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# Selenium content in selected Slovenian foodstuffs and estimated daily intakes of selenium

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**Abstract**

Food is the primary source of selenium for man and, since selenium is an essential trace element, the nutritional selenium status is of importance. Data on this topic are currently lacking in Slovenia. In the present study, selenium contents of some selected foods purchased on the Slovenian market were determined and estimation of the daily dietary intake by analysing 20 diet samples collected in four Slovenian Army barracks was made. In determination of the selenium content in selected food, the highest values were found, as expected, in protein-rich food such as fish, meat and eggs (33–686 ng $g^{-1}$), but lower values in milk and dairy products (12–30 ng $g^{-1}$) and vegetables and fruits (0.3–77 ng $g^{-1}$). Analysis of 20 military total daily diet samples, gave an average selenium daily intake of 87 μg.


*Keywords:* Selenium; Dietary intake; Food; HG-AFS

## 1. Introduction

Selenium is an essential element required in small amounts by animals and humans for the basic functions of life. It has several structural and enzymatic roles, of which the best-known are as an antioxidant through the enzyme glutathione peroxidase and as a catalyst for the production of active thyroid hormone. Glutathione peroxidase is believed to be a critical enzyme in the human body that combats oxidative damage at the cellular level. The enzyme in conjunction with vitamin E, catalyses the reduction of hydrogen peroxide and a range of lipid hydroperoxides in order to protect biological membranes from oxidative degradation (Rayman, 2000).

The daily intake of selenium depends on its concentration in food and the amount of food consumed. Selenium uptake by the plant–animal–human food chain is a consequence of the selenium content in soil (Kabata Pendias, 2001). It varies geographically between and within countries and for that reason it is important to determine the selenium content in different foods and to estimate the daily dietary intake of Se in each country.

High protein food represents a rich source of selenium. Eggs and organ meats, such as liver and kidney have the highest capacity for accumulating selenium (Klapec et al., 1998). Entrails and seafood contain 0.4–1.5 mg $kg^{-1}$, muscle meats 0.1–0.4 mg $kg^{-1}$, cereals and grains less than 0.1 to greater than 0.8 mg $kg^{-1}$, dairy products less than 0.1–0.3 mg $kg^{-1}$, and fruits and vegetables less than 0.1 mg $kg^{-1}$ (DRI, 2000).

There are few data about the selenium contents of foodstuffs collected in Slovenia. Stekar and Muck (1971) determined selenium content in cereals and obtained, in wheat, 0.005–0.188, corn, 0.007–0.058, barley, 0.011–0.084 and oats, 0.037–0.171, all in mg $kg^{-1}$. Dermelj, Byrne, Smodiš, and Stegnar (1988) cited selenium contents for some foodstuffs of Slovenian and former Yugoslavian origin. They obtained 0.05–0.15 in milk, 0.14–0.16 in cabbage, 0.02–0.16 in beef, 0.06–1.03 in

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liver, 0.63–2.4 in kidney, 0.35–1.15 in trout, 0.01–0.2 in cereals and 1.8–47 in mushrooms, all in $mg\,kg^{-1}$ dry weight. Pumpkin seeds were found to contain 0.023–0.037 and oil cake 0.034–0.047 $mg\,kg^{-1}$ of selenium (Kreft, Stibilj, & Trkov, 2002).

The recommended dietary allowance (RDA) (DRI, 2000) for selenium is 55 μg/day for adult man and woman. Estimated values for adequate intake determined by the German and Austrian Nutrition Society and Swiss Nutrition Association are 30–70 μg/day for adult men and women (Reference Values for Nutrient Intake, 2002). The tolerable upper intake level for adults is set at 400 μg/day (DRI, 2000). Most EU countries have selenium dietary levels below RDA guidelines. Different recommended procedures for estimation of the dietary intake of selenium are available: Total diet collections of a market basket of food reflecting a defined total diet of the consumer, selective studies of individual foodstuffs, and duplicate portion studies (Matek, Blanuša, & Grgić, 2000). In Slovenia, in the years 1988–1989 (Pokorn, Gregorič, Poklar, & Eržen, 1991) and 1992 (Pokorn, Stibilj, Gregorič, Dermelj, & Štupar, 1998), the elemental composition of daily diet samples from some old people's homes was determined. The average daily selenium contents were found to be 40 and 30 μg in the years 1988–1989 and in the year 1992, respectively. Both studies showed that levels of selenium were below the recommended dietary allowance of that time and the present recommendations (DRI, 2000; RDA, 1989).

