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Effect of Planting Space on Carotenoid Content and Carotenoid Profile of Two Orange Fleshed Sweet Potato Varieties

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Abstract

In this study, the effect of planting spacing (20, 30 and 40 cm) on the carotenoid contents and carotenoid profile of orange flesh sweet potato (OFSP) was evaluated. The carotenoid profiles of two sweet potato species, planted at different spacing distances were compared. Lutein, zeaxanthin, β-cryptoxanthin, α-carotene, 13-cis-β-carotene, trans-β-carotene, 9-cis-β-carotene and total beta carotene were all determined. Results showed that zeaxanthin concentration ranged from 1.71+0.00 to 4.71+0.01 µg/g, lutein concentration ranged from 1.48+0.00 to 4.76+0.04 µg/g, β-cryptoxanthin concentration ranged from 0.98+0.01 to 7.05+0.03 µg/g, α-carotene concentration ranged from 0.76+0.01 to 2.72+0.01 µg/g, 13-cis-β-carotene concentration ranged from 0.40+0.01 to 2.07+0.01µg/g, trans-β-carotene concentration ranged from 6.55+0.06 to 81.22+0.06 µg/g and 9-cis-β-carotene concentration ranged from 0.19+0.01 to 1.27+0.01 µg/g. The results of carotenoid profile showed that trans-β-carotene had the highest peak value of 60.15µg/g at a planting distance of 30 cm for Umuspo1 while for Ex-Onyunga 20 and 40 cm were favourable distances for maximal production of trans-β-carotene, each giving a yield of about 60µg/g of carotene. These results indicate that Ex-onyunga and Umuspo1 varieties of orange fleshed sweet potatoes are good promising sources of pro-vitamin A that will help to tackle vitamin A deficiency and other ailments in both children and adults.

Keywords: Planting Distances; Carotenoid Content and Profile; Orange Fleshed Sweet Potato Varieties

Introduction

Sweet potato (*Ipomoea batatas*) is a perennial crop grown as an annual [1]. It is a root crop that provides food to a large segment of the world population, especially in the tropics where the bulk of the crop are cultivated and consumed [2,3]. According to FAO statistics, West African sweet potato production stood at 2.516 million metric tons. Sweet potato is high in nutritive value, containing mostly carbohydrate [4]. It is also contains protein, vitamin and mineral contents [5,6]. Sweet potato serves as a staple food vegetable (Fleshy roots and tender leaves), snack food, weaning food, annual feed as well as a raw material for industrial starch and alcohol. It is processed into diverse products [7-9].

Normally, sweet potato flesh colour is white, but some of the cultivars have orange flesh. The orange- fleshed colour is so little known in Nigeria. The orange fleshed sweet potato is extremely rich in bio-available beta-carotene, which the body converts into Vitamin A (Retinol) at a ratio of 12: 1. In addition, Orange- fleshed Sweet Potato (OFSP) contributes significant amount to Vitamin C, E, K and several B vitamins in the human diets. The leaves also have good micronutrient contents and adequate protein (4%) for use as food and animal feed. The orange- fleshed sweet potato (OFSP) roots can be processed into different bakery products and the orange colour attracts consumers. Orange-fleshed Sweet Potato (OFSP) can substitute for potato in making chips and crisp and serve as a partial substitute (20-50%) for wheat flour in bakery products. Orange fleshed sweet potato products have a golden colour that appeals to consumers making marketing easy. All classes of farmers can grow and invest in fresh root products and marketing of orange fleshed sweet potatoes.

Carotenoids are organic pigments that are found in the chloroplasts and chromoplasts of plants and some other photosynthetic organisms, including some bacteria and some fungi. Carotenoids can be produced from fats and other basic organic metabolic building blocks by all these organisms. The only animals known to produce carotenoids are aphids and spider mites, which acquired the ability and genes from fungi [10]. Carotenoids from the diet are stored in the fatty tissues of animals, and exclusively carnivorous animals obtain the compounds from animal fat.

There are over 600 known carotenoids, they are split into two classes, xanthophylls (which contain oxygen) and carotenes (which are purely hydrocarbons, and contain no oxygen). All carotenoids are tetraterpenoids, meaning that they are produced from 8 isoprene molecules and contain 40 carbon atoms. In general, carotenoids absorb wavelengths ranging from 400-550 nanometers

(violet to green light). This causes the compounds to be deeply coloured yellow, orange or red. Carotenoids are the dominant pigment in autumn lead colouration of about 15-30% of tree species, but many plants colours, especially reds and purples, are due to other classes of chemicals. Carotenoids serve two key roles in plants and algae; they absorb light energy for use in photosynthesis, and they protect chlorophyll from photodamage [11]. Carotenoids that contain unsubstituted beta-ionone rings (including beta-carotene, alpha-carotene, beta-cryptoxanthin and gamma-carotene) have vitamin A activity (meaning that they can be converted to retinol), and these and other carotenoids can also act as antioxidants. In the eye, certain other carotenoids (lutein, astaxanthin and zeaxanthin) apparently act directly to absorb damaging blue and near-ultraviolet light, in order to protect the macula of the retina, the part of the eye with the shape vision [12].

