BUSITEMA UNIVERSITY
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P.O.Box 236, Tororo
Gen:+256-454448842
Dir: +256-454448864
Mob: +256-782999874
Fax: +256-454436517
Email:ar@acadreg.busitema.ac.ug
Website:www.busitema.ac.ug

ENHANCING THE SHELF LIFE OF FRESH CASSAVA ROOTS THROUGH COMBINATION OF THE POST-HARVEST PRESERVATION METHODS IN NAGONGERA TOWN COUNCIL, TORORO DISTRICT

BY

NABAYA JOB MAZAKI

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THIS FINAL YEAR REPORT IS SUBMITTED TO THE DEPARTMENT OF BIOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE EDUCATION OF BUSITEMA UNIVERSITY

AUGUST, 2024

CONSENT FOR SUBMISSION

I have satisfactorily read through the Dissertation and consent to its submission to the department of Biology, Nangongera campus for award of Bachelor of Science and education of Busitema University.

Sign .... Date 16/oct/2024....

Mr. Kifuko Richard,

Department of Biology,

Busitema University,

P.O.BOX 236, Tororo, Uganda.

Sign .... Date 20/9/2024

Declaration

I Nabaya Job Mazaki do hereby declare that this research work is my original work and all contents presented are original except where stated by the references and the same work has not been submitted for any award at this or any other university or institution of higher learning.

Candidate.

Sign...Date. 16/Oct/2024..........

Supervisor

This dissertation has been submitted for examination with approval of the supervisor Mr. Kifuko Richard

Signed.. Date. 20/9/24..........

Dedication

This dissertation is dedicated to my fellow students of the biology class of 2021/2024 and my supervisor for the kind reminders, guidance and support accorded to me, thanks sir.

Acknowledgement.

I would like to thank the almighty God for the gift of life He has blessed me with. Had it not been for Him, I would not have been able to succeed in my education. Thank you oh Lord.

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Acronyms

PPD- Postharvest physiological deterioration

NARO- National Agricultural Research Organization

IITA- International Institute of Tropical Agriculture

AFRII- Africa Innovations Institute

IIRR- International Institute of Rural Reconstruction

ABSTRACT

Introduction

This research aimed to address the persistent challenge of post-harvest losses in cassava production within Nagongera Town Council, Tororo District. Despite the key role cassava plays in the local economy and nutrition, the prevalence of post-harvest losses has emerged as a significant obstacle within the Nagongera area based on vivid observance from the nearby cassava growers and sellers, affecting both food security and economic stability. The primary objective of this research was to conduct a comprehensive evaluation of a combination of post-harvest preservation methods tailored to fresh cassava roots in this specific geographical context.

Methods

The technical evaluation involved rigorous experimental trials on two cassava varieties which are locally called Narocus and Pumba to assess the efficacy of a combination of the two mostly used preservation methods that's to say; use of Simple bag material and Wetting the Cassava Roots. Anticipated outcomes included the identification of the most effective preservation methods for fresh cassava roots, a detailed understanding of their economic viability.

The experimentation was done for a period of ten days, of which the first five days were for the individual cassava preservation methods that is storage in the bag material and wetting, this was followed by combination of the preservation methods; in the first case, the cassava which were in the bag material were transferred to the trays for wetting and vice versa.

In the entire study, results on attributes like weight, texture, physical appearance of the two cassava varieties Narocus and Pumba for the individual and combined preservation methods were obtained and tabulated.

Conclusion

Based on the results, the sequential combination of simple bag storage method of cassava preservation followed by wetting was the most effective method as compared to sequential combination of wetting followed by simple bag material method of preservation.

Keywords: Cassava, Preservation, Storage, shelf life.

CHAPTER ONE: INTRODUCTION

1.1 Background

Cassava (*Manihot esculenta Crantz*) holds a significant position as a staple crop globally, particularly in regions like sub-Saharan Africa where it serves as a vital source of nutrition and income for millions of people (Ferraro, et.al.2016). However, one of the persistent challenges associated with cassava cultivation is the rapid post-harvest deterioration of fresh cassava roots. This deterioration, primarily attributed to postharvest physiological deterioration (PPD), presents obstacles to food security and economic stability in cassava-producing regions worldwide (Saravanan, et.al.2016). Across the African continent, cassava production is a linchpin of agricultural activity, contributing substantially to food security and livelihoods (Steensland, 2022). For instance, in Uganda, cassava cultivation is widespread, with Nagongera Town Council in Tororo District standing out as an agricultural hub known for its cassava cultivation. The Nangongera town council extension officer said ‘‘Despite the economic and nutritional importance of cassava, the region grapples with post-harvest losses due to the short shelf life of fresh the cassava roots, imposing constraints on local economies and food systems.’’ In Uganda, cassava plays a crucial role in both rural and urban livelihoods, serving as a staple food and a source of income for many households (Kleih, U et al., 2019). However, the post-harvest challenges, including rapid deterioration of fresh cassava roots, persist (Uchechukwu et.al. 2015), particularly in regions like Nagongera Town Council, Tororo District. Here, the prevalence of post-harvest losses poses significant threats to food security and economic prosperity, underscoring the urgent need for innovative solutions to enhance the shelf life of cassava roots. Against this backdrop, the research was aimed to address the specific challenge of post-harvest losses in fresh cassava roots within Nagongera Town Council, Tororo District. By combining various post-harvest preservation methods tailored to the local context, the research sought to extend the shelf life of fresh cassava roots and mitigate post-harvest losses. Through rigorous experimental trials, economic analyses, and stakeholder engagement the research endeavoured to identify practical, context-specific recommendations that could enhance economic prosperity, and improve food security in the region.

1.2 Problem statement

It has long been known that cassava roots can be preserved for a few days using several simple techniques such as reburial, keeping under water, and coating in mud. There are, however, few recorded instances of successful long-term storage of fresh cassava roots other than by employing high cost systems such as refrigerationn and waxing(Singh et.al.1953). Although refrigeration and certain waxing techniques may be of use in limited situations, such as export marketing, or for experimental purposes, it is not considered that at present such systems can be extensively applied to practical on-farm, local market, or even industrial storage (Arallulo, et.al. 1974).

While previous research has demonstrated the effectiveness of individual preservation methods such as storage in sawdust, waxing, wetting and bagging for extending the shelf life of fresh cassava roots, these methods have inherent limitations in addressing the complex nature of cassava root deterioration (Martin, 2020). There is a lack of research exploring the synergistic effects of combining these preservation methods to maximize shelf life extension and minimize postharvest losses (Nikkhah, M., 2020).

The outcomes of this research are expected to contribute to the development of sustainable preservation strategies for fresh cassava roots, leading to increased shelf life, reduced postharvest losses, improved product quality, and expanded market opportunities for cassava producers.

1.3 Objectives

1.3.1 General Objective:

To enhance the shelf life of fresh cassava roots through the combined application of post-harvest preservation methods.

1.3.2 Specific Objectives:

1. Evaluate the variation of cassava freshness and shelf-life of the two cassava varieties Narocus and Pumba which were selected with time.

2. To assess the efficiency of the individual and combined wetting and use of simple bag material preservation methods of cassava

1.4 Hypothesis

H01: There is no significant difference in the freshness and shelf-life of different cassava varieties.

H02: The sequential combination of the cassava preservation methods selected is more efficient than the individual preservation methods

1.5Justification

The research project to enhance the shelf life of fresh cassava roots through a combination of post-harvest preservation methods in Nagongera Town Council, Tororo District, is due to several critical factors; significance of Cassava in the Local Economy and Nutrition: Cassava (*Manihot esculenta Crantz*) is a staple crop in Uganda, (Kizito, 2006) particularly in Nagongera Town Council. It serves as a primary source of sustenance for the local population and plays a crucial role in the local economy. Therefore, addressing post-harvest losses in cassava production is essential for ensuring food security and economic stability in the region (Akintola, et.al.2017). The research acknowledges the persistent challenge of post-harvest losses in cassava production. While individual preservation methods such as wetting, and bagging have shown promise in extending the shelf life of cassava roots (CA, O. et.al. 2014), there is a gap in understanding how these methods can be synergistically combined to further enhance shelf life and minimize post-harvest losses of cassava. (Tan, et.al. 2022).

