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CONTRIBUTION OF PLANTING SPACE AND HARVESTING PERIOD ON THE NUTRIENT COMPOSITIONS OF SOME OFSP SWEET POTATO VARIETIES GROWN IN SOUTHEAST NIGERIA ULTISOL

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ABSTRACT

Two varieties of OFSP (Ex-Igbariam and Umuspo 3) planted at 20 cm x 1m, 30 cm x 1m and 40 cm x 1m and harvested after 12th and 16th weeks were analyzed for nutrient compositions. The statistical analysis showed wide variations in their proximate, mineral, vitamin and chemical contents. Moisture and protein contents were higher in 12th week of harvest than at 16th week irrespective of planting distance. Ash, fat, fibre and carbohydrate contents were higher at 16th week of harvest irrespective of the planting distance. Specifically, Umuspo 3 was higher in moisture and fat values while Ex-Igbariam was higher in ash, fibre, protein and carbohydrate. Calcium and vitamin C were higher at 12th week of harvest, while magnesium, potassium and vitamin B6 were higher at 16th week of harvest. Specifically, vitamin B6, phosphorus, magnesium and calcium were higher in some Ex-Igbariam lines especially in V4S3 than in Umuspo 3 lines. The chemical results showed that alpha amylase was higher in Ex-Igbariam V4S2 at 16th week of harvest while reducing sugar was higher in Umuspo 3 V1S1at 12th week of harvest. Total carbohydrate was higher in Umuspo 3 V1S1at 12th and 16th weeks of harvest. The general results indicates that the proximate, minerals, vitamin and chemical compositions of most of the variety lines were richer at 16th than at 12th week of harvest irrespective of planting distance. While 40 cm planting distance in V4S3 (Ex-Igbariam) gave higher yield of proximate, mineral, vitamin and chemical parameters, Umuspo 3 did not maintain a particular trend. Ex-Igbariam variety showed higher nutrient values than Umuspo 3 and may be recommended as a nutrient dense sweet potato staple for better nutrition.

Contribution/Originality: This study contributes in the existing literature of the effect of farming practice: planting distance and harvesting time on nutrient composition of OFSP cultivars (Umuspo 3 and Ex-Igbariam) grown in Nigeria. Results showed that Ex-Igbariam was the best OFSP cultivar with dense nutrient content. This research finding can be used to advocate for increased OFSP utilization in Nigeria.

1. INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a dicotyledonous plant that belongs to the morning glory family (Convolvulaceae). Botanically, sweet potato is a perennial that grows as an annual with trailing or twining stems up to 4m long, which sends roots into the soil at the nodes. Sweet potato has large, fleshy edible storage roots which are formed on the underground stem nodes. There are many varieties of sweet potatoes with varying nutrient and tuber yield which usually are affected by planting distance [1]. The staple type with white flesh and white or purple skin has a high starch and dry matter content and the dessert type with orange flesh and orange skin has a high sugar and beta-carotene content [2]. According to South African Department of Agriculture, Forestry and Fisheries, sweet potatoes have been classified into three distinct types. They include the orange/copper skin with orange flesh which are high in beta-carotene content and are quick growers. This is followed by the white/cream skin with white/cream flesh which has a high yield and a good storage life and lastly, the red/purple skin with cream/white flesh which is a very attractive and tasty cultivar when cooked.

In Nigeria, 15 varieties of sweet potato have been identified at the National Root Crop Research Institute, Umudike Nigeria which leads in sweet potato research. These varieties includes CIP440141, K134, NASPOT4, NASPOT2, SPK004, TIS87/0087, CIP 440293, CIP440037, 1900411,NARSP/05/007C, NARSP/05/22, EX-IGBARIAM, EX-OYUNGA, UMUSPO-1, UMUSPO-3 [3].

Growing sweet potatoes requires a minimum space of 1cm x .3m between sweet potato plants [4]. Some sweet potato tubers grow quite large and they need underground space to expand. A vine planting distance of roughly one foot between potato plants assures that the plants top will have the space necessary to attain full size and provide maximum stores of nutrients and sugars needed by the potato tubers to develop. The chemical compositions of sweet potatoes are mainly of starches, sugars and water, three components that are transferred to the root during tuber development and growth. This chemical constituents of orange fleshed sweet potatoes varies among the genotypes [5].

