruits. The temperature and relative humidity reading during the period of storage indicates temperature ranging between 27.8 and 30.6°c with relative humidity of 70-75% and at every four days interval and the test were replicated 4 times. The storage was done for two (2) weeks and some of the fruits were also stored on the floor which was used as control. The tests carried out were to determine some nutritional parameters of orange and okra. The parameters include; ash content, moisture content, crude protein, soluble carbohydrate, crude fat and crude fibre.

3.5 Determination of Ash Content

The apparatus used include: crucible, weighing balance, desiccators and muffle furnace. 2g of sample was weighed into an empty dry and clean crucible with the sample taken to a muffle furnace at a temperature of 350-600°c for two (2) to three (3) hours. At about this time it had turned to white ash. The crucible was placed in desiccators and allowed to cool and reweighed.

$$\%\ Ash\ content := Ash\ content \times 100$$

$$Ash\ content := \frac{w - x}{y - x} \qquad 3.5$$

Where;

$$weight\ of\ empty\ crucible := x$$

$$weight\ of\ crucible + sample := y$$

(Association of Official and Analytical Chemist, 2000)

3.6 Determination of Moisture Content

The following apparatus were used; weighing balance, petridish, oven and desiccators. 2g of the sample was weighed into a clean petridish. The sample and petridish was weighed together then transferred into the oven at a temperature of 105°c to dry at a constant weight for 4 hours. At the end of the 4 hours, crucible plus sample was removed from the oven and transferred to a desiccator to cool for ten minutes. The sample was later reweighed

$$\%\ moisture\ content := \frac{W3}{W1} \times 100$$

Where;

$$weight\ of\ miosture\ lost := W1 - W2 := W$$

$$weight\ of\ sample\ + petridish\ before\ drying := W_1$$

$$weight\ of\ sample\ + petridish\ after\ drying := W_2$$

(Association of Official and Analytical Chemist, 2000)

3.7 Crude Protein Determination (Kjeidahl Nitrogen Method)

The following apparatus were used; conical flask, pipette, burette, kjeidlahl distillation apparatus and digestion block. 1 gram of the ground sample was weighed into a digestion tube, and 10ml of sulphuric acid was added with digestion tablet as catalyst. The tube was heated at the temperature of 360-370°c at an incline angle until frothing subsided and then boiled until the solution was clear. The digested sample was dissolve with distilled water in a 100ml volumetric flask making up to the mark. 5ml of the dissolved digested sample

was transferred to distillation apparatus, and 10ml of boric acid was added to two drops of mixed indicator and which turn brown. This was heated and the distilled ammonia was collected 10ml boric acid / indicator solution. The distillate was collected on completion of distillation and the receiver removed. The colour changes from colourless solution to blue green. Titration of distillate, this is done by titrating the distillate with standard acid solution (0.1N HCL).

$$\%\ nitrogen := \frac{0.014 \times titre\ value \times concentration\ of\ acids \times 10^2}{weight\ of\ sample\ (100\ moisture\ content)} \times 100 \qquad 3.7$$

$$\%\ protein := \%\ nitrogen \times 6.25$$

$$where\ 6.25 := conversion\ factor.$$

(Association of Official and Analytical Chemist, 2000)

3.8 Determination of Soluble Carbohydrate

The following apparatus were used; 10ml cylinder, filter paper, balance, standard flasks and spectrophotometer. 0.2g dried sample was weighed into 250ml conical flask. 20ml distilled was added and reflux for 30 minutes. The mixture was then filtered to obtain the filtrate. 5ml of the filtrate was pipette into a 50ml standard and make up to the mark with distilled water. 2ml of this solution was pipette into the test tubes and 10ml of arthrone-sulphuric acid was added.

$$percentage\ carbohydrate := 100 - (percentage\ of\ ash + percentage\ of\ moisture + percentage\ of\ fat + percentage\ of\ protein \qquad 3.8$$

(Association of Official and Analytical Chemist, 2000)