However, there is a high rate of vitamin A deficiency in both infant and adult in many countries that led to various ailments which sometimes damage the health status of humans. The population consuming OFSP tubers has increased due to the health benefit of β-carotene. Studies have shown that planting space may influence the yields of OFSP and possibly the nutrient composition, thus this study is aimed to determine the effect of planting spacing on carotenoid content and carotenoid profile of OFSP varieties.

Sample Collection

Two types of Orange- fleshed Sweet Potatoes (OFSP) (Umuspo1 and Ex-Onyunga) were used for the study. Orange Fleshed Sweet Potatoes was cultivated in National Root Crops Research Institute (NRCRI), Umudike Farm, Abia State. The tubers were harvested at twelve (12) and sixteen (16) weeks. The two samples used in this research are Umuspo1 and Ex-Onyunga. Each sample had three replicates described as US_1, US_2, US_3 and ES_1, ES_2, ES_3 planted in different spacing as 20 cm, 30 cm and 40 cm respectively.

Determination of Carotenoids

The analysis of the β-carotene in sweet potato sample was carried out according to the method of Rodriguez-Amaya and Kimura [13]. Fresh sweet potato tubers (Umuspo1 and Ex-Onyunga) were selected randomly and washed with clean water. They were peeled, washed and quartered longitudinally. Two opposite sections from each tuber were taken and sliced into small pieces (1 cm) and mixed manually. They were packaged in aluminium foil, labelled and stored at -80oC in a deep freezer. Carotenoids were extracted by grinding about 3 g of each sample in a mortar and pestle with about 50 ml of cold acetone. The residue was filtered in a Buchner funnel equipped with a filter paper (Whatman No.42 filter paper). The residue was returned to the mortar and the extraction was repeated using 20 ml acetone until the residue was nearly colourless. The total extract was transferred to a separating funnel (250 ml) containing 20 ml of petroleum ether. One litre of distilled water was used to wash the organic phase which separated from the aqueous phase. The aqueous phase was discarded. The organic phase was again washed with dilute brine solution to break-up any emulsions that may have formed. The brine solution which separated from the organic phase was discarded. The organic phase was collected through anhydrous Sodium sulphate (15 g) into a 25 ml flat bottom flask. Ten (10) ml of the sample extract concentrated with a rotary evaporator (Buchi Waterbath B-481 Switzerland) and dried under vacuum for reverse-phase, HPLC determination of the various isomers of β-carotene following Rodriguez-Amaya and Kimura formula was used [13].

$$C\ x\ (\mu g/g) = \frac{Ax\ X\ Cs\ (\mu g/ml)\ x\ total\ vol.\ of\ extract\ (ml)}{As\ X\ sample\ weight\ (g)}$$

Where:

Cx	=	Concentration (μg/g) of carotenoid X
Ax	=	Peak Area of the carotenoid
Cs	=	Concentration of standard
As	=	Peak area of the standard

Carotenoid retention after processing of sample was evaluated spectrophotometrically using the method of Rodriguez-Amaya and Kimura [13]. The processing methods used were boiling (100 °C), roasting (120 °C) and oven-drying (60 °C) (Model DHG-90534, England).

Statistical Analysis

Data obtained from this research were expressed as means + standard deviation and were subjected to analysis of variance (ANOVA) at 0.05 probability level. Values that were significantly different were separated by Duncan's multiple range tests using IBM SPSS version 17.

Results

Effect of Spacing on Carotenoid Contents of Umuspo 1 and Ex-onyunga Varieties of Orange Fleshed Sweet Potatoes

The effects of spacing on the carotenoid content of orange- fleshed sweet potato varieties are shown in (Table 1). Results in Table showed that the lutein content of Ex-Onyunga with a spacing distance of 40 cm had the highest concentration of 4.76 μg/g and was significantly different ($p<0.05$) from the lutein content of all other samples. Lutein content of Umuspo 1variety was lower than that of Ex-Onyunga. Umuspo1 OFSP variety planted at 20 cm spacing had the lowest value which was not significantly different from US_2

The zeaxanthin content of Ex-Onyunga OFSP planted at 40 cm apart was the highest (4.71 μg/g). There was no significant difference in the zeaxanthin content of Ex-Onyunga OFSP planted at distances of 20 cm and 30 cm. The zeaxanthin content of Ex-Onyunga OFSP varieties were, however higher than the values observed for Umuspo1 OFSP varieties planted at 20 cm, 30 cm and 40 cm spacing. The lowest value (1.71 μg/g) was observed for Umospo1 sweet potato variety at 20 cm spacing distance.