The low selenium concentration in many food matrices, losses through volatilisation during sample decomposition and the complex composition of food samples are responsible for the difficulty of selenium determination. The first step in selenium determination is usually sample decomposition to make selenium available for the analytical measurement, or to destroy the organic sample matrix to avoid interferences (Borella et al., 1998). Most often used for sample digestion are reagents with high oxidation potential, such as nitric acid, sulphuric acid and hydrogen peroxide (Tinggi, Reilly, & Patterson, 1992), or $Mg(NO_3)_2$ as an ashing aid (Ylaranta, 1983). Recently, microwave digestion has been frequently used as it is very effective, with a reduced digestion time and good reproducibility (Mena, Gomez, Palacios, & Camara, 1999), but it is quite expensive and the cleaning procedure is time consuming.

The most frequently used analytical techniques for selenium detection are fluorometry and atomic absorption spectrometry, both being hydride generation (HG-AAS) and graphite furnace (GF-AAS) techniques; inductively coupled plasma atomic emission spectrometry (ICP-AES); inductively coupled plasma mass spectrometry (ICP-MS) (Borella et al., 1998) and, rarely, γ spectrometry of induced radionuclide $^{75}Se$ in radiochemical neutron activation analysis (RNAA) owing to its high costs and lengthy procedure (Combs & Combs, 1986). Recently, hydride generation atomic fluorescence spectrometry (HG-AFS) has been more frequently used because of its great sensitivity, few matrix interferences and its relatively inexpensive equipment (Cava-Montesinos, Cervera, Pastor, & de la Guardia, 2003).

The purpose of this study was to determine the total selenium content in selected foods of Slovenian origin using various methods and to assess selenium supply in soldiers by analysis of 20 military daily diet samples by the double basket method.

## 2. Materials and methods

### 2.1. Samples and sample preparation

Foods and food items were purchased from market or obtained from local sources.

Milk and milk products were sampled three times in the year 1997 on the market, produced from the same dairy. For the analysis, pasteurised milk with 3.2% fat, yoghurt with 3.2% fat, cheese with 45% fat dry weight, cream with 33% fat and butter with 83% fat were collected.

Beef was collected from bulls of the Brown and Simmental breeds and was destined for the market. Muscle was sampled 7 times over a period of 16 months in the years 2002 and 2003 and, every time, 1 kg of *M. biceps femoris* and *M. longissimus dorsi* was taken from each of four animals.

Turkey (1 sample) and chicken (3 samples) breasts and thigh of Slovenian origin from different producers were purchased in Slovenian markets in the year 2003.

Fish (anchovy, trout, gilt-head bream, mullet), mussels, eggs (each sample was a composite of 60 eggs) and wheat were sampled in the years 2002 and 2003. All samples were of Slovenian origin, except mussels (imported from Spain), mullet (caught in the open sea) and gilt-head beam (caught off Croatia).

Vegetable samples (bean, cabbage, carrot, chicory, cucumber, lettuce, onion, parsley, pepper, radish, tomato) were collected in 12 individual domestic gardens from two different regions of Slovenia in the autumn 2001.