Therefore assessment of chemical composition of orange-fleshed sweet potato (OFSP) genotypes is essential for selecting the cultivar having high amounts of nutrients. In this consideration, the investigation of orange-fleshed sweet potatoes that have the potentials to supplying some basic nutrients to the body becomes a paramount issue. Agricultural practice involving planting spaces and harvesting periods of the tubers of different cultivars of orange-fleshed sweet potatoes to compliment this consideration become equally important.

This study was therefore designed to establish the ideal farming conditions of sweet potato cultivars in the Southeast Nigerian ultisol in order to maximize its nutrient contents bearing in mind some varying agricultural practices. For this, we assessed the ideal planting spaces and maturity periods that will lead to optimal nutrient composition in the orange-fleshed sweet potato varieties thereby selecting the promising cultivar which has an optimum yield and nutrient quality. Vine of the two cultivars of sweet potato was cultivated with different planting spaces (20 cm x 1m, 30 cm x1m and 40 cm x 1m) and tubers harvested at two different periods of 12th and 16th weeks respectively. The harvested tubers were evaluated for nutrients and chemical compositions.

2. MATERIALS AND METHOD

2.1. Planting Materials

Two orange-fleshed sweet potato varieties (Ex-Igbariam and Umuspo 3) of planting distance 40 cm and harvested at 16th as samples are shown in Figures 1a and 1b.

Fig-1a. Ex-Igbariam sample

Fig-1b. Umuspo 3 sample

Source: Kalu, et al. [6]

2.2. Field Work, Experimental Design and Treatments

The sweet potato varieties (UMUSPO 3 and EX-IGBARIAM) were planted at the National Root Crops Research Institute, experimental farm, Umudike, Abia State, Nigeria. Umudike is situated between latitude 05°29N and longitude 07°33 E and 122m altitude and the soil is classified as acidic and sandy loam and characterized as an ultisol [7]. The two different varieties were planted using three different planting spaces: 20cm x 1m, 30cm x 1m and 40cm x 1m. The treatments were arranged as split plot in randomized complete block design with three replications. The blocks of experimental units were uniform so that the observed differences between treatments will be largely due to true differences between treatments. Samples from each variety were harvested at 12th and 16th weeks after planting and their contributions to nutrient compositions was evaluated.

2.3. Chemical Analysis Determination

The moisture content was determined by the gravimetric methods of AOAC (Association of Official Analytical Chemists) [8]. The protein (%N x 6.25) content was determined by the method of Chang [9] using kjeldhal distillation unit. The ash content was determined by the furnace incineration gravimetric method described by James [10]. The fibre content was determined by Weende method as described by Pearson [11]. The fat content was determined by continuous solvent extraction in a soxhlet apparatus as described by James [10] while the carbohydrate content was calculated by difference as described by James [10] that is, % carbohydrate = 100 - % (protein + fat + fibre + ash + moisture content).

A0AC (Association of Official Analytical Chemists) [12] method was used for the determination of mineral elements. The samples were milled to pass through a 0.5 mm sieve using the Thomas Willey milling machine and the flours was stored in specimen bottles. A quantity of 0.2 g of the flours was weighed into 150 mL conical flask and 5 mL of the digestion mixture (selenium + H_2SO_4 + salicylic acid solution) was added. It was allowed to stand overnight for 12h. The sample was placed on a digestion stand set to heat at 30°C for about 2 h. Five (5) mL of Conc. H_2SO_4 was introduced into the flask and heated more vigorously at higher temperature until the material became digested releasing profuse fumes. The digest was allowed to cool. It was transferred into a 50 mL volumetric flask and made up to the mark with distilled water for subsequent use. Calcium (Ca) and magnesium (Mg) were determined by the EDTA versanate complexometric titration method. Potassium (K) was determined by the flame photometric method while phosphorus (P) was determined by the vanado-molybdate yellow method using spectrophotometer. Vitamin C (ascorbic acid) was determined using the Basket titration method according to Okwu and Ndu [13] while vitamin B_6 was determined by microbiological method [12] using *Saccharomyces uvarum* as the assay organism.

