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DIETARY SELENIUM CONTENT IN SOME EGYPTIAN FOODS

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ABSTRACT

Selenium content of a wide variety of foods representing a cross section of the Egyptian diet was determined by atomic absorption spectrometry in several local samples including vegetables, fruits, grains, seeds, dairy products, egg, chicken, fish, mushroom, baby foods and processed foods. Selenium content of the investigated samples varied between 0.2 to 364 µg/kg. Balady and shami bread, garlic, barely and mushroom were found to contain the highest levels of selenium 364,241,212, 135 and 115 µg/ kg on fresh weight basis , respectively, in which 100g of the fresh material could cover 47.3%, 31.3%, 27.5%, 17.5% and 14.9% of the RDA for adult male. These values suggest that a diet well balanced in other nutrients is probably also nutritionally adequate with regard to selenium.

***Key words :** Egyptian foods ,microelement , RDA, selenium.*

1. INTRODUCTION

Selenium (Se) at present, is the object of numerous studies because of its dual nature as a toxic element and also its essentiality to the human organism (Bratter *et al.,* 1984) . The biological effects of selenium in both humans and animals were initially considered only with regard to its toxicity, which appears when the intake of the element is higher than the organism's capacity to eliminate it. Acute intoxication of selenium is observed on the central nerve system, and chronic intoxication has been shown to cause fetotoxicity and teratogenicity in humans (Haanpaa,1990). On the other hand, selenium intake, as an essential ingredient in the daily diet, is of great interest and varied widely among various populations throughout the world (Bunker *et al.,* 1988 and Levander, 1991). Epidemiological studies carried out in several countries have shown the possible effects of selenium in the prevention and regression of cancer (Nomura *et al.,* 1987, Thompson and Ronan, 1990). The evidence suggests that high dietary seleniun intake may decrease the risk of stomach cancer , but is as yet insufficient (Zhang *et al.*, 1994). A larger study conducted across 65 distrcts in China observed no correlation between plasma selenium concentrations and liver cancer mortality (Hsing *et al* ., 1991). Selenium is now generally recognized to be a trace mineral of great importance for human health (Haanpaa,1990). It has several different tasks in the body; it is one of the important antioxidants, it prevents blood clots by inhibiting platelet aggregation, it increases the effectiveness of the immune system and strengthens resistance to viral and bacterial infections, it inhibits chromosome damage, mutations and cancer, it counteracts adverse effects of heavy metals and other toxic substances in the body and it protects the heart muscle from diseases. Haanpaa (1990) also reported that the body does not need much selenium per day. The recommended daily allowance (RDA) according to WHO (1990) for selenium is a mere 55 to 70 μg/day for female and male adults respectively, while it is 10 μg/ day for infants (0-6 months) and the RDA for children between 4 to 10 years, is 20 to 30 μg/day for good health. Haanpaa,(1990) reported that exceeding doses of Se more than 200 μg/day can cause skin rashes, hair and nail breakage, fatigue, and stomach upset. Excessively large doses (more than 1000 μg/day) can lead to serious side effects, including liver damage and potentially fatal heart problems.

Although the principle source of selenium for humans is food, the daily intake mainly depends on the origin of the food products, (Ari *et al.,* 1991). However, in most agricultural areas, soils contain so little available selenium that cultivated crops do not absorb more than traces of this element (Banuelos and Meek, 1989).

In Egypt, investigations of the role of diet in the etiology of such deficiencies have been hindered by the lack of reliable data on the mineral content of locally grown and prepared foods in the country. It is now well realized that considerable variability in nutrient composition exists, depending upon the composition of the soils, growth and storage conditions, food processing and preparation practice and the maturity of the food at consumption (Hoover and Pelican, 1984).