Total diet samples were collected five times in Slovenian Army barracks from different regions, where more than 100 meals per day were prepared. Soldiers nutrition is prepared in compliance with recommendations (Slovene Ministry of Defence, 1994) that are harmonized with USA standards (Nutrition Standard & Education, 2001). Soldiers consume four daily rations (breakfast, snack, lunch and dinner) and beverages composed of food typical in the Slovene diet. At least twice a day meals were composed of meat or fish and their products (fish paste, liver pâte, meat pie, sausages). The duplicate portion technique was used to collect total

diet samples (including beverages) over a period of two months in the year 2002. Twenty composite total diet samples were sampled five times from four barracks. Each menu was sampled twice in two barracks and each composite total diet sample was sampled in triplicate randomly during the meal. Total diet samples were homogenised with a titanium blender.

All samples were frozen at −24 °C and then lyophilised (Christ, Alpha 1–4) at −50 °C and 0.050 mbar, and then milled in an agate mill (Fritsch, Pulverisette 7) (speed: 6; time: 6 min). The particle size was less than 0.45 mm.

### 2.2. Selenium determination

#### 2.2.1. HG-AAS

Milk and dairy products were analysed by the digestion procedure and hydride generation atomic absorption spectrometry (HG-AAS) detection previously described (Stibilj & Cestnik, 1997). 10 g of $Mg(NO_3)_2$ $6H_2O$ were added to 5 g of fresh sample or 1 g of dry sample with 5 ml $H_2O$ and heated on a sand bath to dryness. After that, the digestion mixture was combusted for 30 min at 530 °C in an oven. The residue was dissolved in 5 ml 6 M HCl and heated for 15 min on the sand bath at 90–100 °C to reduce Se (VI) to Se (IV). After that, the sample was transferred to a 50 ml volumetric flask. The standard addition method was used in all cases. Detection was performed by an HG-AAS system (Perkin–Elmer 1100B), with a spectral slit width of 2.0 nm and absorption wavelength of 196 nm. The acetylene flow rate was 2.5 l min$^{-1}$ and air flow rate 11.5 l min$^{-1}$.

#### 2.2.2. RNAA

The selenium content in fish, meat and eggs was determined by radiochemical neutron activation analysis, as described by Dermelj, Hancman, Gosar, Byrne, and Kosta (1985) and Stibilj, Dermelj, Byrne, and Franko (1996). 250–300 mg of sample were transferred to a plastic ampoule. Neutron irradiation of samples and standards was performed in the TRIGA MARK II reactor at the Jožef Stefan Institute. The time of irradiation was 40 h in the rotary specimen rack at a neutron fluence of $1.5 \times 10^{12}$ n cm$^{-2}$ s$^{-1}$. The RNAA procedure for selenium determination is based on destruction of the irradiated sample using $Mg(NO_3)_2 6H_2O$ (ratio 1:10) with added selenium carrier, reduction to Se(IV) with 6 M HCl, reaction between Se(IV) and 4-nitro-1,2-diaminobenzene, and extraction of the chelate 5-nitro-2,1,3-benzoselendiazole with toluene. Then the organic phase was transferred to a vial for measurement of the γ-spectrum of the induced radionuclide $^{75}$Se. After gamma measurement, the chemical yield was determined spectrophotometrically at 343 nm for each aliquot of the sample.

#### 2.2.3. HG-AFS

The digestion procedure for vegetable samples and HG-AFS detection is described in detail elsewhere (Smrkolj & Stibilj, 2004). About 0.150–0.200 g of sample was weighed in a Teflon tube and mineralisation of the sample performed using a digestion mixture of 0.5 ml $H_2SO_4$ and 1.5 ml $HNO_3$ by heating the closed tube in an aluminium block, kept at 130 °C for 60 min. After cooling, 2 ml of $H_2O_2$ were added and tubes were heated for 10 min at 115 °C. Then 0.1 ml of 40% HF was added and the tubes heated for 10 min at 115 °C, and finally, 2 ml of $H_2O_2$ were added and heated for 10 min at 115 °C. After the solution had cooled to room temperature, 0.1 ml $V_2O_5$ in $H_2SO_4$ was added and the tube reheated at 115 °C for approximately 20 min (until the solution became blue in colour). To reduce $Se^{6+}$ to $Se^{4+}$ in 6 M HCl, an appropriate volume (∼2.5 ml) of concentrated HCl was added to the solution and heated for 10 min at 100 °C. Samples were diluted with MilliQ water.

