Carotenoids and β-carotene Content of Non-leafy Green Vegetables (NLGVs) of Bangladesh

SK. Nazrul Islam[1], Sayeeda Naim[1], Saiful Haque[1], Md. Nazrul Islam Khan[1], Sagarmay Barua[1], M.A. Wahed[2], S H Thilsted[3] and N Hassan[1]*

Institute of Nutrition and Food Science, University of Dhaka, Dhaka, Bangladesh[1]
International Centre for Diarrhoeal Disease Research, Bangladesh (ICDR'B) Dhaka[2]
Research Department of Human Nutrition, The Royal Veterinary and Agricultural University, Copenhagen, Denmark[3]

Abstract

Ten popularly consumed non-leafy vegetables (NLGVs) were studied for their total carotenoids and β-carotene contents. The samples were procured from farmer's fields and the major local wholesale markets where vegetables from different parts of the country are brought for sale. Total carotenoids was estimated by spectrophotometric method and β-carotene was determined by HPLC system. The total carotenoids ranged from 49±9μg% for okra to 10460±1297μg% for carrot. A strong seasonality was found in the content of carotenoids. Matured ripe variety contains significantly higher amounts of carotenoids. Tomato (2464±187μg%), sweet pumpkin (4853±1200μg%), carrot (10460±1297μg%) stand out to be the rich sources of carotenoids. β-carotene was found to be ranged from 64±15μg% in potol to 3113±146μg% in carrot. The share of β-carotene to total carotenoids was in between 24% and 97%, but in most of the vegetables the percent of β-carotene was above 70%. Yellow and ripe vegetable varieties have higher β-carotene compared to the rest of the vegetables under analysis. Carotenoids and β-carotene contents of NLGVs vary with the variation of species, their varieties and seasons.

Key words : Carotenoids, β-Carotene, NLGVs.

Introduction

Micronutrient deficiency, especially vitamin A deficiency is a serious public health problem in most of the developing countries[1]. In Bangladesh vitamin A deficiency has been identified to be a major public health problem, in spite of the fact that it has been endowed with plenty of green around and almost everywhere in the country. The nutrient composition of all the available and newly introduced green-yellow

Bangladesh Journal of Nutrition. Vol 16 December 2003. Institute of Nutrition and Food Science, University of Dhaka-1000, Bangladesh

* Author for Correspondence

vegetables is not available. The values available are already forty years old and the analysis was done using traditional methods. With the discovery of modern machines and their high level of accuracy, there is a need to update the existing food tables and to find values for the newly introduced food crops, specially, vegetables. In an effort to update the food value tables and to fill in the data gap we have investigated ten most commonly consumed non-leafy green vegetables in this study.

Materials and Methods

Ten popularly consumed non-leafy vegetables were procured from farmer's fields and the major local wholesale markets where vegetables from different parts of the country are brought for sale. Two to three varieties of each of the ten vegetables were selected for the study. Since about 70% of all vegetables are available in the four winter months (October through January), the study was confined only to vegetables grown in the winter. The selected vegetables comprised Bean (Shim), Folwal potol (Potol), Cowpea (Borboti), Okra (Dharos), Eggplant (Begun), Sweet pumpkin (Mistikumra), Tomato, Bittergourd (Karola), Kakrol and Carrot (Gajar).

Total carotenoids was determined by solvent extraction followed by spectrophotometric method (UV-1201, UV-VIS, Shimadzu, Kyoto, Japan) as described by Raman et al[2]. n-hexane-acetone extract of GLV was passed through a glass column (2.5x40cm) with a sintered glass disk holding a 15cm bed of an adsorbent of alumina and sodium sulphate. Eluted yellow band containing carotenoids was diluted and read in the spectrophotometer at 450nm. Concentration of carotenoid was calculated from its standard calibration graph.

β-carotene was estimated by HPLC (LC-10AD, SHIMADZU, Kyoto, Japan) as described by Muller[3]. Corotenoid eluent concentrated under nitrogen stream was reconstituted with HPLC grade methanol, and 50μl of it was injected into the chromatography on a C_{18} shim pack CLC-ODS (M) column of diameter 4.6mm (Shimadzu, LC Column, 4.6x250mm, Japan) with methanol:tetrahydrofuran (95:5) mobile phase flowing at 1.5ml/min. β-carotene was detected spectrophotometrically at 450nm.

Efforts were made to assess the variation in total carotenoids and β-carotene contents due to seasonality, maturity and species variation.

