Ascorbic acid, Carotenoids and beta-(β) Carotene Contents in Different Varieties of Chillies *(Capsicum annuum* L.) of Bangladesh

SK. Nazrul Islam, Jolly Khanam[1], Saiful Haque[1], Md. Nazrul Islam Khan[1], Sagarmay Barua[1], SH Thilsted[2] and N Hassan[1]*

Institute of Nutrition and Food Science, University of Dhaka, Dhaka-1000, Bangladesh.[1]

Research Department of Human Nutrition, The Royal Veterinary and Agricultural University, Copenhagen, Denmark.[2]

Abstract

Five popularly consumed Chilli varieties (*Capsicum annuum L.)* were investigated for their ascorbic acid, total carotenoids and β-carotene contents. Samples were collected from the local wholesale markets where Chillies produced in different areas of Bangladesh were marketed during early (October-November) and late (February-March) winter. Ascorbic acid was estimated by spectrophotometric method, total carotenoids was determinted by solvent extraction followed by spectrophotometric method, while β-carotene was estimated by HPLC system. Ascorbic acid ranged from 50±8 to 115±5mg% in tender green and 56±11 to182±112mg% in matured red chillies. Carotenoids ranged between 269±37μg% and 1054±61μg% in green chillis, and 2350±225μg% and 8299±1261μg% in red chillies. Highest content of carotenoids was found in red *Balujuri* (8299±1261μg%) and *Buroia* (5420±294μg%) varieties. β-carotene ranged from 255±27 to 411 ±70μg % in the green and 692±230 to 1784±109μg% in the red varieties. In general consistently higher amount of β-carotene was found in all matured red than in tender green Chilli varieties. Percent of β-carotene in total carotenoids was found to be in a range of 20 to 91% in different Chilli varieties.

Introduction

Chilli (*Capsicum annuum L.*) is widely consumed as vegetable in Bangladesh. It is very popular specially among the women. Nutrition surveys since 1981 have consistently indentified Chilli to be a frequently consumed vegetable eaten raw many times in a week with rice. Chilli is a rich source of multiple micronutrients including microminerals and ascorbic acid [1, 2, 3]. It, therefore, holds considerable promise to improve diet quality and nutrition of our people. In view of this and in line with our attempt to update the National Food Composition database, we investigated five local varieties of Chillies for their total carotenoids, β-carotene and ascorbic acid contents in 1999-2000. The present study reports the findings of the study.

Bangladesh Journal of Nutrition. Vol 17 December 2004. Institute of Nutrition and Food Science, University of Dhaka-1000, Bangladesh

* Author for correspondence

Materials and Methods

Five popularly consumed Chilli varieties (*Capsicum annuum L.*) were selected for the study. These were collected from the local wholesale markets where Chillies produced in different areas of Bangladesh were marketed. The sample collection time ranged between early (October-November) and late (February-March) winter.

Ascorbic acid was estimated by spectrophotometer using modified AOAC official method (1998). Briefly, norit treated Chilli extract (in metaphosphoric acid) was treated with 2,4-dintrophylhydrazine solution (2% in 9N sulphuric acid), which was heated at 37°C for 3hr. It was then treated with sulphuric acid (85%) in ice-bath and finally read in a spectrophotometer (UV-1201, UV-VIS, Shimadzu, Kyoto, Japan) at 520nm.

Total carotenoids was estimated by solvent extraction followed by spectrophotometric method (UV-1201, UV-VIS, Shimadzu, Kyoto, Japan) as decribed by Rahman et al.[5] Carotenoids in the GLV was isolated from its n-hexane extract by passing it 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.

β-carotene was estimated by HPLC (LC-10AD, SHIMADZU, Kyoto, Japan) as described by Muller.[6] Corotenoid eluent concentrated under nitrogen stream was reconstituted with HPLC grade mthanol, 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.

Samples were analyzed in triplicate and efforts were made to study the variation in ascorbic acid, total carotenoids and β-carotene contents due to seasonality, maturity and species variation.