Total soluble carbohydrate was determined by phenol sulphuric acid reagent method described by Dubois, et al. [14]. The reducing sugar was determined using the ferricyanide trichloroacetic acid method. One (1) mL of different concentrations (25 to 900µg/mL) of the extract fractions was mixed with potassium ferricyanide (2.5 mL, 1%) and 2.5 mL of phosphate buffer (pH 6.6). The mixture was incubated at 50°C for 20 min. A quantity of 2.5 mL TCA (10%) was added to it and centrifuged at 3000 rpm for 10 min. Two and half (2.5) mL of the supernatant was taken and 2.5 mL water and 0.5 mL $FeCl_3$ (0.1%) were added to it. The absorbance was measured at 620 nm. Higher absorbance of the reaction mixture indicated higher reducing power.

Total α-amylase activity was determined using the dinitrosalycylic acid (DNSA) assay of Bernfeld [15]. The enzyme was first extracted using sweet potato roots. The roots were thoroughly washed in water and sliced. One hundred (100) grams of the sample was then homogenized in a Waring blender for three minutes with 300 mL of cold extraction buffer consisting of 20 mM Sodium phosphate (pH 6.0), containing 0.3% Sodium chloride, 0.2% Calcium chloride and 0.001% Mercaptoethanol. It was then filtered through four layers of cheesecloth. This extract was centrifuged at 13,000 x g for 10 minutes, and the supernatant removed and kept on ice for further use in amylase activity assays.

2.4. Data Analysis

Data were statistically analyzed with Statistical Analysis Software program (SAS 9.0) using one way analysis of variance (ANOVA). Least significant differences were calculated at $p < 0.05$. Mean comparison was made for all the significant treatments and mean ± standard deviation is presented in the tables of results.

3. RESULTS AND DISCUSSION

Table 1 shows the proximate composition of the sweet potato varieties planted 20 cm x 1m, 30 cm x 1m and 40 cm x 1m and harvested at12th and 16th weeks. There were significant variations in proximate composition of the sweet potato varieties harvested at 12th and 16th weeks respectively. The moisture content at 12th and 16th weeks of harvest and 20cm spacing showed higher values in Ex-Igbariam V4S1 (69.33 and 63.33 %) and in Umuspo 3 S1V1 (86.07 and 83.10 %) respectively. Specifically, the moisture content at 16th week of harvest irrespective of variety and spacing was lower than those harvested at 12th week. The observation was that the moisture content decreased at 16th week of harvest due to increase in fibre and carbohydrate contents. Umospo 3 lines (S1V1, S1S2 and S1V3) maintained higher moisture values than Ex-Igbariam (V4S1, V4S2 and V4S3) in both 12th and 16th weeks of harvest. The moisture content of Ex-Igbariam variety was within the range reported by Ingabire and Vasanthakaalam [16] on white and yellow varieties of sweet potatoes.

