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Effect of different storage conditions on biophysical and nutritional properties of sweetpotato storage roots in Uganda

2021

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RTB Consumer Report

Effect of different storage conditions on biophysical and nutritional properties of sweetpotato storage roots in Uganda

Published by the CGIAR Research Program on Roots, Tubers and Bananas

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Correct citation: Mariam Nakitto, Mukani Moyo, Lucy Mwaura, Elizabeth Wafula and Diego Naziri (2021). Effect of different storage conditions on biophysical and nutritional properties of sweetpotato storage roots in Uganda. CGIAR Research Program on Roots, Tubers and Bananas (RTB). Available online at: www.rtb.cgiar.org

November 2021

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Abstract

Most recent studies on sweetpotato storage in Africa have compared the effect of different storage facilities such as storage bags and traditional and modified pits on the quality of sweetpotato. There are limited recent studies on the effect of storage conditions with regards to different temperature and humidity conditions on biophysical and nutritional composition of sweetpotato storage roots by variety. The objective of the study was to characterize shelf stability of sweetpotato storage roots and compare the biophysical and nutritional changes among six sweetpotato genotypes stored in three temperature-humidity conditions. Sweetpotato storage roots of six released varieties of varying flesh colors (Ejumula, SPK004, NASPOT 8, NASPOT 10 O, NASPOT 13 O, and Tanzania) were harvested from farmers' fields in Serere. They were stored under three different storage conditions: cold (8-10°C), warm (30°C, >90% humidity), and room conditions without heaping. Three roots of each variety were retrieved at baseline, day 1, day 4, day 7 and day 14 of the experiment. These roots were freeze-dried to evaluate dry matter content. The freeze-dried powders were scanned with NIRS to analyse their starch, sugar (glucose, fructose, sucrose) and betacarotene contents. The powder was packaged in airtight plastic bags and transported to FANEL in Kenya where it was analysed for sugar, vitamin C and betacarotene content using HPLC. The data were analysed using ANOVA with repeated measures. Roots of NASPOT 8 started spoiling or rotting during storage under all three conditions, and most varieties started sprouting in warm conditions. There was no significant loss in dry matter of the samples until the last day. Starch content decreased while sucrose content of the roots increased over the storage period. The highest increase in sucrose was observed in roots stored under cold conditions, with the highest increase observed in roots of Tanzania. The roots were generally low in vitamin C. Storage and variety had mixed effects on betacarotene content. The study demonstrated that sweetpotato roots of some varieties can be stored under room conditions for longer than one week, albeit some nutritional loss trade-offs. The sensory and safety effects of these storage conditions should be studied, especially among varieties that keep for long in room conditions to develop storage practice recommendations and build suitable infrastructures.

1 INTRODUCTION

Sweetpotato is an important economic, food and nutrition security crop in Uganda. The potential of this crop could be enhanced by strategies to prolong the duration in which its eating quality is maintained after harvest. Some of the most important considerations to make in sweetpotato storage are temperature and relative humidity. While cooler temperatures reduce the rate of proliferation of microorganisms, high humidity ensures minimal loss of moisture such that the eating quality of the sweetpotato is maintained. Farmers in more developed countries can afford to store sweetpotato roots in controlled or modified temperature and humidity storage to ensure longer shelf life. However, most farmers in resource poor areas can only afford to store roots underground, within the mounds in the garden, or in simple granaries. While long-term storage of sweetpotatoes in different storage facilities has been previously studied, recent studies comparing the physiological and nutritional changes of sweetpotatoes in different temperature and humidity environments by variety are rare. Therefore, this study was initiated by RTB Cluster 4.1. to characterize the shelf stability of sweetpotato storage roots and compare the biophysical and nutritional changes among sweetpotato genotypes of varying flesh colors stored in three temperature-humidity conditions.

1.1 Study objectives

The aim of the study was to characterize the shelf stability of sweetpotato storage roots and compare the biophysical and nutritional changes among sweetpotato genotypes of varying flesh colors stored in three temperature-humidity conditions.

The specific objectives of the study were:

i. Establish the shelf life of freshly harvested sweetpotato roots when stored under different humidity and temperature conditions
ii. Identify the most suitable storage conditions for raw sweetpotato
iii. Compare changes in nutritional composition (dry matter, sugars, vitamin C, beta-carotenes) among six sweetpotato genotypes with varying flesh color stored in different conditions of temperature and humidity

2 METHODOLOGY

2.1 Samples and sampling

2.1.1 Source of samples

Due to the restrictions of the COVID pandemic, planting in Serere for the 2020A MDP trial was late and in off-season. As a result, the harvest in November was poor and we samples were obtained from farmers. This introduces new sources of bias such as variation in growing environments and maturity. Also, time factor as researchers move from one location of sample collection to the next becomes a challenge. Information concerning these sources of bias were collected as a basis for discussion.

Sweetpotato genotypes were obtained from sweetpotato farmers in Serere district in eastern Uganda. Six genotypes were obtained from three farmers with each supplying two varieties. All sweetpotato roots were harvested on the morning of 13th December, 2020. Atmospheric temperature ranged from 26.5^{o}C to 34.5^{o}C, and humidity ranged from 40.8 % to 62.7 %. Upon harvest, the roots were collected and put in labeled cloth-like bags. They were transported with protection from direct sunlight in conditions where temperature ranged from 37.3^{o}C to 27.3^{o}C and humidity was from 41.8 % to 54.8 % They reached the laboratories in Namulonge on Monday, 14 December, 2020 where they were washed with clean water and left at room temperature (atmospheric temperature : 24.3 – 27.9, humidity: 67 %- 77 %) overnight. The experiment was set up on Tuesday, 15th December, 2020.

Table 1. Locations from which varieties were harvested

Farmer	Gender	Genotype	Location			GPS	Distance
			Village	Parish	Sub-county		
A	Woman	▪Tanzania ▪SPK 004	Akisimi	Orupe	Kateera	1.4833265, 33.5494144	0 (reference)
B	Man	▪NASPOT 10 O ▪Ejumula	Marubanya	Odungura	Olio	1.5702297, 33.519784	13
C	Woman	▪NASPOT 8 ▪NASPOT 13	Kamusala A	Kamusala	Kateeta		17

2.1.2 Flesh and skin colors of the genotypes and their planting dates

The genotypes used in the study were of varying flesh colors as shown in Table 2.

