NUTRITION STUDIES IN BIHAR. PART III. ESTIMATION OF CAROTENE AND ASCORBIC ACID IN COMMON FRUITS AND VEGETABLES.

By K. Mitra. H. C. Mittra and A. C. Roy.

The carotene and ascorbic acid content of various leafy and other vegetables and fruits commonly grown in Bihar have been estimated chemically. Of the fruits analysed ripe Barhar (*Artocarpus lakoocha*) and the juice of the ripe palmyra fruits have been found to be very rich in carotene. Another vegetable having exceedingly high ascorbic acid content has been Chathail (*Momordica cochinchinensis*). The leafy vegetables analysed gave high carotene and ascorbic acid values.

The literature on the importance of carotene and ascorbic acid in human nutrition is steadily growing in volume. In the absence of a comprehensive table of food values field workers engaged in dietary survey experience difficulty in assessing the complete value of daily intake (comprising of diverse edibles) in terms of proximate principles of food, particularly the different vitamins.

Inspite of the slight (at times negligible) variability inevitably associated with animal experiments, biological assay is still accepted as the standard method as far as the vitamins are concerned. But the chemical methods of assessment have been receiving more and more attention from workers all over, being quicker, less complicated and more economical. As regards ascorbic acid the chemical methods of estimation inspite of its slight drawbacks has been universally accepted. With carotene, the methods have yet to be perfected but for ordinary purposes of dietary study and propaganda, the chemical methods have their uses.

Experimental.

Carotene.—The extraction of carotene from the vegetables and fruits was done exactly by the technique described by Ahmed *et al* (*Indian J. Med. Res.*, 1937, **24**, 801) but the estimation of the ethereal extract containing the carotenoid pigment was done by colour comparison method advocated by Guilbert (*Ind. Eng. Chem. Anal. Ed.*, 1934, **6**, 452) and subsequently modified by Petersen *et al* (*ibid.*, 1937, **9**, 71). The latter method eliminates the use of Lovibond tintometer and more commonly available colorimeter is used instead. The stock dye solution was made

by dissolving naphthol yellow (3·06 g.) and Orange-G crystals (0·45 g.) in one litre of water. The stock dye solution (5 c. c.) was further diluted to 1 litre and this constituted the standard dye solution, the colour of which matched with a solution containing 2·4 mg. of β-carotene per litre. Banerji and Ramasarma (*Agric. & Live-stock in India*, 1938, **8**, 253) have used potassium dichromate as the standard dye solution, but the authors found the former dye standard as efficient as the latter by duplicate set of experiments. It was further observed that in removal of xanthophyll, ethyl alcohol worked as efficiently as its next lower homologue, the latter being advocated by Guilbert (*loc. cit.*).

Ascorbic Acid.—The estimation of ascorbic acid was made by dichlorophenol-indophenol titration method (Birch *et al.*, *Biochem. J.*, 1933, **27**, 590) with the addition of pyrophosphate as advocated by Giri (*Indian J. Med. Res.*, 1938, **26**, 166). Considerable difficulty was experienced in the determination of the end-point (in titration) if the juice extracted from fruits or vegetables was highly coloured. Wherever necessary, blank control titrations were made simultaneously but this method did not work if the extracted juice showed slightest red tinge. Consequently all doubtful results have been left out of the table below. In such cases extractions made with metaphosphoric acid on the lines recently advocated by Lanke (*Skand. Arch. Physiol.*, 1939, **81**, 300) may help future workers to determine the end-point with some amount of precision.

TABLE I.

Leafy vegetables.

Figures are given in mg. per 100 g. of the material.

No.	Hindi name.	Eng. name.	Bot. name.	Carotene.	Ascorbic acid.
1	Alu sag*	Tender stalks of potato.	*Solanum tuberosum*	12·2 mg.	73·6mg.
2	Bathua sag	Goose foot	*Chenopodium album*	12·4	65·4
3	Boont sag	Tender Bengal gram plant.	*Cicer arietinum*	18·4	199·8
4	Dhania sag	Coriander plant	*Coriandrum sativum*	11·6	82·2
5	Gajar sag	Stalk of carrot.	*Daucus carota*	14·8	92·8

* *Sag* means tender leaves and stem of the plant unless otherwise mentioned.

Statements within bracket gives the character of the edible and not specific names.

TABLE I (*contd.*).