At 12th and 16th weeks of harvest, the ash content of Ex-Igbariam V4S1 (0.73 and 0.83%), V4S2 (0.63 and 0.87%) and V4S3 (0.73 and 0.83) were higher and statistically different ($P<0.05$) from Umuspo 3 variety V1S1 (0.43 and 0.53%), V1S2 (0.63 and 0.43%) and V1S3 (0.63 and 0.67%) respectively. There were increases in ash content at 16th week of harvest for the two varieties at different spaces except for VIS2 which was 31.75% lower. Ash content obtained in this study agrees with the value (0.83%) reported by Abubakar, et al. [17] but was higher than the values (0.42 and 0.43%) reported by Ingabire and Vasanthakaalam [16] for white and yellow sweet potato varieties. The fat content of Umuspo 3 variety at 12th and 16th weeks of harvest was significantly different ($P<0.05$) from Ex-Igbariam variety irrespective of the spacing distance with VIS1 having the highest value (1.93%) while V4S2 had the least value (0.40%). It was observed that Ex-Igbariam V4S2 (0.87%) and V4S3 (1.53%) showed high fat content at 16th week of harvest while V1S1 (1.93%) and V1S3 (1.33%) had high fat content at 12th of harvest. These differences are indicative of the effect of spacing and genotype which in the case of Umuspo 3, may be due to the high lipophilic property which is high in carotenoid content over Ex-Igbariam variety as was reported by Ukom, et al. [18] . Irrespective of variety and vine spacing, it was observed that fibre content was higher at 16th week of harvest than at 12th week of harvest. However, the highest values were 2.81% for V4S2 (Ex-Igbariam) and 2.21% for V1S2 (Umuspo 3) varieties respectively. This indicates that reduced moisture content and maturity (longer period of harvest) of the sweet potato varieties at 16th week favours higher fibre formation particularly at 30 cm vine spacing. Our study showed that fibre content of the sweet potato varieties were higher than those reported by Ingabire and Vasanthakaalam [16] for white and yellow sweet potato varieties (0.12% and 0.13%) respectively. With the exception V1S3, protein content was higher at 12th week of harvest than at 16th week of harvest. However, the protein content of V4S3 (2.81 and 2.54) at both 12th and 16th weeks of harvest were higher than other values while there was no significant difference in Umuspo 3 variety at 12th week of harvest. The protein content obtained in this study are higher than those reported by Ingabire and Vasanthakaalam [16] on sweet potato varieties but were lower than the values reported by other authors on sweet potato varieties [17, 18]. The carbohydrate content showed that V4S3 was significantly different and was higher than other values at both 12th and 16th weeks of harvest indicating the impact of 40 cm planting distance on carbohydrate yield.

Table-1. Contributions of planting distance and harvesting period to proximate composition of sweet potato (*Ipomea batatas*) varieties (%)

Samples/planting Space	Moisture		Ash		Fat		Fibre		Protein		Carbohydrate	
	12weeks	16weeks	12weeks	16weeks	12weeks	16weeks	12weeks	16weeks	12weeks	16weeks	12weeks	16weeks
V4S1	$69.33^{d}\pm0.15$	$63.97^{d}\pm0.12$	$0.73^{a}\pm0.06$	$0.83^{a}\pm0.06$	$0.47^{cd}\pm0.12$	$0.47^{c}\pm0.23$	$0.59^{b}\pm0.02$	$1.74^{c}\pm0.02$	$2.63^{ab}\pm0.03$	$2.37^{b}\pm0.01$	$26.25^{b}\pm0.23$	$30.62^{b}\pm0.21$
V4S2	$69.17^{d}\pm0.06$	$63.47^{d}\pm0.21$	$0.63^{a}\pm0.06$	$0.87^{a}\pm0.06$	$0.40^{d}\pm0.20$	$0.87^{bc}\pm0.12$	$1.05^{a}\pm0.06$	$2.81^{a}\pm0.12$	$2.47^{b}\pm0.01$	$2.21^{c}\pm0.03$	$26.28^{b}\pm0.27$	$29.75^{c}\pm0.06$
V4S3	$66.83^{e}\pm0.21$	$61.30^{e}\pm0.21$	$0.73^{a}\pm0.06$	$0.83^{a}\pm0.06$	$0.47^{cd}\pm0.23$	$1.53^{a}\pm0.12$	$1.30^{a}\pm0.06$	$1.73^{c}\pm0.12$	$2.81^{a}\pm0.05$	$2.54^{a}\pm0.02$	$27.86^{a}\pm0.33$	$32.06^{a}\pm0.16$
V1S1	$86.07^{a}\pm0.31$	$83.10^{a}\pm1.13$	$0.43^{b}\pm0.06$	$0.53^{c}\pm0.06$	$1.93^{a}\pm0.31$	$1.27^{ab}\pm0.12$	$0.55^{b}\pm0.23$	$1.57^{c}\pm0.20$	$2.26^{c}\pm0.15$	$2.07^{d}\pm0.03$	$8.76^{e}\pm0.32$	$12.13^{e}\pm0.28$
V1S2	$83.53^{b}\pm2.1$	$79.93^{c}\pm0.15$	$0.63^{a}\pm0.06$	$0.43^{c}\pm0.06$	$0.87^{c}\pm0.31$	$1.07^{b}\pm0.23$	$1.41^{a}\pm0.31$	$2.21^{b}\pm0.12$	$2.12^{c}\pm0.01$	$2.00^{e}\pm0.47$	$11.44^{d}\pm0.56$	$14.33^{d}\pm0.23$
V1S3	$81.27^{c}\pm0.15$	$81.03^{b}\pm0.06$	$0.63^{b}\pm0.0^{b}\pm0.06$	$0.67^{b}\pm0.06$	$1.33^{b}\pm0.12$	$0.93^{b}\pm0.42$	$0.55^{b}\pm0.42$	$1.14^{d}\pm0.00$	$2.10^{c}\pm0.19$	$2.33^{b}\pm0.02$	$13.92^{c}\pm0.21$	$13.96^{d}\pm0.39$