3.9 Determination of Crude Fat (Soxhlet Method)

The following apparatus were used; thimbles, cotton wool, soxhlet apparatus, extraction flask, (250-300ml) metallic cups, filter paper (optional) and petroleum ether or hexane reagents. Extraction flask was washed and dried in the oven and allowed to cool in the dessicator and washed. The soxhlet extractor with reflux condenser was fitted up and water started flowing through the condenser, 2g of dried sample was weighed on a filter paper folded and structured into a fat free extraction thimble and plunged lightly with cotton wool. The thimble is placed in the extraction barrel and hexane was added until it siphons over once in the flask directly below it. After tightened, all point flask and reflux sample was heated for about six (6) hours. The barrel was replaced and the solvent distilled off, until the extraction flask was almost dry. The flask containing the fat was detached and dried in the oven at a low temperature to evaporate the solvent completely.

$$\%\ fat := \frac{[(weight\ of\ flask + fat) - (weight\ of\ empty\ flask)]}{sample\ weight} \times 100 \qquad 3.9$$

(Association of Official and Analytical Chemist, 2000)

3.10 Determination of Crude Fibre

The following apparatus were used; conical flask, beaker, filter paper and heating mantle. About 2.0grams of the sample was weighed and defatted using a soxhlet extractor. The defatted residue was transferred to 250ml beaker, and then 25ml of 10% sulphuric acid was added. The mixture was boiled for 30minutes, at the end of the boiling period; the solution acid was removed by the means of suction through filter paper. The filtrate was collected in the suction flask to control the efficiency of the filtration. The residue was washed three times by boiling water; the boiling water was added with 25ml of 10% sodium hydroxide. The beaker was then heated and boiling continued for thirty minutes, the residue was washed with ethanol to remove fat. The residue was later placed on the water bath to remove water content. This was weighed in a crucible and was put into a

muffle furnace at 600°C for two hours to ash. After cooling the crucible containing the ash was placed in a desiccator and the sample was later reweighed.

$$\%\ crude\ fibre := \frac{100(W1 - W2)}{W} \qquad 3.10$$

Where W_1= weight of residue and crucible before ashing

W_2= weight of crucible with ash after ashing

W= weight of sample before extraction.

(Association of Official Analytical chemist 2000)

3. 11 Determination of Vitamin C (Titrimetric Method)

The following were the apparatus used; conical flask, burette, weighing balance. 5g of the ground samples were weighed into a 250ml conical flask. 100ml of distilled water was added to dissolve. The mixture obtained was allowed to stand for three (3) hours and subsequently filtered for three (3) hours, 5ml of the filtrate was measured into 250ml conical flask, 50ml distilled water was added and the mixture swirled round gently to ensure smooth and uniform dissolution. Two drops of starch indicator was added and titrated with standard 0.1N12 solution and a deep blue colour appeared which persist for at least a minute.

$$vitamin\ c\ per\ ml := 8.82mg/ml$$

$$vitamin\ c\ in\ mg\ per\ 100g := Titre\ value \times 8.82$$

CHAPTER FOUR

4.0. RESULTS AND DISCUSSIONS

4.1 Results

The results below shows the nutritional analysis of the samples (orange and okra) of two different varieties immediately they were brought from the farm and during storage (interval of four days) using the pot-in-pot and the floor. In table 1, it was observed that both the orange and okra has their highest values of moisture content and vitamin C, the value of moisture content for orange C and N are (88.00) and (85.00)% and the okra A and B are (86.00) and (82.00)% with a relative percentage difference of (3.41)% and (4.65)% respectively.The vitamin C for orange C and N are (45.00) and (44.00)Mg and the okra A and B are (24.00) and (23.50)Mg with a relative percentage difference of (2.22)Mg and (2.08)Mg Their lowest value is in the protein and crude fibre content. Orange C and orange N are (0.80) and (0.72)% and okra A and okra B are (0.56) and (0.82)% for the protein and a value of (1.00) and (1.50)% for the crude fibre. Never orange (6.00)% and okra A (4.00)% was high in Ash content compared to Cipher orange (2.00)% and okra B (2.00)% which maintained the same Ash content. The fat content in the never orange (5.93)% was higher than that of the cipher orange (5.00)% and a slight difference between the okra A and okra B. The carbohydrate content in the cipher orange (8.20)% was higher than the never orange (5.38)% and also the okra B was higher than the okra A.

Table 4.1: Result on the nutritional composition before storage.

