J.Natn. Sci. Foundation Sri Lanka 2007 35(4): 251-253

SHORT COMMUNICATION

The carotenoids of some selected Sri Lankan non-leafy vegetables

A.M.B. Priyadarshani and U.G. Chandrika*

Department of Biochemistry, Faculty of Medical Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda.

Revised: 31 October 2006 ; Accepted: 21 May 2007

Abstract: This study was carried out to determine the carotenoid content of raw carrot *(Daucus carota)*, pumpkin *(Cucurbita maxima)*, squash *(Cucurbita moschata)* and yellow, orange sweet potato *(Ipomoea batatas)* commonly available in Sri Lanka. The carotenoid profile was determined by Open Column Chromatography (OCC) and spectrophotometry and quantification was done by High Performance Liquid Chromatography (HPLC). The results showed that the major pro-vitamin A carotenoid in each vegetable was β-carotene and the mean (n=6) content of β-carotene, α-carotene and lutein in carrot were 43.8 ± 5.6, 20.5 ± 1.7 and 3.8 ± 0.4 μg/g fresh weight (FW) respectively. In pumpkin, the content of carotenoids ranged from 3.0 to 50.9 μg/g FW for β-carotene, from 1.2 to 27.3 μg/g FW for α-carotene and from 8.2 to 45.8 μg/g FW for lutein. β-carotene and α-carotene concentrations of squash were 6.0 ± 0.8 and 5.1 ± 1.1 μg/g FW, respectively. β-carotene was the only detected carotenoid from sweet potato and it ranged from 14.7 to 59.0 μg/g FW among the five varieties.

Keywords: Carotenoids, *Cucurbita maxima*, *Cucurbita moschata*, *Daucus carota*, *Ipomoea batatas*

INTRODUCTION

Vitamin A deficiency is one of the major health problems in Sri Lanka, which is more prevalent among pre-school children[1]. Dietary interventions have been planned to solve the vitamin A deficiency by increasing the intake of pro-vitamin A carotenoids which is critical for dietary improvement. This has been suggested as a sustainable alternative to overcome vitamin A deficiency globally[2]. Therefore, information about the carotenoid composition and content of vegetables that are widely available in Sri Lanka is needed to encourage the intake of foods rich in pro-vitamin A carotenoids by vitamin A deficient population. The carotenoid content of some Sri Lankan fruits and green leafy vegetables has previously been reported[3-7]. Carrot, pumpkin, squash, orange and yellow sweet potato which are widely recognized as good sources of pro-vitamin A carotenoids, have not been studied in Sri Lanka. The objective of this study was to determine the carotenoid composition and content of carrot (*Daucus carota*, variety: new kuroda), five common varieties of pumpkin (*Cucurbita maxima*, varieties: Arjuna, Ruhunu, Meemini, Samson, Janani), squash (*Cucurbita moschata*, variety: batana) and five common varieties of orange, yellow sweet potato (*Ipomoea batatas*, varieties: CARI-426, P_2 - 20, CIP- 440060, 420027, 187617-1).

METHODS AND MATERIALS

Samples of carrot, pumpkin, squash and sweet potato were purchased at random from in and around the Colombo District for analysis. The dentification of vegetables was confirmed by the Horticultural Crop Research and Development Institute, Gannoruwa, Kandy. From each vegetable, six different batches were analysed. Analysis was carried out according to the method of Rodriguez-Amaya[8]. The sample was ground with cold acetone and celite using motor and pestle. β-Apo-8'carotenal was added as the internal standard. The resultant mulch was filtered through a sintered glass funnel. Grinding and filtration was repeated 4 times until the residue was colourless. The filtrates were combined and transferred to petroleum ether (specified boiling range of 60-80 °C) and separated in a column prepared with MgO:celite (1:1 activated at 110 °C for 4 h) for the identification of each carotenoid. The column was developed with petroleum ether and increasing concentrations of acetone in petroleum ether[8]. Identification was done by ultraviolet, visible absorption spectra (λ_{max} and spectral fine structure), order of elution in Open Column Chromatography (OCC) and Reverse Phase High Performance Liquid Chromatography (RP-HPLC) retention time. Carotenoids were quantified by HPLC. The samples dried under nitrogen gas were dissolved in known volumes of mobile phase solvent, stabilized with 0.1% (w/v) BHT, and filtered through a

* Corresponding author

0.45 μm pore size cellulose membrane filter (Sartorius Filtration AB) before HPLC analysis. The isocratic mobile phase was acetonitrile: methanol: tetrahydrofuran (THF) (58: 35: 7, HPLC grade, Merck). Detection was done at 450 nm. All-*trans*-β-carotene (Sigma, USA), α-carotene (isolated from *Daucus carota* using OCC) and lutein (isolated from *Sesbania grandiflora* using OCC) were used as external standards. The concentrations of carotenoid standards working solutions were confirmed by a spectrophotometer (Shimadzu UV-1601, Kyoto, Japan) and the extinction coefficient values of α-carotene, β-carotene and lutein[8].

