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SELENIUM CONTENT IN FOOD & DRINKING WATER IN EGYPT AND THE DIETARY INTAKE

El-Awamry, Zeinab K.; T.M. Omer and Akila S. Hamza
Central Lab. For Food and Feed (CLFF), Agricultural Research Center, Giza, Egypt.

ABSTRACT

The present work is planned to estimate the daily total dietary intake of Selenium by the Egyptian citizen in diet and drinking water. This data was compared with the international recommended acceptable limit. The daily intake of Selenium from diet was estimated using food groups according to Food Balance Sheet,2002. The method involves the purchase and preparation of the cooked foodstuffs and fresh food commonly used in the diet. However, it does not include food consumed outside the home. Thirty samples, used in the house were collected monthly from 3 governorates (Cairo, Giza and Kalioubia) during the year 2003.The Selenium concentration was measured in each food group.The daily intake of Selenium from diet was 92.06 µg/person/day. Drinking water samples were collected from ten governorates in Egypt. The Selenium content in tap water (the origin is River Nile) ranged from 0.008 – 0.015 µg/L with an average of 0.0122 µg/L. The amount of drinking water consumed by the Egyptian citizen was 3288 ml/day for adult and the Selenium intake from drinking water was 0.04 µg/day.

By comparing the results of the total Selenium intake from diet and drinking water in Egypt with the study presented by Food and Nutrition Board (1989), it was found that the Selenium intake by the Egyptian citizen was 92.1µg/person/day falls within the recommended daily intake set by Food and Nutrition Board (1989) 50-200 µg / person/day represting a safe and adequate range for healthy adults.

INTRODUCTION

Selenium(Se) is an essential trace element that is a component of several enzyme systems. Selenium(Se) is an integral component of glutathione peroxidase, an enzyme that catalyzes the breakdown of hydroperoxides. Vitamin E and Selenium function cooperatively in protecting biologic membranes from oxidative damage. Selenium is found in all human tissues at an average concentrations of about 20 µg / 100g. The liver and kidney contain particularly high amounts. Selenium is an essential component of a family of four enzymes, the glutathione peroxidases .They catalyze reduction and deactivation of free radicals and other potential oxidants using glutathione as the electron donor. They are present in the blood, extracellular fluid, and inside cells and play a central role in the body's antioxidant defense system. Selenium plays an important role in the immune system, It may help regulate production of immunoglobulins (IgG) and tumor necrosis factor (TNF) and may enhance activity of certain white blood cells, the natural killer (NK) cells. Selenium appears to improve the functioning of the immune system and its response to infections (Kiremidjian and Stotzky, 1987).

Selenium is now generally recognized to be a trace element of great importance for human health. It is one of the most important antioxidants which protect the cells from the harmful effects of rancidification. Selenium counteracts cancer and chromosome damage as well as increasing our resistance to viral and bacterial infections (Clarck and Combs, 1986).The

physiological role of Selenium was first appreciated following the demonstration that the element is an essential component of a number of enzymes (Stadtman, 1980). Selenium is found in the active site of many enzymes, such as thioredoxin reductase, which catalyzes some oxidation-reduction systems. The reaction help to protect the body against cancer (Salonen, 1986). An enzyme, glutathione peroxidase requires Se and vitamin E for its formation. This enzyme helps to inhibit the process of oxidation in the body which can be injurious to cells (Robinson *et al.,* 1979). Since, Selenium is a micronutrient element needed in very small quantities, Levander (1976) determined the Selenium content of human diets and found it vary from 30 to 1000 µg/ day. In general, Selenium content of food is influenced by several factors especially soil Selenium content, soil types, climatic conditions, types of food, origin of foods, food processing and treatment (Ciappellano *et al.,* 1990). However, Selenium is generally associated with the protein fraction of the food and thus, foods with a low concentration of protein, frequently have low concentration of Selenium (Persson *et al.,* 1995). Good food sources of Selenium include meats, fish and shellfish, whole grains, cereals, dairy products and vegetables such as broccoli, mushrooms, cabbage and celery. Cappon (1981) found that food processing techniques can remove Selenium. Estimation of adult exposure to Selenium via dietary intake vary over an extremely scale in different parts of the world, however, intakes fall within the range of 20 – 300 µg / day (Diplock, 1987).