Samples	% Moisture	% Ash	% Fat	% Fibre	% Protein	% carbohydrate	vitamin C(Mg)
Orange C	88.00	2.00	5.00	1.00	0.80	8.20	45.00
Orange N	85.00	6.00	5.93	1.50	0.72	5.38	44.00
Okra A	86.00	4.00	5.25	2.20	0.56	5.99	24.00
Okra B	82.00	2.00	5.23	2.50	0.82	7.65	23.50

The mean results obtained during the storage period of each nutritional composition of the samples are discussed below as shown in the tables.

4.2 Moisture Content

The moisture content of the oranges stored in the pot were higher than the ones stored on the floor, orange C pot (84.00)% and orange C floor (81.77)%, orange N pot(82.00)% and the orange N floor (80.00)% with a slight difference of about (3-4)% and the same was observed for the okra stored in the pot (82.00)% and on the floor (80.00)%.

Table 4.2: Approximate mean value of moisture content

Samples	Moisture content %
Orange C pot	84.00
Orange C floor	81.77
Orange N pot	82.00
Orange N floor	80.00
Okra A pot	82.00
Okra A floor	80.00
Okra B pot	80.00
Okra B floor	78.00

4.3 Ash Content

There was no difference in the ash content of all the samples stored both on the floor and in the pot. Orange C pot (1.50)% and orange C floor (1.50)%, orange N pot (5.42)% and orange N floor (5.42)% but the result shows that never variety and okra A (3.17)% has the highest ash content.

Table 4. 3: Approximate mean value for ash content.

Samples	Ash content %
Orange C pot	1.50
Orange C floor	1.50
Orange N pot	5.42
Orange N floor	5.42
Okra A pot	3.17
Okra A floor	3.17
Okra B pot	1.50
Okra B floor	1.5

4.4 Fat Content

The fat content in the cipher orange stored in the pot (4.36)% was higher than those stored on the floor (4.15)% and the same shows for the never variety pot (5.11)% and never variety floor(4.93)% also for the okra A and okra B.

Table 4.4: Approximate mean value of fat content

Sample	Fat content %
Orange C pot	4.36
Orange C floor	4.15
Orange N pot	5.11
Orange N floor	4.93
Okra A pot	5.08
Okra A floor	4.60
Okra B pot	4.43
Okra B floor	4.00

4.5 Crude Fibre Content

The crude fibre content was higher for the cipher orange stored on the floor (1.27) % while that of pot-in-pot showed(1.31)%, the same was also observed for the never orange and okra A floor(2.5)% while okra A pot(2.30)%, okra B floor was also higher than okra B pot.

Table 4.5: Approximate mean value of crude fibre content

Sample	Fibre content %
Orange C pot	1.13
Orange C floor	1.27
Orange N pot	1.57
Orange N floor	1.70
Okra A pot	2.30
Okra A floor	2.50
Okra B pot	2.67
Okra B floor	2.94

4.6 Protein Content

The protein content in cipher orange stored in the pot-in-pot was (0.71)% was higher than the cipher orange stored on the floor(0.53)%, while the never orange stored on the floor was higher than the one stored in the pot, showing a reduction in the protein content of the never orange stored in the pot. The okra A floor was higher than the okra A pot and the same was observed for okra B stored on the floor (0.69)% and okra B pot(0.62)%.

Table 4.6: Approximate Mean Value Of protein content.

Sample	protein content %
Orange C pot	0.71
Orange C floor	0.53
Orange N pot	0.51
Orange N floor	0.54
Okra A pot	0.20
Okra A floor	0.27
Okra B pot	0.62
Okra B floor	0.69

4.7 Carbohydrate Content

The carbohydrate content for the cipher and never orange stored in the pot were higher than those stored on the floor but in the case of the okra variety, okra A floor(5.56)% was higher than okra A pot(4.27)% and okra B floor(6.50)% was higher than okra B pot(5.45)%.

Table 4.7: Approximate Mean Value of Carbohydrate Content.

Sample	carbohydrate content %
Orange C pot	5.44
Orange C floor	5.41
Orange N pot	2.60
Orange N floor	2.56
Okra A pot	4.27
Okra A floor	5.56
Okra B pot	5.45
Okra B floor	6.50.

