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Antinutritional Properties and Vitamin C Content of Greenleafy Vegetables and Their Losses During Home Level Preparations

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ABSTRACT. Some antinutritional properties (oxalate, phytate) and vitamin C content of fifteen Sri Lankan green leafy vegetables and their losses during home level preparation (boiling, steaming, Mallun preparation) were investigated.

The vitamin C contents of the vegetables ranged from 3 mg in Kankun to 235 mg in Passion leaves mg/100g fresh material. Vitamin C is present in considerable amounts in most leafy vegetables. Of the cooking method tested greatest loss was observed in boiling. 32% and 54% loss was observed in 5 min. and 10 min. respectively. Steaming reduced the vitamin C content by 15% and 39% (5 min. and 10 min.). An average of 35% loss showed in Mallun preparation.

The oxalate contents of leafy vegetables ranged from 1.62% in Mukunuwenna to 9.72% in spinach on dry basis. The leaves with high oxalate contents include Thampala 7.2%, Kohila 5.2% and Wattakka 4.2%. Major fraction (80%) found to be water soluble. The greatest loss in oxalate content was observed upto about 50%.

The phytic acid contents of leafy vegetables ranged from 27.96 mg in Gotukola and 230.76 mg in Wattakka/100 g of dry material. Only a range of 3 to 10% of phytate was lost during steaming and boiling than that of steaming.

INTRODUCTION

A wide variety of green leafy vegetables is used in average Sri Lankan diets. They can be grouped into pale yellow or pale green vegetables. Cabbage (*Brassica oleracea*), lettuce (*Lactuca sativa*) and leeks (*Allium empeelprassum*) belongs to the former. Among the dark green leaves the commonest are Thampala (*Amaranthus tricolor*), Spinach

(*Basella alba*), Kankun (*Ipomea aquatica*), Mukunuwenna (*Alternanthera sessilis*) and Gotukola (*Centella asiatica*). Nutritionally leafy vegetables are important because they contain large amounts of certain vitamins, especially vitamin C and A, and minerals (Wickramanayake, 1979). These green leafy vegetables are inexpensive and are easily and quickly cooked.

The nutritional exploitation of green leafy vegetables is limited by the presence of anti-nutritional factors, such as oxalates, phytates, that bind nutrients making them biologically unavailable. Kaushalya and Wagle (1978) reported that some green leafy vegetables, such as spinach, contains considerable amounts of oxalates. Oxalate is present mainly as soluble Na and K salts or insoluble calcium form. The ingestion of large doses of oxalic acid cause corrosive effects in the mouth or intestinal tract, convulsion symptoms and deposition of calcium oxalate crystals in the kidney resulting in stone formation. Acute poisoning from ingestion of oxalate-containing plants is not uncommon. The ingestion of more than 5 g oxalic acid can be toxic to humans (Oke, 1969).

Thytic acid primarily present as the salt of mono and bivalent cations, and is a chelating ion for cations. The effects of phytates in lowering the bio-availability of calcium, iron, zinc and copper are well known (Rainhold, 1971).

In Sri Lanka, leafy greens are prepared mainly in three different ways. Soft mucilaginous leaves, such as Kankun, Wattakka and Kohila are cooked in coconut milk or tempered in coconut oil. Coarser leaves, like Mukunuwenna, Cabbage, Kathurumurunga and Passion leaves, are mixed with grated coconut and cooked over direct flame or tempered in oil (*Mallun*). Leafy greens like Gotukola are eaten as a raw salad.

These different methods of preparation could be expected to alter the nutritive value of leafy vegetables. The extent of any change is variable and, depends on the species, method of preparation and duration of processing. Special attention must therefore be given to minimize the retention of nutrients, particularly of vitamin C, as well as to increase the losses of oxalate and phytate during the home level preparations.

The purpose of the present investigation was to determine the vitamin C content, and oxalate and phytate contents of selected green

leafy vegetables and to study the losses incurred in these components during home level preparations.