Means with different superscript (abcd) within the same column are significantly different ($p<0.05$) Values are means ± standard deviation of three replicate. Sample planting space code: V4S1–Ex-Igbariam 20cm, V4S2–Ex-Igbariam 30cm, V4S3-Ex-Igbariam 40cm, V1S1-Umuspo 3 20cm, V1S2-Umuspo 3 30cm, V1S3-Umuspo 3 40cm

With the exception of V1S3 which maintained similar carbohydrate values at 12th and 16th weeks of harvest, the carbohydrate contents at 16th week of harvest were higher than their corresponding 12th week of harvest. It was also observed that Ex-Igbariam variety lines irrespective of planting distance (V4S1, V4S2 and V4S3) had higher carbohydrate content than their Umuspo 3 lines (V1S1, V1S2 and V1S3) counterparts. Loss of moisture and tuber maturity of the sweet potato at 16th weeks would have contributed to higher carbohydrate content than in 12th week of harvest. The value of carbohydrate obtained for the Ex- Igbariam variety was closer to those reported by Abubakar, et al. [17] for white sweet potato variety (25.74%). From the proximate results, it is convincing that with the exception of fat content, Ex-Igbariam variety lines showed superior nutrient content than Umuspo 3 lines mostly at 30 cm distance and 16th week of harvest

Table 2 show the contributions of harvesting time to the mineral contents of Ex-Igbariam and Umuspo 3 sweet potatoes harvested at 12th and 16th weeks. The results showed significant differences ($p<0.05$) between the minerals. For Ex-Igbariam variety, V4S3 had the highest calcium content at 12th and 16th weeks of harvest (221. 33 and 233.33 mg/100g), while for Umuspo 3, V1S1 had the highest calcium content at 12th and 16th of harvest (179.33 and 188.44 mg/100g) respectively. Although Ex-Igbariam maintained higher calcium content than Umuspo 3, the two sweet potato varieties are rich sources of calcium. Also, the phosphorus content of Ex-Igbariam V4S3 harvested at 12th and 16th weeks (0.24 and 0.25 mg/100g) were significantly higher ($p<0.05$) than that of V4S1, V4S2 and Umuspo 3 samples.

Table-2. Contributions of planting distance and harvesting periods to mineral composition of sweet potato varieties