Precautions taken to minimize losses of carotenoids included performing analysis under dim light and use of nitrogen gas whenever possible to minimize the contact with oxygen. Samples were stored at -20 °C. Triplicate homogenized samples (5 g) were freeze dried and weighed. The moisture content of each sample was calculated based on average weight of the three dried samples.

RESULTS AND DISCUSSION

The mean carotenoid concentrations of the vegetables evaluated in the present study are given in Table 1. The study showed β-carotene and α-carotene are the principal carotenoids and lutein is a minor component in carrot. The values for β-carotene and α-carotene; 43.8 ± 5.6 and 20.5 ± 1.7 μg/g FW respectively of carrot used in the present study are lower than those reported from Brazil; 61.5 ± 9.0 and 35.0 ± 5.0 μg/g for β-carotene and α-carotene[9] respectively and from USA; 86.26 and 31.6 μg/g for β-carotene and α-carotene[10] respectively, on the basis of fresh weight. But the value for lutein obtained in the present study (3.8 ± 0.4 μg/g FW) is similar to the values obtained in the previous studies (5.1 ± 1.0 μg/g FW[9] and 3.94 μg/g FW[10]).

Five types of pumpkin are commonly available in Sri Lanka. Considerable variations in -carotene and -carotene content among the varieties were observed. Lutein is the major contributor to the total carotenoid content of most varieties. According to visual characterization, colour of the pumpkin flesh, which varies from pale yellow to dark orange, correlates with the content of different carotenoids. Variety Arjuna is notably rich in -carotene, which makes this variety dark orange and variety Samson with the highest lutein content showed a dark yellow colour. Variety Meemini had a higher -carotene content than -carotene. Although the cultivars are different, values obtained in this study from some varieties of *Cucurbita maxima* for -carotene (ranges from 3.0 to 50.9 g/g FW) fall within the values reported from Austria for different varieties of *Cucurbita maxima* which range from 1.4 to 7.4 mg/100 g FW[11] but -carotene (1.2 - 27.3 g/g FW) and lutein (8.2 - 45.8 g/g FW) concentrations are lower than the values reported for -carotene (0 - 7.5 mg/100 g FW) and lutein (0.8 - 17 mg/100 g FW)[11]. The values reported for mature *Cucurbita maxima* for -carotene, -carotene and lutein[12] respectively from Brazil is 3.1 to 28.0 g/g FW, not detected to 0.2 g/g FW and 7.2 to 25.3 g/g FW respectively. These values are lower than some of the values obtained in the present study. The data for squash in the present study are lower than those reported previously from Austria (0.98 - 5.9 and 3.1 - 7 mg/100 g for α-carotene and β-carotene, respectively)[11] and Brazil (8.3 - 42.3 and 14.1 - 79.3 g/g for α-carotene

Table 1: Concentrations of the major carotenoids of some selected Sri Lankan non-leafy vegetables[a]

Vegetable	β-Carotene	α-Carotene	Lutein
Carrot	43.8 ± 5.6	20.5 ± 1.7	3.8 ± 0.4
Pumpkin- Varieties:			
Arjuna	50.9 ± 5.7	27.3 ± 3.1	39.1 ± 4.7
Ruhunu	8.7 ± 1.2	6.2 ± 1.0	8.2 ± 1.2
Meemini	6.2 ± 2.1	11.8 ± 3.1	30.8 ± 4.7
Janani	3.0 ± 0.9	1.2 ± 0.3	31.2 ± 2.8
Samson	5.1 ± 0.8	2.0 ± 0.4	45.8 ± 4.8
Squash	6.0 ± 0.8	5.1 ± 1.1	-
Sweet potato-Varieties:			
CARI-426	42.8 ± 4.3	-	-
P_7-20	35.4 ± 5.2	-	-
CIP-440060	37.5 ± 3.8	-	-
420027	59.0 ± 6.2	-	-
187617-1	14.7 ± 2.3	-	-

