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VITAMIN A AND β – CAROTENE CONTENT OF SOME COMMON FOODS

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Abstract : The content of vitamin A and its precursor, β-carotene was determined in some commonly available foods in Sri Lanka. The edible portion of the uncooked food samples were used for analysis. The concentrations of vitamin A and β-carotene were determined by fluorescence and absorbance spectrophotometry by established methods. Fish and ox liver were the richest sources of vitamin A. The vitamin A content in other animal foods except eggs and milk, was not sufficient to make a significant contribution to the daily vitamin A intake in a Sri Lankan diet. The β-carotene content of dark green leafy vegetables ranged from 61.0 – 99.5 μg/g and was two to three times higher than that of other vegetables and fruits. A major proportion of the daily dietary requirement of vitamin A could be obtained as β-carotene from green leafy vegetables.

1. Introduction

Vitamin A is required for growth, reproduction, vision and maintenance of the integrity of epithelial tissues. Its deficiency in the early stages leads to night blindness and xerophthalmia, which may ultimately progress to blindness, if untreated.[2,6] Deficiency of vitamin A is mainly due to inadequate dietary intake of the vitamin or its precursor, β -carotene. Therefore, it is of utmost importance to identify good sources of vitamin A and β -carotene among the foods commonly available in Sri Lanka. In fact, the identification of dietary sources of vitamin A, is listed as a research priority in the latest report published by the WHO expert committee on vitamin A deficiency.[7] The only data available at present is based on analyses carried out in India[3] and on preliminary studies by Atukorala *et al.*[1] in Sri Lanka.

In this study, analyses for vitamin A and β -carotene have been carried out on some commonly available foods in Sri Lanka.

2. Methods

2.1 Sampling: The food samples were purchased from three different areas of Colombo to obtain a mean value for the foods commonly sold in

Colombo. A weighed amount (0.2 – 0.5 g) of the edible portion of the raw, uncooked food was used for analysis. When analyses were carried out on plant foods, specimens (for replicate estimations) were taken from different leaves selected at random. Three different randomly selected samples of each food item were analysed and the mean ± SEM taken.

2.2 **The concentration of Vitamin A** was determined by a modification of the fluorometric method of Thompson and co-workers.[5] Alcoholic KOH (30%) was used for saponification instead of (60%) aqueous KOH and the saponification time was increased to 30 minutes. Vitamin A was selectively extracted into hexane and the fluorescence was measured against a blank using a Perkin–Elmer LS3 fluorescence spectrophotometer. Each sample of food was analysed in triplicate.

Retinyl acetate (Sigma, U.S.A.) was used to prepare a standard solution. Vitamin A derivatives being labile compounds, the absorbance of the diluted standard was checked prior to use. The standard solutions were processed in the same manner as the food samples. The mean percentage recovery was 98.71 ± 1.30.

2.3 **The concentration of β -carotene** was determined by a spectrophotometric method.[3,4]

A standard solution was prepared by dissolving all trans β -carotene (Sigma, U.S.A.) in absolute ethanol (Reiden de Haen, Germany). This stock solution (1 mg/ml) was prepared every two weeks and stored in the dark at 4°C.

Carotenoids were extracted into petroleum ether after saponification of food samples. The petroleum ether extract was washed twice with 92% methanol to remove xanthophylls.[4] Its optical density was measured at 450 nm using a SP 6 – 450 UV visible spectrophotometer. Each estimation was carried out in duplicate.

The mean percentage recovery was 97.5 ± 2.10.

2.4 **Statistical significance** was assessed using the Student's t test.

3. Results and Discussion

The vitamin A content of flesh foods is given in Table I. Both fish and ox liver had more vitamin A than meat or fish. Fish liver had the highest amount of vitamin A (95.03 ± 17.79 μg/g) with slightly lower amounts in ox liver, but the difference was not significant. The amount of vitamin A in chicken was significantly higher ($p < 0.001$) than that of other meats.