For mineralisation of other foodstuffs, digestion was carried out in the same way as for vegetable samples, except that, after addition of 0.5 ml $H_2SO_4$ and 1.5 ml $HNO_3$, the digestion was carried out overnight at 80 °C and then for 60 min at 130 °C in a closed Teflon tube in the aluminium block. Further, no HF was added.

Sensitive detection was achieved by hydride generation atomic fluorescence spectrometry (HG-AFS) with the chemical and instrumental operating conditions adapted from Mazej, Falnoga, and Stibilj (2003).

The analysis of each sample was performed at least in duplicate.

## 3. Results and discussion

### 3.1. Methods

The accuracy of selenium determination was checked by analysing standard reference materials (Table 1).

The detection limit for the HG-AAS method was 4 ng Se g$^{-1}$, for RNAA 1 ngg$^{-1}$ and, for HG-AFS 2.5 ng Se g$^{-1}$, all in milk samples (Mazej, Horvat, Barbone, & Stibilj, 2004). Furthermore, the detection limit for HG-AFS method for meat samples was 0.30 ng g$^{-1}$ solution, for vegetable samples and, for total diet samples, 0.15 ng g$^{-1}$ solution. The most appropriate of these three methods for selenium determination in food is HG-AFS. The influence of the matrix was checked by the standard addition method and no interferences were observed. The average selenium recovery was 90% ($n = 7$), the repeatability of the determination of selenium was mostly around 10% and the reproducibility over a period of 8 months for the determination of selenium in SRM trace elements in spinach leaves was 9% (Smrkolj & Stibilj, 2004). The whole procedure, from weighing to measuring, is performed in the same Teflon

Table 1
Determination of selenium content in reference materials by HG-AAS, HG-AFS and RNAA

| | Selenium content (ng g$^{-1}$ dry weight)[a] | | | |
|---|---|---|---|---|
| Methods/Reference material | HG-AAS | RNAA | HG-AFS | Certified value |
| Trace elements in spinach leaves, NIST 1570a | | 98 ± 18 (4) | 115 ± 15 (4) | 117 ± 9 |
| Bovine muscle powder, NIST 8414 | | | 74 ± 11 (5) | 76 ± 10 |
| Typical diet, NIST 1548 | | 229 ± 6 (4) | 232 ± 12 (7) | 245 ± 28 |
| Whole egg powder, NIST 8415 | | 1500 ± 61 (4) | 1313 ± 77 (5) | 1390 ± 170 |
| Corn bran, NIST 8433 | | | 45 ± 8 (5) | 46 ± 8 |
| Skim milk powder, BCR 063R | 131 ± 4 (6) | 109 ± 3 (3) | 117 ± 13 (4) | 129 |
| Wheat flour, NBS 1567a | | 865, 963 (2) | | 1100 ± 200 |

[a] Average ± standard deviation (number of determination).

tube. Furthermore, the HG-AFS method was economic and environmentally friendly with a small consumption of chemicals, relatively low equipment and operating costs, and short duration of the analysis.

### 3.2. Selenium in selected foodstuffs

The results of selenium determination in selected foodstuffs are presented in Table 2.

The selenium content in milk was 12.5 ng g$^{-1}$ and, in dairy products, in the range 11.9–30.1 ng, all per gram wet weight. Klapec et al. (2004) found 28.7 ng g$^{-1}$ in milk from Croatia, Slovenia's southerly neighbour, a value slightly higher than our result.

Meat provides a significant part of human dietary selenium. Selenium levels in animals depend on their diet, i.e. on the fodder plants of grazing areas and on any selenium addition to fodder, which has been allowed in Slovenia since 1989 and is now authorised by the Fodder Additives Regulation (2003). According to this regulation, the maximum selenium content allowed in complete feed mixtures amounts to 0.5 mg kg$^{-1}$. In Slovenia, manufacturers add selenium to feed mixtures, but there is a gap concerning monitoring of selenium content in meat.