4.8 Vitamin C Content

The vitamin C content in both varieties of orange was high, orange C pot(43.00)Mg while orange N pot(42.60)Mg but with a slight difference of (1 -1.5) Mg and the vitamin C in both varieties of okra was lower, okra A floor(22.00)Mg and okra B floor(21.40)Mg compared to that of the oranges.

Table 4.8: Approximate Mean Value of Vitamin C Content

Sample	Vitamin C content (Mg)
Orange C pot	43.00
Orange C floor	42.27
Orange N pot	42.60
Orange N floor	41.91
Okra A pot	23.00
Okra A floor	22.00
Okra B pot	21.83
Okra B floor	21.40

In general, the nutritional composition of the samples (both orange & okra) stored in the pot-in-pot and on the floor shows a decrease in some of their nutrients except for the ash content.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

From the result of the experiment, it can be concluded that;

1, The pot in pot storage is a better means of storage than the open shelf (floor).

2, Fruits and vegetables should not be stored for too long.

Recommendation

1. The method of pot in pot should be encouraged both in rural and urban areas due to shortage of electricity supply.

2. The pot in pot should be recommended for food and fruit ripening and preservation.

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APPENDIX

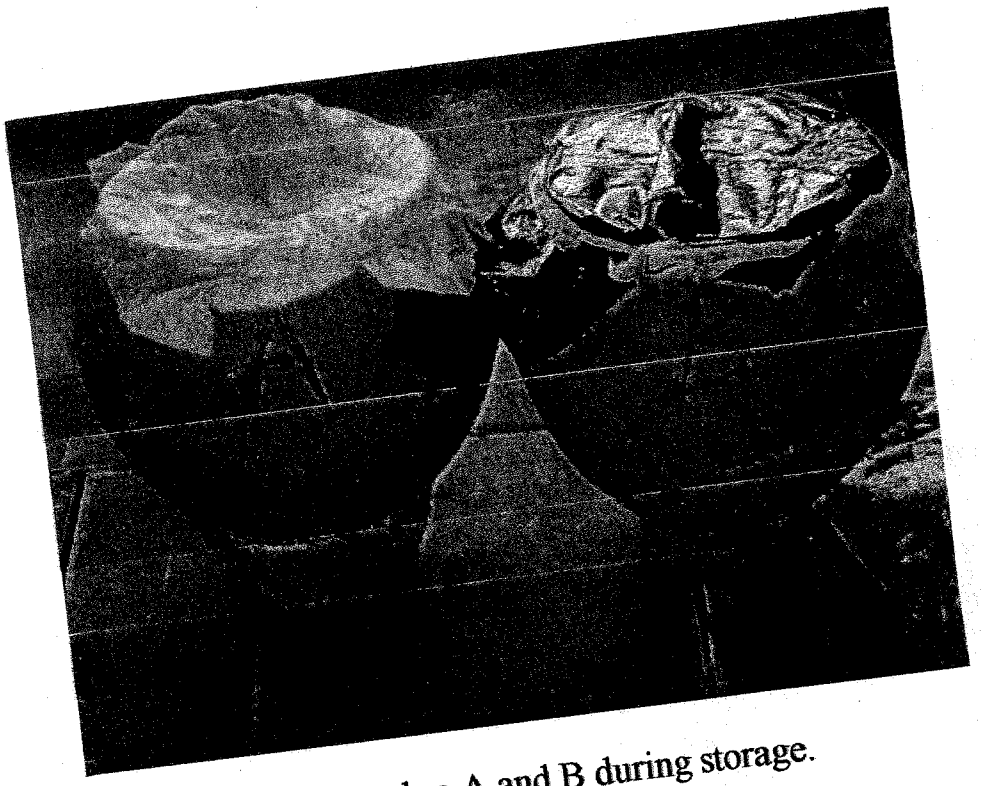

Figure 1 okra A and B during storage.