Table 2. Genotypes harvested, their skin and flesh colors and planting dates

Order of harvesting	Genotype	Other names	Skin color	Flesh color	Planting date
1	Tanzania	"Soroti", "Osokut", "Mbale"	Cream	Cream	17th August
2	SPK 004	Kakamega	Pink	Yellow-orange	17th August
3	Ejumula		Cream	Orange	15th August
4	NASPOT 10 O	"Kabode"	Pink	Orange	15th August
5	NASPOT 13		Cream	Orange	Early August
6	NASPOT 8		Red	Yellow-orange	Early August

2.1.3 Gender considerations during harvesting

Sample collection from farmers involved social interractions and thus gender perspectives had to be put into consideration. In Serere, wives usually weed the garden. Gardens that are not well managed with overgrown weeds are indicative of conflict at home. We avoided obtaining sweetpotatoes from such gardens. Additionally, permission to access the garden and obtain roots was sought from both husband and wife, and also from second generation house heads where applicable. Gardens located close to the house are important for the food security of the household as women, being the main actors in food preparation for the household can quickly harvest crops for food from there. We avoided sourcing material from such gardens.

2.1.4 COVID considerations during harvesting

All global, national and organizational COVID preventative measures were adhered to when engaging farmers during sample collection. We obtained samples from farming households. Only members of that household were involved in harvesting and sorting the sweetpotato roots. No additional labor was sought from members outside the household including neighbors. None of the members of the research team or farming households had any COVID 19 related symptoms.

2.2 Study design

2.2.1 Experimental set-up

The study was designed as a randomized block design. Six sweetpotato genotypes of varied flesh colors were used in this study. Roots were randomly selected from each genotype and placed without heaping in 3 different humidity and temperature conditions (room, warm and cold – Picture 1) for a period of 14 days. The set-up is illustrated in Picture 1.

Picture 1. Set-up of the cold, room and warm experiments

To achieve the cold conditions, roots of different varieties were placed separately on different shelves of a refrigerator controlled between 8 - 10°C. For room conditions, roots were placed on a raised wooden table lined by aluminium foil located in room with brick walls, a tiled roof and cardboard ceiling. The warm conditions were attained in an incubator set at 30°C. Due to respiration of the sweetpotato roots, it was difficult to control the humidity and it was usually above 90%. Roots were washed using clean water to remove any soil or loose debris and patted dry before setting up the experiment.

Temperature and humidity conditions were monitored daily using a wireless hygro-thermometer (EXTECH, FLIR systems Inc, Model No: RH200W) with sensors placed in each of the test conditions. The experiment was set up on the 15th December, 2020 at 11:30 a.m. On each day, temperature and humidity readings were taken in the morning, afternoon and evening, and the minimum and maximum readings were read at the end of the day.

2.2.2 Sampling

Blinding sample codes were generated in excel consisting of numbers or letters or a combination of the two and uniquely assigned to samples by day of experiment, variety, and treatment. Samples were retrieved for data collection at baseline (day 0), day 1 (24 hours from the start of the experiment), day 4 (four days after the start of the experiment), day 7 (7 days after the start of the experiment) and day 14 (14 days after the start of the experiment). On each day of data collection, three biological replicates (storage roots) of each variety were obtained from each treatment. Any roots that were rotting at any time during the experiment were thrown away and not used to make the freeze-dried sample.

2.2.3 Preparation of freeze-dried samples

Roots were washed, peeled, and then washed again with distilled water. They were then patted dry with paper towels and sliced thinly. Thereafter, 70g of sliced flesh was weighed into a plastic bag and frozen then freeze dried. The freeze dried and milled material was combined to make a single powdered sample. This sample was scanned with NIRS in Namulonge (Uganda) and sent to FANEL labs for chemical analysis.

2.2.4 Transportation and storage at FANEL

Ninety individual freeze-dried powdered samples representing the various varieties stored under different storage and time treatments were sent to FANEL laboratories in Kenya via air freight cargo using DHL. At FANEL the samples were stored in cold conditions at -4°C prior to analysis.

2.3 Analyses

2.3.1 Dry matter

Dry matter content was calculated as the weight of a sample after freeze drying expressed as a percentage of the wet sample (wet basis).

Hypothesis: Dry matter content of sweetpotatoes decreases with storage time at different rates in different temperature and humidity conditions

2.3.2 Scanning with NIRS

The samples were scanned with NIRS to quantify several nutritional parameters such as sugar and beta carotene. The three replicates for each genotype, treatment and storage period were pooled together, mixed and scanned twice such that there were two readings. Beta carotenes are stable to heat but susceptible to UV light. It was therefore envisaged that more loss of beta carotene would be observed among roots stored under room conditions since the roots were exposed to light.

2.3.3 Determination of Vitamin C

Vitamin C (ascorbic acid) was analysed using HPLC method as described in Gazdik et al. (2008). First, 2 g of each lyophilized sample (in triplicate) were weighed in a Falcon tube and 10 ml of 3% metaphosphoric acid were added. The sample solution was then homogenized using a vortex for 2 min and centrifuged at 3,000 rpm for 10 min before being filtered (using Whatman #4) in separate clean tubes. The extraction was repeated twice with 5 ml of 3% metaphosphoric acid. The final volume of the extract was topped up to the 20 ml mark with 3% metaphosphoric acid. Finally, the extract was passed through membrane filter 0.45 µm (to remove any small particles) into vials and loaded on the HPLC. Standard test values for the standardized ascorbic acid solutions (µg ascorbic acid per ml) were plotted or calculated by linear regression. The amount of ascorbic acid in the sample in µg of ascorbic acid per ml were read off the standard calibration curve or calculated.

The ascorbic acid content in 100 g of the sample material is calculated by the formula below:

$$\text{Vitamin C (mg/100 g)} = \frac{\mathbf{A2 \times C1 \times V}}{\mathbf{A1 \times 10 \times W}}$$

Where: A1 = peak area of standard solution
C1 = concentration of standard solution (µg/ml)
A2 = peak area of sample
V = final volume of sample (ml)
W = weight of sample (g)

2.3.4 Determination of individual and total sugars

From each sample, 2g of lyophilized material (in triplicate) was weighed into 50ml Falcon tubes. To neutralize the samples, 1 g of CaCO3 was added, followed by 10 mL

of 85 % ethanol. The tubes were capped with aluminum foil and placed on a shaking water bath at 85°C for 1 h. The samples were removed from the shaking water bath, vortexed, centrifuged for 5 minutes at 3000 rpm and immediately filtered through a filter paper into clean 50 mL falcon tubes. The extraction was repeated with 5 mL of 85% ethanol and returned in the water bath for it to boil for 30 minutes. The process of vortexing, centrifugation and filtration was repeated as above. The final volume of the extract was then topped to 10 mL with 85 % ethanol. The extract was concentrated using a vacuum evaporator to 3 ml and topped up with 85 % ethanol to 6ml final volume. The solution was filtered through an ultrafilter (0.45 µm). The samples were kept in sample vials and injected into the HPLC. Individual standard solutions of glucose, sucrose and fructose (Sigma) were prepared at concentrations of 4% and a mixed solution was also prepared at the same concentration and run together with the samples. 10 µl of the sample was injected into the refractive index detector through a Eurospher 100-5 NH_2 (Knauer, Berlin) column with dimensions 250 X 4.6 mm. The mobile phase constituted as follows: Acetonitrile: distilled water: ethanol = 82: 17: 1 at a flow rate of 1 ml/min. The sucrose, glucose and fructose peaks were identified within a 10min run time and peak areas calculated to represent the concentration mg/ml of each.