1.6 Scope

This research aimed to address the persistent challenge of post-harvest losses in cassava production within Nagongera Town Council, Tororo District. Despite the key role cassava plays in the local economy and nutrition, the prevalence of post-harvest losses has emerged as a significant obstacle within the Nagongera area based on vivid observance from the nearby cassava growers and sellers, affecting both food security and economic stability. The primary objective of this research was to conduct a comprehensive evaluation of a combination of post-harvest preservation methods tailored to fresh cassava roots in this specific geographical context.

1.7 Significance and anticipated output

The proposal outlines anticipated outcomes, including the identification of the most effective preservation methods for fresh cassava roots, and understanding their economic viability.

These outcomes are expected to contribute to practical recommendations that can inform local agricultural practices, mitigate post-harvest losses, and enhance both economic prosperity and food security in the region.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Cassava roots (*Manihot esculenta*) are much more perishable than other major root and tuber crops. This has been attributed to the fact that the root of cassava, the storage organ, has no dormancy, has no function in propagation and possesses no bud primordia from which regrowth can occur (Onwueme, 1978).

The short shelf-life of cassava (*Manihot esculenta*) roots is primarily attributed to the postharvest physiological deterioration (PPD), which is triggered as a wound response shortly after harvest. (Desalegn, et.al.2020). PPD is a complex process that is linked to enzymatic stress responses to wounding, involving changes in gene expression, protein synthesis as well as accumulation of secondary metabolites and can be influenced by environmental factors. Visually, PPD is characterized by a blue/black or brown discoloration of the vascular parenchyma, which starts to appear within 24–72 hours of harvest.(Zainuddin et al., 2018).

The rate of PPD is affected by environmental factors such as temperature, humidity, and oxygen. Manipulation of these conditions can delay or hasten the process. For example, storage at 10°C and 80% humidity, waxing, and careful avoidance of physical damage can all delay PPD significantly.(Zainuddin et al., 2018).

2.2 Why there is need for improved methods of cassava preservation

Until recently, it was generally accepted that cassava roots could not be kept in a fresh state for more than a few days after harvest. This presents serious problems in the marketing and utilisation of the crop and results in heavy losses. Under the near subsistence farming conditions under which most of the world's cassava is produced, the normal method of overcoming this difficulty is to leave tie plants in the ground until needed and once harvested. to utilize the roots immediately or to dry them for longer storage life.

Ingram and Humphries (1972) estimate that although cassava may be harvested over a long period of time, leaving the roots in the ground until required unnecessarily occupies three quarters of a million hectares of agricultural land. Furthermore, losses due to pathogens increase when roots remain in the ground too long. Although tile roots may continue to increase in size. They become more fibrous and woodier and their content of extractable starch decreases. The difficulty of holding stocks of fresh roots at a processing plant for even a few days has frequently beet, a major factor inhibiting increasing ill tile Scale of production of dried or processed products (Booth, et.al.1975). In those areas where cassava is marketed as a fresh vegetable, considerable losses occur at all stages in the marketing chain, especially where the crop is grown at some distance from market outlets (Booth, et.al. 1975).

2.3 Requirements for a good preservation technique

In order to store fresh cassava roots, it is necessary to understand their post-harvest behaviour (Uchechukwu-Agua et al., 2015). Two essential requirements of any storage system are; the product should lose as little weight as possible during storage (Hardenburg, et.al,1986). And also, it must be of acceptable quality after storage. The methods developed to meet these requirements should, of course, be devised to yield maximum returns on the investment made, and different techniques should be developed for different circumstances. As most of the world's cassava is produced by small scale farmers, they frequently face severe economic and organizational constraints, emphasis should be placed on simple, inexpensive techniques.

2.4. Phases in which cassava roots deteriorate

Cassava roots generally deteriorate very quickly soon after harvest and this occurs in two separate phases:

a) Physiological, or primary deterioration. This often begins within 24 hours after harvest and is characterized by blue or brown discolorations of the vascular bundles of the roots, called "vascular streaking"(Salcedo, et.al (2011)). There are indications that this primary deterioration is due to wound responses comparable to those observed in other plant storage organs.(*Chapter 4 - Handling and Storage Methods for Fresh Roots and Tubers*, n.d.)

b) Microbial or secondary deterioration. Usually occurs 5-7 days after harvest and involves a wide spectrum of fungi and bacteria which develop in the flesh, causing a variety of wet and dry rots.(*Chapter 4 - Handling and Storage Methods for Fresh Roots and Tubers*, n.d.)

This rapid post-harvest deterioration of Cassava roots places serious constraints on their distribution and use, especially where there are delays in marketing, and on the holding of buffer stocks for large-scale processing. As a result, the selection of a market for which production is intended is influenced by its location and the time scale for delivery rather than its simple proximity to the production area. (*Chapter 4 - Handling and Storage Methods for Fresh Roots and Tubers*, n.d.)

2.5 Other studies done on the cassava preservation methods

The major constraint facing the large-scale production and marketing of fresh cassava (Manihot esculenta) roots is the rapid postharvest physiological deterioration (PPD). (Mbinda et.al 2022). Postharvest physiological deterioration (PPD) of fresh cassava roots limits its shelf-life to about 48 hours. There is a demand for simple, cheap, and logistically feasible solutions for extending the shelf life of fresh cassava roots at industrial processes (Tomlins et al., 2021).

In this study, three different types of bag materials were tested (woven polypropylene, tarpaulin, and jute as a potential storage solution for cassava roots with different levels of mechanical damages (Tomlins et al., 2021). Microclimate (temperature, humidity, $CO2$) was monitored to understand the storage conditions for up to 12 days. The results showed that fresh cassava roots could be stored for 8 days with minimal PPD and starch loss (2.4 %). However, roots with significant mechanical damage (cuts, breakages) had a considerably shorter shelf life in the storage bag, compared to whole roots and roots with retained peduncle (stalk where roots are connected to the main plant). Wetting the roots and type of bag material were not significant factors in determining the shelf life and starch loss (Tomlins et al., 2021). Carbon dioxide concentration in the stores significantly correlates with starch loss in fresh cassava roots and is proposed as a possible method for continuously and remotely monitoring starch loss in large scale commercial operations and reducing postharvest losses (Tomlins et al., 2021).

In another study by Babarinsa and Oluwalana (Effect of storage of fresh cassava in sawdust on Gari processing), roots in this study were stored well in the sawdust for the 12 weeks of experiment. The cassava root remained in excellent conditions at ambient temperatures without the development of discoloration or decay. The only case of rotten was due to the cassava that had mechanical damage before storage in which the stem was not attached to the root. It was also noticed, that sprouting of a new plant occurred after one-week, new plant sprouted from the stem attached to the cassava, this was due to sawdust providing a favourable condition for propagation, hence pruning was done at a regular interval. Some cassavas were left to sprout (for observation) and it was noticed that such cassava showed signs of decaying due to the loss of nutrients to the growing plants.

According to the International Institute of Tropical Agriculture, IITA; Africa Innovations Institute, AFRII; National Agricultural Research Organization, NARO International Institute of Rural Reconstruction, IIRR and Makerere University research, waxing has been found to be effective in extending the shelf-life of cassava and has enabled countries like Costa Rica to export fresh cassava roots. The technology is known to be used on other commodities such as fruits, vegetables and candy to make them shiny and pretty in addition to retarding moisture loss and spoilage. It has a similar impact on fresh cassava appearance. Cassava roots are dipped in melted paraffin wax at 51.5 ^{0}C to 52.5^{0}C (125 ^{0}F to 127 ^{0}F) for one second which adds a smooth thick surface coating to the root. This coating helps to reduce root moisture loss and it drastically extends shelf life to up to 2 months. Further, discoloration of the vascular tissue is reduced. Immediately after waxing the roots will be placed in clean, strong, well ventilated carton boxes. Paraffin wax is a chemical preservative (Paltrinieri, et.al (2014)).