The present investigation has been undertaken to obtain a reliable data on selenium content of locally grown and prepared Egyptian foods.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Vegetables [Carrots(*Dacus carota*),cabbage(*Brassica oleracea*),garlic(*Allium sativum*),lettuce (*Lactuca scariola*), potatoes (*Solanum tuberosum*), tomatoes(*Lycopersicum esculeutum*), peas (*Pisum sativum*), Jew's mallow (*Corchorus olitorius*), green beans (*Phaseolus vulgaris*), spinach (*Pinacia oleracea*) and cucumber (*Cucumis sativus*)] and mushroom (*Pleuorotus ostreatus*).

2.1.2. Fruits [Apple(*Malus communis*) ,banana (*Musa pradidiaca*), orange (*Citrus aurantium*) and peach (*Prunus persica*)].

2.1.3. Grains, seeds and cereal products [Barely (*Hordeum vulgare*),wheat flour(*Triticum vulgare* 72% and 82 % extraction),shami and balady bread (wheat 72 % and 82 % extraction, respectively), wheat (*Triticum vulgare* ,blela), freek (*Triticum vulgare*), burghul (*Triticum vulgare*), rice (*Oryza sativa,polished*), faba bean (*Vicia faba*), lupin (*Lupinus termis*),fenugreek (*Trigonella feonum -grarcum*), peanut (*Arachis hypogaea*), lentil (*Lens culinaris*), soybean (*Glycine max*) and anise (*Pimpinella anisum*)].

2.1.4. Dairy products and egg[Yogurt, cheese(Domiati) and egg (chicken)].

2.1.5. Chicken and fish : Chicken (breast and liver) and fish [Nile perch (*Lates nilolticus*)].

2.1.6. Baby and processed foods [Cerelac (wheat), corn flakes imported from Germany, chipsy with salt (potatoes), Nido (instant dry milk packed in Egypt by Nestle Co.), Nutriben (instant baby cereal mixture of corn, rice and soybean, imported from Spain) and biscuit (BiscoMisr Co.)].

* Ten samples of each material were collected from different locations. All samples were obtained from local market in Cairo Governorate .

2.2.Methods

2.2.1. Moisture content was determined according to A.O.A.C.(1990).

2.2.2. Determination of selenium: Samples were thoroughly washed or peeled, dried under controlled temperature(T=60°C), depending on their humidity, and then ground manually to a fine powder in a mortar. Three subsamples of the edible portions of each sample were taken for analysis. Selenium was determined according to the method of Diaz-Alarcón *et al.*,(1994)as follows:

2.2.2.1. Apparatus: An atomic absorption spectrophotometer (Perkin – Elmer 4100 ZL) was used, with a hydride generator (Perkin Elmer MHS-10) and an 11-mA Hallow cathode lamp, at a slit width of 2.0 nm.

2.2.2.2. Reagents:All solutions were prepared with ultra pure water obtained by filtering double-distilled water immediately before use. The standard solution of selenium (Merck analytical grade) was used at a concentration of 100 ng sodium selenate /ml distilled water, HNO_3 (65%), HCl (37%) and $HClO_4$ (65 %) were also used.

2.2.2.3. Procedure:Amounts of 300 mg of the dried homogenized samples were treated with 5.0 ml concentrated HNO_3 and heated at 80°C for 1h Another 5.0 ml of a 4:1 mixture of

HNO_3 and $HCLO_4$ were added and heating continued for an additional 3 h until the sample was completely mineralized. For reduction of Se^{6+} to Se^{4+}, 2 ml of concentrated Hcl were added to the mineralized sample and continue heating at 100°C for 10 min in a thermostated bath.After cooling, the solution was diluted to a 15 ml with a 1.9 % Hcl solution. An aliquot of the produced solution was used for determination of selenium.