$$\text{Amount of each sugar (g/100g)} = \frac{A_{SPL} \times C_{STD}}{A_{STD}} \times \frac{V}{W}$$

Where: ASPL = area/peak height of each sugar in sample solution
ASTD = area/peak height of sugar standard
CSTD = concentration of sugar standard (g/100 mL)
V = total volume of prepared sample solution (mL)
W = weight of sample (g)

2.3.5 Determination of carotenoids in sweetpotato samples

The method is based on saponification using ethanol (with Butylated hydroxytoluene) and 80 % KOH. Carotenoid were extracted using hexane. The extract was washed, dried under nitrogen, reconstituted and injected into the HPLC. Quantification was done against previously prepared carotenoid standards. The procedure was done under yellow light using amber glassware and aluminum foil to minimize loss of carotenoids during analysis.

2.4 Data Analysis

Data were collected and entered in a database in Excel. In order to understand the temporal effect of storage conditions on different varieties over time, ANOVA with repeated measures was used (α=5 %).

3 RESULTS

3.1 Qualitative biophysical changes during storage

The qualitative changes in the different genotypes of sweetpotato by storage condition over the study period are summarized in Table 3.

Table 3. Qualitative biophysical changes of different sweetpotato varieties by storage conditions

Genotype	Storage conditions		
	Cold	Room	Warm
Ejumula			Day 14: Sprouting
Kakamega			
NASPOT 10 O		Day 7: Rotting	Day 14: Sprouting
NASPOT13 O			Day 7: Bad smell
NASPOT 8	Day 7: Black streaks	Day 7: Rotting	Day 14: Rotting
	Day 14: Spoiling		
Tanzania			Day 7: Sprouting

NASPOT 8 changed the most as it developed black streaks in cold storage, and started rotting in other conditions. On the other hand, Kakamega showed no observed physical qualitative changes over the period. Roots stored in warm conditions were especially affected by sprouting.

The results show that incidence of qualitative changes was dependent on both variety and storage conditions. Ejumula, Kakamega and Tanzania did not present with changes such as rotting, developing black streaks in flesh, or repulsive smells. Most qualitative changes were observed in roots of NASPOT 8 in all storage treatments. Cold storage conditions preserved the qualitative quality of the roots. Roots of NASPOT 8 and NASPOT 10 O started rotting half-way through the experiment in room temperature conditions. Most varieties sprouted during storage under warm conditions, while others rotted or developed bad smells. Sweetpotatoes stored in warm conditions such as in sand pits have been shown to also sprout during storage.

3.2 Changes in dry matter content of sweetpotato during storage

The graphs in Figure 1. show the change in dry matter of the storage roots over the storage period by variety. There was a significant difference between the varieties used in the study ($p<0.001$). NASPOT 10 O, commonly known as Kabode, was lowest in dry matter (30.8%) followed by Kakamega (32.5%), NASPOT 8 (36.5%) and Ejumula (37.4%), Tanzania (38.8%) and NASPOT 13 O (40.1%) had the highest level of dry matter. NASPOT 13 O was the only orange fleshed variety with a dry matter content significantly higher than Tanzania, a consumer preferred cream fleshed variety. There was no significant change in the variation among the varieties with time.

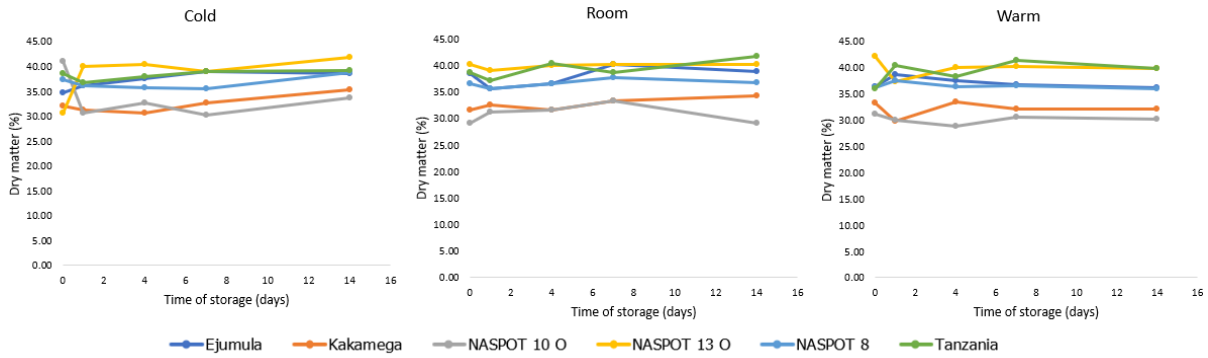

Figure 1. Dry matter content (%) of different sweetpotato genotypes by storage condition during 14 day storage period

There was no significant variation in dry matter content of the roots over time (p = 0.448) until the last day which is evidence for the quadratic relationship between time and storage conditions (p = 0.040). The dry matter of the roots stored in room conditions is higher than that of the roots in cold and warm storage conditions. This could be attributed to the low humidity in the room conditions, compared to other conditions that could have facilitated more water loss by evaporation from the roots. This relationship was further modified by variety and the interaction between the three factors was also quadratic in nature (p = 0.028).

3.3 Results of chemical analysis using NIRS

3.3.1 Changes in starch and sugar composition among sweetpotato roots

The changes in starch content of the sweetpotato generally decreased with time (Table 4.) following a linear or quadratic trend over time. Roots stored in cold conditions generally had the highest decline in their starch content. However, NASPOT 10 O and Ejumula experienced the highest decline in percentage starch while stored in warm conditions indicating variety specific variations in starch loss by storage conditions.