It has a potential to open up future research into using plant origin materials to reduce the cost incurred by using paraffin wax. In their findings, they also added that the local preservation methods some retailers are using is by soaking roots in water which could keep roots for 5-7 days if the water is changed every day while others cover the cassava roots to keep them in humid conditions.

Table 1. The summary of the results from other researchers can be summarized in the table below.

Preservation Method	Duration	Researcher
Wetting the roots(soaking)	5-7 days	International Institute of Tropical Agriculture, IITA; Africa Innovations Institute, AFRII; National Agricultural Research Organization, NARO International Institute of Rural Reconstruction, IIRR and Makerere University Research
Waxing	2 months.	International Institute of Tropical Agriculture, IITA; Africa Innovations Institute, AFRII; National Agricultural Research Organization, NARO International Institute of Rural Reconstruction, IIRR and Makerere University Research
Box storage with saw dust	12 weeks	Babarinsa and Oluwalana (Effect of storage of fresh cassava in sawdust on Gari processing),
Simple bag material	8 days	(Mbinda & Mukami, 2022)

2.6 The gap and what should be done

Despite the findings from other researchers, demonstrating the efficacy of individual preservation methods such as storage in sawdust, waxing, wetting and bagging, there remains a gap in understanding how these methods can be synergistically combined to further enhance the shelf life of fresh cassava roots. While these methods have shown promise individually, their combined effects have yet to be thoroughly explored. By investigating the sequential or simultaneous application of these preservation techniques, my research aims to provide a comprehensive understanding of how different preservation methods (mainly wetting and use of bag material) can complement each other to maximize shelf life extension and minimize postharvest losses of fresh cassava roots. This holistic approach to preservation strategy development is essential for addressing the complex challenges associated with cassava root deterioration and ensuring the viability of large-scale production and marketing efforts.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This section of the research report explains how the assessment was carried out, the study area, the research instruments which were used, procedures, processing and analysis.
The technical evaluation involved rigorous experimental trials on two cassava varieties which are locally called Narocus and Pumba to assess the efficacy of a combination of the two mostly used preservation methods that's to say; use of Simple bag material and Wetting the cassava Roots.

3.1 Experimental research design

Cassava 12-months old Narocus (A) and Pumba (B), high cyanide cultivar was harvested carefully by gently lifting the roots from the Nagongera farm campus settlement in Nagongera town council, Tororo district. The harvesting was done very early in the morning after wetting the soil, this was to ensure the wetness and softness of the soil so as to minimize damage. Harvesting was done with part of the stem (2cm-5cm) still attached to limit ingress decay into the roots. (Olaleye et al., 2013,). After which, the cassava samples were taken to the laboratory for experimentation

The technical evaluation involved rigorous experimental trials on two cassava varieties which are locally called Narocus and Pumba to assess the efficacy of a combination of the two mostly used preservation methods that's to say; use of Simple bag material and Wetting the Cassava Roots. Anticipated outcomes included the identification of the most effective preservation methods for fresh cassava roots, a detailed understanding of their economic viability.
The experimentation was done for a period of ten days, of which the first five days were for the individual cassava preservation methods that is storage in the bag material and wetting, this was followed by combination of the preservation methods; in the first case, the cassava which were in the bag material were transferred to the trays for wetting and vice versa.

3.2 Study area

The study was done in Busitema University, Nagongera campus farm land, in Nagongera town council, which is a faculty of education in Tororo district, most students and lecturers in this area are involved in cassava cultivation and selling.

3.3 Sample collection procedure

Materials and requirements

A hoe

A panga

Two trays

Labels

Water

Step by step procedure which was followed

a) A panga was used to clear the area where the cassava was to be uprooted.

b) Some of the branches were cut off using the panga, this was done to make it easier to uproot the cassava samples

c) Using the hoe, the soil around the base of the plant about 30cm away from the roots was loosened, as in figure1below.

d) The plant stem was then grasped and gently pulled the cassava plant upwards.as in figure 1 below.

e) The roots obtained were inspected for any damages and those that were damaged were removed.

f) The undamaged and healthy roots of both varieties A and B were cut with a panga from the peduncle and collected on the labelled trays separately as in figure 2.

g) These were then carried to the laboratory washed to remove and soil.

Figure 1. Collection site of the cassava samples.

Figure 2. Variety A(Narocus)

Figure 3. Variety B (Pumba)

3.4 storage of the cassava roots

Before preserving the cassava roots, the 20 kg cassava samples of both varieties A and B were weighed and grouped into six batches according to the table below.

Table 3. Showing the different weights of the cassava samples used in the experimentation for both varieties A and B.

Batch	Weight(kg)	Method of Preservation
1(variety A)	20	No preservation
2(variety B)	20	No preservation
3(variety A)	20	Bag material
4(variety B)	20	Bag material
5(variety A)	20	Wetting
6(variety B)	20	Wetting

3.6. How weighing was done

Figure 4. weighing of the cassava samples.

Figure 5. weighing of the cassava samples.

3.7. Actual experimentation of the preservation methods

a) Simple Bag Material:

i. Fresh cassava roots of each variety A and B were stored in locally sourced, breathable bags.

The bags were sealed after loading the roots to evaluate the impact of reduced airflow on shelf life.

ii. These were then kept for a period of five days in a cool dry place.

iii. Regular monitoring of the batch for signs of damage or deterioration were conducted accompanied with weighing every day up to the fifth day.

iv. Data on attributes such as texture, weight and visual quality for the bag storage preservation method was collected.

Figure 6. bag material for storage of the cassava.

b) Wetting the Cassava Roots:

The roots of both varieties A and B were placed on a tray and lightly sprayed with water and kept for five days, simulating a simple and accessible preservation method.

Regular monitoring of the batch for signs of damage or deterioration conducted accompanied with weighing every day up to the fifth day.

Data on attributes such as texture, weight and visual quality for the wetting preservation method was collected.

Figure 7. Wetting preservation on trays.

3.8 Sequential combination of the preservation methods.

i) Simple Bag Material + Wetting:

1) The batch of cassava roots used for Simple Bag Material preservation was transferred to a tray for wetting.
2) The cassava was then kept for five days while wetting daily for the five days.
3) The batch was then stored in a cool and well-ventilated environment.
4) Regular monitoring of the batch for signs of damage or deterioration conducted accompanied with weighing every day up to the fifth day.
5) Data on attributes such as texture, weight and visual quality for the combined preservation method was collected.

ii) Wetting + simple bag material

1) The batch of cassava roots used for the wetting preservation method was transferred to the breathable bag for continued preservation.
2) The cassava was then kept for five days
3) The batch was then stored in a cool and well-ventilated environment.
4) Regular monitoring of the batch for signs of damage or deterioration conducted accompanied with weighing every day up to the fifth day.

5) Data on attributes such as texture, weight and visual quality for the combined preservation method was collected.

3.9 Texture measurement

Method: Texture Sensory Evaluation

Sample Preparation:

The samples were labelled and presented to a panel of people who evaluated the texture.

Measurement:

The panel members evaluated the texture attributes of the cassava samples of both varieties using a sensory evaluation scale.
A Likert scale (e.g., 1-5) was used to quantify the perceived texture.

Analysis:

Average the scores from multiple evaluators for each combination of the preservation methods were obtained.

The cassava samples were rated basing on the following attributes

1. Very Soft:

The cassava was extremely soft, almost mushy, and lacked firmness.

2. Soft:

The cassava was moderately soft but still maintained some firmness.

3. Moderate:

The cassava had a balanced texture with a combination of firmness and softness.

4. Firm:

The cassava was noticeably firm, with minimal softness.

5. Very Firm:

The cassava was very firm, exhibiting a substantial resistance to pressure, and lacked softness.

Figure 8. A panel of people evaluating the texture of the cassava samples.

3.10 Visual quality measurement of the cassava roots.

The external appearance of each cassava root was examined for signs of decay, discoloration, and mould,

Any abnormalities or irregularities, such as cracks or blemishes, which indicated spoilage or deterioration were looked for.

Detailed observations of the visual quality assessment for each sample, including any abnormalities or deviations from expected standards, was recorded.

Photographs were taken as necessary to document visual characteristics for further analysis.