Results

Carotenoids and β-carotene contents of NLGVs (non-leafy green vegetables) vary with the variation of species, their varieties and seasons.

The total carotenoids ranged from 49±9 for Okra to 10460±1297μg% for carrot. A strong seasonality was found in the content of carotenoids, the higher values being associated with most of the early winter (October-November) varieties. Matured ripe variety contains significantly higher amounts of carotenoids. Tomato (2464±187μg%), sweet pumpkin (4853±1200μg%), carrot (10460±1297μg%) stand out to be the rich sources of carotenoids (table 1).

Table 1. Total carotenoids in selected vegetables by variety and season

Vegetables	Total carotenoids in μg%		P value
	Early winter	Late winter	
Bean (Shim)			
Green	172.6±27.2	356.9±80.5	$^{a}P>0.05$
Greenish white	178.2±5.0	542.4±64.1	$^{b}P<0.01$
Folwal potol (Potol)			
Big	172.6±27.2	171.3±10.8	$^{ab}P>0.05$
Small	178.2±5.0	175.0±30.8	
Cowpea (Borboti)			
Green	519.7±22.5	358.0±54.2	$^{ab}p<0.01$
Red	367.5±65.1	172.2±23.3	
Okra (Daros)	48.7±8.5	233.9±55.4	$^{b}P<0.01$
Eggplant (Begun)			
Round black	101.3±9.3	125.3±30.6	$^{ab}P>0.05$
Round green	98.5±4.5	103.0±4.2	
Long black	111.8±24.5	98.3±25.1	
Sweet pumpkin			
Yellow	4852.9±1200	3970.2±466.8	$^{ab}P<0.01$
Black	1939.6±161.3	1038.7±549.1	$^{yb}P>0.05$
Tomato			
Semirope	496.0±70.7	368.9±166.8	$^{ab}P<0.01$
Ripe	2463.5±186.9	1738.7±549.1	$^{b}P>0.05$
Bittergourd (Karola)			
Green	131.2±37.3	163.1±19.0	$^{ab}P<0.01$
Semiripe	1235.0±84.9	464.79±26.04	$^{gb}P>0.05$
Ripe	4491.7±369.8	2992.0±793.1	
Kakrol			
Green	72.2±33.3	nd	$^{a}P<0.01$
Semiripe	193.7±23.1		
Ripe	2639.0±448.5		
Carrot (Gajar)	10459.6±1296.8	3216.7±1035.3	$^{b}P<0.01$

a: variation in varieties, b: seasonal variation, nd: not done.

Every sample was analyzed in triplicate. Values were expressed in mean and SD.
Statistics: descriptives, crosstabes, independent-samples t-test

Table 2. β-carotene in selected vegetables

Vegetables	β-carotene in μg%	P value*
Bean (Shim)		
Green	348.7±166.9	P>0.05
Greenish white	417.8±86.7	
Folwal potol (Potol)		
Big	65.4±4.6	P>0.05
Small	63.7±14.9	
Cowpea (Borboti)		
Green	241.6±7.1	P<0.05
Red	153.3±39.2	
Okra (Dharos)	211.8±21.8	
Eggplant (Begun)		
Round black	66.3±15.1	P>0.05
Round green	87.1±12.2	
Long black	82.7±13.5	
Sweet pumpkin		
Yellow	1853.9±379.1	P<0.01
Black	816.1±54.0	
Tomato		
Semirope	324.8±72.7	P>0.05
Ripe	409.6±99.0	
Bittergourd (Karola)		
Green	123.1±29.3	P<0.01
Semiripe	464.8±26	
Carrot (Gajar)	3113.0±146.3	

*Significance: P<0.05

Every sample was analyzed in triplicate. Values were expressed in mean and SD.
Statistics: Descriptives, crosstabes, independent-samples t test

Table 3. Percent of β-carotene in total carotenoids in the selected vegetable varieties

Vegetables	β-carotene in μg%	Total carotenoids	% of β-carotene*
Bean (Shim)			
Green	348.7±166.9	356.9±80.5	97.7
Greenish white	417.8±86.7	542.4±64.1	77.0
Folwal potol (Potol)			
Big	65.4±4.6	171.3±10.8	38.2
Small	63.7±14.9	175.0±30.8	36.4
Cowpea (Borboti)			
Green	241.6±7.1	358.0±54.2	67.5
Red	153.3±39.2	172.2±23.3	89.1
Okra (Dharos)	211.82±21.7	233.9±55.4	90.6
Eggplant (Begun)			
Round black	66.3±15.1	125.28±30.6	52.9
Round green	87.1±12.2	103.0±4.2	85.4
Long black	82.7±13.5	98.3±25.1	85.1
Sweet pumpkin			
Yellow	1853.9±379.1	3970.2±466.8	46.7
Black	816.1±54.0	1038.7±549.1	78.6
Tomato			
Semirope	324.8±72.7	368.9±166.8	88.0
Ripe	409.6±99.0	1738.7±549.1	23.6
Bittergourd (Karola)			
Green	123.1±29.3	163.1±19.0	75.4
Semiripe	464.8±26.0	504.5±81.4	92.1
Carrot (Gajar)	3113.0±146.3	3216.7±1035.2	96.8