Table 1 Vitamin A content of flesh foods

Food	Vitamin A (μg/g) Mean	SEM
Meat		
Beef, muscle	0.29	0.08
Chicken, muscle	2.020	0.20
Mutton, muscle	0.75	0.30
Pork, muscle (lean)	0.349	0.13
Fish		
Seer *(Scomber sp.)**	0.404	0.011
Para *(Carangids)**	0.338	0.089
Kelawalla *(Euthynnus sp.)**	trace	—
Thalapath *(Istiophorus gladius)**	0.115	0.018
Hurulla *(Sardinella sirus)**	1.413	0.204
Salaya *(Sardinella jussieu)*	1.395	0.355
Prawns	1.196	0.495
Liver		
Ox liver	76.84	5.84
Fish liver (Para)	95.03	17.79

Each value is the mean of 3 samples.

* The edible portion of large fish without skin was used for analysis.

Table 2. β–Carotene and vitamin A content of Eggs and Milk

Food	β–Carotene		Vitamin A	
	Mean	SEM	Mean	SEM
Egg, Hen (μg/100 g)	364	72	195	23
Cow's milk (μg/100 ml)				
Pasteurised, bottled	71.0	12.5	52.2	18.5
Pasteurised, packeted	115	17.0	60	14.9
Sterilised, bottled	trace	–	40.5	7.2
Fresh, unboiled	120	8.6	87.6	19.6

Each value is the mean of 3 samples.

Table 3. β–Carotene content of cereals, starchy roots and pulses.

Food	β–Carotene (μg/g)	
	Mean	SEM
Cereals		
Rice, parboiled	–	–
Rice, Raw, milled	–	–
Wheat flour	trace	–
Starchy roots*		
Potato *(Solanum tuberosum)*	2.78	0.40
Sweet potato *(Ipomea batatas)*	2.31	0.47
Innala *(Coleus rotundifolius)*	0.232	0.081
Kiriala (Habarala) *(Colacasia esculenta)*	0.199	0.035
Pulses		
Mysoor Dhal *(Cajanus cajan)*	12.90	3.4
Cow pea *(Vigna unguiculata)*	2.50	0.31
Mung (Green gram) *Phaseolus aureus*	7.22	0.52

Each value is the mean of 3 samples.

* Starchy roots without peel were used for analysis.

Of the different varieties of fish studied, small fish (Hurulla and Salaya) had a significantly higher ($P < 0.01$) amount of vitamin A than large fish (Table 1).

The β -carotene and vitamin A content of eggs and milk is given in Table 2. Eggs provide a rich source of both β -carotene (364 ± 72 μg/100g) and vitamin A (195 ± 23 μg/100g). Fresh, unboiled cow's milk had the highest amount of β -carotene with slightly lower amounts in packeted pasteurised milk and significantly ($p < 0.05$) lower amounts in bottled pasteurised and sterilised milk. Vitamin A content of milk also showed a similar variation, but the difference was not significant.

Rice showed no detectable amounts of β -carotene, while wheat flour contained only traces (Table 3). Of the starchy roots studied, potato and sweet potato had a higher content ($p < 0.01$) of β -carotene than other starchy roots. The β -carotene content in pulses was higher than that in cereals or starchy roots, with Mysoor dhal and green gram having significantly ($p < 0.05$) higher amounts than cowpea.

The β -carotene content of vegetables analysed is given in Table 4. Dark green leafy vegetables had a significantly higher ($p < 0.02$) amounts of β -carotene compared to other vegetables except carrots. Moderate amounts of β -carotene were observed in spring onions, leeks and legumes with levels decreasing in that order. Of the vegetable fruits studied, pumpkin had the most β -carotene (Table 5).

Coconut contained only traces of β -carotene. Among fruits, significantly higher ($p < 0.001$) amounts of β -carotene were found in mango and papaw, with mango of the Karthakolumban variety having the highest amount (Table 6).