Samples/ planting space	Calcium(mg /100g)		Phosphorus(mg/100g)		Magnesium (mg/100g)		Potassium (mg/100g)	
	12weeks	16weeks	12weeks	16weeks	12weeks	16weeks	12weeks	16weeks
V4S1	$150.44^{c}\pm2.78$	$137.78^{d}\pm2.77$	$0.15^{c}\pm0.01$	$0.16^{d}\pm0.00$	$2.82^{b}\pm0.02$	$2.98^{a}\pm0.03$	$5.03^{b}\pm0.09$	$5.16^{a}\pm0.11$
V4S2	$182.22^{b}\pm9.34$	$147.78^{cd}\pm4.73$	$0.15^{c}\pm0.01$	$0.16^{d}\pm0.01$	$2.80^{b}\pm0.07$	$2.95^{ab}\pm0.06$	$5.18^{ab}\pm0.19$	$5.29^{a}\pm0.16$
V4S3	$221.33^{a}\pm1.34$	$223.33^{a}\pm12.35$	$0.24^{a}\pm0.01$	$0.25^{a}\pm0.01$	$2.81^{b}\pm0.02$	$2.96^{ab}\pm0.01$	$5.29^{ab}\pm0.19$	$5.39^{a}\pm0.15$
V1S1	$179.33^{b}\pm1.77$	$188.44^{b}\pm1.02$	$0.18^{b}\pm0.00$	$0.18^{b}\pm0.01$	$2.66^{c}\pm0.04$	$2.82^{c}\pm0.02$	$5.68^{a}\pm0.24$	$5.19^{a}\pm0.16$
V1S2	$148.67^{d}\pm5.29$	$147.55^{cd}\pm2.34$	$0.19^{b}\pm0.01$	$0.17^{c}\pm0.00$	$2.79^{b}\pm0.03$	$2.84^{bc}\pm0.08$	$5.28^{ab}\pm0.32$	$5.18^{a}\pm0.28$
V1S3	$159.78^{c}\pm7.13$	$153.78^{c}\pm10.78$	$0.18^{b}\pm0.00$	$0.16^{d}\pm0.00$	$2.98^{a}\pm0.03$	$2.72^{c}\pm0.12$	$4.79^{b}\pm0.57$	$4.49^{b}\pm0.28$

Means with different superscript (abcd) within the same column are significantly different ($p<0.05$) Values are means $\pm$ standard deviation of three replicate

Sample planting space code: V4S1–Ex-Igbariam 20cm, V4S2–Ex-Igbariam 30cm, V4S3-Ex-Igbariam 40cm, V1S1-Umuspo 3 20cm, V1S2-Umuspo 3 30cm, V1S3-Umuspo 3 40cm

At 16th week, Ex-Igbariam V4S1 and V4S2 increased in phosphorus content by 6.25%. However, it was observed that Umuspo 3 V1S1, V1S2 and V1S3 had a marginal increase, having an average value of 0.18 mg/100g respectively. Although Ex-Igbariam variety had higher magnesium values than Umuspo 3 at 12th and 16th (2.80-2.98 mg/100g) weeks of harvest, there was no significant difference ($P<0.05$) in between the 12th and 16th weeks of harvest in Ex-Igbariam variety line. On the other hand, V1S3 spaced 40 cm and harvested at 12th week had the highest value (2.98 mg/100g) in Umuspo 3 variety lines. Umuspo 3 V1S1, V1S2 and Ex-Igbariam V4S2and V4S3 at 12th and 16th of harvest were higher in potassium content. The results also showed that at 16th week of harvest, there was marginal increase of potassium from the 12th week which may be attributed to the effect of tuber maturity and longer period of harvest. The overall mineral content showed that calcium was the predominant mineral in both sweet potato varieties irrespective of planting distance. This study indicated that at 30 cm and 40 cm planting space and at16th week of harvest, nutrient content showed higher values in most parameters. The reason could be due to less canopy or biomass coverage resulting into higher photosynthetic activity leading to more nutrients buildup.

In Table 3, the vitamin concentration of Ex-Igbariam and Umuspo 3 sweet potato cultivars is displayed. Ex-Igbariam V4S3 harvested at 16th week had higher value of vitamin B_6 (0.22mg/100g) which was significantly different from other samples, while Umuspo 3 V1S1 harvested at 12th week had the least value (0.16mg/100g). Ex-Igbariam V4S1 and Umuspo 3 V1S2 were statistically similar at 12th week of harvest. However, Ex-Igbariam variety contained higher concentration of B_6 than Umuspo 3. Comparing with the B_6 content of Beauregard and LA

07-146 (2.44 and 3.82mg/100g) varieties reported by Wilmer and David [19] our results showed low content of B_6 which may be attributed to varietal and environmental differences.