Values were expressed in mean and SD.
*Percent of β-carotene was calculated on the basis of total carotenoids as 100%.

β-carotene was found to be ranged from 64±15μg% in potol to 3113±146μg% in carrot. The share of β-carotene to total carotenoids was in between 24 for Tomato and 97% for carrot and green bean. But in most of the vegetables the percent of β-carotene was above 70%. Yellow and ripe vegetable varieties such as carrot

(3113±146μg%), Tomato (410±99μg%), and karola (465±26μg%) have higher β-carotene compared to the rest of the vegetables under analysis (table 2,3)

Discussion

The distribution of total carotenoids in plant materials has been reviewed in several publications[4]. Most of the data presented include those reported before 1970s and analysed by using open-column and thin-layer chromatography, which do not permit adequate or accurate separation of the total carotenoids, so the results were reported as total carotene or carotenoids or β-carotene[4]. As most of the carotenoids have absorbance maxima very close to 450nm, which is for β-carotene, it is therefore, difficult to estimate β-carotene content with the spectrophotometric method, but convenient for determination of total carotenoids. HPLC system can precisely identify and determine the β-carotene and other carotenoid profile in plant materials and other sources.

It was observed that total carotenoid values for most of the NLGVs studied corresponded to the β-carotene values reported for these vegetables[2,5-7]. This would be because of assay methods difficulties as described above and the reported values would be for the total carotenoids instead of β-carotene. The share of β-carotene to total carotenoids was shown to be 24 to 97%. However, in most of the vegetables the percent of β-carotene was above 70%. These values are nearly equivalent to those reported for some vegetable by Ong and Tee[4]. Yellow and ripe vegetable varieties have significantly ($P<0.05$) higher β-carotene compared to the rest of the vegetables under analysis.

This study has identified some very rich vegetable sources of carotenoids and β-carotene. In addition to its role in addressing the widely prevalent vitamin A malnutrition, carotenoids also have potential antioxidant activity. Now that the government and the NGOs are very active in addressing the micronutrient malnutrition through homestead horticulture and gardening, these vegetables can be incorporated in the food system, and be popularized their production and consumption. The values derived from the study can also be incorporated to update our old food value tables.

Acknowledgement

We gratefully acknowledge the support received through ENRECA (Programme for Enhancement of Research Capacity in Developing Countries), funded by DANIDA (Danish International Development Assistance), Ministry of Foreign Affairs, Copenhagen, Denmark for the study.

References

1. WHO. Global prevalence of vitamin A deficiency. WHO MDIS working paper 2, 1995.
2. Rahaman MM, Wahed MA and Ali MA. β-carotene loss during different methods of cooking green leafy vegetables in Bangladesh. J. Food Comp. Analysis 1990; 3: 47-53.
3. Muller H. Determination of carotenoid content in selected vegetables and fruit by HPLC and photodiode array detection. Z. Lebensm Unters Forsch A 1997; 204: 88-94.
4. Ong ASH and Tee ES. Natural sources of carotenoids from plant oils. In: Methods of Enzymology. Carotenoids Part A, edited by Packer L, vol 213, chapter 14; Academic Press, Inc. San Diego, 1992: 142-172.
5. Gopalam C, Rama Sastri BV and Balasubra SC. Nutritive value of Indian foods. 2nd ed. edited by Narasinga Rao BS, Deosthale YG, Pan KC, Indian Council of Medical Research, Hyderabad, India, 1993: 24-25.
6. Ali SMK, Malek MA, Jahan K and Salamatulla Q. Deshio Khadday Drobber Pushtiman , 4th ed. Institute of Nutrition and Food Science, University of Dhaka, Dhaka, 1992: 4-8.
7. Darnton –hill I, Hassan, N, Karim R and Duthie MR. Tables of nutrient composition of Bangladeshi foods. World Food Programme, Helen Keller Intrnational Bangladesh, Dhaka, 1988.