3. RESULTS AND DISCUSSION

The contents of selenium in different types of vegetables and fruits are shown in Table (1). From the results, it could be concluded that selenium contents of vegetables ranged from 9.5 µg/ kg in spinach to 212 µg/ kg in garlic while fruits contained 0.7 µg/ kg in apple to 29 µg/ kg in peach . Results showed that garlic contained the highest level of selenium (212 µg/ kg) followed by mushroom (115 µg/ kg), meanwhile all other samples contained less than 50 µg/ kg. Diaz-Alarcon *et al.*, (1994) found that selenium is undetectable in grape, pear , plum and apple and in a minor concentration of 29.65 ng/g in cultivated mushroom . Results also showed that roots (carrots, .41.9 µg/ kg) and leaves [lettuce (36.9 µg/ kg), Jew's mallow (30.2 µg/ kg), cabbage (23 µg/ kg)] vegetables contained moderate quantities of selenium, while spinach, contained the minimal level of selenium (9.5 µg/ kg) on fresh weight basis. On the other hand, since vegetables are very rich in moisture content, when selenium concentration was calculated on a dry weight basis, it was rather high. Selenium concentration in vegetables calculated on dry weight basis was found to be between a minimum of 40.4 µg/ kg in spinach and a maximum of 1177.8 µg/ kg in garlic. Allaway (1969) reported that a poisonous mushroom took up significant amounts of selenium even when grown in soils containing low levels of selenium.

Selenium contents of grain seeds and cereal products are given in Table (2). The results showed that barley was found to contain the highest level of selenium (135 µg/ kg), followed by anise (74.8 µg/ kg). Rice, faba bean, peanut , lentil, wheat flour (72% and 82% extraction) were found to contain moderate levels of selenium. On the other hand, fenugreek, lupin, freek, burghul and wheat (blela) had low contents of selenium; 17.5, 12, 11.1, 9.6 and 2.4 μg/ kg, respectively. Although selenium content of wheat was moderate, the bread (which was processed from wheat) had higher contents of selenium. This may be due to the other ingredients (salt, yeast , water and food additives) that could have additional quantities of selenium. These results are in agreement with those reported by Eurola *et al.*, (1990). Since, moisture content in cereals is rather low, selenium in these groups of food, when calculated on dry weight basis, did not differ greatly than selenium content in the same group when calculated on fresh weight basis. In this group, results showed that selenium content ranged between 2.7 μg/ kg in wheat(belela) and 155.2 μg/ kg in barley on dry weight basis .

Table (1): Selenium content of vegetables, mushroom and fruits.

Material	Moisture (%)	Selenium content (μg/ kg)*		%RDA**
		On fresh weight basis	On dry weight basis	
Vegetables:				
Carrots	87.80	41.9 ± 8.840	343.4 ± 72.474	5.4
Cabbage	85.8	23.0 ± 2.273	162 ± 16.015	3.0
Garlic	82.0	212 ± 7.789	1177.8 ± 43.269	27.5
Lettuce	92.5	36.9 ± 3.922	492.0 ± 52.290	4.8
Potatoes	80.62	ND***	--	-
Tomatoes	92.16	13.0 ± 2.447	165.8± 31.267	1.7
Peas	72.3	15.1 ± 4.010	54.5± 14.480	2.0
Jew`s mallow	85.0	30.2 ± 3.627	201.3 ± 24.170	3.9
Spinach	76.5	9.5 ± 1.614	40.4± 8.183	1.2
Cucumber	95.46	ND***	--	--
Green beans	7.8	26.5 ± 4.056	120.5 ± 4.406	3.4
Mushroom	85.1	115 ± 5.872	771.8 ± 39.402	14.9
Fruits				
Apple	86.95	0.7 ± 0.081	5.4 ± 0.621	0.1
Banana (peeled)	87.0	11.0 ± 1.756	84.6 ± 13.489	1.4
Orange peeled)	84.8	15.0 ± 3.085	98.7± 20.296	1.9
Peach	89.63	29 ± 4.903	279.7 ± 47.274	3.8

n ± SD values of ten samples

RDA covered by 100 g fresh sample = $\frac{\text{Selenium content } (\mu g/\ kg)\ *\ 100}{10 *\ \text{RDA for selenium (for adult male)}}$

