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Türk Besinlerinin Selenyum İçeriği: Yirmi Yıllık Bir İnceleme

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Özet

Selenyum, büyük ölçüde besinlerden elde edilen, beslenme açısından gerekli bir eser elementtir. Selenyumun besin zincirine biyoyararlanımı, toprak organik madde içeriğine, pH'a ve selenyum türleşmesine, selenyum ile kompleks oluşturan iyonların varlığına ve besin işlemeye bağlıdır. Selenyum, DNA sentezinden antiinflamatuvar ve antioksidan etkilere kadar uzanan pleiotropik etkiye sahip iki düzineden fazla selenoproteinin bir bileşenidir. Bu çalışmada, Türk besinlerindeki selenyum varyasyonunun derecesini vurgulanması amaçlanmıştır. Antep fıstığı (54.57 µg / g), ceviz (30.77 µg / g), balık (25.5 µg / g) ve ette (16 µg / g) yüksek miktarda selenyum bulunmuştur. Selenyumun biyoyararlanımı, besin kaynağına ve beslenme durumuna bağlıdır. Bu derleme, Türk besinlerindeki selenyum düzeyini vurgulayan ilk derlemedir. Burada vurgulanan veriler, epidemiyolojik araştırmalarda selenyum alımının değerlendirilmesi için kullanılabilir.

Anahtar Kelimeler

Selenyum içeriği
Besin analizi
Besin bileşimi

Makale Hakkında

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Selenium Content of Turkish Foods: A Twenty-Year Review

Abstract

Selenium is a nutritionally essential trace element majorly obtained from food. The bioavailability of selenium to the food chain depends on soil organic-matter content, pH, and selenium speciation, presence of ions that complex with selenium and food-processing. Selenium is a constituent of more than two dozen selenoproteins that have a pleiotropic effect ranging from DNA synthesis to anti-inflammatory and antioxidant effects. This aimed to highlight the degree of variation of selenium in Turkish foods. High amounts of selenium were found in pistachio (54.57 µg/g), walnut (30.77 µg/g), fish (25.5 µg/g) and meat (16 µg/g). Bioavailability of selenium is dependent on food source and subject’s nutritional status. This is the first review highlighting the selenium level of in Turkish foods. Data highlighted herein can be used for the assessment of selenium intake in epidemiological research.

Keywords

Selenium content
Food analysis
Food composition

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Introduction

In 1817, J. J. Berzelius, a Swedish scientist, isolated and chemically characterised selenium (Se) (Reilly, 2006). Se is present in the environment in varying concentrations, due to both natural and man-made practices (Fordyce, 2013). Mammals are exposed to environmental Se through the skin, inhaled air and water ingested by plants and animals in diet produced from Se containing soils. The concentration range of Se found in nature is 50–90 µg/kg; however, a higher concentration is found in soils of volcanic origin. Se is continuously recycled through atmospheric, terrestrial and marine systems.

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Se is spread from rocks via cycling processes and, as a result, Se concentrations vary markedly (Fordyce, 2013).

Decomposition of Se-rich organic matter and biomethylation by microorganisms cause enrichment of the atmosphere with Se. Reactivity and bioavailability of Se depend on its total content and chemical form in soil. Availability of inorganic Se from plant diminishes as organic matter content in soil increases. Accumulation and uptake of Se by plants depend on its chemical form, precisely on its sulphur (S) constituent (Yu et al., 2014). Se gains entry into the body either as selenocysteine derived from animal selenoproteins or selenomethionine from plants (Sunde, 2012). The human body absorbs >90% of selenomethionine, probably as selenocysteine, with about 50% of Se from selenite and selenite which can vary considerably. Dietary Se must first be converted to selenide (Se2−), which functions as the donor for incorportion of Se into selenoproteins. Inorganic forms of Se, such as selenite (SeO32−), are converted to Se2−; whereas organic forms are metabolised to Se2− (Sunde, 2012).

Se-deficient soils (<0.125 mg/kg) can be found in Turkey, UK, Australia, Finland, Denmark and Northeast to South Central of China. Areas with low soil Se content produce foods that does not ensure ingestion of Se in adequate amounts by mammals and is not affected by selenium nutritional status (Burk & Levander, 2005).

Twenty five selenoprotein genes in human genome, indicating roles for these proteins as oxidoreductases and in regulation of protein degradation or protein folding (Sunde, 2012). Some of the better-known selenoproteins are thioredoxin reductases, glutathione peroxidases, Iodothyronine Deiodinases, selenophosphate synthetase, selenoproteins (Sunde, 2012).

Se protect immunotoxicity via preventing immune cells from oxidative damage (Li, Yin, Yin, Chen, & Wang, 2014). FNB (Food and Nutrition Board) developed the DRI (Dietary Reference Intake) for Se, such that 55 µg/day is recommended for both genders and 70 µg/day for pregnant and lactating women, with an upper tolerable limit of 400 µg/day (Food & Board, 2000). To achieve additional health benefits over general health care, best biological marker(s) to evaluate Se sufficiency have not been determined (Stoffaneller & Morse, 2015). The main interest to food scientists and nutritionists is the capability of food plants to take up (from the soil) and store Se in order to meet the nutritional needs of both farm animals and humans. This review aimed to determine the Se content of foods consumed and exported in Turkey. The information contained herein may be used as basic data for recommendation, treatment, prevention and management of Se-related diseases.

Methods

Literature search

The literature search was conducted using MEDLINE, Web of Science, and Google Scholar (Grey literature). The search was performed from October to December 2020. The terms used to search the included selenium, food analysis, food composition, Turkish, and Turkey; identical Turkish terms were also used for research in DergiPark. The references of this articles were also reviewed to identify eligible studies for inclusion. There were no language restrictions.