Results and Discussion

Chilli varieties and their stage of maturity have influence on their chemical composition. Ascorbic acid ranged from 50±8 to 115±5mg% in tender green and 56±11 to-182±112mg% in matured red chillis (table 1). These amounts are somewhat consistent with those reported by others[2,3]. Highest content of carotenoids was found in red *Balujuri* (8299±1261µg%) and *Baroia* (5420±294µg%) varieties (table 2). β-carotene ranged from 255±27 to 411 ±70µg % in the green and 692±230 to 1784±109µg% in the red varieties (table 3). In general consistently higher amount of β-carotene was found in all of the red matured varieties than that in the tender greens. It would be because of fruit maturity, ripening, surface area, drying up etc and these results consistent with those reported by others[3, 2, 7, 8].

Table 1	Ascorbic acid mg%		
Chilli variety	Early winter	Late winter	P value
Haitta			
Green	57.0±13.1	91.70±7.94	^{a}P>0.05
Red	56.3±10.8	104.93±9.18	^{b}P<0.03
Jingga			
Green	50.1±8.2	67.38±12.86	^{La}P<0.03
Red	66.5±22.4	96.58±9.32	^{b}P>0.05
Baroia			
Green	76.1±4.2	101.52±11.35	^{a}P<0.03
Red	128.7±4.2	126.56±1.33	^{b}P>0.05
Balujuri			
Green	66.7±0.283	107.27±2.16	^{La}P<0.01
Red	108±18.50	123.07±0.47	^{Gb}P<0.03
Kamranga			
Green	99.32±3.22	114.55±5.28	^{Ea}P<0.01
Red	145.51±80.02	182.33±111.70	^{Rb}P<0.05

a: variation in varieties. b: seasonal variation. E: early winter variety. L: late winter variety. G: green variety. R: red variety.
Every sample was analyzed in triplicate. Values were expressed in mean and SD. Statistics: Descriptives, crosstabes, independent-samples t test

Carotenoids ranged between 269±37 and 1054±61μg% in green chillis, and 2350±225 and 8299±1261μg% in red chillies (tables 2). It was also higher in the late than in the early Chilli varieties. Similar variation in β-carotene quantity in different varieties and stages of maturity was also reported.[9] Percent of β-carotene in total carotenoids was found to be in a range of 20 to 91% in different Chilli varieties. Variation in the content of β-carotene in total carotenoids therefore vary widely (table 4). It was observed that percent of β-carotene in total carotenoids was found to be much higher in tender green varieties than that in the matured red varieties. It may be because of the fact that red chilli contains highest amount of carotenoid in the form of cryptoxanthin, therefore red chilli contains very low quantity of β-carotene content.[10, 11]

Table 2. Carotenoids in different Chilli varieties

Chilli variety	Total carotenoids in µg%		P value
	Early winter	Late winter	
Haitta			
Green	414.7± 62.9	509.8±5.0	[a]P<0.01
Red	2840.5±257.9	3474.8±189.0	[b]P<0.04
Jingga			
Green	415.5±27.5	550.4±117.7	[La]P<0.01
Red	2596.3±1301.9	3286.8±475.2	[Gb]P<0.01
Baroia			
Green	456.9±32.7	641.8±172.7	[a]P<0.01
Red	5419.5±293.5	5023.0±1098.2	[b]P>0.05
Balujuri			
Green	268.9±36.6	452.8±34.5	[a]P<0.01
Red	6355.0±672.6	8299.2±1260.5	[Gb]P<0.01
Kamranga			
Green	803.6±45.9	1053.6±60.66	[a]P<0.01
Red	2350.4±225.1	3269.7±318.86	[b]P>0.05

a: variation in varieties. b: seasonal variation. L: late winter variety. G: green variety.
Every sample was analyzed in triplicate. Values were expressed in mean and SD. Statistics: descriptives, crosstabes, independent-samples t test