The United States Food and Nutrition Board (1989) had concluded that for healthy adults, the daily intake of Selenium is 50 to 200 µg/day representing a safe and adequate intake range. Low Selenium intake leads to reproductive impairment, growth depression, mental retardation, weakened immune system, cancer mortality, heart disease, susceptibility to viral infection and hypothyoroidism. (Xia *et al.,* 1994).

Selenium is among the elements known to be absorbed by food and forage plants in excessive amount to create toxicity hazards selenosis results from exposure to large doses of Selenium over a longer period. Human Selenium poisoning from consumption of toxic foods containing high levels of Selenium was reported in china where individuals ingested an average of 4.99 mg Selenium per day (Yang *et al.,* 1983).Several symptomes appear as a result of Selenium poisoning, hair loss, gastro intestinal upsets, white blotchy nails, fatigue, skin eruption, irritability and dental caries. Poisoning is most often associated with consumption of diet containing more than 1000 µg/day (Mc Dowell *et al.,* 1984,) maximum tolerable levels for livestock species have been estimated. Signs of toxicity have been seen in some animal species when 5000 µg/L Se were fed. However, 2000µg/L Selenium has produced no unequivocally toxic signs, and this dietary concentration is suggested as a maximum tolerable level for all species (NRC,1980). The American institute of medicine of the National Academy of Science (2000) has set a tolerable intake level at 400 µg/day.

The present work is planned to estimate the Selenium intake from diet and drinking water in Egypt and comparing this intake with the recommended dietary.

MATERIAL AND METHODS

I- Sampling

I-a. Diet

Twelve food stuffs groups shown in (Table1) were purchased from 3 governorates (Cairo, Giza and Kalioubia), thirty samples were prepared using all types of cooking in the house and were collected monthly during the year 2003 as follows:-

1-Bread and cereals
Wheat bread, wheat bread + maize, maize bread + foenugreek, seed wheat, wheat flour, maize flour and macaroni.
2-Cooked Poultry
3-Cooked meat and meat products
Meat of cows and buffaloes
4-Cooked fish
5-Oils, fat, eggs and dairy products
Maize oil, sunflower oil, olive oil, cotton oil, natural fat, egg, yoghurt, white cheese, chedder, leicester and edam cheese.
6-Sugars
Sugar, honey, molasses, jam and halawa
7-Fresh and cooked vegetables
7-a.Fresh vegetables
Tomato, cucumber, lettuce, peppers, parsely, carrots, onion, water cress and raddish.
7-b.Cooked vegetables
Green bean, squash, spinach, cauliflower, cabbage, kolcasia, molokia, okra, pisum and mushroom.
8-Boiled Potatoes
9-Canned vegetables
Okra, molokia, string bean, pisum.
10- Fresh fruit and fruit products
10-a - Fresh fruits
Oranges, apples, pears, grapes, lemon, banana, mango, date, gawava, apricot, plums, fig and pineapple.
10-b- Fruit products (canned fruit)
11- Bevarages
Beverage, tea, coffee, anise, foenugreek, karkadeh.
12- Milk
Buffaloes milk, cows milk, dried milk and skim milk.

1-b. Drinking water (tap water)

Samples of drinking water (the main source is the River Nile) were taken after allowing the water to flow for five minutes. One liter was taken in a plastic container previously washed with distilled water, dried in air and washed with the water of the samples. Four samples were collected monthly for the year 2003 starting from January till December. The total number of samples is 120 samples.

Table (1): Study of food intake for the Egyptian citizen*.

