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Iodine in pulses and cereals

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Abstract

The iodide content of five types of pulses namely *Phaseolus aureus* (mung bean/green gram), *Cicer arietinum* (chick-peas/kadala), *Lens esculentas* (Mysoor dhal), *Cajanus cajan* (Bengal gram/kadala parippu), & *Viga sinensis* (black pea/cowpea) and three types of cereals namely *Orya sativa* (rice: sudu kekulu (polished), rathu kekulu (raw), samba (parboiled), *Triticum vulgarae* (wheat flour) & *Eleusine coracana* (millet/kurakkan) purchased from two areas in Sri Lanka was determined using the Sandell and Kolthoff reaction.

Of all species analyzed, *Phaseolus aureus* falls into the iodine rich category and can provide the daily recommended quantity of iodine with one single meal. Boiling of these foodstuffs lead to loss of iodine with the relative loss being greater for cereals than for pulses.

Significant differences ($p<0.05$) were seen in the mean iodide levels of each pulse analyzed from the two areas whereas same with cereals were largely non significant ($p>0.05$).

Key words : cereals, pulses, iodide content,

1. Introduction

A significant proportion of the world population suffers from or is at risk of deficiencies of vitamins and minerals (referred to as micronutrients) which are related to overall well-being of all individuals and populations. Vitamin A, iron and iodine are the three important micronutrients that have attracted much attention in the past decade. Of these, iodine deficiency is probably the first nutritional disease of mankind (Hetzel, 1989). The thyroid which requires iodine for producing its hormones, enlarges as a result of iodine deficiency, making goitre the best known sign of such deficiency. This, however, is only a indicator of iodine deficiency as it has many pre-natal and neo-natal effects such as cretinism. physical or mental retardation and deafness that persists through the life span.

Iodine deficiency is a problem faced by almost all countries in the world, threatening roughly 1.6 billion people of which 655 million people have goitre whereas 43 million people are affected by some degree of mental impairment. Yet all of these effects of iodine deficiency can be prevented with simple inexpensive commodity iodized salt. Another approach for elimination and prevention of iodine deficient disorders in Sri Lanka would be from iodine rich dietary sources without recourse to measures such as iodization of salt.

In our search (Deraniyagala and Perera, 1995 and 1996; Jayawardena *et al.*, 1990) for iodine rich food to make Sri Lankans iodine sufficient, we report the iodide levels of five type of pulses namely namely *Phaseolus aureus* (mung bean/green gram), *Cicer arietinum* (chick-peas/kadala), Lens esculentas (Mysoor dhal), *Cajanus cajan* (Bengal gram/kadala parippu), & *Vigna sinensis* (black pea / cowpea) and three types of cereals namely *Oryza sativa* (rice: sudu kekulu (polished), rathu kekulu (raw), samba (parboiled), *Triticum vulgarae* (wheat flour) & *Eleusine coracana* (millet/ kurakkan) and the fate of iodine during boiling. This study will also add to our effort in establishing an iodide column in the Sri Lankan food composition tables (Perera et al., 1979).

2. Materials and methods

Sampling of cereals and pulses for analysis

Seeds of all species mentioned were purchased from local markets in Nugegoda and Galle. *Phaseolus auerus* (mung bean), however, was purchased from three areas, namely Nugegoda, Galle and Ratnapura. From each area, several samples were collected randomly for every species under study from differnt distributing centres found within a half a kilometre distance. The samples were dried in an oven around 60-70°C and then finally ground before ashing.

Ashing of samples

In the case of pulses approximately 1g of accurately weighed (for mung bean 0.5 g) samples and for cereals 3 g (kurakkan 0.5 g) of accurately weighed samples were subjected to alkaline dry ashing using a procedure given below similar to a reported method (Mahesh et al., 1992) Although one gram may be considered to be a very small experimental size, detection limits associated with the method *(vide infra)* permits smaller samples to be used.

