Selenium Content of Common Indian Cereals, Pulses, and Spices

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Selenium is an essential trace element with potent antioxidant activity. Low dietary intake of selenium has been implicated in many chronic degenerative diseases. Information on selenium content of foods is therefore required to quantify its levels in the diet. This study reports on the selenium content of some common food groups, with varietal and geographical differences. The selenium content of cereals, pulses, and spices was analyzed by a fluorometric method. The cereal and pulse samples analyzed are from different locations. The present paper shows the locational and varietal differences in rice and locational differences in sorghum and green gram crops. The dietary intakes of selenium in this region on a rice-based diet in different income groups ranges between 41 and 54 μg/day. These intakes are sufficient to protect the population from selenium deficiency disorders like Keshan's Disease, but are probably not enough to protect against degenerate diseases because they are below the recommended dietary allowances.

Keywords: *Selenium; foodstuffs; varietal differences; locational differences*

INTRODUCTION

Many trace elements occupy a central position in the biological system as functional component of metalloproteins and metalloenzymes. Selenium (Se) is one such trace element which forms the integral part of the enzymes glutathione peroxidase (Rotruck et al., 1973), type 1 iodothyronine deiodinase (Berry et al., 1991) metalloproteins, fatty acid binding protein (Bansal et al., 1989), and selenoprotein P (Read et al., 1990). Glutathione peroxidase reduces the concentration of free radicals formed during various metabolic reactions. Free radicals are implicated in many diseases. Selenium is now considered as an antioxidant nutrient, and the diseases where low selenium is implicated range from nutritional disorders like protein energy malnutrition to degenerative diseases such as cancer, cardiovascular diseases, and cataract (Robinson, 1983). The requirement of selenium in humans is met by dietary intakes. Both animal and plant sources contribute to selenium nutriture. The levels of selenium in foodstuffs are dependent on soil Se, soil characters, argoclimatic conditions, cultivation practices, and the variety of the crops cultivated (Gissel-Nielson, 1971a,b). There is very little information on selenium content of foods from the Indian subcontinent (Bieri and Ahmad, 1976; Srikumar, 1993). In the present study selenium content of selected cereals, pulses, and spices are analyzed. In the present paper varietal and locational differences are also investigated.

MATERIALS AND METHODS

Food Samples. Different cereals, pulses, and spices were collected from major markets of the twin cities of Hyderabad and Secunderabad (Table 1). The other food samples were collected from the towns of districts adjoining the twin cities. The sample for locational differences in rice were collected from different markets after establishing the authenticity regarding the place of cultivation of the variety. The samples were brought to the laboratory, washed with glass-distilled water two or three times in order to remove the dust particles and any other dry matter from the samples. These samples were dried at 60 °C in an oven and dried samples were finely powdered in a variable-speed blender.

Samples were analyzed in duplicate for the selenium content by the fluorometric method of Whetter and Ullrey (1978). The samples were digested with a nitric acid and perchloric acid mixture. The different forms of selenium in the samples were reduced by boiling it with diluted HCl. To this digested mixture was added EDTA solution and the pH was adjusted with ammonia using Cresol red as indicator. The Se in the sample was complexed with 2,3-diaminonaphthalene (DAN) to give a fluorescent compound. The fluorescent compound was extracted with cyclohexane and read on a spectrofluorometer at excitation and emission wave lengths of 378 and 518 nm, respectively. The selenium content of the National Institute of Standards and Technology reference materials 1577 A (bovine liver) gave 0.698 μg of Se/g, 1566 (oyster tissue) gave 2.06 μg of Se/g, and IAEA H9 (human diet) gave 0.117 μg of Se/g, while the certified values of the samples are 0.71, 2.1, and 0.11 μg of Se/g, respectively.

The selenium content of different foodstuffs are given as mean, standard deviation, and relative standard deviation as well as median values. The values were compared by Mann−Whitney−Wilcoxon Rank test for varietal differences and locational difference.

RESULTS AND DISCUSSION

Cereals. The results of the selenium present given in Table 2 show that rice (83 ng of Se/g) is relatively low in selenium when compared to other cereals. The selenium content of rice is comparable with British foods reported by Thorn et al. (1978). The Se content of rice in Greek foods is also lowest compared to other cereals (Bratakos et al., 1987). The selenium content in rice may be low because it is cultivated in standing water conditions, which may reduce the availability of selenium from soil to the plant (Ullrey, 1981). The selenium content of wheat (173 ng of Se/g), jowar (213 ng of Se/g), and bajra (179 ng of Se/g) show that they are good sources of this nutrient in the diet.

