Seasonal variations of carotenoids in orange-fleshed sweetpotato (*Ipomoea batatas* (L.) Lam)

B. Vimala*, Beena Kumari, R. and Bala Nambisan

Central Tuber Crops Research Institute, Thiruvananthapuram 695 017, Kerala, India
*Email: vimalactcri @yahoo. co.in

Abstract

Sweet potato (*Ipomoea batatas* (L.) Lam) is a hexaploid with 90 chromosomes. Due to the hexaploidy and heterozygous nature of the crop, wide range of variability was observed in the tuber yield, morphological and biochemical characters. The flesh colour of the tubers ranged from white to dark orange. In the orange- fleshed tubers, the major carotenoid present is the β – carotene which is a precursor of vitamin A. About 40 clones possessing different intensities of dark orange- flesh colour were selected and evaluated for total carotenoids, β – carotene and dry matter content during summer, kharif and rabi seasons to find out the variability of carotenoids at different seasons. The results indicated that the mean total carotenoid ranged from 8.5 – 15.0 mg/100g fresh weight and β – carotene varied from 6.8 – 13.7 mg/100g fresh weight. Out of 40 clones, stability in total carotenoid and β – carotene was observed in 13 clones. In 5 clones, the total carotenoid was stable and in 4 clones only β – carotene was stable for all the three seasons. Significant differences of total carotenoid and β – carotene content in different seasons was noticed in 18 clones. Majority of the clones possessed above 80% β – carotene and the dry matter was less than 25.0%. Vitamin A is produced in the human body in the presence of its precursor β – carotene. The variability in the carotenoids of orange – fleshed sweet potato can be exploited by selecting high β – carotene clones as a cheap source of vitamin A rich food.

Keywords: seasonal variations, carotenoids, orange-fleshed sweet potato.

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is an important vegetable cum food crop grown in the tropics, sub-tropics and warm temperate regions of the world for its edible tubers. The tubers are used as a source of carbohydrate and leaves are a potential source of proteins and minerals. In addition to its importance as human food, it is also used as an animal feed besides serving as a raw material for the production of alcohol. In India, it is grown throughout the country occupying an area of 1.06 ha with an annual production of 9.64 lakhs tones (FAO, 2000). The flesh colour of the tuber ranges from white to dark orange. In the orange-fleshed sweet potato the major carotenoid present is β-carotene which is a precursor of vitamin-A. The orange- fleshed sweet potato can provide twice the recommended daily requirement of vitamin-A and more than one third of vitamin-C. It is also a substantial source of dietary fibre. β -carotene protects the heart and cardiovascular system, boosts immune functions, speeds up the recovery from respiratory infections such as cold, flu and renders wound healing. As an anti-oxidant, β-carotene has been shown to inhibit oxidative damage due to cholesterol and protects against atherosclerotic plaque formation in human beings. One of the important health problems in India is the prevalence of vitamin- A deficiency in young children and adults. The objective of the present study is to estimate the total carotenoids and β- carotene of the selected orange- fleshed clones at different seasons in order to evaluate the Vitamin A potential.

Materials and methods

The materials included for the study were 40 sweet potato clones possessing different intensities of dark orange-flesh colour which were selected from the polycross breeding programme of orange- fleshed sweet potato. The experiment was conducted in RBD in 3 replications during summer, kharif and rabi seasons following the recommended package practices of CTCRI. Each clone was planted on a 6.0 meter ridge. The spacing between and within the rows were 60.0 and 20.0 cm respectively accommodating 30 plants per clone per replication. The trials were harvested at 90 days after the planting. Biochemical analysis like dry matter, total carotenoids and β-carotene content of all the clones were carried out for the 3 replications and 3 seasons following the method of AOAC (1995).

Carotenoids were extracted and separated using Alumina as adsorbent. The concentration of total carotenoids and β- carotene was calculated by determining OD at 450nm. β- carotene standard was prepared and used for the calculation of carotene in the test sample. Out of total carotenoids the percentage of β- carotene was calculated. In order to determine dry matter content about 100g of tuber sample was kept in a hot air oven at 50 ^{0}C till a constant weight was obtained. From the weight of the dried sample, the percentage of dry matter was calculated. The data on dry matter, total carotenoids, β- carotene and percentage of β-carotene to total carotenoids of all the clones for the three seasons were analysed statistically as per the method given by Gomez & Gomez.(1984).