MATERIALS AND METHODS

Fresh samples of selected green leafy vegetables (Table 1) were collected from retail vegetable markets in Kandy and Peradeniya. They were washed to remove the dirt. Edible portions of fresh leaves (200g) were boiled or steamed for 5 and 10 min, and oven dried at 80 C. Dried materials were ground to pass 60 – mesh sieve and stored in air tight containers for oxalate and phytic acid analysis.

Table 1. Local and botanical names of green leaves used in this study.

Local name	Botanical name
Mukunuwenna	*Alternanthera sessilis*
Kathurumurunga	*Sesbania grandiflora*
Gotukola	*Centella asiatica*
Kankun	*Ipomea aquatica*
Thampala	*Amaranthus tricolor*
Spinach (round shaped)	*Basella alba*
Spinach (oblong shaped)	*Basella rubra*
Penela	*Cardiospermum microcarpum*
Japan batu	*Breynia spp*
Anguna	*Dregia volublis*
Wattakka	*Cucurbita maxima*
Cabbage	*Brassica oleracea*
Passion	*Passiflora edulis*
Lettuce	*Lactuca sativa*
Kohila	*Lasia spinosa*

Determination of oxalate content

Two grams of each sample in triplicate was analyzed for the total oxalate and water soluble oxalate by the procedure of Abaza *et al.*, 1968.

Determination of phytic acid content

About 2 – 3 g of sample was extracted with 3% Trichloro acetic acid and phytic acid was precipitated as ferric phytate using $FeCl_3$. Then ferric content was separated as ferric hydroxide with 0.6 N NaOH. Iron content was analysed calorimetrically. Phosphorus phytate content was calculated using the ratio of 4:6 iron:phosphorus. The amount of phytic acid was estimated by multiplying phosphorus phytate by a factor of 3.553 (Reddy *et al.*, 1982).

Determination of vitamin C content

Ten to twenty grams of edible portions of fresh green leaf samples were extracted with 100 ml of 0.3% Trichloro acetic acid and 0.9 g Ethyleneamine tetraacetic acid. Aliquots of the extracted filtrate was titrated with standardized 2 – 6 dichloro – indophenol dye (Fred, 1966). The samples that were prepared by boiling or steaming for 5 and 10 min, and as *Mallun* were also analysed for their vitamin C contents.

RESULTS AND DISCUSSION

The vitamin C content of the green leaves analysed (Expressed as mg/100 g of fresh weight) ranged from 2.6 in Kankun to 235.7 mg in Passion (Table 2). Almost all the green leafy vegetables contained appreciate amounts of ascorbic acid, which is an important nutrient. Anguna (185.6 mg), Japan batu (87.9 mg), Spinach (43.4 mg), Thampala (45.8 mg) were also found to be very good sources of vitamin C. These values are slightly different from those reported in Food Composition Tables for Sri Lanka (MRI, 1979). Only the values for Mukunuwenna, Spinach and Lettuce were similar, while others were slightly lower. These differences may be attributed to the variations in maturity and environmental conditions. According to Kailasapathy and Koneshan (1988), vitamin C values for Gotukola, Lettuce, Thampala and Wattakka were 7.8, 6.4, 45.7, 4.3 mg, respectively. These figures are similar to hose observed in our investigations.

Table 2. Vitamin C content of the green leafy vegetables (mg/100g fresh weight basis)[a].

Green leafy vegetable	Vitamin C content
Mukunuwenna	16.3 ± 0.47[b]
Kathurumurunga	11.7 ± 0.36
Gotukola	6.8 ± 0.18
Kankun	2.6 ± 0.11
Thampala	45.8 ± 0.28
Spinach (round shaped)	43.6 ± 0.27
Spinach (oblong shaped)	56.1 ± 0.36
Penela	10.3 ± 0.13
Japan batu	87.9 ± 2.31
Anguna	185.6 ± 0.98
Wattakka	3.5 ± 0.12
Cabbage leaves	36.3 ± 1.51
Passion	253.7 ± 2.05
Lettuce	7.3 ± 0.00
Kohila	31.3 ± 0.12

[a] Mean of three determinations
[b] Mean ± S.E.