ʾ : not detectable

There was also variations in the selenium content of the dairy products and egg samples under investigation (Table 3). The highest value of selenium content was in cheese (56.0 µg/ kg) and the lowest value was found in eggs (15.3 µg/ kg). On the other hand , since dairy products and eggs are very rich in moisture content , when selenium concentration was calculated on a dry weight basis, it was rather high. Selenium concentrations in yogurt, cheese and eggs, when calculated on dry weight basis, were 162.4 , 206.6 and 46.4 µg/ kg , respectively. Environmental factors, which have been reviewed extensively (Rosenfeld and Beath, 1964) may cause the differences in selenium concentrations in foods from different geographical areas to vary widely. Also, they reported that the most important factor is the selenium content in the soil. Allaway and Cary, (1966) and Hadjimarkos (1965) found that the difference between two samples of eggs and milk from two different areas to be ten fold. However, other factors could influence the amount of selenium in milk powder.

Table (2): Selenium content of grains, seeds and cereal products.

Material	Moisture (%)	Selenium content (µg/ kg)*		% RDA**
		On fresh weight basis	On dry weight basis	
Barley	13.0	135.0 ± 4.082	155.2 ± 4.719	17.5
Bread: shami.	30	241.0 ± 7.239	344.3 ± 9.843	31.3
Balady.	39	364 ± 11.275	596.7 ± 14.945	47.3
Wheat flour: 72 %	12.98	32.3 ± 2.152	37.1 ± 2.465	4.20
82 %	7.07	24.7 ± 1.651	26.4 ± 1.633	3.20
Wheat (Blela)	12.04	2.4 ± 0.235	2.7 ± 0.261	0.30
Freek	10.26	11.1 ± 0.983	12.4 ± 1.116	1.40
Burghul	12.21	9.6 ± 1.305	10.9 ± 1.478	1.20
Rice (Polished)	12.68	43.5 ± 2.471	49.8 ± 2.834	5.60
Faba bean	11.86	34.5 ± 1.570	39.2 ± 1.793	4.50
Lupin	6.5	12.0 ± 1.404	12.8 ± 1.513	1.60
Fenugreek	13.25	17.5 ± 1.055	20.2 ± 1.186	2.30
Peanut	11.0	34.2 ± 1.147	38.4 ± 1.290	4.40
Lentil	7.9	32.5 ± 2.725	35.3 ± 2.966	4.20
Anise	10.49	74.8 ± 1.333	83.6 ± 1.480	9.70
Soy bean	8.4	47.1 ± 1.076	51.4 ± 1.190	6.10

*Mean ± SD values of ten samples

** % RDA covered by 100 g fresh sample = $\dfrac{\text{Selenium content } (\mu g/\text{ kg}) * 100}{10 * \text{ RDA for selenium (for adult male)}}$

Table (3): Selenium content of some dairy products and eggs.

Material	Moisture (%)	Selenium content (µg/ kg)*		% RDA**
		On fresh weight basis	On dry weight basis	
Yogurt	80.11	32.3 ± 2.599	162.4 ± 13.080	4.2
Cheese	72.7	56.0 ± 4.262	206.6 ± 17.813	7.3
Egg (Boiled)	67.01	15.3 ± 2.888	46.4 ± 8.775	2.0

*Mean ± SD values of ten samples

** % RDA covered by 100 g fresh sample = $\frac{\text{Selenium content (µg/ kg) *}}{\text{10 * RDA for selenium (for adult male)}}$

Results in Table (4) indicated that chicken and fish were found to be very good sources of selenium. The average values for chicken and fish were (20.1 and 20.9 µg/ kg , respectively). Chicken breast (17.2 µg /kg) has lower selenium content than chicken liver (22.9 µg/kg). Meanwhile, selenium content of fish was (20.9 µg/ kg). On the other hand, selenium concentrations in chicken(breast and liver) and fish when calculated on dry weight basis were 66.1 , 95.2 and 114.4 µg/ kg , respectively .

Table (4): Selenium contents of chicken and fish.