Table 4. Starch loss (%) of different sweetpotato genotypes by storage condition over 14 – day storage period analysed using NIRS

Genotype	Room conditions	Warm conditions starch loss (%)	Cold conditions	P value[1]	P value[2]
Ejumula	3.1	3.2	6.6	<0.001	<0.001
Kakamega	0.4	5.0	2.3		
NASPOT 8	1.8	-1.5	9.6		
NASPOT 10 O	2	8.1	7.9		
NASPOT 13 O	-1.9	0.4	6.8		
Tanzania	0.7	-2.0	8.2		

P-value by ANOVA with repeated measures
[1]Among varieties
[2]Among storage conditions

In terms of sugar profiles, Kakamega generally had a higher concentration of fructose than other varieties (Table 5.). The changes in fructose content varied by storage condition and variety. The most significant changes in sugar were noted for sucrose in cold storage conditions.

Table 5. Percentage sugar composition at baseline (day 0) and day 14 of sweetpotato genotypes by storage conditions analysed using NIRS

Variety	Room temperature		Warm conditions		Cold conditions		P value[1]	P value2
	Day 0	Day 14	Day 0	Day 14	Day 0	Day 14		
	mean±SD		mean±SD		mean±SD			
Ejumula	0.7±0.0	1.0±0.1	0.7±0.0	1.0±0.1	0.4±0.1	0.6±0.1	<0.001	<0.001
Kakamega	1.0±0.0	1.2±0.4	0.9±0.5	1.2±0.1	1.2±0.1	1.2±0.1		
NASPOT 8	0.6±0.1	1.1±0.1	0.7±0.1	0.6±0.1	0.5±0.1	1.1±0.1		
NASPOT 10 O	0.4±0.0	2.2±0.5	0.1±0.0	0.6±0.0	0.5±0.1	0.3±0.2		
NASPOT 13 O	0.6±0.1	0.7±0.0	0.8±0.0	0.8±0.0	0.5±0.0	0.7±0.1		
Tanzania	0.8±0.1	0.6±0.1	0.4±0.1	0.3±0.1	0.4±0.1	0.3±0.1		
	Glucose							
Variety	Room temperature		Warm conditions		Cold conditions		P value[1]	P value[2]
	Day 0	Day 14	Day 0	Day 14	Day 0	Day 14		
	mean±SD		mean±SD		mean±SD			
Ejumula	1.2±0.1	1.6±0.3	1.2±0.1	1.5±0.1	1.1±0.1	1.5±0.2	<0.001	0.007
Kakamega	1.4±0.2	1.7±0.1	1.1±0.1	1.8±0.2	1.6±0.1	1.7±0.1		
NASPOT 8	1.4±0.2	1.1±0.1	1.4±0.2	1.4±0.1	1.1±0.1	2.1±0.2		
NASPOT 10 O	1.5±0.1	3.6±0.2	0.7±0.1	1.9±0.1	1.3±0.2	1.4±0.3		
NASPOT 13 O	0.9±0.1	1.0±0.3	1.3±0.0	0.9±0.0	0.7±0.1	1.3±0.2		
Tanzania	1.4±0.1	1.2±0.1	1.2±0.2	1.3±0.1	1.1±0.1	1.4±0.1		
	Sucrose							
Variety	Room temperature		Warm conditions		Cold conditions		P value[1]	P value[2]
	Day 0	Day 14	Day 0	Day 14	Day 0	Day 14		
	mean±SD		mean±SD		mean±SD			
Ejumula	9.2±0.1	13.7±1.9	9.2±0.1	11.9±0.2	13.0±0.2	19.6±0.0	<0.001	<0.001
Kakamega	14.1±0.3	13.5±0.0	10.5±0.2	14.4±0.1	10.2±0.2	13.3±0.0		
NASPOT 8	11.8±0.3	12.6±0.1	11.3±0.1	12.6±0.1	11.2±0.1	22.9±0.1		
NASPOT 10 O	14.1±0.1	11.8±0.1	5.5±0.6	12.1±0.2	11.6±0.2	20.7±0.2		
NASPOT 13 O	13.3±0.2	12.1±0.1	11.2±0.0	11.8±0.0	11.6±0.1	22.9±0.1		
Tanzania	7.9±0.1	8.3±0.3	10.0±0.0	9.8±0.1	8.1±0.2	18.0±0.0		

P-value by ANOVA with repeated measures
[1]Among varieties
[2]Among storage conditions

The amount of sucrose of NASPOT 8, NASPOT 10 O, NASPOT 13 O, and Tanzania had doubled at 14 days compared to the content at baseline. These findings where the starch content of sweetpotatoes decreases as the sucrose content increases during storage has been corroborated by Nabubuya and colleagues (2017).

3.3.2 Changes in betacarotene among sweetpotato roots

Generally, one of the orange varieties - NASPOT 13 O had the highest level of betacarotene, while Tanzania, a cream fleshed variety did not have any betacarotenes (Table 6.). The level of betacarotenes decreased with time for most varieties and storage conditions but increased in other cases. There is no clear relationship between the storage conditions and the amount of betacarotene lost over time. This is because betacarotenes are stable to varied thermal conditions. Previous studies have also reported mixed observations in the changes in betacarotene content of stored sweetpotato over time (Dadango and Gugula, 2011).

Table 6. Average beta-carotene content (mg/100g) at baseline (day 0) and endline (day 14) by variety and storage conditions analysed using NIRS

Genotype	Room temperature		Warm conditions		Cold conditions		P value[1]	P value[2]
	Day 0	Day 14	Day 0	Day 14	Day 0	Day 14		
	mean±SD		mean±SD		mean±SD			
Ejumula	4.8±0.1	8.6±0.1	5.9±0.3	9.9±0.1	13.9±0.3	18.4±0.1	<0.001	<0.001
Kakamega	7.9±0.2	7.0±0.2	3.9±0.3	6.7±0.1	15.1±0.4	9.8±0.0		
NASPOT 8	8.0±0.1	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	6.3±0.1		
NASPOT 10 O	11.2±0.3	9.9±0.2	0.0±0.0	7.7±0.2	8.0±0.1	8.5±0.1		
NASPOT 13 O	22.0±0.2	22.7±0.0	16.6±0.0	13.5±0.0	14.7±0.1	11.6±0.2		
Tanzania	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0		

P-value by ANOVA with repeated measures adjusted by Greenhouse-Geisser ; linear, quadratic, cubic order and order 4 relationship significant ($p<0.001$)

[1]Among varieties

[2]Among storage conditions

3.4 Results from chemical analysis in wet chemistry laboratory (FANEL)

3.4.1 Changes in simple sugar content of sweetpotato roots

The main simple sugar in sweetpotatoes was sucrose (Table 7.). Generally, the sucrose content of the sweetpotatoes increased over time. Similar to results obtained from the NIRS scans, the sucrose content of the sweetpotatoes stored in cold conditions increased the most. In these conditions, the sucrose content of Kakamega and NASPOT 13, each increased by at least 10 g on day 14 compared to baseline, and Tanzania doubled in sucrose content.