Food group	Average per caput supply (kg / person / day)
Bread and cereals	0.738
Cooked poultry	0.0337
Cooked meat and meat products	0.0342
Cooked fish	0.0342
Oils, fats, eggs and dairy products	0.0940
Sugars	0.1013
Fresh and cooked Vegetables	0.3526
Boiled potatoes	0.0494
Canned vegetables	0.003
Fresh fruit and fruit products	0.2723
Beverage (non alcoholic)	0.0100
Milk	0.2126

***Food Balance Sheet 2002.**

II- Measurement of dietary intake of food

The estimation of the dietary intake of Selenium depends on Egyptian Food Balance Sheet (2002). Showing per caput supply while the concentration of Selenium depends on analysis of different food items. As some items are consumed after cooking, samples of poultry, red meat, fish, eggs, vegetables and potatoes were cooked in the laboratory and samples of cooked food were analysed. However, figures does not include food consumed outside the home nor alcoholic, beverage. These foodstuffs were combined into 12 food groups, the proportion of each food in each group reflecting the amount of that food in the average diet.

III-a. Study of Selenium intake from food for the Egyptian citizen

The average consumption of the Egyptian citizen (Kg / person / day) was calculated for the different foodstuff groups according to Food Balance sheet,(2002).

Table (2): Total diet study on Selenium intake**

Food group	Average consumption (kg/person/ day)	Selenium level µg/kg		Selenium intake µg/person/ day
		Mean	Range	
Bread and cereals	0.24	70	60-80	16.8
Cooked poultry	0.059	69	59-79	4.071
Cooked meat and meat products	0.048	120	110-130	5.76
Cooked fish	0.017	110	100-120	1.87
Oils, fats, eggs and dairy products	0.12	60	50-70	7.2
Sugars	0.090	2	1-3	0.18
Fresh and cooked vegetables	0.050	80	70-90	4.0
Boiled potatoes	0.16	7	6-8	1.12
Canned vegetables	0.042	71	61-81	2.982
Fresh fruit and fruit products	0.091	40	30-50	3.64
Beverage (non alcoholic	0.66	1	0.5-1.5	0.66
Milk	0.34	25	15-35	8.5
Total intake				**56.783**

****Food and Nutrition Board, 1989.**

IV. Determination of Selenium

Selenium levels in different foodstuff items and in drinking water was determined according to the method described in AOAC (1996) using Atomic Absorption Spectrophotometer (perkin – elmer model 4100 ZL).

RESULTS AND DISCUSSION

I. Selenium level in different food groups

1. Bread and Cereals

Selenium level in the combined "bread and cereals" food group was found to be 80 µg/kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 59.1 µg / person / day . While, Selenium level was 70 µg/kg and the total intake was 16.8 µg / person / day according to Food and Nutrition Board (1989). Comparing the results of the total intake in Egypt with the study presented by Food and Nutrition Board 1989, it was found that the Egyptian intake exceed the intake of food and nutrition board due to the increased average consumption from this group.

2. Cooked poultry

Selenium level in the cooked poultry group was found to be 38 µg /kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 1.28 µg / person /day. While, Selenium level was 69 µg / kg and the total intake was 4.071µg /person/day according to Food and Nutrition Board (1989). By comparison, the total Selenium intake in Egypt is less than that presented by Food and Nutrition Board (1989) due to the decreased average consumption from this group.

3.Cooked meat and meat products

Selenium level in this group was found to be 80 µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 2.736 µg / person/day. While, Selenium level was 120 µg /kg and the total intake was 5.76 µg / person / day according to Food and Nutrition Board (1989). By comparison, the total intake in Egypt is lower than the total intake presented by the study of food and nutrition board 1989.

4. Cooked fish

Selenium level in the cooked fish group was 52 µg /kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Ssheet in 2002 was 1.77 µg / person /day. While, Selenium level was 110 µg / kg and the total intake was 1.87 µg / person /day according to Food and Nutrition Board (1989). By comparison, the Egyptian intake is lower than the intake presented by Food and Nutrition Board (1989) due to the increased average consumption from this group.

5. Oil, fats, eggs and dairy products

Selenium level in this group was 47 µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person

using per caput supply of Egyptian Food Balance Sheet in 2002 was 4.418 µg / person /day. While, Selenium level was 60 µg / kg and the total intake was 7.2 µg / person /day according to Food and Nutrition Board (1989). By comparison, the Egyptian intake is low due to the decreased average consumption from this group and also due the low Selenium level of the products.

