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USE OF SANDELL AND KOLTHOFF REACTION IN ESTIMATING THE IODINE CONTENT OF SOME FOOD AND WATER SOURCES IN SRI LANKA

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Abstract: The iodine content of coconut/king coconut water, tap water, ground water, fruits, vegetables and spices has been determined using the Sandell and Kolthoff reaction. Coconut/king coconut water is a rich source of iodine compared to tap/ground water and their iodide content fluctuates with maturity. In general, vegetable, fruits and spices are poor sources of iodide. Among the spices, however, higher levels are found in *Cuminum cyminum* (cummin), *Murraya koenigii* (curry leaves) and *Foeniculum vulgare* (maduru).

Key words: Coconut water /king coconut water, fruits, ground water, iodine, spices, tap water, vegetables.

INTRODUCTION

Recently, we highlighted the importance of iodine in human nutrition and our contribution to educate society to check the spread of goitre in Sri Lanka.[1,2,3] In a further effort to make available the iodine levels in food to achieve our ultimate aim of inclusion of iodine data in the Sri Lankan food table,[4] we report here, the iodine content of *Cocos nucifera* (king coconut/coconut), tap and ground water, vegetables, fruits and spices.

METHODS AND MATERIALS

Samples: To study the variation of iodide content with maturity in king coconut (thembili, variety - aurantiaca), nuts were collected from two trees from a home garden in Nugegoda. The nuts were freshly plucked from the same bunch on the day of the analysis. The analysis was carried out in 1995 during the period May to August. The date of emergence of the inflorescence was taken as the first day of the experiment. The first analysis was possible after a period of approximately two months. Tap water samples were collected from twenty locations from Nugegoda and suburbs. Ground water was collected from different parts of Sri Lanka where goitre is known to be both endemic and non-endemic. No special method was used to preserve ground water samples except that they were transported at 4^0C and analyzed within 24 - 48 hours.

Fruits, spices and vegetables were also collected from Nugegoda market. Fruits and spices were collected on two days approximately a month apart whereas

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preliminary data are presented for vegetables collected on a single day with a lesser number of samples.

Determination of iodide in king coconut / coconut water: A known volume (4.00 ml) of king coconut water was diluted to 100.0 ml in a volumetric flask. A 10.00 ml portion of this solution was used in the analysis of iodide.

Determination of iodide in tap / well water : A volume of 16.00 ml was used in the analysis.

Determination of iodide in fruits, spices and vegetables: An accurately known weight (fruits 3 g; spices 5 g; vegetables 3 g) was subjected to alkaline dry ashing.

Details of the method of analysis of iodide and moisture content of the aforementioned samples were similar to those reported by us previously.[1,2]

RESULTS AND DISCUSSION

King coconut/coconut water: The liquid endosperm of the young coconut and king coconut is a popular refreshing and safe drink in Sri Lanka and many parts of the coconut producing areas of the world. The water in young coconut/king coconut, is sterile, and is known to contain carbohydrates, vitamins, amino acids and inorganic minerals [K (major constituent), Na, Mg, Fe, Cu, P, S, Cl] [5,6] but devoid of any toxic or unhealthy constituents. Thus water in tender nuts is recommended as a substitute for saline glucose in intravenous infusions as well as in serious cases of diarrhoea and vomiting, against dehydration of body tissues. Although a large number of inorganic minerals are known to be present in coconut/king coconut water, the presence of iodide is not reported to date. In our continuing effort to identify iodine rich food, we have examined iodine content in coconut/king coconut water and compared it with that found in tap and ground water.

The iodide composition in king coconut fluid was found to fluctuate with maturity with levels falling in the range 2.0×10^{-6} - 7.2×10^{-6} mol dm^{-3}. These observations are based on a study done in 1995 on two king coconut trees. The fluctuation may be related to climate and edaphic factors where plants are grown. Since the fluid content of fruit is changing with maturity, this may also contribute to variation. Similar fluctuations of chloride composition in coconut water at different stages of maturity has also been reported.[6]

The average iodide content in king coconut water appears to be around 4×10^{-6} mol dm^{-3} (508 μg dm^{-3}) based on the data obtained in 1995. If we assume that a mature nut has on the average 250 cm^3 of fluid, the average iodide content in a mature nut is around 130 μg. Thus while king coconut has a potential use as a

refreshing soft drink, one to two nuts a day will give the daily requirement of iodine (150 μg). Hence king coconut can be categorized as a rich source of iodine.