To the accurately weighed sample added 2 cm^3 of 1 M KOH and 1 cm^3 of 10% (W/V) $ZnSO_4$ solution. The sample was dried in an oven at 100°C for $2\frac{1}{2}$ hours. The sample was then transferred to a muffle furnace and heated

at 600° C for 2 hours. The sample was then cooled and added few drops of double distilled water, 1 cm^3 10% Zn SO_4 solution and heated at 600° C in the muffle furnace until white ash is obtained.

Effect of boiling

Accurately weighed samples of the edible portion of seeds (weights similar to that used under the heating ashing of samples) were boiled in 25.0 cm^3 of double distilled water maintaining a constant heating rate. Time of boiling of each type of food material is given below

Food material	**time (min)**
Mung bean	25
Chick-peas (soaked overnight)	30
Mysoor dhal	10
Bengal gram	25
Cowpea	25
Rice	15

After boililng, sample and filtrate were separated and subjected to ashing.

Determinaion of moisture

Moisture content of edible portion of seeds of the cereals and pulses studied were determined by heating an accurately weighed amount to a constant weight in an oven at 120°C.

Determination of iodide in pulses and cereal samples

Each ashed sample was dissolved in double distilled water, centrifuged at 3000 rpm and made up to 100 cm^3 in a volumetric flask. The iodide levels were determined colorimetrically at 420 nm based on the iodide catalyzed reduction of Ce(IV) by As(III) (Sandell and Kolthoff, 1934) (Sandell and Kolthoff reaction) in acidic medium at 40± 1°C using a Galenkamp single beam spectrophotometer. A slightly modified procedure (Wimalasena etal, 1993; Subashinie, 1996) to that reported by Mahesh et al[6]., was used.

In this modified method [As(III)] / [Ce(IV)] ratio is kept high (~12) and log [absorbance (Ce (IV)] is plotted against against time (~5 min) for known iodide concentrations. The gradients of these plots are then plotted against known iodide concentration to obtain the calibration plot (r = 0.9991, mean co-efficient of variation = 0.06%). This calibration plot was used to determine iodide levels of unknown samples.

In a typical experiment to obtain the calibration plot order of adding reagents involved mixing 0.12M As(III) solution and working standard solution of iodide (7 ng per cm^3, 6 ng per cm^3) followed by the addition of 0.02M Ce(IV) at 40°C. The total volume of the reaction mixture was kept at 25.00 cm^3. This volume consists of 6.00 cm^3 As(III), 3.00 cm^3 of Ce(IV) and balance comprising of water and iodide solution solution. The volume of water and iodide was varied to alter the concentration of the iodide in the reaction mixture.

Timing was started when half the Ce(IV) volume has drained to the solution containing As(III), iodide and water.

Precision, detection limit and accuracy

Analysis was repeated four times for each sample. The co-efficient of variation was calculated of be less than 4% for all determinations. The detection limit of this method was found to be 4 ng per cm^3 in the working iodide solution. To evaluate the accuracy of the method iodide solutions of known strength were analysed both at high and low levels of iodide. The accuracy was found to be satisfactory for all the standard solutions.

Statistical analysis of results

The comparison of means of the samples at p=0.05 collected from two different locations were performed using analysis of variance (ANOVA) with the aid of Minitab statitical software version 7.

Reagents

All reagents used in this study were of analytical grade or better and used as received.

3. Results

Table I shows the iodide levels of pulses taken from two areas. The mean iodide content varied from 17 to 454 µg/100g dry weight and was highest for *Phaseolus aureus* (mung bean).

Table II shows the iodide content of cereals taken from the same areas. The values varied from 4 to 45 µg/100g dry weight based on the mean values and was highest for *Eleusine coracana* (kurakkan).

Table I & II also shows that both pulses and cereals lose their iodide content upon boiling and relative loss observed is in the range 22-55% and 30-82% respectively.