3.4.2 Changed in Vitamin C content of sweetpotato roots

According to Table 8., there was generally little vitamin C found in the sweetpotatoes under study in the various storage treatments. The amounts ranged from 0.1 mg/100g to 0.7 mg/100g (Ejumula, cold storage conditions on day 14). Despite vitamin C being a thermal labile nutrient, the warm and room temperature conditions did not have a significant negative effect on its composition over time since the temperatures were not very high.

Table 7. Percentage sugar composition (dmb) composition at baseline(day 0) and day 14 of sweetpotato genotypes by storage conditions analysed using HPLC

	Fructose					
Genotype	Room temperature		Warm conditions		Cold conditions	
	Day 0 mean±SD	Day 14	Day 0 mean±SD	Day 14	Day 0 mean±SD	Day 14
Ejumula	0.17±0.1	0.74±0.0	0.1±0.0	1.4±0.2	0.4±0.0	0.4±0.1
Kakamega	0.5±0.0	1.1±0.0	0.2±0.0	0.6±0.0	0.8±0.0	1.2±0.0
NASPOT 8	0.4±0.0	0.9±0.0	0.3±0.0	0.2±0.0	0.2±0.0	1.4±0.0
NASPOT 10 O	0.8±0.1	3.8±0.1	1.3±0.1	2.0±0.1	0.9±0.0	0.9±0.0
NASPOT 13 O	0.2±0.0	0.1±0.0	0.2±0.0	0.1±0.0	0.1±0.0	0.9±0.0
Tanzania	0.1±0.0	0.1±0.0	0.1±0.0	0.0±0.0	0.0±0.0	0.1±0.0
	Glucose					
Genotype	Room temperature		Warm conditions		Cold conditions	
	Day 0 mean±SD	Day 14	Day 0 mean±SD	Day 14	Day 0 mean±SD	Day 14
Ejumula	0.40±0.0	0.19±0.2	0.3±0.0	1.9±0.4	0.6±0.0	0.6±0.1
Kakamega	0.9±0.0	0.6±0.0	0.6±0.0	1.7±0.5	0.4±0.0	1.0±0.3
NASPOT 8	0.7±0.0	1.5±0.1	0.6±0.0	0.6±0.0	0.4±0.0	1.8±0.1
NASPOT 10 O	1.2±0.2	5.4±0.2	1.9±	3.7±0.2	1.6±0.1	1.3±0.1
NASPOT 13 O	0.6±0.1	0.4±0.1	0.3±0.1	0.3±0.0	0.2±0.0	1.1±0.1
Tanzania	0.2±0.1	0.2±0.0	0.2±0.0	0.2±0.0	0.1±0.0	0.2±0.1
	Sucrose					
Genotype	Room temperature		Warm conditions		Cold conditions	
	Day 0 mean±SD	Day 14	Day 0 mean±SD	Day 14	Day 0 mean±SD	Day 14
Ejumula	18.0±0.6	23.6±1.4	17.1±1.0	22.4±1.8	25.7±1.5	33.5±3.0
Kakamega	24.4±0.4	24.9±0.5	31.9±1.9	32.2±1.4	21.6±3.0	30.9±2.7
NASPOT 8	17.4±0.4	23.0±1.0	22.7±1.0	23.8±0.9	19.7±0.8	34.5±1.5
NASPOT 10 O	24.6±0.9	29.4±1.3	24.4±0.7	22.1±1.7	29.0±1.3	35.5±3.6
NASPOT 13 O	28.2±1.6	31.8±0.8	18.7±1.7	24.8±0.4	18.8±0.6	27.9±2.6
Tanzania	15.9±1.3	13.1±0.7	17.3±1.3	18.0±1.4	14.1±0.4	32.0±0.4
	Total sugar					
Genotype	Room temperature		Warm conditions		Cold conditions	
	Day 0	Day 14	Day 0	Day 14	Day 0	Day 14
	mean±SD		mean±SD		mean±SD	
Ejumula	18.5±0.7	25.5±1.2	17.6±1.0	25.7±2.0	26.6±1.5	34.5±3.0
Kakamega	24.8±0.4	28.2±0.5	31.8±1.9	34.4±2.0	23.7±3.0	34.0±2.3
NASPOT 8	18.5±0.4	25.5±1.0	23.6±0.1	24.7±0.9	20.3±0.8	37.7±1.6
NASPOT 10 O	26.6±1.2	38.6±1.5	27.6±0.9	27.8±2.0	31.4±1.5	37.5±3.8
NASPOT 13 O	29.0±1.7	32.4±0.9	19.2±1.7	25.2±0.5	19.0±0.7	29.9±2.6
Tanzania	16.3±1.4	13.3±0.7	17.6±1.4	18.2±1.5	14.2±0.4	32.4±0.4

Table 8. Average vitamin C content (mg/100g, dmb) at baseline(day 0) and day 14 of sweetpotato genotypes by storage conditions analysed using HPLC

Genotype	Room temperature		Warm conditions		Cold conditions	
	Day 0	Day 14	Day 0	Day 14	Day 0	Day 14
	mean±SD		mean±SD		mean±SD	
Ejumula	0.2±0.0	0.2±0.0	0.3±0.0	0.3±0.0	0.3±0.0	0.7±0.1
Kakamega	0.4±0.1	0.3±0.0	0.2±0.0	0.2±0.0	0.3±0.0	0.4±0.0
NASPOT 8	0.4±0.1	0.6±0.1	0.5±0.1	0.1±0.0	0.1±0.0	0.0±0.0
NASPOT 10 O	0.5±0.0	0.6±0.0	0.1±0.0	0.2±0.0	0.5±0.0	0.4±0.0
NASPOT 13 O	0.2±0.0	0.3±0.0	0.2±0.0	0.3±0.0	0.1±0.0	0.1±0.0
Tanzania	0.2±0.0	0.2±0.0	0.1±0.0	0.1±0.0	0.1±0.0	0.1±0.0

3.4.3 Betacarotene

There are mixed results concerning the changes in betacarotene content among the different varieties studied and the times.