6. Sugars

Selenium level in this group was 3µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 0.303 µg / person /day. While, Selenium level was 2 µg / kg and the total intake was 0.18 µg / person /day according to Food and Nutrition Board (1989). By comparison, the total Selenium intake by the Egyptian citizen is higher than that of Food and Nutrition Board (1989) due to the increased average consumption from this group.

7.Fresh and cooked vegetables

Selenium level in this group was 53µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 18.68 µg / person /day. While, Selenium level was 80 µg / kg and the total Selenium intake was 4 µg / person /day according to Food and Nutrition Board (1989).

8.Boiled potatoes

Selenium level in this group was 4.375µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 0.215 µg / person /day. While, Selenium level was 7 µg / kg and the total Selenium intake was 1.12 µg / person /day according to Food and Nutrition Board (1989). By comparison, the Egyptian intake is higher than that of Food and Nutrition Board (1989).

9.Canned vegetables

Selenium level in this group was 5.375 µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 0.016 µg / person /day. While, Selenium level was 71 µg / kg and the total Selenium intake was 2.982 µg / person /day according to Food and Nutrition Board (1989). By comparison, the Egyptian total intake in this group is lower than that of Food and Nutrition Board (1989) due to the decreased average consumption from this.

10. Fresh fruit and fruit products

Selenium level in this group was 2.9 µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 0.789 µg / person /day. While, Selenium level was 40 µg / kg and the total Selenium intake was 3.64 µg / person /day according to Food and Nutrition Board (1989). By comparison, the total intake in Egypt is less than the total Selenium intake found by the study of Food and Nutrition Board (1989).

11.

12. Beverage (non alcoholic)

Selenium level in this group was 0.01 µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 0.0001 µg / person /day. While, Selenium level was 1 µg / kg and the total Selenium intake was 0.66 µg / person /day according to Food and Nutrition Board (1989). By comparison, the total intake in Egypt is lower than the intake described by Food and Nutrition Board (1989) due to the decreased average consumption from this group.

Table (3): Estimated total dietary intake of Selenium (µg / person/day) in Egypt 2003

Food group*	Average consumption*	Selenium level	Selenium intake**
	kg/person/day)	µg/kg	µg/person/ day
Bread and cereals	0.7383	80	59.1
Cooked poultry	0.0337	38	1.28
Cooked meat and meat products	0.0342	80	2.736
Cooked fish	0.0342	52	1.77
Oils, fats,eggs and dairy products	0.0940	47	4.418
Sugars	0.1013	3	0.303
Fresh and cooked vegetables	0. 3526	53	18.68
Boiled potatoes	0.0493	4.375	0.215
Canned vegetables	0.0030	5.375	0.016
Fresh fruit and fruit products	0.2723	2.9	0.7896
Beverage (non alcoholic)	0.0100	0.01	0.0001
Milk	0.2121	13	2.757
Total intake			92.06

* Food Balance Sheet, 2002.

**Selenium intake (µg / person /day) = Average per caput supply x Selenium concentration (Kg/person/day) (µg/kg)

13. Milk

Selenium level in this group was 13 µg / kg according to laboratory analysis as shown in (Table 3) and calculation of total daily intake per person using per caput supply of Egyptian Food Balance Sheet in 2002 was 2.757 µg / person /day. While, Selenium level was 25 µg / kg and the total intake was 8.5 µg / person /day according to Food and Nutrition Board (1989). It is clear that the total Selenium in Egypt is too much lower than the total Selenium intake presented by Food and Nutrition Board (1989) due to the decreased average consumption from this group.

II.a. Dietary intake of Selenium from diet

By comparing the results of the total Selenium intake in Egypt with the study presented by Food and Nutrition Board 1989, it was found that the average Selenium intake was 92.06 µg /day, whereas, the Selenium intake set by Food and Nutrition Board was 56.783 µg /day. Food and Nutrition Board (1989) has concluded that for healthy adults.The daily intake of Selenium must be 50 – 200 µg / day representing a safe and adequate intake range.