Sample	Lutein Conc (μg/g)	Zeaxanthin Conc (μg/g)	μ-cryptaxanthin Conc (μg/g)	μ-carotene Conc (μg/g)	13-cis BC Conc (μg/g)	Trans BC Conc (μg/g)	9-cis BC Conc (μg/g)	Total BC Conc (μg/g)
US_1	1.48+0.00^e	1.71+0.00^e	2.59+0.01^d	1.28+0.01^d	1.07+0.00^d	21.83+0.03^d	0.82+0.01^d	23.72+0.04^d
US_2	1.49+0.01^e	2.00+0.01^d	0.98+0.01^f	0.76+0.01^f	0.40+0.01^f	6.55+0.06^f	0.19+0.01^f	7.13+0.06^f
US_3	1.96+0.01^d	2.45+0.01^c	1.32+0.00^e	1.25+0.00^e	0.57+0.00^e	8.40+0.01^e	0.42+0.00^e	9.39+0.04^e
ES_1	3.40+0.00^b	2.96+0.01^b	6.59+0.00^b	2.09+0.01^b	2.07+0.01^a	81.22+0.06^a	1.38+0.01^a	84.67+0.08^a
ES_2	3.11+0.02^c	2.94+0.00^b	5.76+0.02^c	1.92+0.01^c	1.96+0.01^b	68.81+0.30^c	1.22+0.03^c	71.99+0.35^c
ES_3	4.76+0.04^a	4.71+0.01^a	7.05+0.03^a	2.72+0.01^a	1.91+0.02^c	73.52+0.08^b	1.27+0.01^b	76.69+0.12^b

Value (means) with different superscripts are significantly different from one another ($p<0.05$), US_1 = Umuspo1 planted at 20cm, US_2 = Umuspo1 planted at 30cm, US_3 = Umuspo1 planted at 40cm, ES_1 = Ex-Onyunga planted at 20cm, ES_2 = Ex-Onyunga planted at 30cm, ES_3 = Ex-Onyunga planted at 40cm.

Table 1: Carotenoid Content of Orange Fleshed Sweet Potatoes (Umuspo1 and Ex-Onyunga) varieties

The effect of planting distance of Umuspo1 and Ex-Onyunga varieties of OFSP on zeaxanthin concentration is shown in Table 1. The highest zeaxanthin concentration was obtained in sample US_3 as the least was from US_1.Table 1 shows that the β-cryptoxanthin content of Ex-Onyunga Orange Fleshed Sweet Potato (OFSP) planted at a spacing of 40 cm was the highest amount (7.05 μg/g) which was significantly different ($p<0.05$) from the β-cryptoxanthin content of all other samples. This was followed by the β-cryptoxanthin content of Ex-Onyunga planted at 20 cm spacing which was also significantly different ($p<0.05$) from other samples. β-cryptoxanthin content of Umuspo1 varieties were lower than that of Ex-Onyunga. The lowest β-cryptoxanthin concentration (0.98 μg/g) was observed in Umospo1 sweet potato variety planted at 30 cm spacing.

Alpha-carotene (α – carotene) contents of OFSP are presented in Table 1. The result shows that Ex-Onyunga OFSP planted 40 cm apart had the highest α–carotene concentration (2.72 μg/g) that was significantly different ($p<0.05$) from α–carotene content of all other samples. Alpha–carotene content of Umuspo1 varieties was lower than that of Ex-Onyunga. The lowest α–carotene concentration (0.76 μg/g) was observed in Umuspo1 sweet potato variety planted at 30 cm spacing.

The 13-cis β-carotene (BC) content of Ex-Onyunga OFSP with a spacing distance of 20 cm had the highest concentration of 2.07 μg/g and was significantly different ($p<0.05$) from 13-cis BC content of Ex-Onyunga planted at 30 cm and 40 cm. The effect of planting distance on the 13-cis β-carotene is shown in Table 1, which indicates that a spacing distance of 20 cm gave better amount of 13-cis β-carotene. Data from Table 1 also indicated that 13-cis BC contents of Umuspo 1 varieties were lower than that of Ex-Onyunga. The lowest concentration (0.40 μg/g) was observed in Umuspo 1 sweet potato planted at a distance of 30 cm which was significantly different ($p<0.05$) from all other samples.