The iodide content of two varieties of young coconut (local name 'kurumba') plucked from different areas of Sri Lanka have also been examined. The results are given in Table 1 and are comparable to that of king coconut. The varying concentrations of iodine in a particular variety analyzed from two different areas may indicate that iodine concentration in food of plant origin is dependent on the iodine concentration in soil.

Table 1: Iodine content in young coconut water. (values are 95% confidence limits in μg dm^{-3}).

Variety (form)		Iodine content
Nana (regia)	N	168±16(5)
	M	131±16(7)
Nana (Pumilla)	B	320±25(8)
	K	240±27(6)
Typica (gon thembilli)	N	347±23(8)
	W	416±30(6)

Number of nuts analyzed is given in parenthesis. Nuts analyzed are of similar maturity.
N: Nugegoda, M: Matugama, B: Boralesgamuwa, W: Wadduwa, K: Kalutara

Table 2: Iodine content in ground water samples from different parts of Sri Lanka. (Values are 95% confidence limits in μg dm^{-3}).

District	Iodine content
*Kalutara	1.1±0.7(8)
* Ratnapura	1.2±0.3(8)
*Kegalle	1.8±0.6(8)
Colombo (Nugegoda)	6.7±0.8(10)
*Anuradhapura (Eppawala)	9.8±0.7(8)
*Monaragala	1.0±0.7(8)
Polonnaruwa	8.9±0.9(8)
* Kandy	2.1±0.5(10)

Number of wells analyzed is given in parenthesis
* indicates high goitre prevalence areas.

Tap water and ground water: The iodine concentration in tap water sampled from twenty locations on three consecutive days in the month of August 1997 in Nugegoda and its suburbs was as little as 0.72 ± 0.19 μg dm^{-3}. This will be further reduced on boiling and drinking water from taps will provide only a negligible fraction of the daily requirement of iodine. The low iodine content in drinking water, may partly be due to chlorination at the point of distribution.

The ground water analyzed from various parts of Sri Lanka is given in Table 2. In this preliminary study, water samples were collected from a 1 km^2 area in a given district. The results in Table 2 show that iodine concentration in ground water from five districts, namely Kalutara, Ratnapura, Kegalle, Monaragala and Kandy, is significantly low compared to other districts. This may partially explain the high incidence of goitre in the population in these areas. Moreover, iodide levels in ground water in non-endemic areas are higher by factor of > 10 compared to tap water. It is also worth noting that iodine in tap/ground water is considerably low compared to sea water which was 49 ± 3 μg dm^{-3} for 10 samples and compares well with reported values (50 - 60 μg dm^{-3}).

Spices: Table 3 gives the iodide levels of seventeen varieties of spices collected on two days approximately a month apart from Nugegoda. The iodide content ranged from 4 - 5 μg/100g and among the species analyzed, iodide content was highest in *Cuminum cyminum* (cummin) followed by *Murraya koenigii* (curry leaves) and *Foeniculum vulgare* (maduru). The mean iodide contents observed for each species on two different days were compared statistically and the differences were found to be largely non significant ($p>0.05$). The fact that chief ingredients of curry powder are coriander, suduru and maduru, (5:2:1), prompts one to classify curry powder as a rich source of iodine in its own right. The small quantities, however, that are used in cooking may not reflect the virtues of curry powder as a potential iodide rich dietary source. Although no data on iodide content in spices have been reported, the ability of spices to absorb iodide has been investigated.[7]

Fruits: Results in Table 4 show that fruits (fifteen species) are poor sources of iodide (3 - 21 μg/100g) with highest level found in *Annona squamosa* (sugar apple). In cases where different varieties of the same species have been analyzed (Tables 4: 1, 12, 14 and 15) no significant differences were observed in the case of *Psidium guajava* (guava) and *Vitis vinifera* (grapes) but with *Musa paradisiaca* (banana) and *Mangifera indica* (mango) the levels were significant. Of the different varieties of bananas analyzed, ambon and kolikuttu showed elevated levels whereas with mango, "beti" mango showed the highest.