We determined the selenium content in meat that is offered on the market and levels were in the ranges 33–155 for beef, 153–686 for fish, 97–154 for chicken and 99–116 for turkey, all in ng g$^{-1}$. Selenium content in beef was determined in muscle (*M. longissimus dorsi* and *M. biceps femoris*) from bulls of the Brown and Simmental breeds. These two breeds represent the majority of the breeding stock and available beef in Slovenia. A very high variation in selenium content in beef was found and the reason is that these contents reflect the daily selenium addition in fodder per animal, that was in our case 0.4 or 4.4 mg/animal/day for Brown and Simmental breeds, respectively. The information on selenium addition in fodder is available regarding tracking of origin of sample, that is in Slovenia established by the Beef Labeling Regulation (2001). We compared these values with literature data for some other countries, but the values for the USA were higher, as expected, because soil in North America is high in selenium and consequently higher selenium contents are present in animal tissues (Combs & Combs, 1986). Selenium analysis of chicken breasts from our study, with extensive indoor rearing, gave higher results than those obtained from farmyard rearing obtained by Stibilj and Holcman (2002) and are on the other hand more comparable with those obtained by Daun and Akesson (2004).

The selenium contents in the fresh matter of yolks were 424 and 351 ng g$^{-1}$ and were higher than in whites, which were 61 and 70 ngg$^{-1}$. The values from our study were significantly higher, as are most, than those obtained by Stibilj and Holcman (2002) which were 147 ng g$^{-1}$ in yolk and 43.3 ng g$^{-1}$ in white. This difference in selenium contents shows the influence of selenium addition to fodder since hens from the study of Stibilj and Holcman (2002) were fed only on home produced fodder.

Selenium contents found in vegetables were in a very wide range, from 0.3 ng in lettuce to 77 ng in cabbage and 81 ng in beans, all per g wet weight. Cabbage, as expected, had very high selenium content, since plants with a high content of sulphur-containing compounds are a rich source of selenium. Furthermore, beans have rather high protein content and consequently higher amounts of selenium. Our data on the selenium content in vegetables purchased in Slovenia were in the same range as obtained in Croatia (Klapec et al., 2004) and also in the other literature data.

In short, meat and sea foods contribute the major part of daily dietary selenium, but milk, dairy products and vegetables are not negligible sources because high amounts are consumed.

### 3.3. Selenium in military total diet samples

For estimation of the daily selenium intake, we chose to sample the entire diet for military personnel during sustained operations. By analysing 20 total diet samples from 4 barracks in different regions of Slovenia we were able to check if the average daily intake meets the recommendations of 50 μg per day (Slovene Ministry of Defence, 1994). Table 3 gives average values of the se-

Table 2
Selenium content of selected foodstuffs and comparison with literature data

