



Variability of Carotenoids and Dry Matter Content in Orange-fleshed Sweet Potato (*Ipomoea batatas* (L.) Lam.) During Storage

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Abstract

Orange-fleshed sweet potatoes (OFSP) possess carotenoids, which is a precursor of vitamin A. Planting time and processing methods are believed to affect carotene content of orange-fleshed sweet potato storage roots. Since OFSP are a rich source of β -carotene, it is essential to determine whether sweet potato carotenoids are stable during storage. The changes in dry matter and carotenoids were studied at regular intervals during 35 days of storage in 10 orange-fleshed sweet potato clones at Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala, India. There was a significant variation in the content of total carotenoids (10.32 – 13.99 mg 100g⁻¹ f.w) and β -carotene (9.02 – 12.16 mg 100g⁻¹ f.w) among the clones. A gradual increase in dry matter from 24.1 to 25.5% was observed during storage, due to depletion of moisture. There was no significant change in total carotenoids and β -carotene content in the OFSP clones during the storage period. The results of the study indicated that the total carotenoids and β -carotene in sweet potato storage roots had high stability during storage.

Key words: Orange-fleshed sweet potato, storage, β -carotene, carotenoids, dry matter

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam.) is an important food crop cultivated throughout the tropics and warm temperate regions of the world for its edible storage roots. The flesh colour of the root varies from different shades of white, cream, yellow to dark-orange depending upon the pigment present. In the orange-fleshed sweet potato (OFSP) the major carotenoid present is β -carotene, which is a precursor of vitamin A. Hence, orange-fleshed sweet potato storage roots can be used to tackle vitamin A deficiency, a major health problem among rural population in most developing countries. Sweet potato roots have high moisture content and relatively thin and delicate skin (Woolfe, 1987). They remain metabolically active even after harvest and are easily damageable and highly perishable, which makes their storage most difficult. Storing the fresh root is an expensive procedure.

Hence, fresh roots are not stored in many parts of the tropics. In other words, roots are harvested as and when needed and used directly for consumption. However, in the tropical conditions, the tubers are stored for short periods of up to one month. Since OFSP are a rich source of carotenoids, it is essential to determine whether sweet potato carotenoids are stable during storage. The objectives of the present study were to find out the changes in dry matter, total carotenoids and β -carotene content during storage and to determine the variability of these characters in different clones under storage.

Materials and Methods

Experimental material, design and treatments

From the sweet potato germplasm maintained at Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, Kerala, India, 20 clones possessing

different intensities of orange-flesh colour were selected for the poly-cross breeding. About 150 vine cuttings from each clone were planted in an isolation block in three replications. Cuttings of 20-30 cm length from the apical portion of the vines were selected for planting. The clones were randomly planted to get equal chances of intercrossing with each other. About 1000 seeds were collected, scarified and used for raising seedlings. Germination was observed in 900 seeds, of which only 300 clones possessed orange-fleshed storage roots. The undesirable clones were again rejected based on various agronomic characters at seventh stage of evaluation and only 40 clones were finally selected. The colour intensity was measured using the colour chart for sweet potato developed by CIP (Burgos et al., 2009). From these, 10 clones (CO3-50-17, CO3-50-34, CO3-50-36, CO3-50-39, CO3-50-43, CO3-50-6, KS-115, ST-10-11, ST-10-4 and SV3-8) were selected for storage studies. The experiment was conducted in Randomised Block Design with three replications. The plot size was $4.0 \times 1.8 \text{ m}^2$ and the distance between and within the ridges was 60 and 20 cm accommodating 60 plants/clone/replication. The crop was raised following the recommended package of practices standardized by Central Tuber Crops Research Institute (CTCRI, 2004). The crop was harvested 90 days after planting. Triplicate samples (about 10 kg) of marketable roots of uniform size, free from sweet potato weevil were collected for the analysis. Immediately after harvest, the adhering soil and dirt were removed from the storage roots, stored in net bags, suspended by jute ropes from the roof ceiling. The samples were analyzed in triplicate for dry matter, total carotenoids and β -carotene content on 1st, 7th, 14th, 21st, 28th and 35th day after storage. The same experiment was repeated for three seasons (Summer: March to May, Kharif: June to August and Rabi: October to December months) during the year 2008. Since there was no seasonal difference for the above characters the mean data for the three seasons on dry matter, total carotenoids and β -carotene were statistically analyzed. The comparison of mean values with least significant difference was carried out with the package Genstat DE3 (Genstat, 2008).