The results of trans-β-carotene are presented in Table 1. Ex-Onyunga OFSP planted 20 cm apart had the highest trans-β-carotene concentration (81.22 μg/g) and was significantly different ($p<0.05$) from the trans-β-carotene content of all other samples. This was followed by the trans-β-carotene content of Ex-Onyunga planted at 40 cm spacing which was also significantly different ($p<0.05$) from other samples. Planting distance had significant effect on trans-β-carotene of Ex-Onyunga. A planting distance of 20 cm resulted in higher trans-β-carotene concentration. Trans-β-carotene content of Umuspo1 OFSP was totally lower than those of Ex-Onyunga. The lowest trans-β-carotene concentration (6.55 μg/g) was observed in Umuspo1 OFSP variety planted at 30 cm spacing.

The 9-cis β-carotene of Ex-Onyunga with a spacing distance of 20 cm had the highest concentration of 1.38 μg/g which was significantly different ($p<0.05$) from the 9-cis-β-carotene content of every other sample (Table 1). 9-cis-β-carotene of Ex-Onyunga planted at 40 cm was significantly ($p<0.05$) higher than that of Ex-Onyunga OFSP variety planted at 30 cm. However, 9-cis-β-carotene content of Umuspo1 varieties was lower than that of Ex-Onyunga. The lowest 9-cis-β-carotene concentration (0.19 μg/g) was observed in Umuspo1 sweet potato variety planted at 30 cm spacing.

The Carotenoid Profile of Two Orange Fleshed Sweet Potatoes (OFSP) varieties (Ex-Onyunga ES_1, ES_2, ES3 and Umospo1 US_1, US_2, US_3) planted at different spacing distances

The chromatograms for the carotenoid content of the two Orange Fleshed Sweet Potato (OFSP) varieties (Ex-Onyunga and Umuspo1) of *Ipomea batatas L.Lam* planted at different spacing distances quantified xanthophylls (such as lutein, zeaxanthin, β-cryptoxanthin) and carotenes (such as α-carotene, 9-cis-β-carotene, 13-cis-β-carotene and trans-β-carotene). The identification of the absorption peak of each carotenoid is the function of its retention time related to that of the internal standard. The chromatographic behaviour of the carotenoids is correlated with their structures and the maximum absorption spectra (μmax) were recorded by the photodiode array detector and compared with the internal standard. The absorption peak area and height aids in carotenoid quantifications.

Figure 1 shows that the chromatogram of the carotenoid fraction in Umuspo1 (US1) OFSP variety planted at 20cm distance spacing had eleven (11) carotenoid fractions eluted at different retention times. Seven (7) major peaks were identified using standards and quantified as appropriate. Trans-β-carotene predominated with a concentration of 21.83μg/g and percentage area of 69.80% being the highest. This was followed by β-cryptoxanthin (2.59μg/g) (8.03%), zeaxanthin (1.71μg/g) (4.63%), lutein (1.48μg/g) (4.07%), α-carotene (1.28μg/g) (3.66%), 13-cis-β-carotene (1.07μg/g) (3.14%) and 9-cis-β-carotene (0.82μg/g) (2.28%).

