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CAROTENOID CONTENT OF SOME GREEN PLANTS

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Total carotenoid and carotene contents of thirty fresh green plants of different families have been determined, Some leguminous and graminous plants have been found to be the rich sources. Total carotenoid and carotene contents of leaves and stems of some leguminous plants have also been determined separately. The effect of blanching on some leguminous plants shows that it is not necessary from the enzymatic viewpoint if the extraction is to follow very soon after cutting. The spectra in petroleum ether of all plant extracts both before and after chromatography are similar and in the latter case these closely resemble with that of β-carotene. Vitamin A potency of all plants has also been calculated.

Carotenoids, the fat-soluble pigments of plant and animal origin are of great biological importance due to their vitamin A potency. In addition, these pigments may provide exceptional and very desirable food colours which enhance the consumer acceptability of processed foods. This vitamin A potency coupled with their usefulness as attractive food colours, makes their determination both in foods and feeds of great practical and scientific importance.

Vitamin A deficiency found in certain sections of the the population of Pakistan as revealed by the national nutrition survey[1,2] may be ameliorated by the intake of vitamin A rich foods such as fish liver oils and leafy vegetables which are rich sources of carotenes. Another way to improve vitamin A nutrition is to feed vitamin A or β-carotene-fortified foods. Vitamin A or β-carotene fortification of foods necessitates its production in sizeable quantities from chemical and vegetable sources.

Various workers[3–5] have reported the carotene content of vegetables grown in India and Pakistan. Sadana and Ahmad[6] determined the carotene content of common vegetables and assessed their vitamin A potency. Ali *et al.*[7] reinvestigated the carotene content of some common vegetables in raw and cooked state. Their work had mainly been confined to vegetables and they had not estimated the carotene content of other green plants.

The aim of the present investigations is to determine the carotene content of some green plants (cultivated or wild) mainly used as animal feeds and to develop a process of producing carotenoids on large scale from the right vegetable source for their use in processed foods.

No attempt has been made to separate and characterise the individual carotenoids and they have been estimated as total carotenoids and carotenes in terms of all-trans β-carotene. The vitamin A potency has also been calculated on the basis of total carotene content as all-trans β-carotene because according to Booth[8] the total carotene content is the usually accepted criterion of vitamin A value in most plant materials containing appreciable amounts of β-carotene.

Experimental

All the solvents used were of commercial grade. Alumina (Merck) was deactivated to such an extent as to allow only β-carotene or less polar compounds to pass through using petroleum ether as the eluent.

Beckman DB and Unicam Spectrophotometers were used for spectrophotometric studies.

Green plant samples were procured from cultivated as well as wild species. Grass samples were obtained from Nursery of Ranger's Improvement Scheme, Lahore, in the month of January. Samples of leguminous plants, wheat varieties and other plants were collected in February. Representative samples were obtained by chopping and thoroughly mixing the plants.

Extraction Procedure.—The procedure adopted was essentially of Kemmerer and Fraps.[9]

The results calculated on the basis of fresh weight in whole figures have been given in Table 1 and spectra of lucerne extract have also been recorded in Fig. 1.

Carotenoid Content of Leaves and Stems of Some Leguminous Plants.—Leaves of fresh field-grown leguminous plants of similar growth were hand-picked and mixed well. The stems were chopped and mixed thoroughly. Leaves and stems were extracted separately as described before. The results have been recorded in Table 2.

Effect of Blanching on the Carotenoid Content of Some Leguminous Plants.—The effect of blanching

on the carotenoid content of leguminous plants had been studied and blanching was done in two ways.

1. By immersion in boiling water. Sample (10 g) was wrapped in muslin cloth, tied with a string and blanched by immersion in boiling water for 5 min.

2. Steam blanching. Sample (10 g) was wrapped as above, tied and suspended with a string in a pressure cooker and blanched by steam at atmospheric pressure for 5 min.

The blanched samples were extracted by the same procedure as described previously. The results have been recorded in Table 3.

Discussion

The carotenoid content of 30 plants of different families was estimated and the results have been recorded (Table 1) according to familes. The actual comparison of the carotenoid contents of various families seems rather difficult as the plants differ in maturity and age.