Estimation of carotenoids and dry matter

Total carotenoids and β -carotene were estimated based on the procedure described by AOAC (2000). For

estimation of total carotenoids, two gram root samples were extracted repeatedly with hexane-acetone mixture (60:40) till the residue was colourless. The extract was decanted into a separating funnel and washed repeatedly with distilled water. The upper hexane layer was collected and dried using anhydrous sodium sulphate. The volume was measured and the optical density (OD) was recorded at 450 nm. For extraction of β -carotene, the extract of total carotenoids was subjected to column chromatography on neutral alumina and β -carotene was eluted using hexane: acetone (96:4). The volume was noted and OD measured at 450 nm. The concentration of total and β -carotene was calculated using a calibration curve with β -carotene as standard. The concentration was also confirmed using the extinction coefficient value for β -carotene in hexane.

For the determination of dry matter, 20g of fresh tuber was cut into small pieces and dried to a constant weight in a hot air oven at 105°C and percentage of dry matter was calculated.

Results and Discussion

The changes in dry matter, total carotenoids and β -carotene in the storage roots of the 10 clones during 35 days of storage are shown in Tables 1 to 3. After 35th day of storage, sweet potato weevil infestation initiated in majority of the storage roots, while some showed germination. Hence, observations were taken till 35th day of storage.

Dry matter content

The orange-fleshed sweet potato clones in general, possess low dry matter content. Initial dry matter content of the 10 clones ranged from 20.9 % (ST-10-11) to 24.1% (CO3-50-17) (Table 1). There was no significant difference for the first two weeks among the clones. Subsequently the dry matter increased from 14th to 35th day of storage from 23.4 to 25.5% as shown in Table 1. The increase in dry matter content during storage can be attributed to the loss of moisture (Lin et al., 1989).

Carotenoid content

The total carotenoids in the 10 orange-fleshed clones ranged between 10.32 – 13.99 mg100g⁻¹f.w. (Table 2). The initial β -carotene content ranged from 9.02 – 12.16 mg 100g⁻¹f.w. Clone ST-10-11 had the highest total

Table 1. Dry matter content (%) in the storage roots of the sweet potato clones during 35 days of storage

Clone	Days after storage					
	1	7	14	21	28	35
CO3-50-17	24.4	24.2	24.2	24.6	24.7	24.8
CO3-50-34	22.5	22.7	22.9	23.6	24.0	24.2
CO3-50-36	22.0	22.7	22.8	23.3	23.6	24.2
CO3-50-39	22.3	20.8	23.4	23.7	23.8	23.9
CO3-50-43	22.4	23.2	23.2	23.8	23.8	23.6
CO3-50-6	23.6	23.8	24.1	24.8	25.1	25.5
KS-115	21.3	22.2	22.3	23.4	23.8	23.8
ST-10-11	20.9	22.2	21.3	21.6	23.0	23.4
ST-10-4	23.2	23.4	23.7	23.7	23.8	23.9
SV-3-8	23.2	23.9	24.0	24.1	24.3	24.6
CD (0.05)	0.50					

Table 2. Total carotenoid content (mg 100g⁻¹f.w.) in the storage roots of sweet potato clones during 35 days of storage