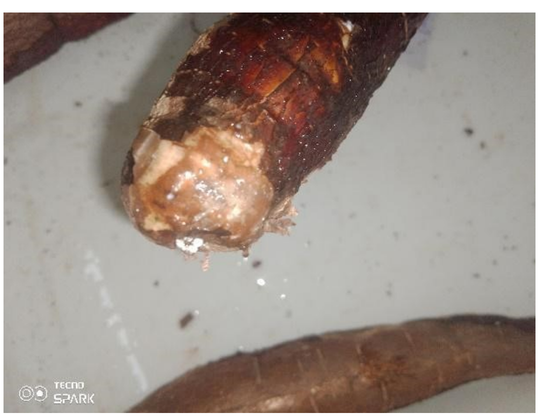


Figure 9. Photographs of the visual quality of the cassava samples.

Figure 10. Photographs of the visual quality of the cassava samples.

3.11**. Data analysis**

Data was checked to ensure that all the entries were correct. Data entry and analysis was done using Microsoft Excel.

3.12 **Data presentation**

Tables, pictorials and graphs, have been used in data presentation.

CHAPTER FOUR: RESULTS

This section presents the results of the variation in the weight, texture, and physical appearance of the two cassava varieties Narocus(A) and Pumba(B) for the individual preservation methods and the continued combination of the preservation methods and also those of the control.

4.0 Results for the no preservation

Here, the cassava varieties A and B were exposed to atmospheric conditions, no preservation method applied for five days.

Day	Weights Of variety A(kg)	Average weights of variety A(kg)	Weights of variety B(kg)	Average weights of variety B(kg)
1	20	1.33	20	1.33
2	18	1.20	19	1.27
3	17	1.13	17	1.13
4	15	1.00	17	1.13
5	14	0.93	15	1.00

Table 5. Weight of the cassava roots of Narocus and Pumba varieties

Figure 11. Showing variation of the average weights of variety A for no preservation method.

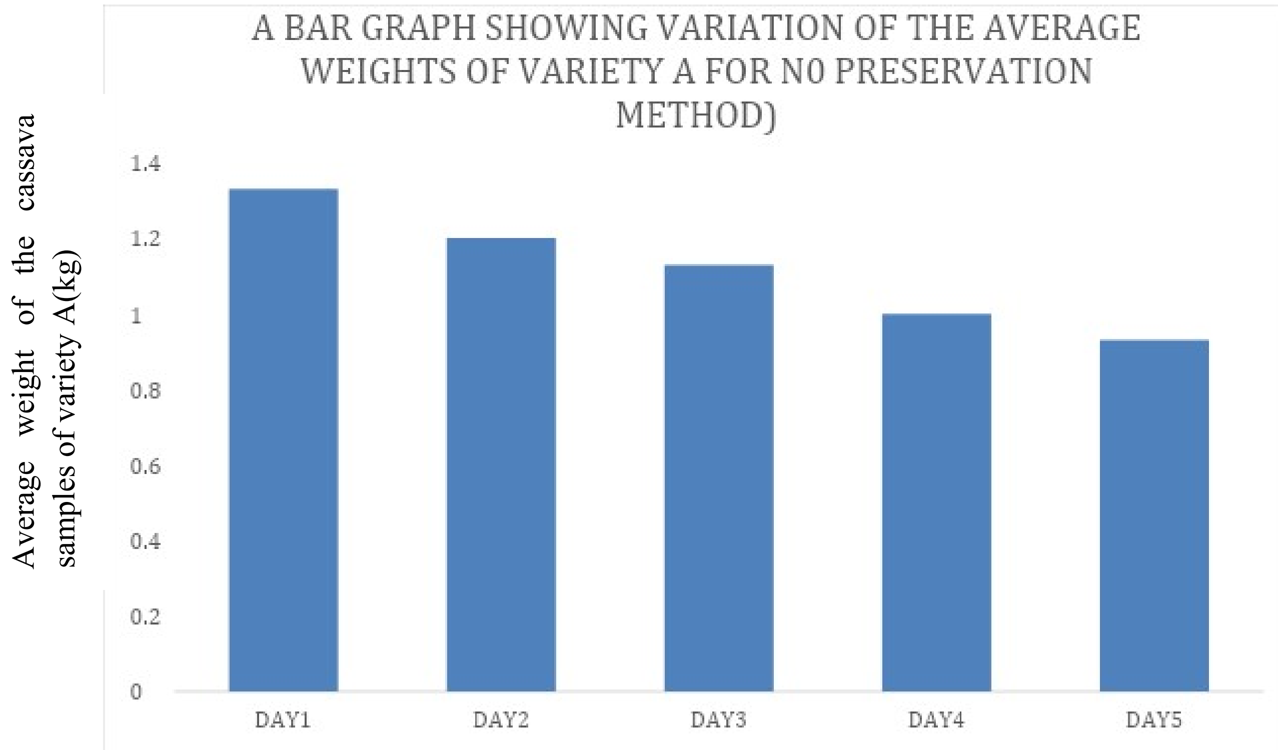
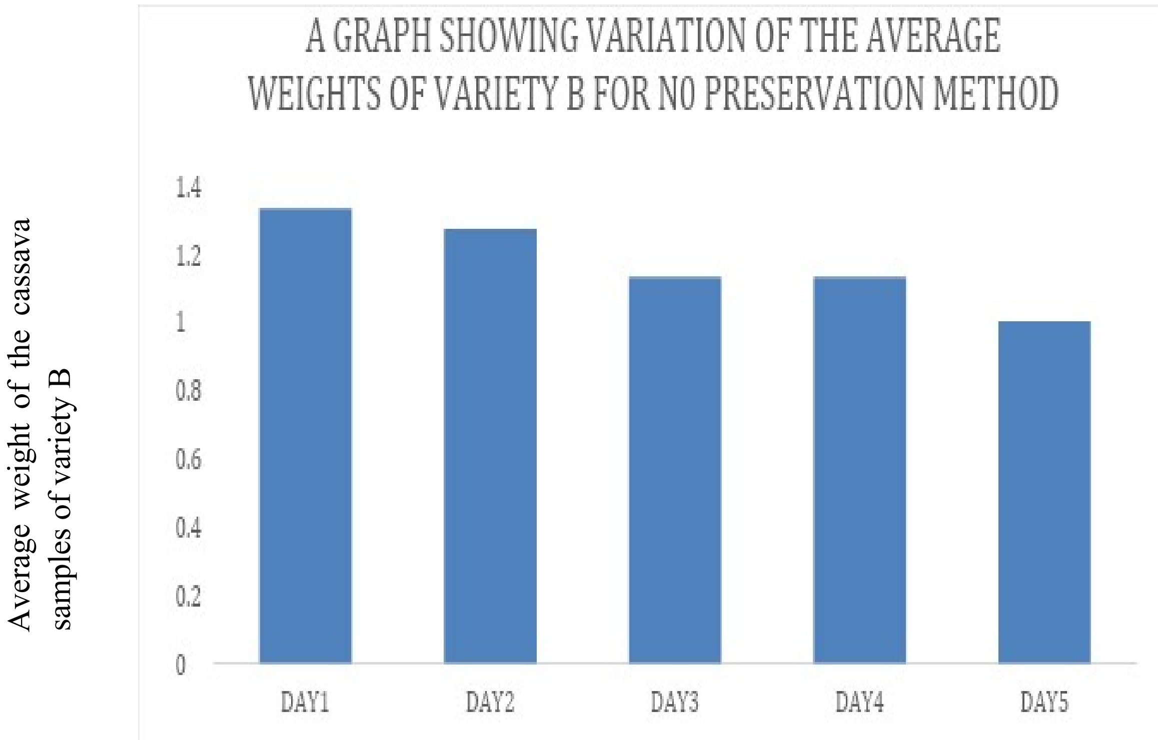


Figure 12. Showing variation of the average weights of variety B for no preservation



From figure 11 and figure 12; these results show the rapid deterioration of cassava roots in the average weight when exposed to atmospheric conditions without any preservation method. With day five in each case having the lowest average weight.