[a] Data presented as μg/g fresh weight ± SD (n = 6)

and β-carotene, respectively)[12] and -carotene content of squash was also lower when compared to carrot, some pumpkin varieties and sweet potato evaluated in this study. -carotene was the only carotenoid detected in sweet potato, which ranges from 14.7 to 59.0 g/g FW. However, previous studies on sweet potato have been given results of 64 and a range of 50 - 160 g/g FW for β-carotene from Egypt and United States[13], respectively. Variation in the carotenoid concentrations of samples from the same species could be due to the varietal differences, stage of maturity as well as climate.These results suggest that carrot, pumpkin variety Arjuna, sweet potato varieties CARI-426 and 420027 are rich sources of β-carotene and others are good sources of pro-vitamin A carotenoids. These findings are useful for dietary intervention programmes to alleviate vitamin A deficiency in Sri Lanka as well as other developing countries.

Acknowledgement

This research was supported by the International Foundation for Science, Stockholm, Sweden and Organization for the Prohibition of Chemical Weapons (OPCW), The Hague, Netherlands, (Research grant No: E/3655-1), IPICS, SRI:07, Uppsala, Sweden and University of Sri Jayewardenepura grant ASP/6/PR/2003/14.

References

1. Medical Research Institute (1998). *Report of the Survey on Vitamin A Deficiency Status of Children in Sri Lanka* 1995/96. United Nations Children Fund. (UNICEF).
2. Underwood B.A. & Arthur P. (1996). The contribution of vitamin A to public health. *Journal of the Federation of American Societies for Experimental Biology* **10** (9): 1040-1048.
3. Chandrika U.G., Svanberg U. & Jansz E.R. (2006). *In-vitro* accessibility of β-carotene from cooked Sri Lankan green leafy vegetables and their estimated contribution to vitamin A requirement. *Journal of the Science of Food and Agriculture* **86** (1): 54-61.
4. Chandrika U.G., Jansz E.R. & Warnasuriya N.D. (2005). Identification and HPLC quantification of carotenoids of the fruit pulp of *Chrysophyllum roxburghii*. *Journal of the National Science Foundation of Sri Lanka* **33** (2): 93-98.
5. Chandrika U.G., Jansz E.R., Wickramasinghe S.M.D.N. & Warnasuriya N.D. (2003). Carotenoids in yellow-and red-fleshed papaya *(Carica papaya L.)*. *Journal of the Science of Food and Agriculture* **83**(12):1279-1282.
6. Chandrika U.G., Jansz E.R. & Warnasuriya N.D. (2005). Analysis of carotenoids in ripe jackfruit (*Artocarpus heterophyllus*) kernel and study of their bioconversion in rats. *Journal of the Science of Food and Agriculture* **85**: (2)186-190.
7. Ratnayake R.M.S., Wimalasiri W.R. & Perera P.A.J. (1993). A simple method for the separation of pro-vitamin A carotenoids. *Chemistry in Sri Lanka* **10**(2):06.
8. Rodriguez-Amaya D.B. (1999). *A Guide to Carotenoid Analysis in Foods*. ILSI Press, Washington DC.
9. Niizu P.Y. & Rodriguez-Amaya D.B. (2005). New data on the carotenoid composition of raw salad vegetables. *Journal of Food Composition and Analysis* **18**(8):739-749.
10. Sulaeman A., Keeler L., Giraud D.W., Taylor S.L., Wehling R.L. & Driskell J.A. (2001). Carotenoid content and physicochemical and sensory characteristics of carrot chips deep - fried in different oils at several temperatures. *Journal of Food Science* **66**(9): 1257-1264.
11. Murkovic M., Mulleder U. & Neunteufl H. (2002). Carotenoid content in different varieties of pumpkins. *Journal of Food Composition and Analysis* **15**(6):633-638.
12. Arima H.K. & Rodriguez-Amaya D.B. (1988). Carotenoid composition and vitamin A value of commercial Brazilian squashes and pumpkins *Journal of Micronutrient Analysis* **4**(3):177-191.
13. Rodriguez-Amaya D.B. (1997). Carotenoids and food preparation. In: *The retention of pro-vitamin A carotenoids in prepared, processed and stored foods*. United States Agency for International Development (USAID).