Table 9. Average beta-carotene content of different sweetpotato genotypes (mg/100g dm) at baseline (day 0) and endline (day 14) by variety and storage conditions analysed using HPLC

Variety	Room temperature		Warm conditions		Cold conditions	
	Day 0	Day 14	Day 0	Day 14	Day 0	Day 14
	mean±SD		mean±SD		mean±SD	
Ejumula	4.8±0.1	8.6±0.1	5.9±0.3	9.9±0.1	13.9±0.3	18.4±0.1
Kakamega	7.9±0.2	7.0±0.2	3.9±0.3	6.7±0.1	15.1±0.4	9.8±0.0
NASPOT 8	8.0±0.1	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	6.3±0.1
NASPOT 10 O	11.2±0.3	9.9±0.2	0.0±0.0	7.7±0.2	8.0±0.1	8.5±0.1
NASPOT 13 O	22.0±0.2	22.7±0.0	16.6±0.0	13.5±0.0	14.7±0.1	11.6±0.2
Tanzania	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0

3.4.4 Overall nutritional changes in sweetpotato roots during storage

Even though there is growing evidence that the sweetness of boiled sweetpotato is predicted by maltose in cooked sweetpotato, sucrose is still the main predictor of sweet taste in raw sweetpotato. Thus, the increasing sucrose levels may indicate increased sweetness. The increased sucrose follows the reduced starch content. Starch is still believed to be an important factor in the texture of boiled sweetpotatoes, especially mealiness. The increase in sugar composition could also indicate the possibility of increased sweetness of samples once cooked. There is therefore a possible effect of the storage on the sensory attributes of the sweetpotato after cooking. While sweet products are desirable, loss of starch could contribute to reduced mealiness in texture and the effect of the trade-off on consumer acceptability should be an objective of future research.

4 CONCLUSIONS

4.1 Main Findings

Generally, this study shows the relationship between temperature and humidity storage conditions and variety on shelf stability of sweetpotato roots. Specific findings are summarized below:

1) The dry matter content is consistent until after the first week. This indicates that dry matter is a fairly stable parameter in sweetpotato stored for less than two weeks.

2) Sugar composition increased while starch content decreased variably among genotypes and storage conditions which suggests a storage condition and variety dependent influence on changes in sugar and starch composition of sweetpotatos in storage even within short storage period of 2 weeks

3) There were mixed trends in changes in betacarotene composition of sweetpotato roots over the storage period by variety and storage composition and as such the effect of variety and storage conditions on the level of betacarotene of sweetpotato roots remains inconclusive

4.2 Limitations

The study was conducted in a laboratory space with tiled roof and a ceiling. The construction details of the building could have contributed to the room conditions and the results should thus be interpreted with caution to consider the housing of sweetpotato farmers.

4.3 Implications

The study shows that there are some varieties that can stay longer than others under room conditions in Uganda. The potential use of room temperature condition is important since it requires no environmental modification resulting in minimal economic burden. Replicate studies to validate the findings and complimentary studies to identify more shelf stable varieties are necessary to further explore and validate this observation. Furthermore, recommended practices such as not heaping that could facilitate the extended shelf stability of sweetpotato roots stored under these conditions should be established and included in extension messages. Upon validation, if a link between variety and shelf life stability in room conditions is confirmed, breeders should study possible genetic underpinnings for this observation and select for shelf stability.

NASPOT 8, a well-known orange fleshed sweetpotato variety not only spoiled quickly but was also found to have no beta-carotenes in many cases, regardless of storage condition and analytical method. These results should be interpreted with caution as it is not conclusive evidence that NASPOT 8 is not a source of betacarotene. However, it is possible that other factors such as maturity play a role in the accumulation of betacarotene in different sweetpotato varieties. Based on this supposition, a temporal study on the development of betacarotene in different sweetpotato varieties would be beneficial to validate this observation and provide consumers with important recommendations.

5 REFERENCES

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Appendix 1. Changes in sugar content, vitamin C and beta careotene composition of sweetpotato genotypes by storage treatment over the period of the study using HPLC (FANEL)

Genotype	Storage treatment	Time (days)	Sample code	Fructose g/100g	Glucose g/100g	Sucrose g/100g	Total sugar g/100g	Vitamin C (mg/100g)	Beta carotene (mg/100g)
EJUMULA	ROOM	0	20SPSSS125	0.17±0.1	0.398±0.0	17.98566±0.6	18.54062±0.7	0.23±0.0	9206.6±12.7
		1	20SPSSS166	0.292805±0.0	0.520577±0.0	19.45398±1.1	20.26732±1.2	0.25±0.1	12981.3±93.3
		4	20SPSSS518	0.41886±0.1	0.814317±0.2	28.27577±2.6	29.50894±2.8	0.27±0.0	14523.7±35.3
		7	20SPSSS192	0.363366±0.0	0.63809±0.1	19.30422±0.9	20.30567±1.0	0.23±0.0	8918.0±57.1
		14	20SPSSS237	0.74±0.0	1.19±0.2	23.60299±1.4	25.53±1.2	0.22±0.0	18021.2±17.9
	WARM	0	20SPSSSQ93	0.142673±0.0	0.342852±0.0	17.07879±1.0	17.56432±1.0	0.31±0.0	14848.3±70.0
		1	20SPSSST00	0.318321±0.0	0.614531±0.2	21.19952±1.3	22.13237±1.4	0.22±0.0	5383.2±101.5
		4	20SPSSSW73	0.661898±0.0	1.353157±0.1	22.11634±0.6	24.1314±0.7	0.18±0.0	10844.0±33.8
		7	20SPSSSV97	0.482459±0.0	0.752946±0.1	21.35154±0.2	22.58694±0.3	0.23±0.0	8022.1±63.9
		14	20SPSSSB57	1.41284±0.2	1.859158±0.4	22.38619±1.8	25.65818±2.0	0.30±0.0	14280.4±70.6
	COLD	0	20SPSSSRCO	0.369491±0.0	0.558233±0.0	25.69662±1.5	26.62434±1.5	0.27±0.0	14409.3±58.8
		1	20SPSSSPJV	0.545446±0.1	1.029989±0.1	31.55463±0.8	33.13006±0.5	0.29±0.0	17402.0±125.4
		4	20SPSSSBCS	0.234046±0.0	0.481152±0.0	26.56373±1.4	27.27893±1.5	0.28±0.0	14566.9±42.4
		7	20SPSSSPWH	0.888749±0.0	1.108698±0.1	22.08952±0.8	24.08697±1.0	0.28±0.0	9197.2±86.8
		14	20SPSSSPAW	0.356±0.1	0.623±0.1	33.50143±3.0	34.4839±3.0	0.74±0.1	8497.1±45.6
KAKAMEGA	ROOM	0	20SPSSS131	0.455168±0.0	0.916138±0.0	24.43349±0.4	25.8048±0.4	0.36±0.1	14783.3±104.4
		1	20SPSSS194	0.518582±0.1	1.212996±0.3	23.30413±1.6	25.0357±1.9	0.33±0.0	14740.0±99.7
		4	20SPSSS519	1.169572±0.1	2.338648±0.1	31.45186±1.7	34.96008±1.7	0.20±0.0	14357.9±48.6
		7	20SPSSS374	1.190943±0.0	1.951269±0.0	21.26385±2.5	24.40606±2.5	0.19±0.0	22156.5±108.7
		14	20SPSSS304	1.088965±0.0	2.244419±0.1	24.89515±0.5	28.22854±0.5	0.33±0.0	17635.1±87.2
	WARM	0	20SPSSSY38	0.163435±0.0	0.599523±0.0	31.0204±1.9	31.78335±1.9	0.24±0.0	15506.7±61.1
		1	20SPSSSH30	0.653644±0.0	1.447327±0.1	25.27235±1.8	27.37332±1.9	0.42±0.0	12162.5±44.2
		4	20SPSSSE28	0.555575±0.0	1.163786±0.1	22.6825±1.1	24.40187±1.2	0.19±0.0	16889.5±114.6
		7	20SPSSSZ70	1.158358±0.1	2.945665±0.3	33.64532±0.9	37.74935±1.3	0.30±0.0	15330.3±42.5
		14	20SPSSSB13	0.56±0.1	1.67±0.5	32.17848±1.4	34.408±2.0	0.24±0.0	16302.4±24.6
	COLD	0	20SPSSSQHL	0.754792±0.0	1.392537±0.0	21.56386±3.0	23.71119±3.0	0.32±0.0	12128.4±80.0
		1	20SPSSSIAK	0.886791±0.0	1.880669±0.1	39.06508±1.5	41.83254±1.6	0.37±0.0	11938.1±92.9