Table 6. Texture of the cassava roots of Narocus(A) and Pumba(B) varieties

		Attributes for A				**Attributes for B**				
Day	**Very soft**	**soft**	**Moderate**	**Firm**	**Ver y firm**	**Ver y soft**	**soft**	**Moderate**	**Firm**	**Very firm**
1				**4**						**5**
2				**4**						**5**
3			**3**					**3**		
4		**2**					**2**			
5	**1**					**2**				

From table 6, shows that the texture of cassava variety A varied from firm, remained firm on day two, changed to moderately firm, to soft and finally very soft on day five.

For Variety B, from day 1 to day 5, The texture varied from very firm on day one and two, to moderately firm on day three, and to soft on day four and day five.

Table 7. Physical Appearance of the cassava roots of Narocus(A) and Pumba(B) varieties

Day	Discoloration of variety A	Decay for variety A	Mold formation for variety A	Discoloration for variety B	Decay for variety B	Mold formation for variety B
1	✕	✕	✕	✕	✕	✕
2	✔	✕	✕	✕	✕	✕
3	✔	✔	✔	✔	✕	✕
4	✔	✔	✔	✔	✔	✔
5	✔	✔	✔	✔	✔	✔

4.1 BAG MATERIAL PRESERVATION METHOD

Table 8. Weights of the cassava roots of Narocus(A) and Pumba(B) varieties for simple bag material preservation for the first five days.

Day	**Weights Of variety A(kg)**	**Average weights of variety A(kg)**	**Weights of variety B(kg)**	**Average weights of variety B(kg)**
1	**20**	**1.25**	**20**	**1.25**
2	**20**	**1.25**	**20**	**1.25**
3	**19**	**1.19**	**20**	**1.25**
4	**18**	**1.13**	**19**	**1.19**
5	**17**	**1.06**	**19**	**1.19**

Figure 13. Shows variation of the average weights of cassava Variety A for bag material storage preservation method.

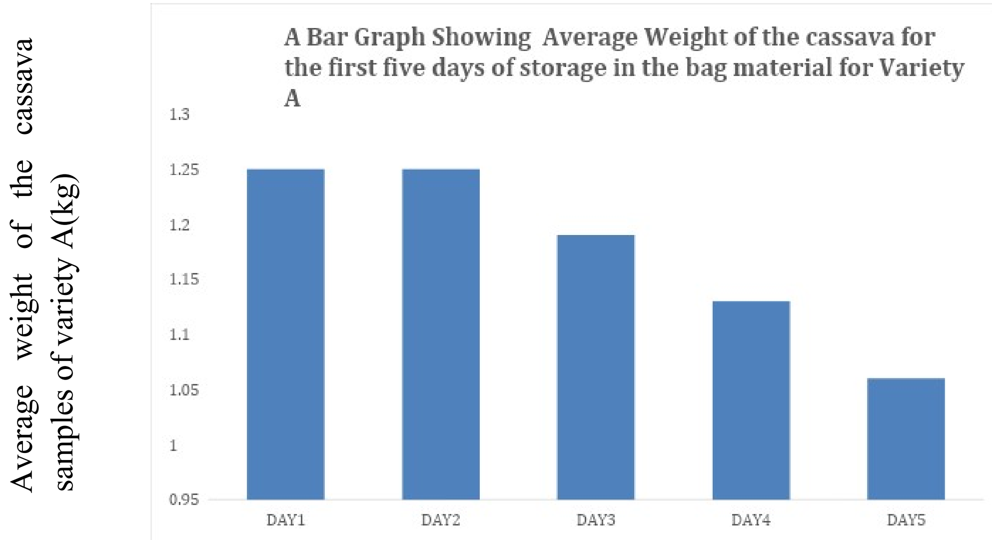
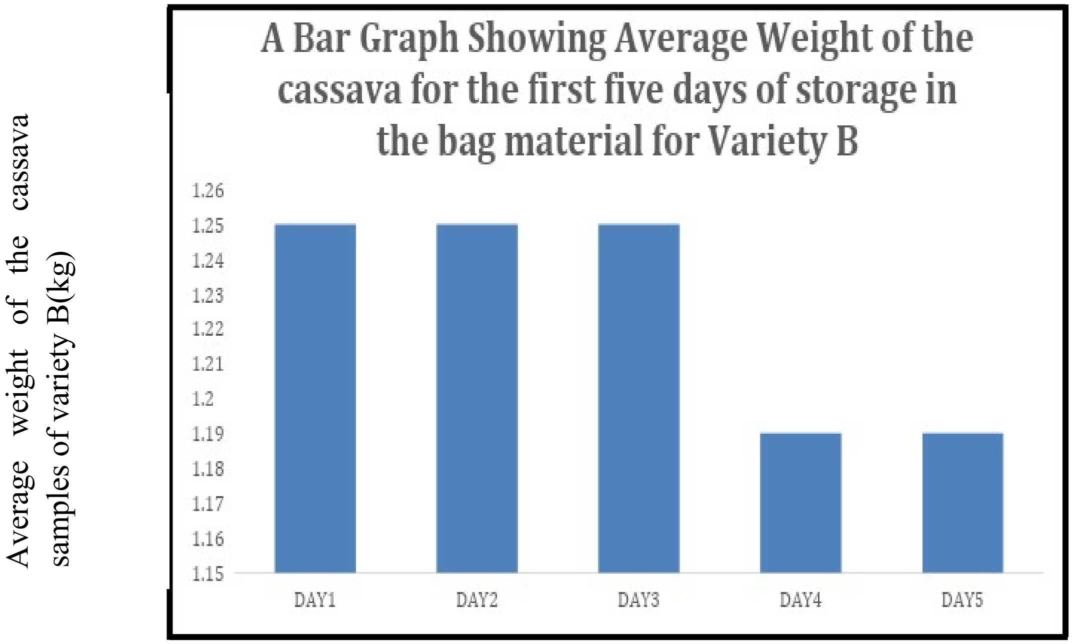


Figure 14. Shows variation of the average weights of cassava Variety B for bag material storage preservation method.



The figure 13 and figure 14; show that both cassava varieties A and B show a gradual decrease in weight over the five days, which is expected due to moisture loss during storage. Variety A starts with a higher average weight (1.25 kg) at day one but decreases more rapidly compared to Variety B. Variety B maintains a more consistent average weight of 1.25 kg for three days, indicating potentially better moisture retention in the roots.

Table 9. Texture of the cassava roots of Narocus(A) and Pumba(B) varieties for simple bag material preservation for the first five days.

	Attributes for A					**Attributes for B**				
Day	**Very soft**	**Soft**	**Moderate**	**Firm**	**Very firm**	**Very soft**	**Soft**	**Moderate**	**Firm**	**Very firm**
1				**4**						**5**
2				**4**						**5**
3			**3**							**5**
4			**3**						**4**	
5			**3**						**4**	

Table 9. shows that for cassava variety A, from day 1 to day 5, the texture was firm from days one and two, later became moderately firm on day three and remained moderately firm up to day 5, whereas for variety B, from day 1 to day 5, the texture varied from very firm on day one, two and three, to firm on day four and day five.

Table 10. Physical Appearance of the cassava roots of Narocus(A) and Pumba(B) varieties for simple bag material preservation for the first five days.

Day	Discoloration for variety A	Decay for variety A	Mold formation for variety A	Discoloration for variety B	Decay for variety B	Mold formation for variety B
1	✕	✕	✕	✕	✕	✕
2	✕	✕	✕	✕	✕	✕
3	✕	✕	✕	✕	✕	✕
4	✕	✕	✕	✕	✕	✕
5	✕	✕	✕	✕	✕	✕

4.2 Wetting Preservation method

Table 11. Weights of the cassava roots of Narocus(A) and Pumba(B) varieties for wetting preservation method for the first five days.