Vegetables: Table 5 gives the preliminary data on iodide content in vegetables. All vegetables analyzed contain lower iodine content (range 1-9 μg/100g) with average iodide in root vegetables (Table 5 : 1-8) being higher than in fruit vegetables (Table 5 : 9-15).

Table 3 : Iodine content of spices (values are mean ± s.d. µg/100g wet weight).

Species	Iodide content
Cinnamomum zeylanicum (E : cinnamon, S : kurundu))	11.8±0.6(18)
Allium sativum (E : garlic, S : sudulunu)	4.2 ± 0.5(20)
Zingiber officinale (E : ginger, S : inguru)	8.1 ± 0.7(19)
Garcinia cambogia (E : goraka, S : goraka)	9.1 ± 0.6(20)
Trigonella foenum - graecum (E : fenugreek, S : uluhal)	18.5 ± 0.8(19)
Cuminum cyminum (E : cummin, S : suduru)	50.2 ± 1.4(19)
Elettaria cardamomum (E : cardamons, S : enasal)	27.7 ± 0.9(20)
Eugenia caryophyllata	10.9 ± 1.2(10)
(E : cloves, S : karabunati)	11.7 ± 0.4 (9)
Foeniculum vulgare (E : sweet cummin or fennel, S : maduru)	40.1 ± 1.8(19)
Capsicum frutescens	12.9 ± 0.7(10)
(E : red chillies, dried, S : welu miris)	12.3 ± 0.4(9)
Tamarindus indica (E : tamarind, S : siyambala)	33.7 ± 1.6(20)
Brassica nigra (E : mustard seeds, S : aba)	10.3 ± 0.5(20)
Pandanus latifolia (E : rampe, S : rampe)	30.9 ± 1.3(19)
Cymbopogon citratus (E : lemon grass, S : sera)	12.2 ± 0.5(20)
Murraya koenigii (E : curry leaves, S: karapincha)	44.1± 0.7(20)
Piper nigrum (E : pepper(black), S: gammiris)	22.9 ± 0.7(18)
Coriandrum sativum	25.1 ± 1.2(8)
(E : coriander, S: koththamalli)	27.2 ± 1.1 (8)

Total number of samples analyzed is given in parenthesis. A single value for each determination indicates that the two means are not significant ($p>0.05$); when the means are significant ($p<0.05$) they are expressed separately.

E : English, S : Sinhala

Table 4 : Iodine content in fruits including moisture. (values are mean ± s.d. in μg/100g wet weight)