No.	Hindi name.	Eng. name.	Bot. name.	Carotene.	Ascorbic acid.
6	Gendhari sag	Love-lies-bleeding	*Amaranthus caudatus*	14·8	77·3
7	Kachnar ka patta	(Leaves only)	*Bauhinia variegata*	8·4	69·6
8	Kaddoo sag	Bottle gourd	*Lagenaria vulgaris*	9·7	33·0
9	Kalmi sag	Ipomea	*Impomœa sepiaria*	10·8	43·7
10	Kanta gendhari sag	Thorny pigweed leaves	*Amaranthus spinosus*	26·8	133·9
11	Kelao ka patta	Tender leaves of pea only	*Pisum arvense*	24·4	105·7
12	Kelao sag	Tender pea leaves & stem	Do	15·5	109·4
13	Khesari sag	Tender lathyrus	*Lathyrus sativus*	15·5	81·3
14	Konhra sag	Pumpkin	*Cucurbita maxima*	10·1	38·7
15	Lahsun ka patta	Green stalks of garlic	*Allium sativum*	4·2	94·1
16	Lal sag	Red pigweed	*Amaranthus rubrum*	11·5	?
17	Lofa sag	...	*Malva verticillata*	7·5	43·3
18	Methi sag	Fenugreek	*Trigonella foenum-graecum*	9·1	92·6
19	Murai sag	Stalk of radish	*Raphanus sativus*	7·4	126·4
20	Palki sag	Spinach	*Spinacia oleracea*	6·1	41·2
21	Parwar sag	...	*Trichosanthes dioica*	13·4	110·2
22	Patua sag	Tender leaves & stem of jute	*Corchorus capsularis*	10·8	66·2
23	Piyaz ka patta	Green stalks of onion	*Allium cepa*	2·0	27·7
24	Podina	Mint	*Mentha viridis*	8·7	?
25	Pooin sag	...	*Bassella rubra*	4·8	79·4
26	Salad ka sag	Lettuce	*Lactuca sativa*	6·8	50·9
27	Sarso sag	Rape seed leaves	*Brassica napus*	8·8	118·3
28	Sowa sag	Sowa	*Peucedanum sowa*	15·0	77·5

TABLE II.

Other vegetables.

[Figures are given in mg. per 100 g. of material]

No.	Hindi name.	Eng. name.	Bot. name.	Carotene.	Ascorbic acid.
1	Bakala	...	*Vicia faba*	0·9	50·1
2	Barsema	Sword bean	*Canavalia ensiformis*	0·2	25·0
3	Chalta	...	*Dillenia indica*	0·1	9·0
4	Chathail or kheksa (big)	Hilly variety	*Momordica cochin chinensis*	0·4	65·0
5	Do (small)	Country variety	Do	1·8	246·9
6	Gajar	Carrot	*Daucus carota*	7·7	25·0
7	Gulcharni	(Flower stalks)	*Calonyction muricatum*	0·6	19·1
8	Gullar	Figs	*Ficus hispida*	0·3	5·7
9	Jhingi	Ridge gourd	*Luffa acutangula*	0·4	15·8
10	Kachri boont	Tender Bengal gram	*Cicer arietinum*	2·2	73·7
11	Kamrak	...	*Averrhoa carambola*	0·4	30·4
12	Kankari	Gourd fruit	*Cucumis melo var utilissimus*	0·2	16·7
13	Katcha Aam	Green mango	*Mangifera indica*	Trace	43·6
14	Katcha Barhar	...	*Artocarpus lakoocha*	?	32·7
15	Katcha matar (Kabuli matar)	English peas green	*Pisum sativum*	1·2	23·5
16	Matar	Country peas green	*Pisum arvense*	3·1	18·9
17	Katcha papita (chhilka)	Skin of green papaya	*Carica papaya*	2·4	72·4
18	Do. (gudda)	Do. (pulp)	Do	0·4	32·0
19	Katcha arhar ka dana	Tender red gram	*Cajanus indicus*	0·8	29·7
20	Kawachia sem	Cowage	*Mucuna capitata*	0·6	26·8
21	Kelao sag ke danti	Stem of pea	*Pisum arvense*	6·8	47·3
22	Konhra flower	Flower of pumpkin	*Cucurbita maxima*	1·0	22·6
23	Kudrum (patwa)	Roselle or red sorrel	*Hibiscus sabdariffa*	0·4	?

TABLE II (*contd.*).

Other vegetables.

No.	Hindi name.	Eng. name.	Bot. name.	Carotene.	Ascorbic acid
24	Kundri	...	*Cephalandra indica*	0·3	21·3
25	Lataru bia	(Vegetable)	*Dioscorea alata*	0·4	15·1
26	Lataru	(Tuber)	Do.	0·1	16·4
27	Muchkund (Kanak-champa)	...	*Pterospermum acerifolium*	0.4	18·6
28	Nenua	Vegetable marrow	*Luffa aegyptiaca*	0·2	10·0
29	Parwar (green)	...	*Trichosanthes dioica*	0·5	42·4
30	Do (ripe)	...	Do	1·5	?
31	Raharia sem (Guar)	Cluster bean	*Cyamopsis psoralioides*	1·2	38·1
32	Ramtorai (Bhindi)	Ladies finger	*Hibiscus esculentus*	0·3	17·4
33	Roma or Boro (red).	Cow pea pods	*Vigna catiang*	0·6	24·0
34	Do (greenish white)	Do	Do	0·6	28·4
35	Saijan ka phool	Drumstick flower	*Moringa oleifera*	0·9	142·9
36	Sem	Broad bean (big)	*Dolichos lablab*	0·3	17·4
37	Do (small)	Do (small)	Do	0·7	17·8
38	Soothuy	...	*Dioscorea fasciculata*	Trace	11·9

TABLE III.