Table-3. Contribution of planting distance and harvesting periods to the vitamin content of sweet potato varieties

Sample/planting space		Vitamin B6 (mg/100g))	Vitamin C (mg/100g	
	12weeks	16weeks	12weeks	16weeks
V4S1	0.19 ^{b}±0.01	0.21^{b}±0.00	86.11 ^{a}±1.69	80.65^{a}±0.45
V4S2	0.20 ^{a}±0.01	0.21^{b}±0.01	83.80 ^{a}±2.90	77.58^{b}±0.89
V4S3	0.18 ^{c}±0.01	0.22^{a}±0.01	42.92 ^{b}±1.89	40.00^{c}±1.26
V1S1	0.16 ^{d}±0.01	0.19^{c}±0.00	30.53 ^{c}±0.59	26.48^{e}±0.44
V1S2	0.19 ^{b}±0.00	0.17^{e}±0.00	30.24 ^{c}±1.17	34.20^{d}±1.05
V1S3	0.18 ^{c}±0.00	0.18^{d}±0.00	40.77 ^{b}±2.59	34.39^{d}±0.44

Means with different superscript (abc) within the same column are significantly different (p<0.05) Values are means ± standard deviation of three replicate

Sample planting space code: V4S1–Ex-Igbariam 20cm, V4S2–Ex-Igbariam 30cm, V4S3-Ex-Igbariam 40cm, V1S1-Umuspo 3 20cm, V1S2-Umuspo 3 30cm, V1S3-Umuspo 3 40cm

The vitamin C content at 12th and 16th weeks of harvest in Ex-Igbariam V4S2 and V4S1 were higher and significantly different (P<0.05) from Umuspo 3 V1S1, V1S2 and V1S3 respectively. Ex-Igbariam V4S1 had higher value (86.11mg/100g) of vitamin C at 12th week while Umuspo 3 V1S1 had the least value (26.48 mg/100g) at 16th week. The vitamin C contents of Ex-Igbariam V4S1 and V4S2 at both 12th and 16th weeks of harvest were more than twice the values of Umuspo 3 samples. Tariku, et al. [20] reported that the juice made from 100% Kulfo, an orange fleshed sweet potato variety contained 0.13mg/L vitamin C while a composite juice made from the Kuklfo variety and mango in the ratio of 90.10 and 80:20 had 12.02mg/L and 86.96mg/L vitamin C content which is within the concentration of vitamin C obtained in this study especially for Ex-Igbariam variety. Vitamin C is a strong antioxidant that can scavenge free radicals and prevent cellular oxidation and damage.

Table-4. Contributions of planting distance and harvesting time to the chemical contents of Sweet potato (*Ipomea batatas)* varieties.

Samples/planting space	Alpha amylase (IU/100g)		Reducing sugar(mg/100g)		Totalsoluble carbohydrate (mg/100g)	
	12weeks	16weeks	12weeks	16weeks	12weeks	16weeks
V4S1	22.24 ^{c}±5.25	26.04 ^{c}±6.04	192.23 ^{bc}±5.73	174.21^{c}±4.31	39.86 ^{d}±0.91	43.21 ^{b}±2.15
V4S2	41.60 ^{a}±2.00	47.52 ^{a}±3.58	185.31^{c} ±1.59	164.03^{d}±3.88	39.08 ^{d}±0.53	39.88 ^{b}±0.54
V4S3	33.84 ^{b}±0.41	38.90 ^{b}±0.88	177.88 ^{c}±2.43	161.23^{d}±2.59	39.94 ^{d}±1.63	37.86 ^{c}±1.29
V1S1	37.06 ^{ab}±1.14	43.96 ^{ab}±0.10	234.33^{a}±10.36	238.25 ^{a}±1.85	57.14 ^{a}±0.95	52.98 ^{a}±0.54
V1S2	25.61^{c} ±2.77	24.78^{c} ±2.03	221.05^{ab}±2.92	163.16^{d}±1.05	46.19^{c} ±0.55	50.59 ^{a}±5.41
V1S3	26.93 ^{c}±1.62	42.01 ^{ab}±1.05	243.68 ^{a}±43.3	211.75^{b}±1.85	52.14 ^{b}±1.07	50.47 ^{a}±0.74

Means with different superscript (abc) within the same column are significantly different (p<0.05) Values are means ± standard deviation of three replicate