Species	Iodide content	Moisture Content (%)
Psidium guajava		
(E : guava, S : pera)	6.0±0.8(20)	66.7±0.8(3)
Garcinia mangostana	4.6 ± 0.7 (19)	83.1 ± 0.7 (3)
(E : Mangosteen, S : mangosteen)		
Ananas comosus	5.5 ± 0.6 (20)	88.5 ± 0.8 (3)
(E : pineapple, S : annasi)		
Citrus limon	4.0 ± 0.5 (18)	84.2 ± 0.7 (3)
(E : lemon, S : lemon)		
Citrus reticulata	3.8 ± 0.7 (16)	88.1 ± 1.1 (3)
(E : mandarin, S : naran)		
Carica papaya	12.8 ± 1.2 (19)	86.3 ± 1.8 (3)
(E : papaya, S : gaslabu)		
Limonia acidissma	17.1 ± 0.7 (18)	68.8 ± 0.7 (3)
(E : woodapple, S : divul)		
Anona squamosa	20.9 ± 0.8 (18)	80.2 ± 0.6 (3)
(E : custard apple, S : atha)		
Aegle marmelos	16.7 ± 0.8 (9)	66.8 ± 0.8 (3)
(E : bael, S : beli)	18.1 (0.6 (10)	
Punica granatum	13.8 ± 0.9 (18)	74.9 ± 1.1 (3)
(E : pomegranate, S : delum)		
Persea gratissima	12.8 ± 0.6 (18)	77.5 ± 0.8 (3)
(E : avocado, S : aligeta pera)		
Vitis vinifera		
(E : grapes, S : midi)		
Cultivar: Cabernet sauvignon	3.5± 0.8 (20)	81.5± 1.1 (3)
Thompson Seedless	3.7±0.6 (18)	80.1 ± 0.9 (3)
Emperor table grape	3.1 ± 0.7 (16)	81.5 ± 0.7 (3)
Malus pumila		
(E : apples, S : apple)		
green apple	4.6± 0.7 (14)	3.9 ± 0.7 (16)
red apple	85.1± 0.7 (3)	84.7 ± 0.8 (3)
Mangifera india		
(E : mango, S : amba)		
Cultivar: betti mango	15.5 ± 1.2 (18)	83.6 ± 1.1 (3)
Jaffna mango	12.7 ± 0.9 (18)	82.1 ± 1.1 (3)
karthakolomban	7.6 ± 0.8 (18)	85.9 ± 0.8 (3)
Musa paradisiaca		
(E : banana, S : kesel)		
Cultivar: kolikuttu	13.7 ± 1.4 (19)	70.2 ± 1.1 (3)
ambun	17.8 ± 0.8 (17)	72.1 ± 0.9 (3)
anamalu	6.8 ± 0.5 (18)	69.3 ± 0.8 (3)

Cont.....

Species	Iodide content	Moisture Content (%)
seeni kesel	8.7 ± 0.9 (19)	70.9 ± 0.6 (3)
ambul	10.0 ± 0.8 (16)	73.1 ± 0.9 (3)

Total number of samples analyzed is given in parenthesis. A single value for each determination indicates that the two means are not significant ($p<0.05$); when the means are significant ($p<0.05$) they are expressed separately.

E : English, S : Sinhala

Table 5 : Iodine content in vegetables. (values are 95% confidence limits in μg/100g wet weight)

Species	Iodide content	Moisture Content (%)
Beta vulgaris (E : beet root, S : beet root)	4.9 ± 0.7 (5)	87.1 ± 0.9 (3)
Daucus carota (E : carrot, S : carrot)	7.2 ± 0.6 (5)	75.1 ± 0.7 (3)
Allium porrum (E : leek, S : leek)	2.3 ± 0.5 (5)	82.1 ± 1.5 (3)
Raphanus sativus (E : radish, S : rabu)	5.5 ± 1.0 (5)	91.2 ± 1.7 (3)
Brasilca oleracea (E : knol khol, S : knol khol)	7.9 ± 0.3 (5)	90.2 ± 1.1 (3)
Solanum tuberosum (E : potato, S : arthapal)	8.5 ± 0.5 (5)	76.3 ± 0.9 (3)
Dioscorea rotundata (E : white yam, S : kiriala)	8.6 ± 0.5 (5)	71.3 ±(1.3 (3)
Allium rubrum (E : red onion, S : rathulunu)	2.7 ± 0.3 (5)	82.3 ± 0.9 (3)
Cucumis sativus (E : cucumber, S : pipingna)	1.0 ± 0.3 (5)	95.8 ± 0.8 (3)
Momordica charantia (E : bitter gourd, S : karawila)	4.3 ± 0.3 (5)	86.3 ± 0.7 (3)
Hibiscus esculentus (E : ladies fingers, S : bandakka)	3.4 ± 0.3 (5)	84.3 ± 0.9 (3)
Solanum melongena (E : brinjal, S : vambatu)	1.5 ± 0.3 (5)	87.3 ± 0.5 (3)
Lycopersicon esculentum (E : tomato, S : thakkali)	3.9 ± 0.5 (5)	92.3 ± 0.6 (3)
Cucurbita maxima (E : pumpkin, S : wattakka)	1.4 ± 0.3 (5)	91.2 ± 0.7 (3)
Phaseolus vulgaris (E : french bean, S : bonchi)	6.4 ± 0.3 (5)	88.9 ± 1.2 (3)

Total number of samples analyzed is given in parenthesis.

E : English, S : Sinhala

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