Table I : Iodide content of raw and boiled pulses including moisture content

(values are mean ± ts (Dick, 1973) in µg/100g dry weight, t = student's t value at 95% probability, s = standard deviation)

Species	Raw seeds	Significance	Boiled seeds	Significance	Iodide lost to the water	Moisture content[a]
1. Phaseolus aureus	N 454±77(10)		320±70(10)		74±16(10)	13±2(6)
	G 350±63(10)	SD	265±65(10)	SD	66±14(10)	
	R 413±77(10)		321±77(10)		86±9(10)	
2. Cicer arietinum	N 17±5(10)	SD	10±5(10)	SD	3.6±0.7(10)	14±1(4)
	G 22±7(9)		13±7(10)		5.5±0.5(10)	
3. Lens esculentas	N 22±7(9)	SD	14±5(10)	SD	3±2(10)	17±3(4)
	G 12±7(10)		7±5(9)		4±2(9)	
4. Cajanus cajan	N 21±7(10)	SD	12±5(9)	SD	5±2(9)	13±1(4)
	G 18±9(13)		10±5(11)		7±7(11)	
5. Vigna sinensis	N 26±7(10)	SD	12±5(10)	SD	11±5(10)	17±1(4)
	N 34±7(10)		21±7(10)		8±5(10)	

Total number of samples analyzed are given in parenthesis. N = Nugegoda, G = Galle, R = Ratnapuea SD = Significantly different ($p<0.05$); NSD = Not significantly different ($p>0.05$)

a. average value

Table II : Iodide content of raw and boiled cereals moisture content

(values are mean ± ts (Dick, 1973) in µg/100g dry weight, t = student's t value at 95% probability, s = standard deviation)

Species	Raw seeds/flour	Significance	Boiled seeds	Significance	Iodide lost to the water	Moisture content
1. Oryza sativa						
(1) Rathu kekulu (raw)	N 4±2(10)	NSD	1.5±1.6(10)	NSD	1.1±0.9(10)	18±1(4)
	G 4±2(10)		1.6±1.8(10)		0.9±1.2(10)	
(11) Sudu kekulu (polished)	N 7±5(10)	SD	5±2(10)	NSD	3±2(10)	18±1(4)
	G 10±5(10)		6±4(10)		4±2(10)	
(111) Samba (parboiled)	N 6±5(9)	NSD	2±2(9)	NSD	1±1(9)	18±1(4)
	G 7±5(9)		2±2(9)		2±1(9)	
2.Triticum vulgarae (wheat flour)	N 13±7(10)	NSD	-	-	-	15.4±0.8(4)
	G 15±7(9)					
3.Eleusine coracana (kurakkan flour)	N 42±5(8)	SD	-	-	-	17.7±0.8(4)
	G 45±7(9)					

Total mumber of smples analyzed are given in parenthesis. N = Nugegoda, G = Galle
SD = Significantly different ($p<0.05$); NSD = Not significantly different ($p>0.05$)

a. average value

4. Discussion

The results of this study show that cereals and pulses could be classified in general as poor sources of iodine. *Phaseolus aureus* (mung bean), however, contained considerably high iodide content and can provide the daily recommended allowance (150 μg) with one single meal. The mean iodide content observed for each food material from the two locations of purchase were compared statistically and significant differences ($p<0.05$) were found between them in the case of pulses and largely non significant ($p<0.05$) for cereals. Although the iodide content in cultivars depends on the soil iodide content, the present study took into consideration what is available in the market irrespective of where they were grown. The ultimate aim of our continuing investigation on this subject was to make the consumer aware in general the nutritional significance (i. e. the iodide range) of food in the hope of building a healthy society. As expected, iodide content of pulses and cereals decreased during boiling and it should be noted that the ratio of food : water at 1 : 25 used in this investigation does not reflect actual cooking conditions. Moreover, the iodine lost during boiling was found to concentrate in the water extract while the balance appears to have lost to the atmosphere. Finally, it is noteworthy to mention that iodide levels reported by us are significantly lower than previously reported for Mysoor dhal (5200 μg/100 g) wheat flour (129 μg/100 g) and kurakkan (125 μg/100 g) using an iorn selective electrode (Perera *el at.*, 1994).

5. Conclusion

Although pulses and cereals are poor sources of iodine, *Phaseolus aureus* is very rich in iodide and can provide the daily requirement of iodine with one single meal.

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