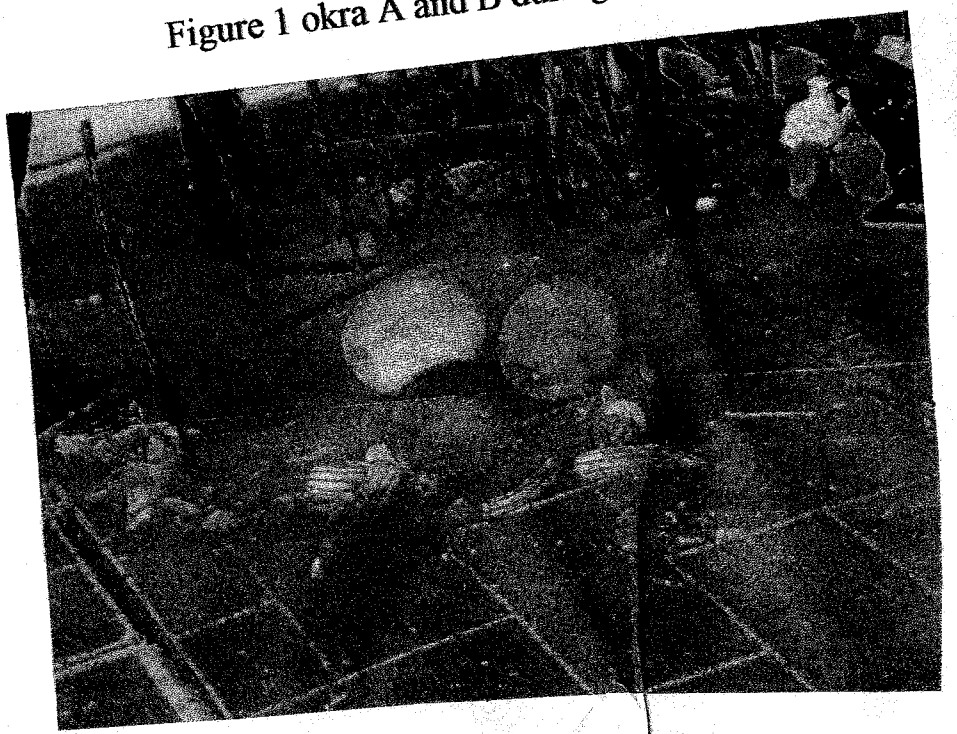

Figure 2 samples during storage on the floor.

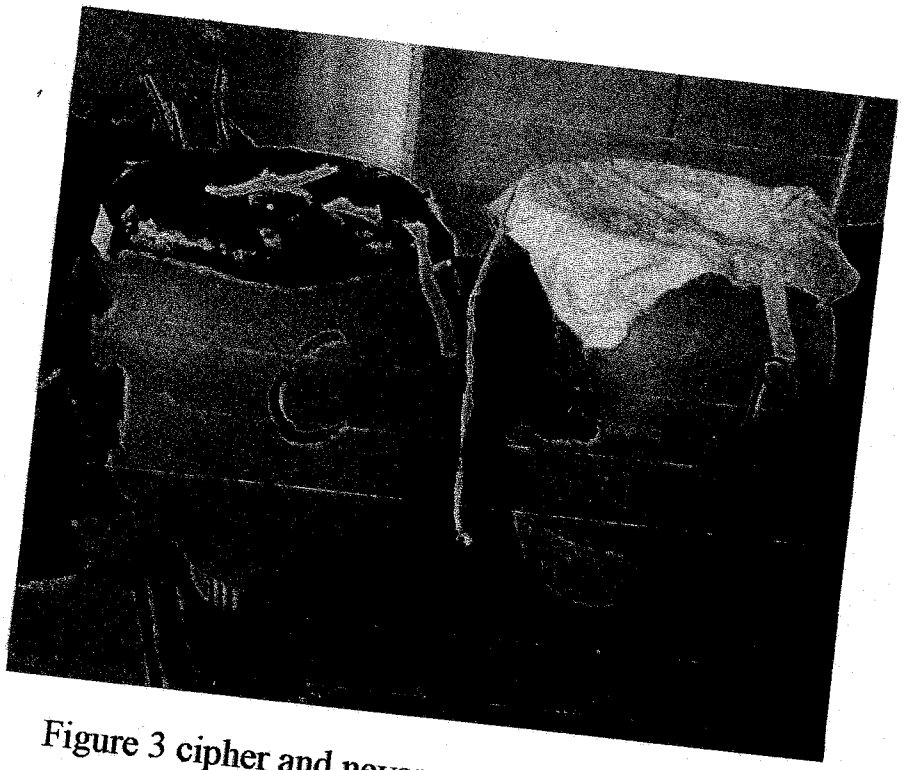

Figure 3 cipher and never orange during storage.