[Figures are given in mg. per 100 g. of material].

Fruits.

No.	Hindi name.	Eng. name.	Bot. name.	Carotene.	Ascorbic acid.
1	Aam Bombai	Mango	*Mangifera indica*	6·0	10·3 ?
2	Aam sipia	Do	Do	2·6	
3	Amra	Hog plum	*Spondios mangifera*	0·4	37·6
4	Bael	Wood apple	*Aegle marmelos*	0·1	4·7
5	Barhar (ripe) (Beng. Mādār)	...	*Artocarpus lakoocha*	18·0	?
6	Bayr (bara)	Indian plum (sweet)	*Zizyphus jujuba*	0·5	22·3

TABLE III (*contd.*).

Fruits.

No.	Vern. name.	Eng. name.	Bot. name.	Carotene.	Ascorbic acid.
7	Bayr (chhota)	Do (small)	Do	0·4	30·5
8	Falsa	...	*Grewia asiatica*	0·3	10·5
9	Gab	...	*Diospyros embryopteris*	0·2	22·3
10	Jamun	Black berry	*Eugenia jambolana*	0·1	?
11	Kadam	(Inflorescence)	*Anthocephalus cadamba*	2·5	16·5
12	Kaint	Elephant apple	*Feronia elephantum*	Trace	21·9
13	Kalaonda	(Acid berries)	*Carissa carandus*	0·1	18·4
14	Kend	...	*Diospyros melanoxylon*	0·1	4·1
15	Kesaur	...	*Pachyrhizus angulata*	Nil	25·9
16	Kharbuja	Musk melon	*Cucumis melo*	0·5	12·1
17	Khirni	...	*Mimusops hexandra*	1·3	24·2
18	Loquat	Loquat	*Eriobotrya japonica*	0·4	?
19	Makoh	Cape goosebery	*Physalis peruviana*	3·4	22·8
20	Pakka papita (chhilka)	Ripe papaya (skin)	*Carica papaya*	4·7	51·4
21	Do (gudda)	do (pulp).	Do	2·8	50·9
22	Piyal	...	*Buchanania latifolia*	1·4	7·7
23	Sarifa	Custard apple	*Anona squamosa*	Nil	36·7
24	Singhara	Water chestnut	*Trapa bispinosa*	Trace	16·3
25	Tarbuja	Water melon	*Citrullus vulgaris*	1·8	7·0
26	Tarh ka pheda	Ripe palmyra fruit (mesocarp)	*Borassus flabellifer*	7·6	24·0
27	Toont hara	Mulberry (green variety).	*Morus indica*	0·2	?
28	Toont lal	Do (red variety)	Do	0·2	?
29	Velowa	Orange cups of marking nut	*Semecarpus anacardium*	0·9	41·4

DISCUSSION.

It is quite evident from the above tables that the leafy vegetables are very rich sources of vitamins A and C. Of the 28 kinds of *sags* analysed

the less popular edible leaves *e.g. Boont, Khesari, Kelao* and *Kanta gendhari sags* were found to exceed in carotene and ascorbic acid content the more popular *palki sag, pooin sag,* or *salad ka sag.* It has further been noticed that leaves of the plants are richer in both the protective elements as compared with their respective stems. The consumption of the tender stems and leaves of jute plant (*Pat sag*) is very popular with the poorer section of people in the Purnea district, otherwise it is a rare commodity in this province. From the results published by Levy *et. al* (*South African Med. J.*, 1936, **10**, 699) it appears that common edible leaves of South Africa are richer in vitamin C potency as compared to their homologus in Bihar. The findings of Rudra (*Biochem J.*, 1936, **30**, 701) could be confirmed in the case of green papaya ; the skin being a richer source of vitamin C than the pulp. In the case of the ripe fruit no such difference could be noticed. Amongst the vegetables *Chathail* or *Kheksa* (*Momordica cochinchinensis*) was found to be an extremely rich source of vitamin C. This vegetable creeper grows in abundance all over the province, though not a very popular article of dietary.

Out of the 29 different fruits analysed for carotene ripe *Barhar* seemed to be an exceedingly rich source. The tree yielding this fruit is ubiquitous in its distribution all over the province. The fruits are sweet and slightly acid in taste but are not popular with the middle class people. The juice or the mesocarp of the ripe palmyra fruit was found to be another rich source of carotene. *Bhelowa* or marking nuts are not considered edibles in major part of this province but in Chotanagpur division and in the district of Santal Parganas the orange-coloured calyx of the nut is much coveted by the children. They are eaten raw. During cold months in these districts one often encounters children with dark stains on their lips caused by injudicious bite at the nut (the juice of the nut itself being caustic).

It is by no means pretended that the list is complete. This investigation was started with an idea to emphasise 'the desirability of a better acquaintance with our inexpensive food resources,' consequently the edibles selected for analysis are cheap and easily available.

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NUTRITION SCHEME,
PUBLIC HEALTH LABORATORIES,
BANKIPUR, PATNA.

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