Pulses. The selenium content of green gram (98 ng of Se/g) is low when compared to other foodstuffs analyzed in this food group (Table 2). Redgram dhal (203 ng of Se/g) has the highest selenium content among the legumes analyzed. This legume is preferred in the diets of a segment of the population in this region. The

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Table 1. Cereals, Pulses, and Spices Analyzed from the Twin City Markets

foodstuffs	botanical name	foodstuffs	botanical name
		Cereals	
rice	*Oryza sativa*	wheat	*Triticum aestivum*
sorghum	*Sorghum vulgare*	bajra	*Pennisetum typhoideum*
		Pulses	
redgram dhal	*Cajanus cajan*	bengalgram dhal	*Cier arietinum*
green gram dhal	*Phaseolus aureus* Roxb	black gram dhal	*Phaseolus mungo*
lentil	*Lens esculenta*		
		Spices	
turmeric	*Curcuma longa* L	coriander seed	*Coriandrum sativum*
mustard seed	*Brassica nigra*	fenugreek seed	*Trignella foenum-graecum*
red chili powder	*Capsicum annuum*	pepper	*Piper nigrum*
cumin	*Cuminum cyminum*		

Table 2. Selenium Content of Cereals, Pulses, and Spices from Market Samples from Hyderabad, Andhra Pradesh, India

foodstuffs	Se content (ng/g) mean ± SD	RSD	median	range
	Cereals			
rice *Oryza sativa*	99 ± 43 (6)	44	83	58−176
wheat *Triticum aestivum*	170 ± 69 (5)	41	173	62−263
sorghum *Sorghum vulgare*	189 ± 69 (4)	36	213	91−287
bajra *Pennisetum typhoideum*	127 ± 78 (4)	61	179	146−391
	Pulses			
redgram dhal *Cajanus cajan*	225 ± 82 (5)	36	203	131−376
bengalgram dhal *Cier arietinum*	161 ± 58 (5)	36	180	94−235
greengram dhal *Phaseolus aureus* Roxb	95 ± 41 (5)	43	98	28−150
blackgram dhal *Phaseolus mungo*	164 ± 84 (5)	51	119	68−265
lentil *Lens esculenta*	208 ± 88 (5)	42	179	146−391
	Spices			
turmeric *Curcuma domestica*	45 ± 12 (4)	27	49	26−62
coriander seed *Coriandrum sativum*	132 ± 12 (3)	9	136	117−145
mustard seed *Brassica nigra*	201 ± 152 (3)	76	128	92−423
fenugreek seed *Trignella foenum-graecum*	63 ± 16 (3)	25	59	50−86
red chili powder *Capsicum annuum*	79 ± 6 (3)	7	81	57−98
pepper *Piper nigrum*	17 ± 17 (3)	100	4	2−35
cumin *Cuminum cyminum*	120 ± 130 (3)	108	52	21−286

[a] Figures in parentheses indicate the number of samples analyzed.

selenium content of lentil (176 ng of Se/g) and bengal gram dhal (180 ng of Se/g) is twice that of the German pulses value of 90 ng of Se/g (Souci et al., 1994) and 2−3 times lower than the Egyptian pulses value of 560−320 ng of Se/g (Askar and Bielig, 1983). Legumes appear to be an important food group that contribute to the selenium content of the diet (Lane et al., 1983). However, in India, the legume production is on the decline (Lal, 1994).

Spices. The selenium content of spices also shows variation as observed in cereals and pulses. The lowest selenium content is observed in black pepper (4 ng of Se/g) while the highest is observed in coriander seeds (136 ng of Se/g). Mustard seed (128 ng of Se/g) is also a good source of selenium. In New Zealand, where the selenium content of foodstuffs is low, mustard seeds have the highest selenium content (Thomson and Robinson, 1990). Mustard plants are known to be selenium accumulators among field crops (Moffat, 1995).

Table 3. Locational Differences in Selenium Content of Different Foodstuffs

foodstuffs	Se content (ng/g) based on location[a] twin cities	Nalgonda	Suryapet
rice	82.8 (6)	22.7[b] (10)	70.5 (3)
sorghum	212.7 (4)	201.5 (4)	
greengram dhal	97.6 (5)	127.0 (5)	

[a] Values given are median values. Figures in parentheses are the number of samples analyzed. [b] $P < 0.05\%$.