Genotype	Storage treatment	Time (days)	Sample code	Fructose g/100g	Glucose g/100g	Sucrose g/100g	Total sugar g/100g	Vitamin C (mg/100g)	Beta carotene (mg/100g)
		4	20SPSSSWVY	0.986577±0.0	1.612235±0.2	32.43079±0.3	35.02961±0.5	0.51±0.0	17094.6±112.5
		7	20SPSSSYY	1.49336±0.1	2.463789±0.1	27.77844±0.9	31.73559±1.0	0.27±0.0	7900.1±147.0
		14	20SPSSSHMS	1.163758±0.1	1.944402±0.3	30.87842±2.7	33.98658±2.3	0.40±0.0	14031.8±36.8
NASPOT 8	ROOM	0	20SPSSS333	0.415±0.0	0.650298±0.0	17.44851±0.4	18.5136±0.4	0.42±0.1	0 ± 0.0
		1	20SPSSS688	0.517±0.1	0.768964±0.1	24.85262±0.7	26.1382±0.9	0.79±0.1	0 ± 0.0
		4	20SPSSS877	0.819724±0.0	1.179713±0.1	22.54672±0.5	24.54616±0.7	0.37±0.1	0 ± 0.0
		7	20SPSSS369	0.774881±0.0	1.236371±0.1	23.92023±0.7	25.93148±0.7	0.22±0.1	0 ± 0.0
		14	20SPSSS781	0.896±0.0	1.534095±0.1	23.02182±1.0	25.45219±1.0	0.64±0.1	0 ± 0.0
	WARM	0	20SPSSSO14	0.304±0.0	0.578518±0.0	22.70128±0.0	23.58399±0.1	0.48±0.1	0 ± 0.0
		1	20SPSSSD72	0.734219±0.0	1.019995±0.0	18.42316±0.3	20.17737±0.3	0.12±0.0	0 ± 0.0
		4	20SPSSSA15	0.650898±0.1	1.080127±0.1	23.27158±0.6	25.0026±0.8	0.23±0.0	0 ± 0.0
		7	20SPSSSI04	0.589±0.0	1.163715±0.1	25.13808±1.4	26.89118±1.5	0.61±0.1	0 ± 0.0
		14	20SPSSSQ57	0.22±0.0	0.63±0.0	23.81879±0.9	24.6673±0.9	0.11±0.0	0 ± 0.0
	COLD	0	20SPSSSMKH	0.230884±0.0	0.368±0.0	19.73841±0.8	20.33771±0.8	0.07±0.0	0 ± 0.0
		1	20SPSSSVZX	0.39±0.1	0.59±0.2	20.74993±0.4	21.73244±0.7	0.11±0.0	0 ± 0.0
		4	20SPSSSBTR	0.629829±0.1	0.895047±0.0	32.40319±0.7	33.92806±0.7	0.27±0.1	0 ± 0.0
		7	20SPSSSJPY	0.393308±0.0	0.567162±0.0	30.56705±1.5	31.52752±1.5	0.12±0.0	5117.8±18.7
		14	20SPSSSNOO	1.436502±0.1	1.76±0.1	34.53554±1.5	37.72875±1.6	0.11±0.0	0 ± 0.0
NASPOT 10 O	ROOM	0	20SPSSS659	0.76±0.1	1.24±0.2	24.60884±0.9	26.611±1.2	0.46±0.0	14977.0±88.9
		1	20SPSSS526	1.760557±0.1	2.314713±0.2	26.11274±2.8	30.18801±3.0	0.54±0.0	11463.6±34.4
		4	20SPSSS236	3.033856±0.0	3.688055±0.0	26.17155±0.1	32.89346±0.1	0.43±0.0	19824.2±101.6
		7	20SPSSS685	0.556249±0.0	0.897333±0.2	27.28899±1.8	28.74257±2.0	0.35±0.0	11289.5±47.0
		14	20SPSSS726	3.81756±0.1	5.434437±0.2	29.38122±1.3	38.63321±1.5	0.55±0.0	19868.0±117.4
	WARM	0	20SPSSSJ95	1.302237±0.1	1.896431	24.35732±0.7	27.55599±0.9	0.10±0.0	0 ± 0.0
		1	20SPSSSX88	0.553126±0.1	0.828716±0.1	23.69857±0.9	25.08041±0.8	0.40±0.0	8778.4±68.6
		4	20SPSSSZ78	2.128159±0.0	1.894752±0.3	37.88352±3.3	41.90643±3.1	0.58±0.0	18917.2±74.9
		7	20SPSSSB33	0.976741±0.2	1.480538±0.5	22.52223±1.4	24.97951±1.7	0.41±0.0	9199.3±111.2
		14	20SPSSSV78	2.03±0.1	3.66±0.2	22.12622±1.7	27.82±2.0	0.23±0.0	13363.8±77.6