| Food | Selenium content[a] ($ng\,g^{-1}$ wet weight) | |
|---|---|---|
| | This study | Other authors |
| *Meat and fish* | | |
| Beef | $35 \pm 3$ (4) [33–39][b]; $143 \pm 8$ (10) [130–155][c] | 438[1]; 55.7[2]; 340–470[3]; 17.3–66.7[4]; 81[5]; 76[6]; 42–142[7]; 102, 99[8]; 131.1, 75.9[9] |
| *Chicken* | | |
| Thigh | $128 \pm 22$ (3) [113–153] | 33.0–215.1[4]; 60[8]; 69[10] |
| Breast | $119 \pm 31$ (3) [97–154] | 333, 349[3], 123.2 [4]; 115[5]; 47[8]; 108[10]; 56.5[11] |
| Fish | [153–686] (4) | 196.1–520.7[4]; 282, 265[5]; 197[8]; 310–630[12] |
| Mussel | 563, 555 (2) | |
| *Turkey* | | |
| Thigh | 99 (1) | 150[6]; 108[10] |
| Breast | 116 (1) | 100[6]; 69[10] |
| *Milk and dairy products* | | |
| Milk | $12.5 \pm 0.9$ (3) [11.6–13.4] | 51[3]; 7.1[4]; 18[5]; 15[6]; 6.7–47.6[7d] ; 28.7[9]; 25.9[12]; 37[13]; 13[15] |
| Yoghurt | $12.4 \pm 0.5$ (3) [11.9–12.8] | 14[6]; 3.2[8]; 29.9[9]; 20[12]; 22[13] |
| Cream | $15.3 \pm 1.4$ (3) [13.8–16.5] | 11[6]; 12[8]; 10[12] |
| Butter | $24.0 \pm 6.3$ (3) [17.5–30.1] | 18[8]; 10.8[12]; 7[13] |
| Cheese | $23.2 \pm 3.1$ (3) [20.5–26.7] | 133[3]; 40.5[4], 16–140[6]; 72.6[9]; 70, 78.9[12] |
| *Eggs* | | |
| White | 61, 70 (2) | 87.5[4]; 64[5]; 63[8]; 43.3[11]; 200[13] |
| Yolk | 424, 351 (2) | 342.2[4]; 241[5], 237[8]; 147.3[11]; 560[13] |
| *Vegetables and cereals*[e] | | |
| Beans | $52.6 \pm 21.3$ (4) [30.4–81.4] | 18[5]; 210.4[15] |
| Buckwheat | 43.3 (1) | |
| Cabbage | [1.1–76.7] (7) | 7.5[4]; 66.1, 8.3[9], 86[13] |
| Carrot | [0.6–11.6] (10) | 1.3[4]; 19.6, 8.1[9]; 14[13] |
| Chicory | [0.4–10.4] (8) | |
| Cucumber | $14.7 \pm 9.7$ (4) [1.6–24.3] | 11.5, 6.3[9]; 1.1[13] |
| Lettuce | [0.3–20] (6) | 0.9[4]; 14.5[9]; 100[13]; 2.39[14] |
| Onion | [1.1–10.5] (6) | 5.8[4]; 15.3, 12.4[9]; 55[13] |
| Parsley | [1.4–24.2] (11) | 2.0[4]; 17.6, 9[9] |
| Pepper | 11, 1.4 (2) | 0.7[4]; 9.1, 11.4[9]; 0.84[13] |
| Potato | $1.5 \pm 0.3$ (4) [1.1–1.7] | 3.5[4]; 16[6]; 9.5, 7.2[9]; 1.3[14] |
| Pumpkin | 0.7; 3.9 (2) | |
| Radish | 4.5 (1) | 0.7, 0.7[4] |
| Tomato | [1.1–29.1] (4) | 0.5[4]; 7.9, 10.2[9] |
| Wheat | 11, 9 (2) | 35.5[15] |

[1]Hintze, Lardy, Marchello, and Finley (2001), [2]Hussein and Bruggeman (1999), [3]Finley, Matthys, Shuler, and Korynta (1996), [4]Kadrabova, Mandaric, and Ginter (1997), [5]Murphy and Cashman (2001), [6]Barclay, MacPherson, and Dixon (1995), [7]Tinggi (2003), [8]Simonoff, Hamon, Moretto, Llabador, and Simonoff (1988), [9]Klapec et al. (2004), [10]Daun and Akesson (2004), [11]Stibilj and Holcman (2002), [12]McNaugton and Marks (2002), [13]USDA (2002), [14]Diaz-Alarcon, Navarro-Alarcon, Lopez-Garcia de la Serrana, and Lopez-Martinez (1994), [15]Diaz-Alarcon, Navarro-Alarcon, Lopez-Garcia de la Serrana, and Lopez-Martinez (1996).

[a] Average ± standard deviation (number of samples) (range).

[b] Selenium addition to fodder: 0.4 mg Se per day.

[c] Selenium addition to fodder: 4.4 mg Se per day.

[d] $\mu g\,l^{-1}$.