Table 4. Locational Differences in Selenium Content of Rice (Bapatla Cultivar)

location	Se content (ng/g)	location	Se content (ng/g)
Nalgonda	22	Bapatla	77
Warangal	54	Kankuntla	166
Suryapet	74		

Table 5. Varietal Difference in Selenium Content of Rice

variety	Se content (ng/g) mean ± SD	RSD	median	range
Sona Masuri	119 ± 45 (3)	38	114	60−176
Hamsa	51 ± 19 (3)	37	60	26−69
Phalguna	42 ± 13 (3)	31	37	30−58
Suwarna	41 ± 25 (3)	61	31	20−72

Locational Differences. The results of analysis of various cereals and pulses show variation in the selenium content. The market samples in the twin cities are procured from adjorning states as well as within the state. The area in which foodstuffs are grown may be one of the source of variation in the selenium content of foodstuffs. Hence the major foods grown in Nalgonda and Suryapet were analyzed for selenium content. Rice is the staple food in these areas and jowar and green gram are the other crops selected on the basis of the area of cultivation. There are significant differences (Table 3) in the selenium content of rice from Nalgonda (23 ng of Se/g) when compared to the twin cities (83 ng of Se/g) and Suryapet (70 ng of Se/g). The selenium content of rice samples from the twin cities and Suryapet were not significantly different from each other by statistical comparisons. The jowar and green gram samples from the twin cities (213 and 98 ng of Se/g) were not significantly different from samples of Nalgonda for these two crops (201 and 127 ng of Se/g). These locational differences were observed in China (Jian-An et al., 1987) and in the USA (Kubato et al., 1967) in different crops.

Table 6. Contribution of Selenium from Food Groups Analyzed

			rice		pulses		condiments	
	total calories (kcal)	total selenium intake (μg/day)	Se[a]	cal[b]	Se	cal	Se	cal
high income	2605	43.5	74.2	43.3	22.1	7.5	3.7	2.2
industrial labor	2194	54.0	88.4	75.8	8.9	4.4	2.7	2.5
slum	1685	41.1	88.6	75.3	9.1	4.5	2.2	2.0

[a] Percentage intake from food groups. [b] Percentage of total calories.

The locational differences observed in rice were further investigated by analyzing the same rice variety from different locations. The results presented in Table 4 show that the selenium content of rice from different areas also shows variation. The lowest level of selenium in this variety is from the Nalgonda (22 ng of Se/g) area. These differences could be attributable to the soil selenium content and the ability of the plant to concentrate selenium. Thus, location, with its variable soil selenium levels, is a source of variation in the selenium content of rice.

Varietal Differences. The different varieties cultivated may also be a source of variation in the selenium content of the foodstuffs. Rice is the major staple food in this region of the country. A few popular rice varieties were collected from local market and analyzed for selenium content. The results in Table 5 show that there are varietal difference in the selenium content. These varietal difference were also observed in other foodstuffs, like soyabean (Wanchoke., 1978) and wheat (Watkinson, 1981). These varietal differences could be attributable to the inherent capacity to accumulate Se and soil types in different geographical regions with varying agronomic practices in the cultivation of crops (Combs, Jr., 1988).

The present paper deals with the Se content of major cereals and pulses consumed in this population. There is variation in the Selenium content of different foodstuffs. The variation in the present investigation in rice could be attributed to the area where the crop was grown and the variety of the crop cultivated. The variation in the selenium content of foodstuffs makes it difficult to compute the dietary intakes of this nutrient in the population. The dietary intakes have to be calculated on the basis of the food obtained in a particular region and should only be taken for computation of the dietary intakes of this nutrient in that population. The staple food in this area is rice and most of the pulses analyzed are consumed by the population. Hence for calculating the dietary intakes of Se, a weighted average of pulses/spices and condiments analyzed was computed. The computed average was 171 and 92 ng of Se/g in pulses and spices, respectively. The probable dietary intake of Se from the food analyzed, based on the National Nutrition Monitoring Bureau Survey (1984 and 1994), for Hyderabad and for different income groups are as follows: high income group population, 43.5 μg/day; industrial laborer population, 54.0 μg/day, and urban slum population, 41.1 μg/day. The calorie and selenium levels of these food groups consumed by these three population groups are given in Table 6. The data on dietary intake for urban slums is from the report from the National Nutrition Monitoring Bureau published in 1994, whereas those for the other groups were published in 1984.

These intakes are 11.5%−32.6% lower when compared to the other parts of the country as reported by Srikumar (1993). The cereals contribute the major portion of selenium in the vegetarian diets in this part of the country. However, the computed intake of selenium in different groups is less than the U.S. RDA, which prescribes 70 μg Se/day for men and 55 μg Se/day for women. Therefore it is important to establish the selenium nutritional status in different groups and the dietary sources of selenium in order to find its requirement in the diet.

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