II.b- Selenium level in drinking water

Data obtained from analysis of Selenium concentrations of tap water is recorded in Table (4). It is evident from these data that Selenium concentration of tap water obtained from 10 governorates of Egypt ranging from (0.008 to 0.015) µg /L with a mean of 0.0122 µg/L. The amount of Selenium intake from water is dependent on the Selenium content of water and on the amount of water consumed daily. The intake of Selenium from water was therefore calculated and found 0.04 µg /day.

Table (4): Selenium concentration as µg/l in drinking water all over the year 2003 from 10 governorates of Egypt

Months / Location	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average and Range
Cairo	0.01	0.011	0.016	0.018	0.012	0.014	0.012	0.015	0.016	0.017	0.011	0.012	0.014 0.01-0.018
Giza	0.016	0.016	0.015	0.011	0.009	0.008	0.017	0.015	0.013	0.012	0.011	0.016	0.0125 0.008-0.017
Kaliobia	0.009	0.007	0.008	0.01	0.008	0.008	0.009	0.009	0.01	0.01	0.01	0.11	0.012 0.007-0.01
Fayoum	0.01	0.012	0.014	0.013	0.016	0.011	0.01	0.01	0.012	0.013	0.013	0.014	0.013 0.01-0.016
Menia	0.015	0.017	0.019	0.016	0.011	0.013	0.016	0.018	0.017	0.015	0.014	0.015	0.015 0.011-0.019
Dakahlya	0.01	0.011	0.013	0.016	0.017	0.014	0.016	0.012	0.014	0.013	0.016	0.015	0.0135 0.01-0.017
Alexandria	0.011	0.013	0.014	0.016	0.017	0.018	0.017	0.015	0.016	0.012	0.011	0.01	0.014 0.01-0.018
Ismailia	0.009	0.008	0.008	0.007	0.009	0.009	0.009	0.008	0.007	0.006	0.01	0.009	0.008 0.006-0.01
Suez	0.011	0.009	0.01	0.007	0.008	0.011	0.012	0.011	0.013	0.014	0.009	0.01	0.0105 0.007-0.014
Port – Said	0.009	0.01	0.012	0.009	0.008	0.007	0.011	0.01	0.008	0.009	0.012	0.01	0.095 0.007-0.012

II-c- Total Selenium intake from diet and drinking water

The total Selenium intake from diet and drinking water in Egypt was calculated and was found to be 92.10 µg/day. Food and Nutrition Board (1989), has calculated that daily Selenium intake should be in the range of 50-200 µg / day for a safe life for individuals, so the Egyptian intake (92.1 µg/day) falls within this level representing adequate intake range.

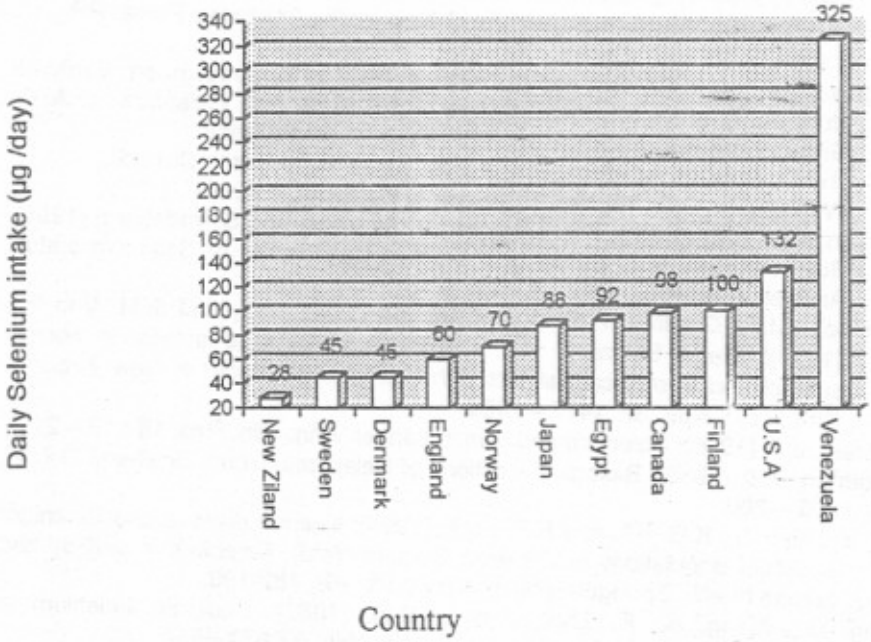
III. International comparison of dietary intake of Selenium

The dietary intake of Selenium in Egypt and various countries (National Academy of Science, 2000) was recorded and represented in Fig(1).