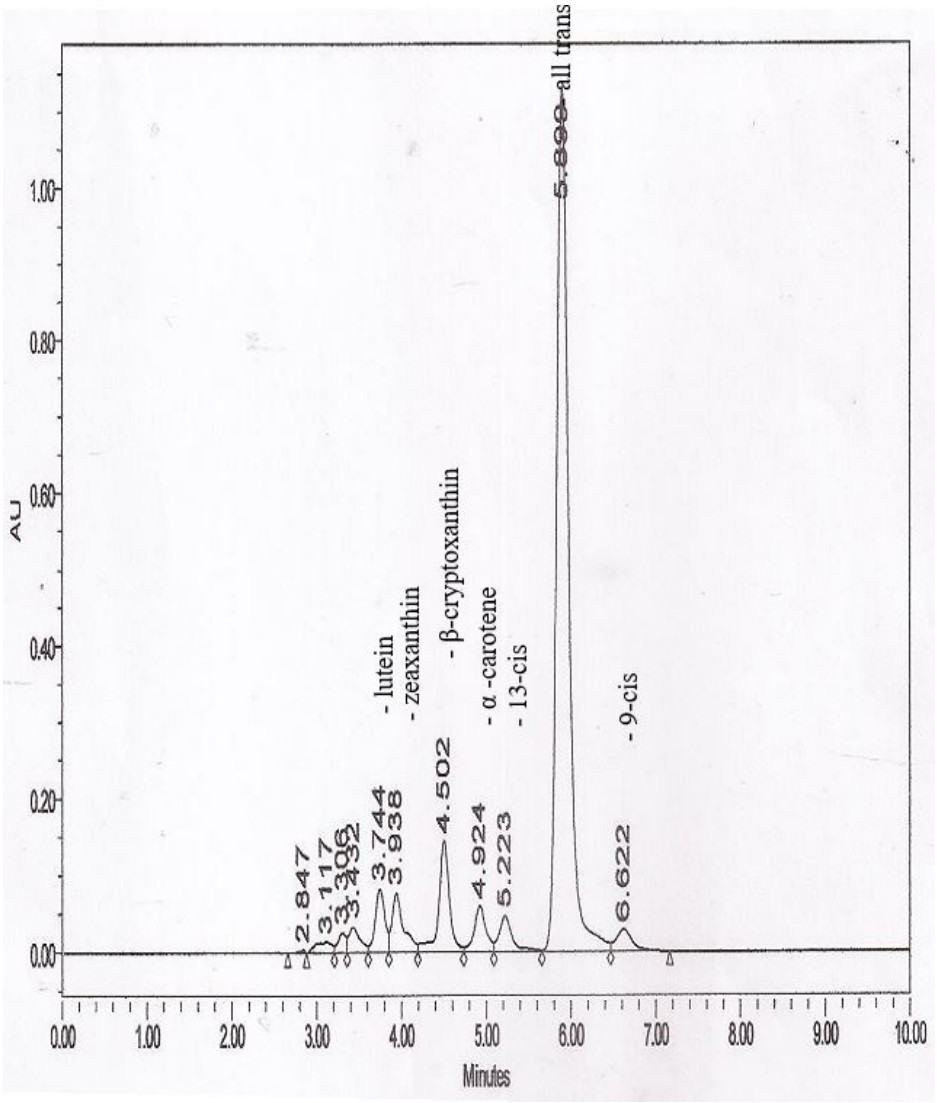

Figure 1: The chromatogram of carotenoid fraction in Umuspo1 (US1) OFSPvariety planted at 20 cm spacing

Figure 2 Shows the chromatogram of carotenoid fraction in Umospo1 (US2) OFSP variety planted at 30cm distance spacing. There were twelve (12) carotenoid fractions eluted at different retention times, although only seven (7) major peaks were identified, quantified and recorded. Trans-β-carotene predominated with the highest concentration (6.55 μg/g) and percentage area (48.90 μg/g). This was followed by lutein (1.49 μg/g) (12.76 %), β-cryptoxanthin (0.98 μg/g) (6.64 %), α-carotene (0.76 μg/g) (5.15 %), 13-cis-β-carotene (0.40 μg/g) (2.24 %), zeaxanthin (2.00 μg/g) (1.70 %) and 9-cis-β-carotene (0.19 μg/g) (0.69 %).

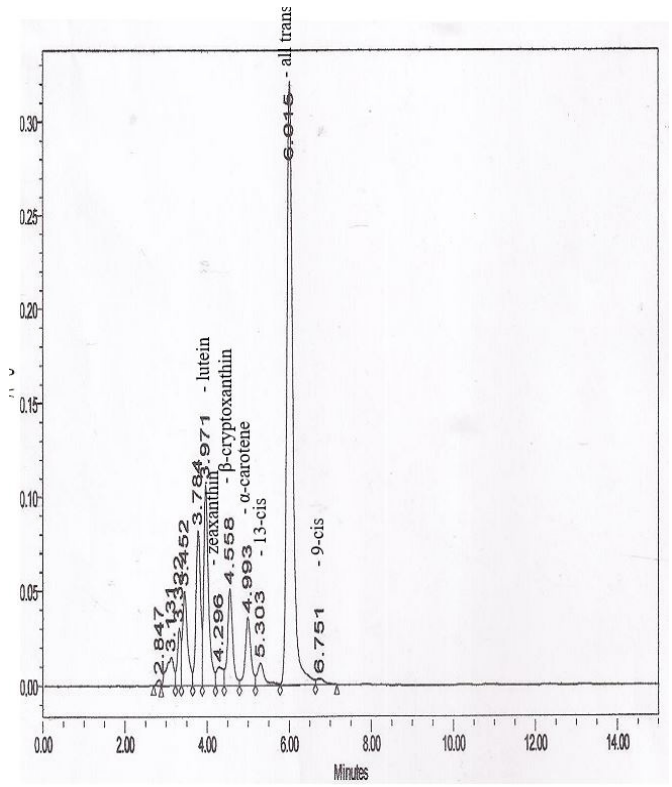

Figure 2: The chromatogram of carotenoid fraction in Umuspo1 (US2) OFSP variety Planted at 30 cm spacing

Figure 3 shows the chromatogram of the carotenoid fraction in Umospo1 (US3) OFSP variety planted at 40 cm distance spacing had fourteen (14) carotenoid fractions eluted at different retention times. Based on available standards, only seven (7) major peaks were identified, quantified and recorded.