Material	Moisture (%)	Selenium content (µg/ kg)*		% RDA**
		On fresh weight basis	On dry weight basis	
Chicken :				
Breast	73.98	17.2 ± 3.185	66.1 ± 12.257	2.2
Liver	75.95	22.9 ± 1.937	95.2 ± 8.051	3.0
Fish	81.74	20.9 ± 1.161	114.4 ± 6.356	2.7

*Mean ± SD values of ten samples

** % RDA covered by 100 g fresh sample = $\frac{\text{Selenium content (µg/ kg) * 100}}{\text{10 * RDA for selenium (for adult male)}}$

A few commercial baby foods were investigated to obtain some indication of the effects of processing on selenium content (Table 5).

Selenium contents varied between the different sources of baby foods collected from the market. The lowest value for selenium content was (0.2 µg/ kg) for Nutriben and the highest content was (52.4 µg/ kg) for corn flakes. since, moisture content in baby and processed foods are rather low, selenium in these groups of food when calculated on dry weight basis, did not differ, greatly than selenium content in the same group when calculated on fresh weight basis. In this group results showed that selenium content ranged between 0.21µg/ kg in Nutriben and 55.6 µg/ kg in corn flakes on dry weight basis .

Table (5): Selenium contents of baby and processed foods

Product	Moisture (%)	Selenium content (µg/ kg)*		% RDA**
		On fresh weight basis	On dry weight basis	
Cerelac (wheat)	2.2	11.1 ± 1.178	11.3 ± 1.222	1.4
Corn Flakes	5.74	52.4 ± 0.264	55.6 ± 0.289	6.8
Chipsy	3.08	1.61 ± 0.350	1.7 ± 0.368	0.2
Nido	3.0	32.3 ± 1.146	33.3 ± 1.147	4.2
Nutriben	6.90	0.2 ± 0.014	0.21 ± 0.019	0.03
Biscuit	4.29	14.6 ± 0.603	15.3 ± 0.651	1.9

*Mean ± SD values of ten samples

** % RDA covered by 100 g fresh sample $= \frac{\text{Selenium content (µg/ kg) * 100}}{\text{10 * RDA for selenium (for adult male)}}$

Baby and processed foods (cereals and vegetable) had also lower selenium content than the fresh samples analyzed. Finally , it must be recognized that many selenium compounds are quite volatile and could thus be lost as a result of food cooking or processing. Higgs *et al.*, (1972) found that dry heating of cereals led to 7 to 23% losses of selenium and boiling mushroom led to 44% losses . Also , from the results in Tables (1-5), one may conclude that balady and shami bread , garlic , barley and mushroom were found to be the richest material samples that covered 47.3 , 31.3, 27.5, 17.5 and 14.9 % of the RDA for selenium from 100g fresh material , respectively .

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محتوى السينينيوم فى بعض الأغذية المصرية

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ملخص

تـم تقديـر محتوى السيلينيوم في أصناف عديدة من الأطعمة تشمل عدة مجموعـات مـن الأغذيـة المصرية المحلية مثل بعض أنواع من الخضراوات والفواكـه و الحـبوب و الـبذور و منتجات اللبن و البيض و الدواجن و السمك و المشـروم و بعـض أغذيـة الأطفال وبعض الأغذية المصنعة. تراوح محتوى الأغذيـة محل الدراسة من السيلينيوم من ٠,٢ إلى ٣٦٤ ميكروجرام / كجم. وقد دلـت النـتائج على أن الخبز البلدى و الشامي والثوم و الشعير و المشروم كانت أكـبر العيـنات تحت الدراسة احتواءاً للسيلينيوم. و محتوى السيلينيوم للعينات السـابقة على التوالى هو ٣٦٤ ، ٢٤١ ، ٢١٢ ، ١٣٥ ، ١١٥ ميكرو جرام / كجم عينة على أساس الوزن الرطب حيث ان كل ١٠٠ جرام من الوزن الطازج من هذه العينات يغطى ٤٧,٣% ، ٣١,٣% ، ٢٧,٥% ، ١٧,٥% و ١٤,٩% من الاحتياجات اليومية للشخص البالغ.

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