Table 1 will reveal that the first five plants of family Leguminosae are very rich in carotenoids and their carotenoid content varies from 175–295 μg/g. Lucerne contains the maximum and Maina the minimum quantities of carotenoids. It may be mentioned that all of these four plants were of similar maturity from the second cutting.

In this family Rewari contains comparatively small quantity of carotenoids and peels of peas is the poorest source. It is interesting to note that although differences in carotenoids and carotene contents are quite significant, the % carotenes in total carotenoids is fairly uniform, (varying between 49–57). It may also be noted that although the carotenoid and carotene contents of Senji and Maina are less than those of lucerne, they contain higher % of carotenes than the former.

In case of family Graminae, varieties of wheat and grass are also rich in carotenoids. Among wheat varieties the variation in the carotenoid contents is from 98–257 μg/g, Mexipak-red being the richest and C-591 being the poorest in carotenoids. These plants were also of almost similar maturity and were cut before earing. The colour of grains of these varieties varies from cream yellow to brownish and from this it would be attractive to speculate that the variation in colour is probably due to difference in their carotenoid contents.

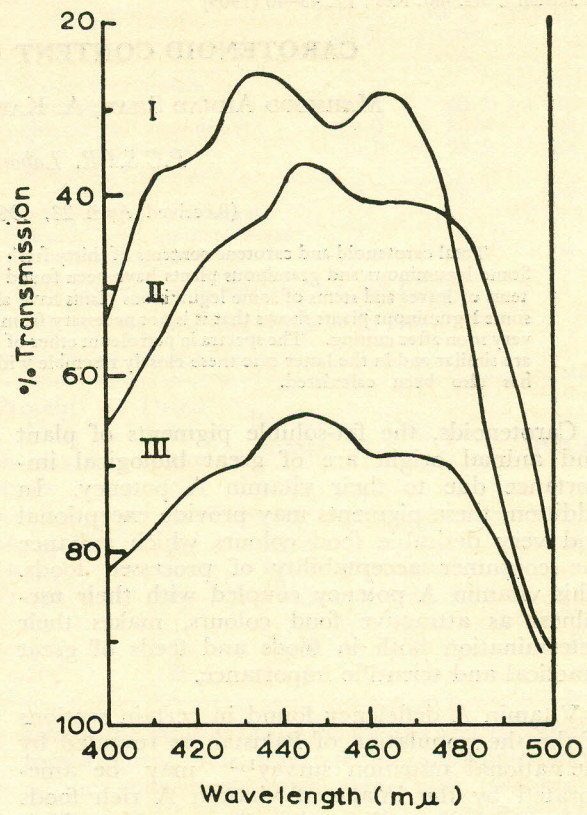

Fig. 1.—Spectral properties of lucerne extract in petroleum ether. I, before chromatography; II, after chromatography, and III, pure β-carotene.

This difference in carotenoid content is retained in their grains and the brownish colour of Mexipak-red variety wheat is probably due to higher content of carotenoids as compared with other varieties. Barley and oats also contain appreciable amounts of carotenoids.

In grass varieties the carotenoid and carotene content varies from 48 to 210 μg/g and 23 to 103 μg/g, respectively. Dhamon has the highest and Dabbh the lowest quantities of carotenoids. It will be observed that all the plants of this family have fairly similar % of carotenes i.e. 48–52% of total carotenoids. Laily, carrot shoots, salt bush (Lana) and kashni have almost equal quantities of carotenoids and their carotenoid contents vary from 115 to 120 μg/g. The first three also contain almost equal quantities of carotenes (70–73 μg/g) and % of carotenes (61–65%) but the first one has comparatively small quantity of carotenes (52 μg/g) and % carotenes (45%). The carotenoid content of tara mera, shoots of onion and garlic varies from 87–98 μg/g and they roughly contain equal % of carotenes.

TABLE 1.—CAROTENOID CONTENTS OF VARIOUS GREEN PLANTS.