Trans-β-carotene was the highest sharp peak recorded with the concentration of 8.40 µg/g and percentage area of 47.45% among other carotenoids obtained at 40 cm spacing distances. This was also followed by zeaxanthin (2.45 µg/g) (6.99 %), β-cryptoxanthin (1.32 µg/g) (6.40 %), α-carotene (1.25 µg/g) (2.70%), lutein (1.96µg/g) (1.95 %), 9-cis-β-carotene (0.42 µg/g) (1.84 %) and 13-cis-β-carotene (0.57 µg/g) (1.08 %).

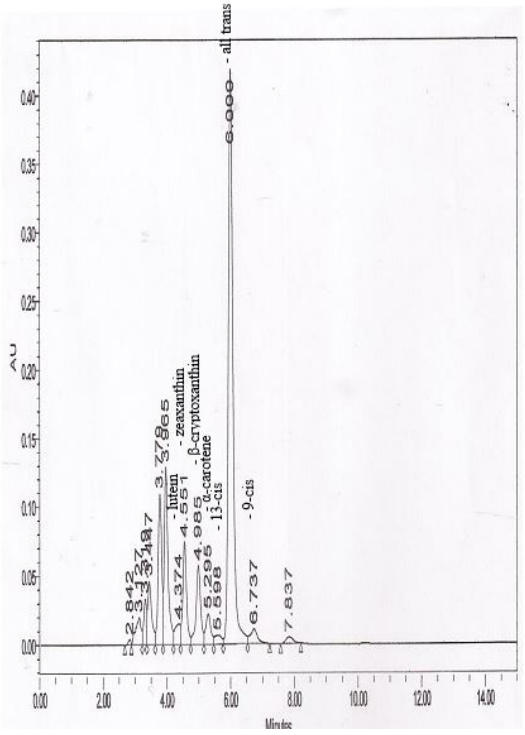

Figure 3: The chromatogram of carotenoid fraction in Umuspo1 (US3) OFSP variety planted at 40 cm spacing

Figure 4 shows the chromatogram of the carotenoid fraction in Ex-Onyunga (ES1) OFSP variety planted at 20 cm spacing had sixteen (16) carotenoid fractions eluted at different retention times. Out of the seven (7) peaks identified, trans-β-carotene was the highest peak and was sharp; with a concentration of 81.22µg/g and percentage area of 79.62% (amidst other carotenoids obtained from 20 cm spacing distance of Ex-Onyunga OFSP variety). This was followed by β-cryptoxanthin (6.59 µg/g) (6.40 %), lutein (3.40 µg/g) (2.44 %), 13-cis-β-carotene (2.07 µg/g) (1.92 %), α-carotene (2.09 µg/g) (1.84 %), 9-cis-β-carotene (1.38 µg/g) (1.25 %) and zeaxanthin (2.94 µg/g) (0.50 %).

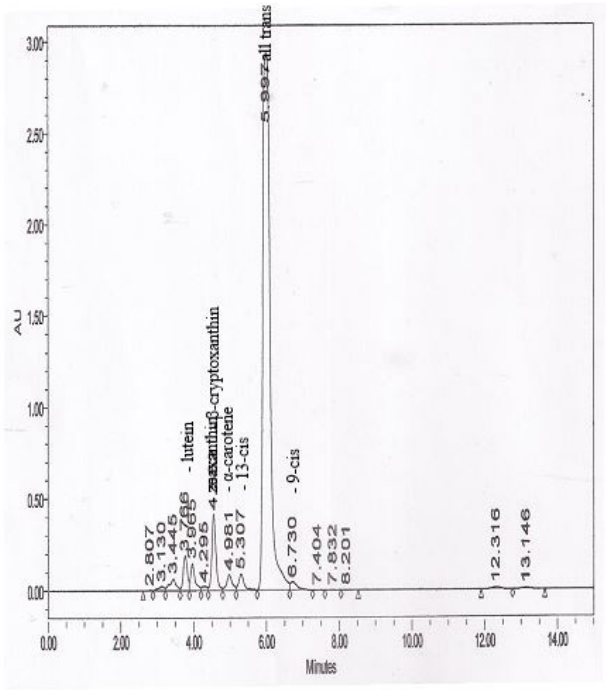

Figure 4: The chromatogram of carotenoid fraction in Ex-Onyunga (ES1) OFSP variety planted at 20 cm spacing