According to the FAO/WHO (1974), recommended dietary allowance of vitamin C for a moderately active adult is 30 mg per day. Of the fifteen green leafy vegetables studied, Passion, Anguna, Japan batu, Spinach and Thampala are good sources of vitamin C. Consumption of about 13, 16, 34, 60 and 65 g of these leaves, respectively, could satisfy the recommended dietary intake of vitamin C. In the case of Wattakka, Gotukola and Kankun, one has to consume around 850, 440 and 1000 g to satisfy the RDA for vitamin C. But these quantities are too much to be consumed in a day.

The percent loss of ascorbic acid during boiling, steaming and *Mallun* preparation is given in Table 3. The loss of vitamin C in green leafy vegetables ranged from 19 to 45% and 38 to 81% at 5 min. and

10 min. respectively when boiling is employed. Steaming reduced the vitamin C content by 11 – 24% in 5 min. and 18 – 63% in 10 min. *Mallun* preparation observed a loss ranged from 8 – 51%.

Oomen and Grubben (1977) reported that 18% and 25% loss of vitamin C of Mukunuwenna in 5 min. and 10 min. boiling respectively. The percent reduction observed in cabbage was 14% and 20% during steaming. The results of our study is slightly comparable with above investigation.

Table 3. Percent loss of vitamin C of green leaves during boiling, steaming and *Mallun* preparation[a].

Leafy green vegetable	% loss of vitamin C				
	Boiling		Steaming		*Mallun* preparation
	5 min	10 min	5 min	10 min	(10 min)
Mukunuwenna	25	50	12	31	31
Kathurumurunga	30	50	22	42	26
Kankun			10	63	54
Thampala	45	81	13	60	
Spinach (round)	34	62			
Spinach (oblong)	28	45			
Penela	19	50	11	27	
Japan batu	40	48	24	52	51
Anguna			8	21	8
Wattakka	45	63	18	45	
Cabbage			10	18	51
Passion			20	34	25
Kohila	23	38			
Mean	32.1	54.1	14.8	39.3	35.1

[a] Based on 3 replicate determinations.

The data revealed that the vitamin C losses varied with the type of green leaves, method of preparation and duration of preparation. The greatest loss in vitamin C was observed in Thampala which was 81% and 60% during boiling and steaming (10 min.), respectively. A 63% loss in 10 min. steaming was observed with Kankun.

The average loss was highest during boiling (54.1%) than during steaming (39.3%) and *Mallun* preparation (35.1%). Being a water soluble vitamin, a greater loss due to leaching into water may be expected during boiling. Steaming reduces the contact between the food and water so that less nutrients are leached out. Loss of vitamin C was lowest during *Mallun* preparation and this may be due to the direct heating and also to some protective role from oil which may have caused less vitamin C oxidation (Wickramanayake, 1979). In boiling and steaming the amount of retained vitamin C decreased with increasing cooking time. The results show that the best method of preparation to maximize vitamin C retention would be steaming for 5 min, which reduces vitamin C only by about 15%.

Data on total and water soluble oxalate contents of the green leafy vegetables are given in Table 4. Total oxalate content ranged from 1.62% (Mukunuwenna) to 9.72% (Spinach with round shaped leaves) on a dry basis. Spinach with oblong shaped leaves contained 7.98% oxalates. Similar results have been reported by Kaushalya and Wagle (1988), who found spinach to contain 8.69% oxalate (dry basis). Thampala, Kohila and Wattakka also contain considerable amounts of oxalate, the value being 7.20, 5.22 and 4.15%, respectively. The value for other green leaves ranged from 1.62 to 2.52%.