Genotype	Storage treatment	Time (days)	Sample code	Fructose g/100g	Glucose g/100g	Sucrose g/100g	Total sugar g/100g	Vitamin C (mg/100g)	Beta carotene (mg/100g)
	COLD	0	20SPSSSFOC	0.784893±0.0	1.59081±0.1	29.02491±1.3	31.40062±1.5	0.48±0.0	0 ± 0.0
		1	20SPSSSVTY	1.29±0.1	1.89±0.0	27.81147±2.0	31.00092±2.1	0.41±0.0	14980.7±66.4
		4	20SPSSSINC	1.28±0.2	2.31±0.2	31.07882±2.6	34.671±3.0	0.27±0.1	18496.7±93.4
		7	20SPSSSLQU	1.440227±0.0	2.265±0.1	45.35044±0.7	49.05567±0.6	0.42±0.1	26297.1±92.4
		14	20SPSSSCRL	0.898486±0.0	1.269512±0.1	35.33564±3.6	37.50363±3.8	0.36±0.0	14553.1±100.8
NASPOT 13 O	ROOM	0	20SPSSS288	0.212365±0.0	0.627545±0.1	28.17287±1.6	29.01278±1.7	0.22±0.0	16284.0±125.8
		1	20SPSSS729	0.226065±0.0	0.406955±0.0	28.5226±0.4	29.15562±0.4	0.20±0.0	16981.3±88.3
		4	20SPSSS872	0.272049±0.0	0.399168±0.0	27.9762±0.5	28.64742±0.5	0.21±0.1	11557.5±154.6
		7	20SPSSS422	0.09±0.0	0.19±0.0	23.32215±1.5	23.513±1.5	0.14±0.0	9382.4±62.1
		14	20SPSSS810	0.12825±0.0	0.43434±0.1	31.83719±0.8	32.39978±0.9	0.25±0.0	14592.7±92.0
	WARM	0	20SPSSSP42	0.192052±0.0	0.283546±0.0	18.70563±1.7	19.18123±1.7	0.17±0.0	13672.8±92.3
		1	20SPSSSX27	0.344901±0.0	0.561545±0.1	25.84505±0.6	26.7515±0.7	0.32±0.0	18222.1±57.7
		4	20SPSSSL93	0.421856±0.0	0.729666±0.1	25.35188±1.7	26.5034±1.8	0.07±0.0	14652.0±22.8
		7	20SPSSST30	1.069641±0.1	1.348406±0.1	21.67144±1.6	28.11382±5.9	0.19±0.0	16173.5±127.2
		14	20SPSSSC86	0.058597±0.0	0.319311±0.0	24.78397±0.4	25.16187±0.5	0.28±0.0	9485.5±97.7
	COLD	0	20SPSSSZGL	0.055081±0.0	0.194808±0.0	18.7675±0.6	19.01739±0.7	0.14±0.0	30050.0±155.3
		1	20SPSSS153	0.270101±0.0	0.46773±0.1	24.10319±1.9	24.84102±2.0	0.20±0.1	18621.2±139.3
		4	20SPSSSRFI	0.17±0.0	0.33±0.0	21.5051±1.5	21.99718±1.5	0.49±0.0	19365.8±35.5
		7	20SPSSSDSZ	0.23±0.0	0.39±0.0	29.18081±0.7	29.80576±0.7	0.16±0.0	16311.5±92.2
		14	20SPSSSAMR	0.862498±0.0	1.112095±0.1	27.9039±2.6	29.87849±2.6	0.14±0.0	12149.0±106.0
TANZANIA	ROOM	0	20SPSSS890	0.128045±0.0	0.179167±0.0	15.94613±1.3	16.25334±1.4	0.15±0.0	0 ± 0.0
		1	20SPSSS337	0.183±0.1	0.23±0.1	14.91339±4.8	15.32562±4.9	0.45±0.0	0 ± 0.0
		4	20SPSSS695	0.191746±0.0	0.239337±0.0	16.32974±1.1	16.76083±1.1	0.19±0.0	0 ± 0.0
		7	20SPSSS343	0.180557±0.0	0.2785±0.1	20.01993±0.9	20.47899±1.0	0.25±0.0	0 ± 0.0
		14	20SPSSS352	0.076105±0.0	0.162603±0.0	13.07716±0.7	13.31587±0.7	0.18±0.0	0 ± 0.0
	WARM	0	20SPSSS012	0.092765±0.0	0.17±0.0	17.31079±1.3	17.57452±1.4	0.09±0.0	0 ± 0.0
		1	20SPSSSC58	0.028329±0.0	0.112168±0.0	13.85492±2.2	13.99542±2.3	0.09±0.0	0 ± 0.0
		4	20SPSSSJ26	0.181197±0.1	0.221009±0.0	20.8666±0.9	21.2688±0.9	0.06±0.0	0 ± 0.0

Genotype	Storage treatment	Time (days)	Sample code	Fructose g/100g	Glucose g/100g	Sucrose g/100g	Total sugar g/100g	Vitamin C (mg/100g)	Beta carotene (mg/100g)
		7	20SPSSSN99	0.051054±0.0	0.15±0.0	17.56746±0.5	17.77113±0.5	0.07±0.0	0 ± 0.0
		14	20SPSSSI11	0.041±0.0	0.15±0.0	17.9672±1.4	18.16105±1.5	0.14±0.0	0 ± 0.0
	COLD	0	20SPSSSDIS	0.03634±0.0	0.106218±0.0	14.06292±0.4	14.20547±0.4	0.07±0.0	0 ± 0.0
		1	20SPSSSXCE	0.156±0.0	0.22±0.0	18.14307±1.0	18.51776±1.0	0.29±0.0	0 ± 0.0
		4	20SPSSSMJA	0.0738±0.0	0.153514±0.0	18.88005±0.6	19.10737±0.5	0.09±0.0	0 ± 0.0
		7	20SPSSSJW	0.041246±0.0	0.110659±0.0	20.91707±0.4	21.06898±0.4	0.06±0.0	0 ± 0.0
		14	20SPSSSHZC	0.139084±0.0	0.247146±0.1	32.0036±0.4	32.38983±0.4	0.12±0.0	0 ± 0.0

RESEARCH PROGRAM ON Roots, Tubers and Bananas

CGIAR

The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is a partnership collaboration led by the International Potato Center implemented jointly with the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), and the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), that includes a growing number of research and development partners. RTB brings together research on its mandate crops: bananas and plantains, cassava, potato, sweetpotato, yams, and minor roots and tubers, to improve nutrition and food security and foster greater gender equity especially among some of the world's poorest and most vulnerable populations.

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