4. Conclusions

The results obtained in the study are comparable to a similar study carried out on Indian foods.[3] The food samples were analysed in the fresh state as purchased and the effect of cooking or processing on the vitamin A and β -carotene content was not studied.

Both fish and ox liver were rich sources of preformed vitamin A. Meat and fish, with a low content of vitamin A (0.2 – 2 μg/g) do not make a significant contribution to the vitamin A supply in an average Sri Lankan diet. Eggs and milk form a richer source of preformed vitamin A and β -carotene.

Table 4. β–Carotene content of vegetables.

Food	β–Carotene (μg/g) Mean	SEM
Dark-Green leafy vegetables		
Mukunuwenna *(Alternanthera sessilis)*	99.5	16.7
Kankun *(Ipomea aquatica)*	81.4	12.0
Gotukola *(Centella asiatica)*	87.1	19.5
Kathurumurunga *(Sesbania grandiflora)*	75.8	28.2
Spinach *(Basella alba)*	61.9	10.7
Sarana *(Sesuvium portulacastrum)*	76.5	12.2
Other vegetables		
Leeks *(Allium porrum)*	21.29	6.01
Cabbages *(Brassica oleracea)*	2.75	0.65
Carrots* *(Daucus carota)*	40.39	1.17
Spring onions *(Allium cepa)*	30.36	0.73
Legumes		
Beans *(Phaseolus vulgaris)*	18.60	0.99
Winged Beans *(Phaseolus lunatus)*	17.69	1.05
String Beans *(Vigna cylindrica)*	7.59	0.03

Each value is the mean of 3 samples.

*Food without peel was used for analysis.

Table 5. β—Carotene content of vegetable fruits

Food	β—Carotene (μg/g) Mean	SEM
Vegetable fruits		
Brinjals *(Solanum melongena)*	2.13	0.65
Pumpkin* *(Cucurbita mixima)*	12.77	0.89
Snake gourd *(Trichosanthes anguina)*	5.14	3.88
Bitter gourd *(Mormordia charantia)*	2.34	0.56
Ladies fingers *(Hibiscus esculenteus)*	3.25	0.98
Ribbed *gourd* *(Luffa acutangula)*	1.82	1.06

Each value is the mean of 3 samples.

The edible part of each food was used for analysis.

*Food without peel was used for analysis.

Table 6. β–Carotene content of fruits

Food	β- Carotene (μg/g) Mean	SEM
Coconut *(Cocos nucifera)*	trace	–
Fruits*		
Orange *(Citrus sinensis)*	2.06	0.76
Plantains (Ambul variety) – *Musa sapientum*	2.81	0.42
Plantains (Kolikuttu variety) – *Musa sapientum*	2.58	0.30
Pineapple *(Ananas comosus)*	5.15	0.62
Papaw *(Carica papaya)*	22.4	0.49
Mango *(Mangifera Indica)*	20.96	0.58
Mango *(Karthakolumban variety)- Mangifera Indica*	31.51	1.10
Guavas+ *(Psidium guajava)*	8.97	0.86
Ripe Jak fruit *(Artocarpus heterophyllus)*	2.71	0.60

Each value is the mean of 3 samples.

* The edible portion of each fruit without skin or seeds was used for analysis.

\+ The fruit was used with skin.

Most of the commonly available plant foods showed significant amounts of β -carotene. The dark green leafy vegetables analysed (e.g. Mukunuwenna, Gotukola) had a two to three times higher content of β -carotene compared with other vegetables, and therefore constitute a very important dietary source, although the biological activity of β -carotene per unit weight is lower than that of vitamin A (1 International unit of vitamin A = 0.3 μg vitamin A or 0.6 μg β -carotene[2]). Other vegetables (carrots, leeks, spring onions and legumes) were moderate sources of β -carotene. Fruits, especially papaw and some varieties of mango, also make an important contribution to the supply of β -carotene as they can be consumed in the raw state without prior processing. These studies suggest that a major part of the daily dietary requirement of vitamin A in a Sri Lankan diet could be had in the form of β -carotene from commonly available plant foods.

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