Major fraction of the oxalates present in green leafy vegetables were found to be water soluble (80% of total oxalate). Oke (1969) reported that spinach and rhubarb contain appreciable oxalates (0.3 – 1.2% and 0.2 – 1.3%, respectively on a fresh weight basis), while others such as lettuce and cabbage contained only one-tenth of the above amounts.

Table 5 presents the mean oxalate contents of boiled and steamed (10 min) green leaves and their percent losses. The results show that there was a reduction of total and water soluble oxalate in green leaves. However the percent losses were highly variable among the green leaf types.

Table 4. Water soluble and total oxalate content of green leafy vegetables (dry basis)[a].

Type of Leaves	Water soluble oxalate %	Total oxalate %
Mukunuwenna	1.2 ± 0.02	1.6 ± 0.02
Kathurumurunga	1.6 ± 0.03	1.8 ± 0.00
Gotukola	1.6 ± 0.03	1.8 ± 0.00
Kankun	1.0 ± 0.05	2.4 ± 0.11
Thampala	5.2 ± 0.02	7.2 ± 0.04
Spinach (round shaped)	7.6 ± 0.09	9.7 ± 0.03
Spinach (oblong shaped)	5.9 ± 0.00	7.9 ± 0.06
Penela	2.3 ± 0.09	2.5 ± 0.08
Japan batu	2.1 ± 0.05	2.3 ± 0.00
Anguna	1.4 ± 0.00	1.9 ± 0.08
Wattakka	3.9 ± 0.08	4.2 ± 0.02
Cabbage	2.1 ± 0.05	2.3 ± 0.03
Passion	1.5 ± 0.00	1.7 ± 0.06
Lettuce	1.6 ± 0.05	1.9 ± 0.02
Kohila	4.1 ± 0.05	5.2 ± 0.00
Mean	2.8	3.6

[a] Mean of the three determinations.

The extent of loss of water soluble and total oxalate content is almost the same in all leaves, with the exception of Kankun, Passion and Cabbage. The retention of oxalates in Mukunuwenna, Kathurumurunga and Cabbage leaves during boiling was found to be greater than steamed samples. Oxalate reduction observed in spinach during boiling was extremely low (Table 5). In Wattaka and Mukunuwenna oxalate losses were 47 and 37%, respectively. Cabbage, Kathurumurunga and Thampala also lost considerable amounts during boiling. Gotukola recorded the great reduction in oxalate content during steaming (60%).

Table 5. Oxalate contents (% dry basis) of green leaves boiled or steamed 10 min.[a]

Type of Leaves	Boiled (10 min)	Steamed (10 min)
Mukunuwenna	1.0 (37)	1.2 (24)
Kathurumurunga	1.5 (16)	1.6 (13)
Gotukola	0.6 (63)	0.7 (60)
Kankun	1.4 (42)	1.9 (20)
Thampala	4.8 (33)	5.3 (25)
Spinach (round shaped)	11.5 (0)	9.6 (1)
Spinach (oblong shaped)	7.7 (2.8)	7.8 (2)
Penela	1.9 (22)	2.2 (11)
Japan batu	1.2 (49)	1.5 (33)
Anguna	1.5 (18)	1.9 (2)
Wattakka	2.1 (47)	3.8 (7)
Cabbage	1.7 (27)	2.2 (4)
Passion	1.4 (16)	1.5 (13)
Lettuce	–	–
Kohila	4.7 (8)	5.1 (3)
Mean percent loss	27	16

[a] Mean of three determinations.
[b] Values in parenthesis refer to loss in oxalates in a percentage basis.

The leafy vegetables were found to contain phytic acid from 28.0 to 230.0 mg per 100 g dry basis (Table 6). Wattakka leaves recorded the highest value and Gotukola the lowest. The contents of phytic acid in Anguna, Mukunuwenna, Japan batu and Passion leaves were 99.1, 102.3, 165.2 and 124.1 mg/100 g, respectively. The levels of phytic acid in leafy vegetables are low when compared to those contained in cereals and pulses. Generally cereals contain 500 to 1890 mg per 100 g. Legumes such as soybean, mung bean and black bean containing 2335 mg, 950 mg and 885 mg of phytic acid per 100 g of defatted meal. Literature available on phytic acid content of green leafy vegetables is limited. According to the Averill and King (1926) leafy vegetables such as Lettuce, Celery and Spinach are devoid of phytate.