Day	Weights of variety A(kg)	Average weights of variety A(kg)	Weights of variety B(kg)	Average weights of variety B(kg)
1	20	1.67	20	1.67
2	21	1.75	20	1.67
3	21.5	1.79	22	1.83
4	22	1.83	23	1.92
5	22	1.83	23	1.92

Figure 15. Shows variation of the average weights of Variety A for wetting preservation

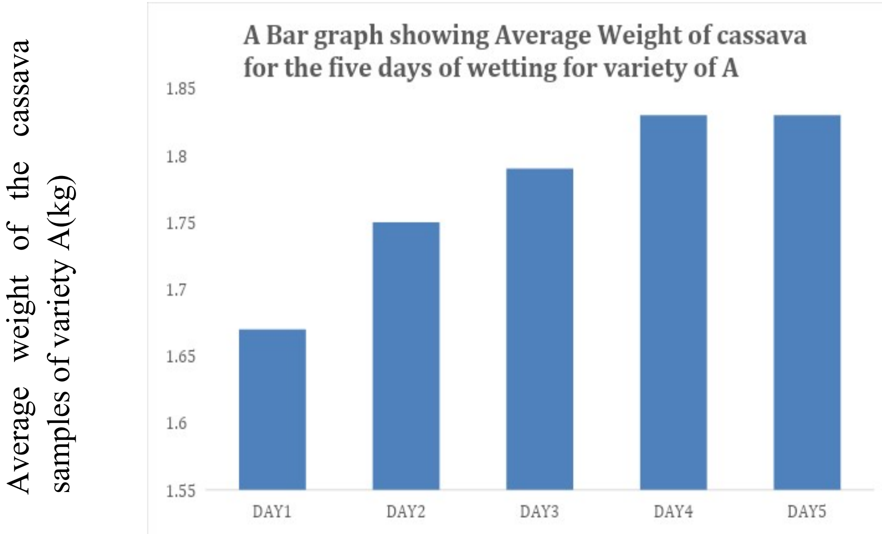


Figure 15, shows that, the average weight of the cassava roots of variety A increased from 1.67 kg on Day 1 to 1.83 kg on Day 5. This steady increase suggests that the wetting method effectively maintained or slightly improved the water content of the cassava roots, indicating reduced moisture loss and possibly even some moisture uptake.

Figure 16. Shows variation of the average weights of Variety B for wetting preservation

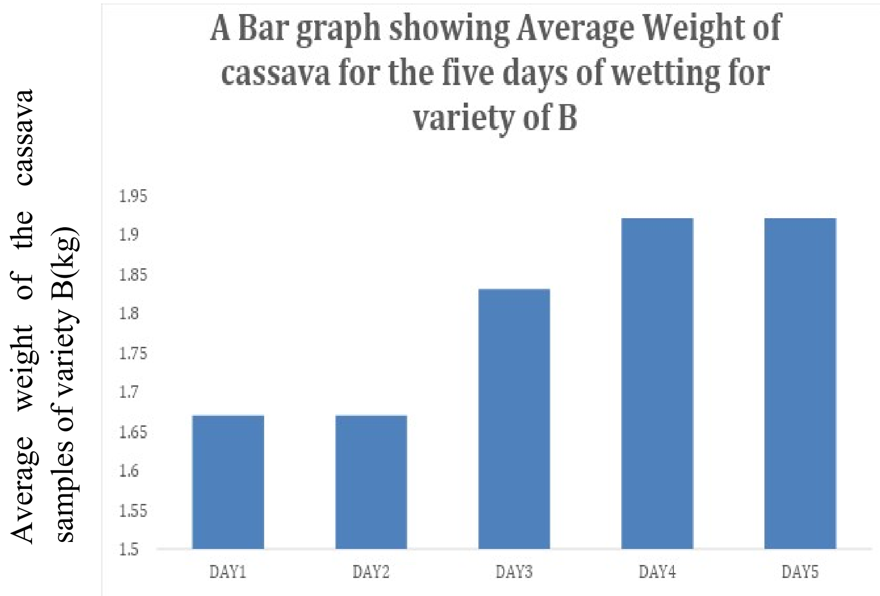


Figure 16, shows that the average weight of the cassava roots increased from 1.67 kg on Day 1 to 1.92 kg on Day 5. Similar to Variety A, Variety B showed a consistent increase in weight, with a slightly higher overall gain in average weight compared to Variety A. This suggests that variety B has a better moisture retention capacity.

Table 12. Texture of the cassava roots of Narocus(A) and Pumba(B) varieties for wetting preservation method for the first five days

	Attributes for A					Attributes for B				
Day	Ver y soft	Soft	Moderate	Firm	Ver y firm	Ver y Soft	Soft	Moderate	Firm	Very firm
1				4						5
2				4						5
3				4						5
4				4					4	
5				4					4	

Table 12, shows that the texture of the cassava variety A, consistently remained firm from day one to day five, while for Variety B, from day 1 to day 5, The texture was very firm from day one and three, and later became moderately firm on day four and five.

Table 13. Physical Appearance of the cassava roots of Narocus(A) and Pumba(B) varieties for wetting preservation method for the first five days.

Day	Discoloration for variety A	Decay for variety A	Mold formation for variety A	Discoloration For variety B	Decay for variety B	Mold formation for variety B
1	×	×	×	×	×	×
2	×	×	×	×	×	×
3	×	×	×	×	×	×
4	×	×	×	×	×	×
5	×	×	×	×	×	×

4.3 Combination after five days

Wetting preservation method + bag material preservation method. (samples from bag material transferred to a tray for wetting).

Table 14. Weight of the cassava roots of Narocus(A) and Pumba(B) varieties for another five days of combination of samples from bag transferred to tray for wetting.

Day	Weights Of variety A(kg)	Average weights of variety A(kg)	Weights of variety B(kg)	Average weights of variety B(kg)
6	17	1.06	19	1.19
7	18	1.13	19	1.19
8	18	1.13	20	1.25
9	18	1.13	20	1.25
10	19	1.19	21	1.31

Figure 17. **Showing variation of the average weights of variety A for the combination of the wetting preservation method and bag material preservation method.**

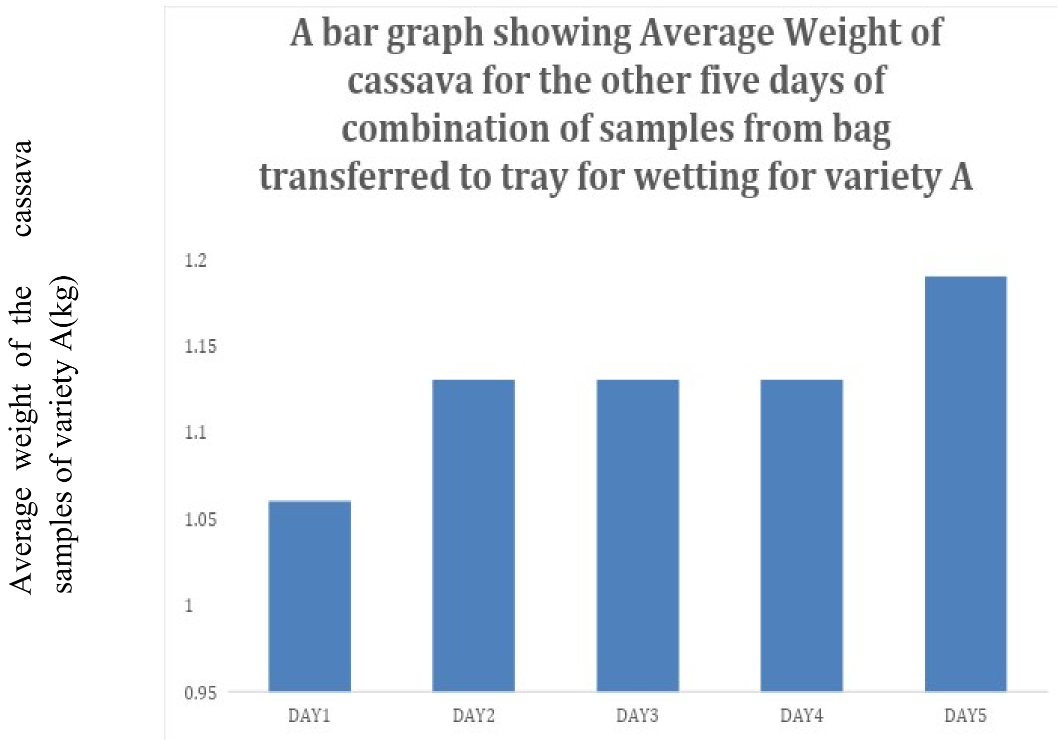


Figure 17, shows that the average weight of the cassava roots increased from 1.06 kg on Day 6 to 1.19 kg on Day 10. The steady weight increase suggests that the combination of bag material preservation followed by wetting effectively maintained or even slightly improved the water content of the cassava roots. This indicates reduced moisture loss and possibly some moisture uptake, similar to the wetting-only method.