It is necessary to exercise caution in comparing dietary intakes from different countries because of the different methods used to arrive at these estimates. Nevertheless, bearing in mind the different methodologies used, the composition and the weight of the diet, the agricultural and horticultural practices in the various countries.

From Fig (1) Newziland represented the country with the least Selenium daily intake (28µg/day) and consequently it suffers from Selenium deficiency. On the other hand, Venezuela represented the country with an excessive Selenium daily intake after comparison with the recommended

daily intake set by food and Nutrition Board and was designed to be 50 – 200 µg /day. The total Selenium intake from diet and drinking water in Egypt (92.1 µg /person / day) falls within the recommended daily intake represting a safe range for healthy adults.



Fig(1): Human daily Selenium intake in different countries

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محتوى الأغذية ومياه الشرب من السيلنيوم فى مصر وتقدير الأحتياج اليومى

زينب خليل العوامرى – طارق محمد يحيى عمر – عقيلة صالح حمزه

المعمل المركزى للأغذية والأعلاف– مركز البحوث الزراعية – الجيزة – مصر

استهدفت هذه الدراسة تقدير الماخوذ الكلى من السيلنيوم فى اليوم للمواطن المصرى من الغذاء ومياه الشرب فى مصر لمعرفة تأثير هذا المستوى على الصحة العامة ومقارنته بالحد المسموح به عالميا. تم تقدير الإستهلاك اليومى من السيلنيوم فى الغذاء حيث تم شراء وتجهيز الأغذية المطبوخة شائعة الاستخدام وهذه المجموعات لا تحتوى على أغذية مستهلكة من خارج المنزل وقد تم دمج هذه الأغذية فى اثنى عشر مجموعة وكل مجموعة تشمل نوعية متشابهةمن الغذاء وهي كالتالي الخبز والمواد النشوية – الدواجن –اللحوم ومنتجاتها – الاسماك – الزيوت والدهون والبيض ومنتجات الالبان – السكريات – الخضروات – البطاطس – الخضروات المعلبه – الفواكه الطازجه و منتجاتها – المشروبات واخيرا الالبان وقد تم جمع ٣٠ عينه من كل مجموعه من الاثني عشر مجموعه السابقه شهريا والتي تستهلك في المنازل من ثلاث محافظات القاهره ، الجيزه والفليوبيه خلال عام ٢٠٠٣ وقد تم تقدير السيلنيوم في كل مجموعه. وكان الماخوذ الكلي من السيلنيوم للمواطن المصري يوميا من الغذاء ٩٢,٠٦ ميكروجرام /شخص/ يوم. تم تجميع عينات مياه شرب من عشر محافظات من جمهوريه مصر العربيه. كان محتوي مياه الشرب من السيلنيوم (مصدرها نهر النيل) يتراوح ٠,٠٠٨ – ٠,١٥ ميكروجرام /لتر بمتوسط ٠,٠١٢٢ ميكروجرام/ لتر. كميه المياه التي يستهلكها المواطن المصري ٣٢٨٨ مللي / يوم للكبار وبالتالي يكون الماخوذ من السيلنيوم من مياه الشرب ٠,٠٤ ميكروجرام/ يوم .

وبمقارنه نتائج المأخوذ الكلي من السيلنيوم في مصر بما وضعته منظمه Food and Nutrition Board سنه ١٩٨٩ وجد ان المأخوذ الكلى للشخص المصري ٩٢,١ميكروجرام/ شخص /يوم فى حين ان الماخوذ الكلى الأمن من ٥٠ – ٢٠٠ ميكروجرام /شخص/ يوم . وبالتالى يكون المأخوذ اليومىفى مصر يقع فى الحد الأمن.