Figure 5 shows the chromatogram of the carotenoid fraction in Ex-Onyunga (ES2) OFSP variety planted at 30 cm spacing. There were fourteen (14) carotenoid fractions eluted at different retention times. Out of the seven (7) major peaks identified, trans-β-carotene predominated with a concentration of 68.81 µg/g and percentage area of 79.02 %. This was followed by β-cryptoxanthin (5.76 µg/g) (6.53 %), lutein (3.11 µg/g) (2.85 %), 13-cis-β-carotene (1.96 µg/g) (2.14 %), α-carotene (1.92 µg/g) (1.98 %), 9-cis-β-carotene (1.22 µg/g) (1.27 %) and zeaxanthin (2.94 µg/g) (0.51 %). However, trans-β-carotene is the highest percentage area achieved than others.

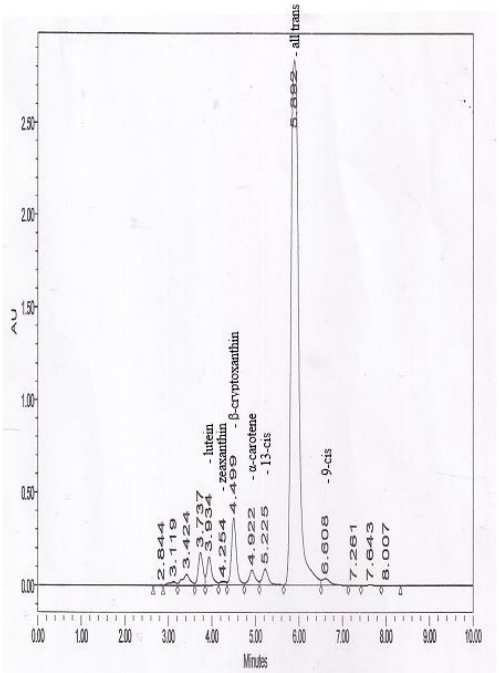

Figure 5: The chromatogram of carotenoid fraction in Ex-Onyunga (ES2) OFSP variety Planted at 30 cm spacing

Figure 6 shows the chromatogram of the carotenoid fraction in Ex-Onyunga (ES3) OFSP variety planted at 40 cm spacing. The chromatogram showed seventeen (17) peaks. Trans-β-carotene was the highest sharp peak among other peaks with a concentration of 73.52 µg/g and percentage area of 74.39 %. This was followed by β-cryptoxanthin (7.05 µg/g) (7.11 %), lutein (4.76 µg/g) (4.00 %), α-carotene (2.72 µg/g) (2.47 %), 13-cis-β-carotene (1.91 µg/g) (1.81 %), 9-cis-β-carotene (1.27 µg/g) (1.18 %) and zeaxanthin (4.71 µg/g) (0.7 %).

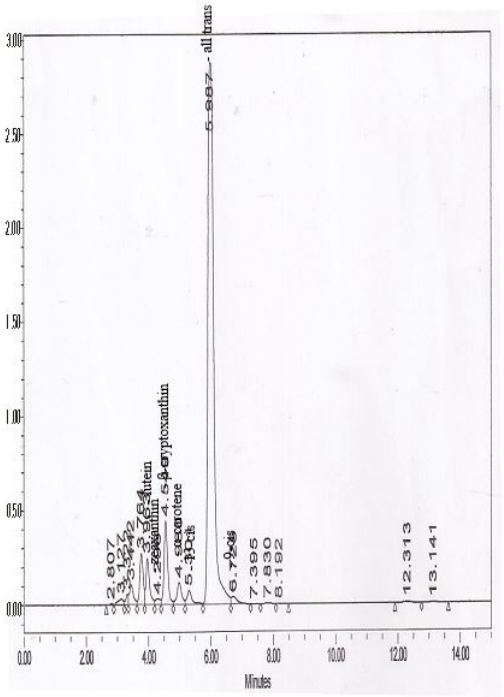

Figure 6: TThe chromatogram of carotenoid fraction in Ex-Onyunga (ES2) OFSP variety Planted at 40 cm spacing

Discussion

Carotenoid content

Quantitatively, Ex-Onyunga contained higher amounts of lutein, zeaxanthin, β-cryptoxanthin, α-carotene, 3-cis β-carotene, trans-β-carotene, 9-cis β-carotene and total β-carotene. In terms of spacing, 40 cm spacing for Ex-Onyunga was better for the accumulation of lutein, zeaxanthin, β-cryptoxanthin and α-carotene while 20 cm spacing was better for all forms of beta-carotene.