Figure 18. Showing variation of the average weights of variety B for the combination of the wetting preservation method and bag material preservation method.

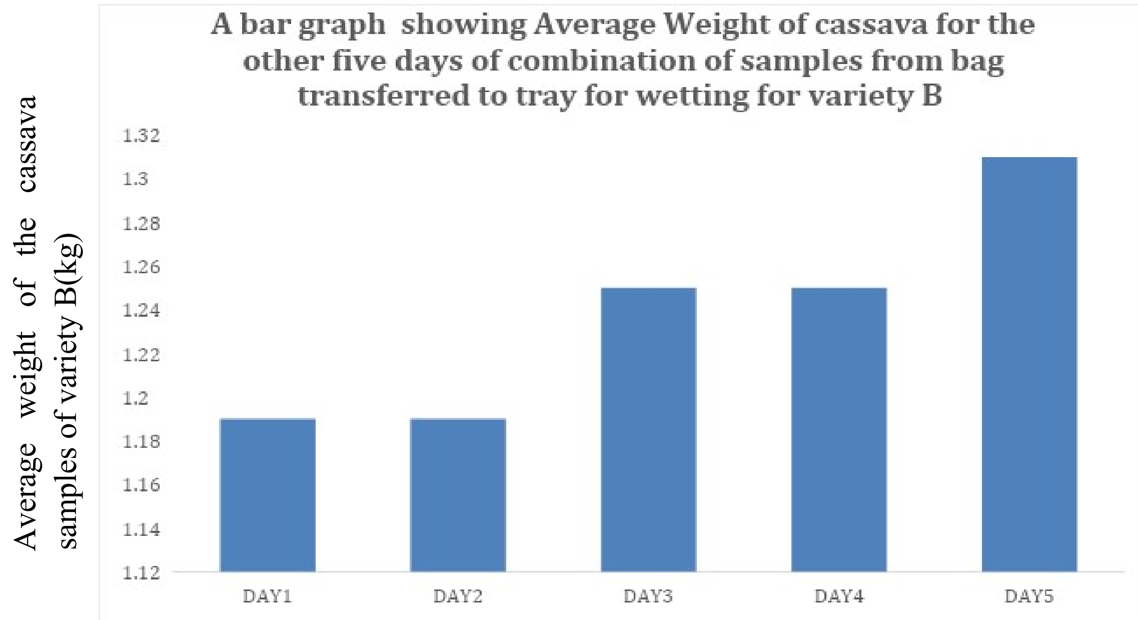


Figure 18, shows that the average weight of the cassava roots increased from 1.19 kg on Day 6 to 1.31 kg on Day 10. Variety B exhibited a consistent weight increase, with a slightly higher overall gain compared to Variety A. This suggests that the combination method was also effective for this variety, maintaining moisture content and reducing spoilage. The combination of bag material and wetting preservation methods demonstrates a positive effect on maintaining the weight and quality of cassava roots. Both varieties showed an increase in weight over the five days, indicating that this combined approach can be an effective preservation strategy.

Table 13: Texture of the cassava roots of Narocus(A) and Pumba(B) varieties for another five days of combination of samples from bag transferred to tray for wetting.

	Attributes for A					Attributes for B				
Day	**Ver y soft**	**Soft**	**Moderate**	**Firm**	**Very firm**	**Ver y soft**	**soft**	**Moderate**	**Firm**	**Very firm**
6			**3**						**4**	
7			**3**						**4**	
8			**3**						**4**	
9			**3**						**4**	
10			**3**					**3**		

Table 13, shows that for cassava variety A, from day 6 to day10; The texture is "moderately firm" (with a value of 3 on each day).

Variety B, from days 6 to 9: The texture is "Firm" (with a value of 4 on each day with the texture being "moderately Firm" (value of 3), at day 10 indicating a slight softening compared to earlier days. This suggests that both varieties exhibit stable textural characteristics during the preservation period, but while Variety A stays consistently moderately firm, Variety B stays firm and becomes slightly softer by day 10.

Table 14: Physical Appearance of the cassava roots of Narocus(A) and Pumba(B) varieties for another five days of combination of samples from bag transferred to tray for wetting

Day	Discoloration for variety A	Decay for variety A	Mould formation for variety A	Discoloration For variety B	Decay for variety B	Mould formation for variety B
6	✕	✕	✕	✕	✕	✕
7	✕	✕	✕	✕	✕	✕
8	✔	✕	✕	✕	✕	✕
9	✔	✕	✕	✔	✔	✔
10	✔	✔	✔	✔	✔	✔

Wetting preservation method + bag material preservation method. (Previously wetted samples transferred to bag material).

Time of the study, 5 days

Table 15. Weight of cassava roots of the Narocus and Pumba varieties for the other five days of combination of the previously wetted samples transferred to bag material for preservation.

Day	Weights of variety A(kg)	Average weights of variety A(kg)	Weights of variety B(kg)	Average weights of variety B(kg)
6	22	1.83	23	1.92
7	22	1.83	22	1.83
8	22	1.83	22	1.83
9	21	1.75	22	1.83
10	19	1.58	20	1.67

Figure 19. Shows variation of the average weights of variety A for the combination of the previously wetted samples transferred to bag material for preservation

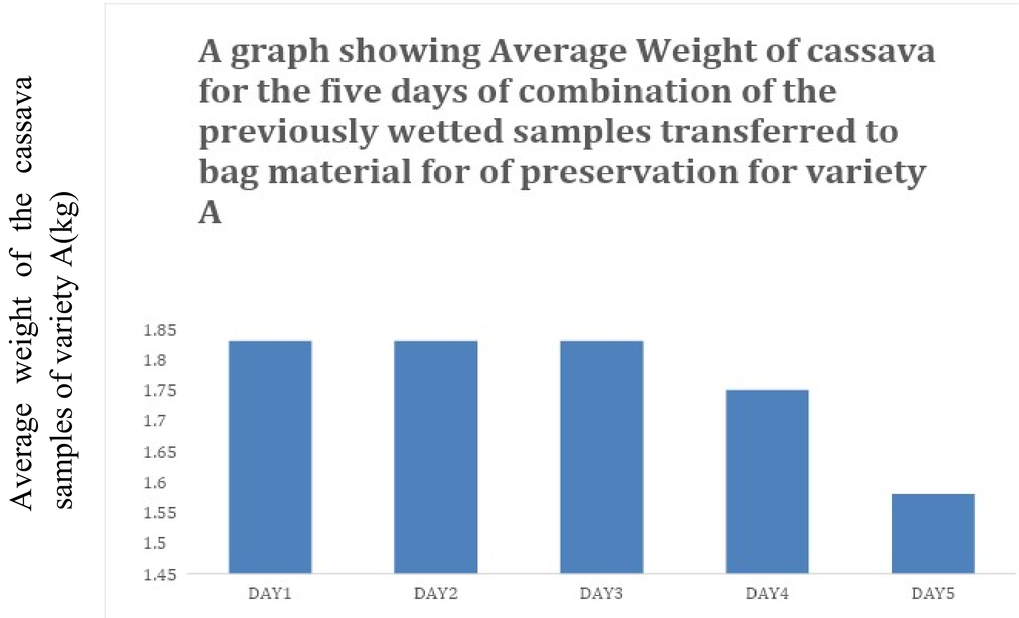


Figure 19, shows that the average weight of the cassava roots of variety A, decreased from 1.83 kg on Day 6 to 1.58 kg on Day 10. This steady decrease in weight suggests that transferring wetted cassava roots to bag material for storage might have led to moisture loss over the five days.

Figure 20. Shows variation of the average weights of variety B for the combination of the previously wetted samples transferred to bag material for preservation.