Sample planting space code: V4S1–Ex-Igbariam 20cm, V4S2–Ex-Igbariam 30cm, V4S3-Ex-Igbariam 40cm, V1S1-Umuspo 3 20cm, V1S2-Umuspo 3 30cm, V1S3-Umuspo 3 40cm

Table 4 showed the chemical content of the sweet potato varieties. At 12th and 16th of harvest, Ex-Igbariam V4S2 had the highest concentration of α-amylase (41.60 and 47.52 IU/100g), followed by Umuspo 3 V1S1 (37.06 and 43.96 IU/100g) at 12th and 16th of harvest. At 16th week of harvest, α-amylase concentration of Ex-Igbariam and Umuspo 3 varieties was higher than the 12th week of harvest indicating increased biosynthesis of α-amylase at 16th week maturity. However, Ex-Igbariam V4S1 (22.24 and 26.04 IU/100g) and Umuspo 3 V1S2 (25.61 and 24.78 IU/100g) were the least concentration of α-amylase. The α-amylase content of white sweet potato cultivar 277 (31.8 IU/100g) reported by Nandutu, et al. [21] compared with the value obtained in this study. The implications are that these sweet potato varieties can be incorporated into other foods with low α-amylase content for optimal α-amylase activities. The reducing sugar content of Umuspo 3 VIS1 and VIS3 are statistically similar (p>0.05) (234.33 and 238.25mg/100g) and (243.68 and 211.75mg/100g) and were higher than other samples at the 12th and 16th weeks of harvest. Ex-Igbariam V4S3 had the least value (177.88 and 161.23mg/100g) at 12th and 16th weeks of harvest. The observation was that at 12th week, the reducing sugar content was higher than the 16th week harvest irrespective of variety. The total soluble carbohydrate content of sample V1S1 at 12th and 16th harvest (57.14 and

52.98 mg/100g) were higher than other samples. No significant differences in soluble carbohydrate content existed between Ex-Igbariam samples. Umuspo 3 variety at 12th and 16th weeks exhibited higher total soluble carbohydrate content than Ex-Igbariam content at 12th and 16th weeks respectively. In this study, Umuspo 3 variety showed higher concentrations of total soluble carbohydrate and reducing sugar which is in agreement with the findings of Jeran and Drost [2] that, OFSP varieties have higher sugar and carotenoids content. The variations in the nutrient composition, namely, mineral, chemical, vitamin and proximate contents of the sweet potato varieties exhibited positive effects in different planting spacing and harvesting periods. Observation was that Ex-Igbariam variety planted 40 cm apart in rows and harvested at 12th and 16th weeks contained higher calcium content than other samples. The reducing sugar and total soluble carbohydrate of Umuspo 3 variety planted 20 cm apart and harvested at 12th and 16th weeks had higher values, while vitamin C content was higher in Ex-Igbariam variety planted 20cm and 30cm and harvested at 12th and 16th weeks. It was also observed that the moisture content of Umuspo 3 planted 30 and 40cm apart had higher values, while the carbohydrate content of Ex-Igbariam spaced 40cm and harvested at16th week was higher than those of Umuspo 3.

4. CONCLUSION

This present study has highlighted the effect of planting distance and harvesting time on the proximate, minerals, vitamins and chemical contents of OFSP Ex-Igbariam and Umuspo 3 sweet potato varieties. At 16th week of harvest, the nutrient values were higher in the sweet potato varieties, but especially in in Ex-Igbariam cultivar than in Umuspo 3 cultivar irrespective of planting distance. Vitamin B6 was higher at the 16th week of harvest while vitamin C content was higher at 12th week of harvest specifically in Ex-Igbariam variety irrespective of planting distance. Alpha amylase was higher at the 16th week of harvest while, the reducing sugar content was higher in 12th week of harvest. The results further showed that Umuspo 3 variety had higher concentration of total carbohydrate and reducing sugar than Ex-Igbariam variety lines. This study has proved that Ex-Igbariam variety harvested at 16th week and spaced at 30 cm x1m and 40 cm x 1m apart were the best for maximum nutrient yield in our study and can serve as a recommendation in Southeast Nigeria ultisol.

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