Clone	Days after storage					
	1	7	14	21	28	35
CO3-50-17	12.20	12.24	12.22	12.19	12.27	12.31
CO3-50-34	12.59	12.57	12.62	12.60	12.64	12.66
CO3-50-36	12.34	12.34	12.36	12.40	12.43	12.32
CO3-50-39	12.16	12.21	12.23	12.19	12.24	12.15
CO3-50-43	13.04	13.09	13.13	13.08	13.11	13.06
CO3-50-6	11.51	11.61	11.63	11.54	11.59	11.53
KS-115	11.24	11.28	11.32	11.22	11.30	11.31
ST-10-11	13.99	14.10	14.07	14.00	14.09	14.11
ST-10-4	12.56	12.58	12.63	12.55	12.63	12.54
SV-3-8	10.32	10.39	10.41	10.37	10.30	10.43
CD (0.05)	0.12					

carotenoids and β -carotene content, while clone SV3-8 had the lowest. In all the clones, the ratio of β -carotene to total carotenoids varied from 81 – 90%. No significant difference was noticed in the total carotenoid and β -carotene content within the clones from the 1st to 35th day of storage (Table 3). The results indicated that total carotenoids, including β -carotene showed high stability during the storage period of 35 days.

Planting time and processing methods are believed to affect carotene content of sweet potato tubers. Studies on the genotype \times environment interaction specified an increasing trend in β -carotene in all the clones tested

(Manrique and Hermann., 2000). Cultivar differences, seasonal changes, stage of maturity, storage time and conditions after harvest etc., are responsible for variation in β -carotene content among the clones (Ezell and Wilcox, 1946). Previous reports suggested that the concentration of carotenoids in unprocessed tubers may increase during curing and storage (Ezell et al., 1952; Okwuowulu, 2003). Storability was significantly found to be affected by harvest age elsewhere (Anderson, 1956). Studies on the effect of storage on weight and carotene content of some sweet potato varieties indicated that the carotene gain approached to 10-15% of the original amount of carotene and the varieties defined the way carotene change took place after harvest (Mercadante and Rodriguez - Amaya, 1991).

The sweet potato storage root continues to be metabolically active even after harvest, exhibiting continued synthesis and degradation of proteins as well as other biologically active amines (Bureau and Bushway, 1986). The stability of carotenoids has been found to vary in different crops like carrots, leafy vegetables and sweet potato. A similar study in carrots revealed a significant decrease in the β -carotene content with the increase in storage period, which was also affected by temperature (Dutta et al., 2005). Carotenogenesis continue even after harvest, provided the fruit or vegetable remains intact (Arima and Rodriguez-Amaya, 1990). However,

Table 3. Content of β -carotene (mg 100g⁻¹f.w.) in the storage roots of sweet potato clones during 35 days of storage

Clone	Days after storage					
	1	7	14	21	28	35
CO3-50-17	10.25	10.27	10.29	10.26	10.31	10.28
CO3-50-34	11.32	11.33	11.30	11.39	11.32	11.35
CO3-50-36	10.68	10.70	10.70	10.38	10.73	10.69
CO3-50-39	10.10	10.08	10.16	10.21	10.09	10.15
CO3-50-43	11.43	11.40	10.47	11.51	11.49	11.50
CO3-50-6	9.40	9.45	9.46	9.48	9.51	9.50
KS-115	9.15	9.20	9.27	9.14	9.22	9.19
ST-10-11	12.16	12.18	12.30	12.09	12.25	12.21
ST-10-4	10.38	10.40	10.44	10.40	10.43	10.46
SV-3-8	9.02	10.07	9.10	9.13	9.11	9.09
CD (0.05)	0.13					

this was not observed in our study. Our earlier studies had shown that the content of carotenoids (including β -carotene) in these OFSP clones was affected by processing (Vimala et al., 2011).

Conclusion

Sweet potato is known to produce considerable amount of food calories per unit area per unit time. It is a source of energy in cases where it invariably replaces rice and wheat at times of scarcity. It is estimated that 200 g of sweet potato containing 7.5-12.16 mg 100g⁻¹f.w. of β -carotene would provide the recommended diet of 3-4 and 5-6 days respectively for adults and children. Orange-fleshed sweet potato clones could be used as a rich source of β -carotene to prevent vitamin A deficiency. The fact that the carotenoids in sweet potato are stable up to one month when stored in the fresh form is an added advantage for its utilization as a nutritive crop.

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