Results and discussion

Sweet potato is a hexaploid and cross pollinated crop. Because of the hexaploidy and heterozygous nature of the crop a wide range of variability was observed in the seedling progenies for flesh colour, carotenoid and dry matter content. The biochemical analysis of the 40 clones showed that the total carotenoids in summer season ranged from 6.3 to 15.3 mg/ 100 g. fresh weight. In kharif season, it varied from 8.2- 15.5 mg/100g. fresh weight and in the rabi season the range was between 9.1 - 15.2 mg/100 g. fresh weight. The total carotenoid content and β-carotene was less than 10 mg / 100 m f.w. only in six clones.

The present studies showed that tuber carotenoid content was associated with the flesh colour as reported by Lin *et al* (1989). The β- carotene in 23 clones was 10.0 – 13.5 mg/100 g. f. w. in summer season and in the kharif and rabi season it varied from 10.1 – 13.8 and 10.0 – 14.5 mg / 100g f. w. respectively. The flesh colour of the tuber was positively correlated to the carotenoid content. Simonne *et al* (1993) reported that the carotenoids especially β- carotene was responsible for the orange flesh colour of sweet potato tubers and the depth of the orange flesh colour was mainly a function of the concentration of the β- carotene. The percentage of β- carotene to total carotenoids varied from 78 – 95 % which was higher than the value reported by Woolfe (1992).The clones ST 14- 6, KS-2, CO3 – 50 -33, CO3 – 50 -34 and ST 10 – 8 possessed above 90 % β- carotene in the summer season. In kharif season, 7 clones *viz,* ST- 14- 1, ST- 14-22, CO3- 50-33, ST 10 – 8, ST 10- 19, 108-2 and CIP- SWA-2 showed above 90% β- carotene. However, in rabi season only three clones ST 14-1, KS- 63, CO3- 50-33 possessed above 90 % β carotene.

The mean value of carotenoids in 3 seasons showed that out of 40 clones, significant difference of total carotenoids and β- carotene was noticed in 18 clones between different seasons. It may be due to the interaction of the genotype with the environmental factors. Thirteen clones (ST-14-22, ST-14-34, ST-14-39, KS - 37, CO3-50-23, CO3-50-39, CO3-50-43, ST- 10-4, ST-10-12, ST-10-19, SV3-17, 362-7, 108-14) possessed a stability in total carotenoids and β-carotene content at all the three seasons. However, five clones were stable only for total carotenoids contents (ST-14-1, ST-14-3, ST-14-47, ST-14-53, SV-3-8) and four clones (ST-14-16, ST-14-27, ST-10-8, CIP SWA 2 (2)) had a stable β- carotene content. Generally dry matter was less than 25 %. in all the high carotene clones. Only 6 - 7 clones possessed 25 – 27 % dry matter at different seasons. It has already been reported (Hernandez ,*et a*l.,1967; Jones, 1977; Zhang and Xie,1988) that negative correlation exists between dry matter content and carotenoids. The earlier studies of Vimala *et al* (2006) indicated that the highest total carotenoid of 14.0 mg /100g. f. w. was recorded in ST- 14. However in the present study it was observed that six clones possessed more than 14.0mg/100g.f.w. total carotenoids for all the three seasons .

Vitamin-A is produced by the human body when it has sufficient quantities of its pre-cursor β- carotene. The average daily requirement of β- carotene for children is 2.4 mg, adults is 3.5 mg and for lactating mother it is 5 mg (W.H.O 1995). It is estimated that 300-400μg equivalents of retinol per day satisfy the requirement for children upto 10 years of age which is equivalent to 2.1-2.4mg/100g.f.w. carotene. Usually a ratio of 4:1- 8:1 is used to convert β-carotene into retinol since the human body could not convert all the β-carotene. The major problem which results in vitamin-A deficiency in developing countries is due to the low dietary intake of vitamin A (Buycks,1996). One possible solution to control vitamin A deficiency in these areas is to increase the availability of a cheap source of vitamin rich food. A regular intake of 100g.of dark orange- fleshed sweet potato per day provides the recommended daily amount of vitamin A for children and adults which protects them from vitamin A deficiency (Tsou and Hong,1992). Sweet potato provides adequate amount of calories, vitamin C, vitamin D and other micronutrients such as iron and zinc. Orange-fleshed sweet potatoes can play a significant role in the developing world as a viable, long term, cost effective, culturally acceptable, self- reliant, and sustainable food based approach to control vitamin A deficiency.

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