Common name	Botanical name	Carotenoids before chromato-graphy µg/g	Carotenoids after chromato-graphy µg/g	Carotene percentage	Vitamin A* potency I.U./g
	Family Leguminosae				
Lucerne	*Medicago sativa*	295	150	51.0	250
Berseem	*Trifolium alexandrium*	250	135	54.0	225
Shaftal (Shatalah)	*Trifolium resupinatum*	223	126	57.0	210
Senji	*Melilotus parviflora*	215	120	56.0	200
Maina	*Medicago denticulata*	175	85	49.0	142
Peas (Peels of mater)	*Pisum sativum*	14.0	—	—	—
Rewari	*Vicia sativa*	108	38	33.0	63
	Family Graminae				
Wheat varieties	*Triticum vulgare*				
Mexipak red		257	130	51.0	217
Penjamo		240	123	51.0	205
Lerma rajo		236	122	52.0	203
Mexipak white		200	98	49.0	163
C-591		98	50	51.0	163
Barley	*Hordeum distichum*	99	48	49.0	83
Oats (Jai)	*Avena sativa*	125	65	52.0	108
Grasses					
Khabbal grass	*Cynodon dactylon*	182	90	49.0	150
Dhamon ,,	*Cenchrus setigerus*	210	103	49.0	171
Garam ,,	*Panicum virgatum*	142	72	51.0	120
Naru ,,	*Sporobolus airoides*	198	97	49.0	167
Pahari jow	—	190	85	50.0	142
Russian grass	*Diplachne fusca*	126	62	49.0	103
Boolu ,,	*Eragrostis bicolor*	128	62	49.0	103
Dabbh ,,	*Eragrostis curvulis*	48	23	48.0	38
Pluan ,,	*Bothriochloa intermedia*	78	42	54.0	70
	Family Cruciferae				
Tara mera	*Eruca sativa*	93	48	52.0	80
	Family Convalvaceae				
Laily	*Convolvulus arvensis*	120	73	61.0	122
	Family Compositae				
Kashni	*Cinchorium intybus*	115	52	45.0	87
	Family Umbelliferae				
Carrot (shoots)	*Daucus carota*	118	72	61.0	120
	Family Amaryllidaceae				
Onion (shoots)	*Allium cepa*	98	47	48.0	78
Garlic (shoots)	*Allium sativum*	87	40	46.0	67
	Family Chenopodiaceae				
Salt bush (Lana)	*Suaeda fruticosa*	115	70	65.0	117

*0.6 µg of β-carotene equals one international unit of vitamin A.

TABLE 2.—CAROTENOID CONTENT OF LEAVES AND STEMS OF SOME LEGUMINOUS PLANTS.

Name of plant	Leaves		% Carotene	Stem		% Carotene	Leaves to stem ratio of carotenoids	
	A μg/g	B μg/g		A μg/g	B μg/g		A	B
Lucerne	410	203	50	160	65	41	2.6	3.1
Berseem	396	200	51	157	60	38	2.5	3.3
Shatalah	386	195	51	155	57	37	2.5	3.4
Senji	380	192	51	145	52	36	2.6	3.7

A—Before chromatography. B—After chromatography.

TABLE 3.—EFFECT OF BLANCHING ON THE CAROTENOID CONTENT OF SOME LEGUMINOUS PLANTS.

Name of plant	Treatment								
	Control		% Carotenes	Water blanched		% Carotenes	Steam blanched		% Carotenes
	A	B		A	B		A	B	
	μg/g	μ/g		μg/g	μg/g		μg/g	μg/g	
Lucerne	295	150	51	296	152	51	298	152	51
Berseem	250	135	54	253	136	54	254	138	54
Shatalah	223	126	56	225	128.2	57	230	129	56
Senji	215	115	53	219	119.0	55	225	116	52

A—Carotenoids before chromatography. B—Carotenoids after chromatography.

Vitamin A potency of all the plants varies with their carotene contents and it has been calculated by dividing the latter with 0.6 as 0.6 μg of pure all-trans β-carotene is equivalent to one international unit of vitamin A.

Conclusions

It can safely be concluded from these studies that green fodders of family Leguminosae are the best sources for the commercial production of carotenoids.

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