[e] A part of results was already published (Falnoga, Jereb, & Smrkolj, 2003).

lenium content in 20 daily military total diets, sample mass and energy value of the samples. An average daily selenium intake of 87 $\mu g\,day^{-1}$ was obtained, with a range of selenium intake of 34–163 $\mu g\,day^{-1}$ at an average energy value of 3770 kcal, and average content 0.089 $\mu g\,Se\,g^{-1}$ lyophilised sample. Our average selenium daily intake meets the recommended value of 50 $\mu g\,day^{-1}$ (Slovene Ministry of Defence, 1994), but 10% of total diets contained less than the recommended value. Furthermore, it is evident that the average daily intake from this study meets the RDA value of 55 μg per adult person per day. The recommended nutrient density for selenium is not yet set (WHO, 1998).

The average selenium daily intake of 87 μg is higher than data from previous Slovene studies. Pokorn et al. (1991) obtained 40 μg selenium for 56 samples collected in the years 1988 and 1989 and Pokorn et al. (1998) obtained 30 μg selenium for 51 samples in the year 1992, for diets collected in old peoples homes. The selenium content in μg on a dry matter basis was similar in the study from the year 1992 (0.09 $\mu g\,Se\,g^{-1}$) and in our study, but the daily intake was lower. The reason lies in

Table 3
Average weight, energy value and selenium content in 20 military daily diet samples (average ± SD) and comparison with literature data

| Country | Sample mass (g) | Energy value (kcal) | Selenium content ($\mu g\,g^{-1}$ lyoph. sample) | Selenium intake ($\mu g\,day^{-1}$) | Reference |
|---|---|---|---|---|---|
| Slovenia | $3957 \pm 401$ | $3770 \pm 538$ | $0.089 \pm 0.023$ | $87 \pm 28$ (34–163) | This study |
| Austria | | | | 42.9 | Pfannhauser et al. (2000) |
| Croatia | | | | 27.3 | Klapec et al. (1998) |
| Croatia | 1675 | 2055 | | 33.9 | Matek et al. (2000) |
| Netherlands | | | | 67 | Foster and Sumar (1997) |
| Poland | | | | 30–40 | Wasowicz, Gromadzinska, Rydzynski, and Tomczak (2003) |
| Poland | | 2052 (1885–2212) | 0.048–0.072 | 19–32 | Ratkovska, Marzec, Stibilj, Wojtasik, and Kunachowicz (2004) |
| Slovenia[a] | | 1942 | | 40 | Pokorn et al. (1991) |
| Slovenia[a] | | 1675 | 0.09 | 30 | Pokorn et al. (1998) |
| Spain | | | | 32.3 | Diaz-Alarcon et al. (1996) |
| Switzerland | | | | 70 | Foster and Sumar (1997) |
| Turkey | | | | 30 | Foster and Sumar (1997) |

[a] From old people's homes.

the different calorific values of daily diet samples in studies from 1988–89 and 1992 of 1942 and 1675 kcal, respectively, in comparison to the present study with 3770 kcal. This means that the daily intake for selenium is satisfied if the mass of consumed food is high enough, but can be a problem for old people who need a lower energy value of food. For that reason they should consume foods with high selenium levels.

In contrast, our value of the selenium content per g lyophilised sample was higher than that reported by Ratkovska et al. (2004) for Poland, with values from 0.048 to 0.072 $\mu g\,g^{-1}$ lyophilised sample. They analysed daily diet samples constituted in the laboratory on the basis of data on food consumption obtained from studies of household budgets. The average daily energy intake was 2052 kcal (1885–2212 kcal) (Kunachowicz & Klys, 2000). We can speculate that Slovene food contains more selenium or that we choose foodstuffs richer in selenium.

A comparison of daily intakes of selenium by Slovenian soldiers (18–27 years old) with reported values in other European countries and with RDA (DRI, 2000) is given in Table 3. Results show that daily intake of selenium is comparable to the values reported for countries such as Switzerland and the Netherlands. But, on the other hand, our result is higher than those obtained in Austria, Turkey and Croatia.

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