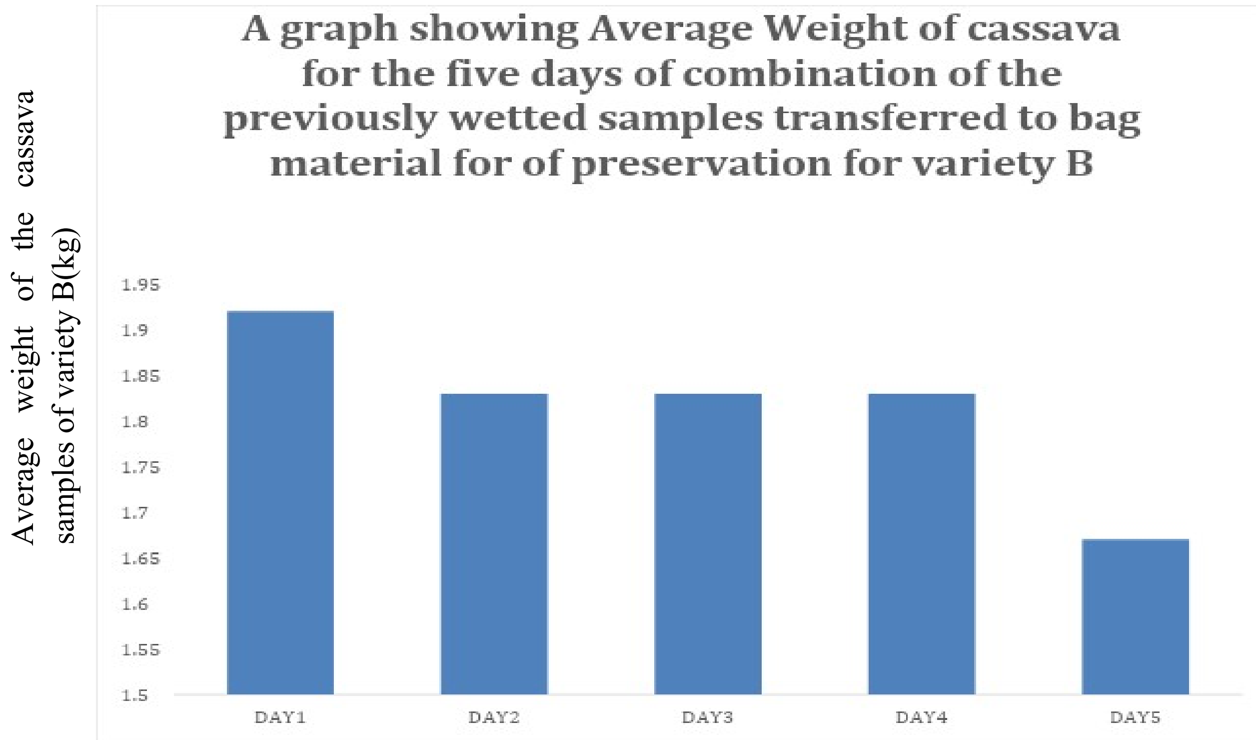


Figure 20, shows that the average weight of the cassava roots of variety B decreased from 1.92 kg on Day 6 to 1.67 kg on Day 10. Similar to Variety A, Variety B showed a weight decrease, indicating that the combined method might not be as effective in maintaining moisture content compared to other methods tested.

The observed weight loss in both varieties suggests that while wetting preservation alone can maintain or increase the moisture content of cassava roots, transferring them to bag material storage may not sustain this effect.

Table 16. Texture of cassava roots of the Narocus and Pumba varieties for the other five days of combination of the previously wetted samples transferred to bag material for preservation.

	Attributes for variety A					Attributes for variety B				
Day	**Ver y soft**	**Soft**	**Moderate**	**Firm**	**Ver y firm**	**Ver y Soft**	**Soft**	**Moderate**	**Firm**	**Very firm**
6				**4**					**4**	
7				**4**					**4**	
8				**4**					**4**	
9				**4**					**4**	
10			**3**						**4**	

Table 16, shows that for both varieties (Narocus and Pumba), the texture tends to remain consistently firm from day 6 to day 9. Variety B shows an increase in firmness on day 10, indicating that its texture becomes more rigid over time.

This table suggests that the preservation method impacts both varieties similarly, though Variety B shows a slight increase in firmness on day 10 compared to Variety A.

Table 17. Physical Appearance of cassava roots of the Narocus and Pumba varieties for the other five days of combination of the previously wetted samples transferred to bag material for preservation.

Day	Discoloration for variety A	Decay for variety A	Mould formation for variety A	Discoloration for variety B	Decay for variety B	Mould formation for variety B
6	✕	✕	✕	✕	✕	✕
7	✕	✕	✕	✕	✕	✕
8	✕	✕	✕	✕	✕	✕
9	✕	✕	✕	✕	✕	✕
10	✔	✕	✕	✕	✕	✕

CHAPTER FIVE: DISCUSSION OF RESULTS

The findings from figures 11 and 12 emphasize the rapid deterioration of cassava roots in non-preserved conditions, highlighting the necessity for effective preservation methods. Cassava, being a perishable crop, is susceptible to weight loss primarily due to moisture loss and microbial activity, which are accelerated in non-preserved conditions. (Onwueme 1978,). The findings align with existing literature on the shelf life of cassava, where factors such as temperature, humidity, and exposure to air play crucial roles in determining spoilage rate. (R.H. Booth (1977))

From findings from figure 13 and 14; Variety B seems to retain moisture better, as indicated by the consistent average weight over the first three days compared to Variety A, which shows a quicker decline.

According to the findings from figure 15 and figure 16; the increase in weight for both varieties over the five days indicates that the wetting preservation method is effective in maintaining the moisture content of cassava roots. This method helps to reduce weight loss typically associated with post-harvest handling, which is crucial for maintaining market quality and consumer acceptance. The difference in weight gain between Variety A and Variety B may be attributed to inherent differences in their physiological characteristics, such as skin permeability, initial moisture content, and the capacity to absorb and retain water. Variety B showed a higher weight increase compared to Variety A, suggesting that it might be more suited for wetting preservation.

For sustainable food security and economic viability, it is imperative to explore and implement effective preservation techniques that can extend the shelf life of cassava, thereby reducing post-harvest losses. Techniques like vacuum packaging, cool storage, and chemical treatments have been studied for their efficacy in maintaining cassava quality.

The wetting preservation method proves to be a viable technique for maintaining the weight and quality of cassava roots over a short period.

Also, based on the findings from figure 17 and figure 18; Combining bag material preservation with wetting (sequentially transferring the cassava varieties from the bag material to the trays for wetting) is an effective method for maintaining the weight and quality of cassava root.

From figures 19 and 20; the combination of wetting followed by bag material storage shows a decline in cassava root weight over five days, suggesting that this method might not effectively preserve moisture. This highlights the importance of optimizing preservation strategies and understanding the interactions between different methods.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1Conclusion

Throughout the entire experimentation, the freshness and shelf life of the cassava varieties Narocus and Pumba varied with time, based on the attributes of weight, texture and physical appearance, however, cassava variety of Pumba maintained its freshness, better than the cassava variety A. These findings do not agree with the hypothesis which stated that there is no significant difference in the freshness and shelf life of the cassava varieties Narocus and Pumba which were selected.

Also, the results of the sequential combination of the cassava preservation methods that is to say wetting followed by storage in bag material and storage in bag material followed by wetting of the cassava samples, varied slightly, in which the latter was more efficient, at maintaining the freshness of the cassava samples collected. Generally, the sequential combination of the cassava preservation methods is more efficient than the individual methods, of bag storage and wetting, since they increase on the shelf life. This is in agreement with the null hypothesis, which stated that the sequential combination of the cassava preservation methods is more efficient than the individual preservation methods.

6.2 Recommendation

From the above conclusions based on this research, I would recommend the following to be done by other researchers.

Further studies could explore longer wetting periods beyond 10 days, different environmental conditions, and other cassava varieties to optimize this preservation method.

Further studies could explore different bag materials, environmental conditions, and additional cassava varieties to optimize this combined preservation method.

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