Table 3. β- Carotene content in different Chilli varieties

Chilli variety	β-carotene µg%	P value*
Haitta		
Green	348.0±137.2	P>0.05
Red	692.0±229.5	
Jingga		
Green	255.1±27.1	P≤0.03
Red	1250.6±522.0	
Baroia		
Green	282.2±38.0	P<0.01
Red	1068.0±100.7	
Balujuri		
Green	411.1±70.1	P>0.05
Red	1783.7±108.5	
Kamranga		
Green	383.3±16.4	P<0.01
Red	890.1±158.5	

*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 4. Percent of β-carotene in total carotenoids in Chillis

Chilli variety	β-carotene in μg%	Total carotenoids	% of β-carotene*
Haitta			
Green	348.0±137.2	509.8±5.0	68.26
Red	692.0±229.5	3474.8±189.0	19.91
Jingga			
Green	255.1±27.1	550.4±117.7	46.34
Red	1250.6±522.0	3286.8±475.2	38.05
Baroia			
Green	282.2±38.0	641.8±172.7	43.98
Red	1068.0±100.7	5023.0±1098.2	21.26
Balujuri			
Green	411.1±70.1	452.8±34.5	90.78
Red	1783.65±108.5	8299.2±1260.5	21.49
Kamranga			
Green	383.3±16.4	1053.6±60.66	36.37
Red	890.1±158.5	3269.7±318.86	27.22

Values were expressed in mean and SD.

*Percent of β-carotene was calculated on basis of total carotenoids as 100%.

Conclusions

This study identified Chilli to be an excellent source of ascorbic acid and carotenoids. The habitual Bangladeshi diet is grossly low in ascorbic acid and vitamin A, and micronutrient malnutrition is widely prevalent. Like green-yellow vegetables, Chillies can also constitute an important source of these limiting micronutrients. Unlike vegetables, Chillies are consumed raw and so its vitamin C retention is higher. Chillies, therefore, can play an important role in improving vitamin C and vitamin A content of Bangladeshi diet, and can help improve the nutritional status of the people. The findings derived from present study can also be used in updating the existing 'Food Composition Table' of Bangladesh.

Acknowledgement

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

References

1. Adegoke GO, Allamu AE, Akingbala JO, Akanni AO. Influence of sundrying on the chemical composition, aflatoxin content and fungal counts of two pepper varieties—Capsicum annum and *Capsicum frutescens*. Plant Foods Hum Nutr 1996; 49(2): 113-117.
2. Khadi BM, Goud JV, Patil VB. Variation in ascorbic acid and mineral content in fruits of some varieties of chilli (Capsicum annum L). Plant Foods Hum Nutr 1987; 37(1): 9-15.
3. Saimbhi MS, Kaur G, Nandpuri KS. Chemical constituents in mature and red fruits of some varieties of chilli (Capsicum annum L). Qual Plant-Plant Foods Hum Nutr 1977; 27(2): 171-175.
4. AOAC. Official methods, 16th ed. edited by William S, volume II, Chapter 45; Publication by AOAC International, Maryland, USA,1998: 16-18.
5. Rahaman MM, Wahed MA, Ali MA. β-carotene lossws during different methods of cooking green leafy vegetables in Bangladesh. J. Food Comp. Analysis 1990; 3:47-53.
6. 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.AOAC (1998) vitamin C
7. Mishra RS, Khatai M. Effect of growth substance on the ascorbic acid content of fresh green and red fruits of chillies. Indian J Sci Indust 1969; 3: 177-178.
8. Khaleque MA, illias GNM, Qaisuddin M. Study of variabilty and correlation of some chemical characteristics in chilli (Capsicum annum L). Bangladesh J Bot 1991; 20(1): 37-41.
9. Howlader MHK, Hossain T. Biochemical changes in chilli fruits at different stages of fruit development. Ann Bangladesh Agric 1996; 6(1): 145-149.
10. Camera B, Bogbo O. Demonstration and solubilization of lycopene cyclase from *Caspicum* chromoplast membranes. Plat Physiol 1986; 80(1): 172-174.
11. 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.