Lutein helps to keep the eyes safe from oxidative stress and the higher-energy photons of blue light [14]. Various research studies have shown that a direct relationship exists between lutein intake and pigmentation in the eye [15]. Also, lutein may help reduce the risk of certain types of cancer, particularly those of the breast and lungs [16]. Zeaxanthin is a bioactive compound that migrates to the eyes and is drawn into the lens, macula and fovea (at the centre of the retina). In the macula and fovea, zeaxanthin helps build the yellow macular pigment shield that protects eye cells from dangerous light with high frequencies. It also provides powerful antioxidant activity, neutralizing the free radicals that destroy eye cells [17]. Lutein is beneficial for the eyes. Together with zeaxanthin, it enhances vision, fights eye diseases like cataracts and age-related macular degeneration. It is also good for lung function and brain health, helps in reducing bad LDL cholesterol and severity of congestive heart failure. According to Lorenzo et al., β-cryptoxanthin is a source of vitamin A, but about 2 times less effective than β-carotene. In addition, several observational epidemiological studies suggest that β-cryptoxanthin could potentially act as a chemopreventive agent against lung cancer [18,19]. Thus, Lain et al. concluded that β-cryptoxanthin may be of potential benefit to people who are at risk of diabetes and lung cancer [19]. Studies have concluded that β-cryptoxanthin helps to reduce the risk of lung cancer and colon cancer. Alpha-carotene functions as an antioxidant in the human system. Antioxidants stop free radicals from causing cells to break down, or oxidize. Powerful antioxidants like alpha-carotene remove destructive free radicals from the body before they cause the tissue damage that can lead to chronic diseases like heart disease and cancer. It may help prevent cancer by stimulating cell-to-cell communication, a process which researchers now believe is necessary to ensure proper cell division. Research studies show that the human body can convert alpha-carotene into vitamin A for the maintenance of healthy skin and bones, good vision, and robust immune system. According to Hansen et al. [20]. 13-cis BC acts as a hormone in signalling processes where it binds to nuclear receptors and controls normal reproduction and maintenance of epithelial tissue. It is also involved in preventing carcinogenesis, by acting as a chemo-preventive agent in epithelial carcinogenesis, and as a differentiating agent in acute promyelocytic leukaemia [20]. Trans-β-carotene has the potential to act as a lipid-soluble chain breaking antioxidant to quench singlet oxygen and interact with free radicals to prevent oxidative stress [21]. This action has the effect of lowering the risk of chronic diseases such as cardiovascular diseases [22]. The importance of the 9-cis isomer has been linked to the fact that it is a direct precursor in the intestinal enterocyte

to 9-cis retinoic acid [23]. Retinoic acids act as a hormone in signalling processes where it binds to nuclear receptors and controls normal reproduction and maintenance of epithelial tissues [20]. Specifically, 9-cis retinoic acid binds to the human nuclear retinoic acid receptor (RAR) and retinoid X receptor (R X R-α) and plays a significant role in the expression of normal epithelial and squamous tissue growth [24,25]. Planting distances harvesting periods and soil nutrient management have been shown by earlier researches to influence the nutrients found in sweet potatoes [26-29].

Carotenoid Profile

Although only seven peaks were identified (due to the limited number of internal standards), Ex-Onyunga OFSP variety had more peaks than Umuspo 1 OFSP variety. Samples cultivated at different spacing levels had 14-17 peaks while Umuspo 1 samples had 11-14 peaks. In all the chromatograms, All- trans beta-carotene had the highest peak which was stood out as much higher as the major peak when compared with the other carotenoids. The result also indicated that lutein concentration ranged from 1.48 μg/g to 4.76 μg/g, β-cryptoxanthin concentration ranged from 0.98 μg/g to 7.05 μg/g, α-carotene concentration ranged from 0.76 μg/g to 2.75 μg/g, 13-cis-β-carotene concentration ranged from 0.40 μg/g to 2.07 μg/g, trans-β-carotene concentration ranged from 6.55 μg/g to 81.22 μg/g and 9-cis-β-carotene concentration ranged from 0.19 μg/g to 1.38 μg/g. The carotenoid profiles show different levels of elution with Trans -beta -carotene with the highest peak; which indicated that Trans beta -carotene predominated the OFSP varieties

Conclusion

This study has clearly demonstrated the effects of planting spacing (20, 30 and 40 cm) on the carotenoid contents and carotenoid profile of orange fleshed sweet potatoes varieties. The results showed that planting spacing had significant effects on the carotenoid content and its profile. Trans-Beta -carotene, lutein and Beta-cryptoxanthin levels of the Ex-Onyunga OFSP variety was higher than that of Umuspo 1 irrespective of the planting distance, while zeaxanthin levels of Umuspo 1 was higher. Twenty (20) cm distance was the most favourable for the production of carotenes whiles 40cm was a more ideal spacing for the production of xanthophylls.

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