Table 6. Mean values of phytic acid content and their percent losses at boiling and steaming (mg/100 g dry basis).

Type of Leaves	Fresh Leaves	Boiled (10 min)	Steamed (10 min)
Mukunuwenna	102.3 ± 2.17[a]	97.9 (5)[b]	99.1 (3)
Kathurumurunga	69.1 ± 0.84	64.5 (7)	66.9 (5)
Gotukola	28.0 ± 0.83	27.9 (1)	26.4 (6)
Kankun	38.9 ± 0.00	36.8 (5)	38.9 (0)
Thampala	65.9 ± 0.34	64.0 (3)	64.8 (2)
Spinach (round shaped)	91.7 ± 0.88	88.9 (3)	90.2 (2)
Spinach (oblong shaped)	86.1 ± 1.70	82.0 (5)	83.5 (3)
Penela	164.2 ± 1.91	151.3 (8)	154.6 (5)
Japan batu	165.2 ± 1.60	155.6 (6)	158.8 (4)
Anguna	99.1 ± 2.01	97.2 (2)	98.2 (3)
Wattakka	230.8 ± 5.30	205.7 (10)	218.3 (5)
Cabbage	121.9 ± 3.21	121.5 (.02)	121.3(.04)
Passion	124.1 ± 1.90	115.4 (7)	117.8 (5)
Lettuce	57.7 ± 0.78	–	–
Kohila	68.8 ± 1.02	66.6 (3)	65.4 (5)
Mean	102.4 ± 50.1	98.2	100.5

[a] Mean ± SE
[b] Values in parenthesis refer to loss in oxalates in a percentage basis.

Very little phytic acid was lost during boiling and steaming for 10 min (Table 6). Reinhold (1971) noted that destruction of phytate during cooking depends on several factors such as presence or absence of active phytate, pH and concentration of ionizable calcium. According to the literature, ingestion of 2.8 g or more phytic acid content per day may cause reduction in the bioavailability of calcium, iron and zinc. However, based on our data, the levels of phytate in green leaves are too low to be of any nutritional concern.

REFERENCES

Abaza, R.H., Blake, J.T. and Fisher, E.J. (1968). J.A.O.A.C., 51 (5) : 963 – 966.

Averill, H.P. and King, C.G. (1926). The phytin content of foodstuffs. J. Am. Chem. Soc., 48 : 784.

FAO/WHO (1974). Hand book on Human Nutritional Requirements.

Fred, M. (1966). Methods of vitamin Assay, 3rd ed. Interscience, New York.

Kailasapathy, K. and Koneshan, T. Effect of wilting on the Ascorbate contents of selected fresh green leafy vegetables consumed in Sri Lanka. J. Agric. Food Chem. 34 (2) : 259 – 262.

Kaushalya, G. and Wagle, D.S. (1988). Nutritional and Anti – nutritional factors of green leafy vegetables.

MRI (1979). Food consumption tables, Sri Lanka.

Oke, O.L. (1969). Oxalic acid in plant and in nutrition. World Review of Nutrition and Dietetics. 62.

Oomen, H.A.P.C. and Grubben, G.J.H. (1977). Tropical leafy vegetables in Human nutrition. Department of Agricultural Research, Amsterdam, The Netherlands. p. 25 – 41.

Rainhold, J.G. (1971). High phytate content of rural indian bread. Am. J. Clin. Nutr., 24 : 1024.

Reddy, N.R., Sathe, S.K. and Salunke, D.K. (1982). Phytates in Legumes and cereals. Adv. Food Res. 28 : 1 – 92.

Wickramanayake, T.W. (1979). Foods and Diets. K. Double I Press, Kandy, Sri Lanka.