Inclusion criteria

Only articles reporting Se content in Turkish foods were included.

Exclusion criteria

Articles that were published more than 20 years ago were excluded. Also studies whose objectives were to evaluate the Se content in exported foods, and to measure the effects of Se supplementation in Turkish foods were not used.

Article selection and data extraction

All articles found using the keywords were initially assessed according to the manuscript's titles, keywords, and abstracts. Nevertheless, full-text articles were also used when there was not sufficient information for the paper' selection.

The data extracted included Se content in Turkish food. Such as sample size, the methodology, levels and measurement units. Measurement units varied according to the study i.e. mg/kg, µg/g, mg/100 g, mg/g and ng/g). Therefore, all values were converted to µg/g according to the stipulations of the WHO.

Results and Discussion

Advancements in rapid analytical measurements have provided accurate data on Se concentrations in foods. Mostly, mammals obtain nearly all their Se from foods. Twenty-eight research articles were included in this review. Data on Se content of Turkish foods are summarised in Table 1.

Table 1. Selenium content (µg/g) of Turkish food

Product	No of samples	Range/mean (µg/g)	Method	Reference
Milk	21	0.014-0.021/ 0.018±0.002	ICP-MS	(Saribal, 2020)
	12	n.d.-0.35/ 0.23±0.12	ICP-AES	(Ayar, Sert, & Akın, 2009)
Butter		n.d.-0.74/0.32±0.36		
Cheese		n.d.- 0.780		
Meat Fish	34	16±0.7,8-46±5/16 13.2±8-36.8±7/25.5	ICP-OES	(Demirezen & Uruç, 2006)
Canned fish	20	0.96±0.07-3.64±0.32	FG-FAAS	(Mustafa Tuzen & Soylak, 2007a)
Fish	40	0.19±0.02-0.85±0.05		(Mustafa Tuzen, 2009)
Gill Liver Muscle	30	0.0013±0.178 0.025±0.039 0.514±0.096	ICP-MS	(Can et al., 2012)
Fish Se content in Autumn, Winter,	60	0.56±0.32-0.65±0.56		(Yabanlı et al., 2014)

Spring, Summer				
	151	0.96±0.15-1.86±0.38		(Ulusoy et al., 2019)
Chicken	3	0.17±0.01-0.91±0.08	GFAAS	(Uluozlu, Tuzen, Mendil, & Soylak, 2009)
Egg		0.10±0.01-0.29±0.01		
Bread	18	0.412-1.860/ 2.023±0.364	ICP-OES	(Gülfen, 2012)
Rhubarb	12	0.099±0.007-0.141±0.00	FL	(Munzuroğlu, Karataş, & Gür, 2000)
Dried apricot Fresh apricot	8	0.260-0.360/ 0.312 0.084–0.124/ 0.108	FL	(Munzuroglu et al., 2003)
Dried apricot	10	0.32±0.03-0.64±0.05	FG-FAAS	(Saracoglu et al., 2009)
Garlic: Dry weight Fresh weight	88	0.968-9.33 / 3.66 0.345-2.33 / 0.94	ICP-OES	(Turan et al., 2010)
Canned foods	4	0.05±0.01–0.35±0.02	FG-FAAS	(Mustafa Tuzen & Soylak, 2007b)
Hazelnut	3	0.6±0.00	AAS	(Alasalvar et al., 2003)
	48	0.96-1.39	ICP-MS	(Simsek & Aykut, 2007)
	15	0.06±0.00-8.11±0.11	AAS	(Alasalvar et al., 2009)
	18	0.02-0.04	ICP-MS	(Özkutlu et al., 2011)
Unhulled Hulled	45	1.9±0.2-7.4±0.4 8.2±0.4-13.10±1.1		(Dundar & Altundag, 2004)

Pistachio	42	11.44±0.23-190.71±3.97/ 54.57	FL	(Özrenk et al., 2012)
Walnut		7.25±0.88-57.67±1.16/ 30.77		
Vinegar	25	0.04±0.02-0.16±0.02	ICP-MS	(Ozturk et al., 2015)
Bee pollen	23	0.593-5.085/2.560	ICP-OES	(Sema Sandikci Altunatmaz et al., 2017)
Honey	25	0.038-0.113	FAAS	(M Tuzen et al., 2007)
	71	n.d.- 0.066/ 0.054±0.011	ICP-MS	(Kılıç Altun, Dinç, Paksoy, Temamoğulları, & Savrunlu, 2017)
	65	0.476-19.88/2.183±1.67	ICP-OES	(S. S. Altunatmaz et al., 2019)
Medicinal and Aromatic Plants	10	0.011-1.133±104	ICP-OES	(Ozkutlu, Sekeroglu, Koca, & Yazıcı, 2011)
Baby foods	57	0.12±0.01- 0.32±0.03	AAS	(Saracoglu, Saygi, Uluozlu, Tuzen, & Soylak, 2007)

The most important food sources of Se include meat (16-46 µg/g), seafood (0.2-37 µg/g), pistachio (11-191 µg/g), walnut (7-58 µg/g), honey (n.d.-20 µg/g) and bee pollen (0.6-5 µg/g). Food-processing such as cooking and drying may reduce Se content of foods through evaporation; moreover, variation due to seasonal changes or geographical location may also reduce Se content of foods (Navarro-Alarcon & Cabrera-Vique, 2008).

Being an essential source of nutrient, milk and milk products are important nutritional choices. Se concentration variations are observed widely (if not universally) in cow milk. A range of non-detectable (n.d.) – 0.35 µg/g has been observed in milk, based on published data. As Se diffuses to brine during ripening from curd, cheese samples have higher concentrations of Se than milk. It was shown that mean serum concentration of Se in cows during early lactation increases when compared to cows during dry period and peak lactation. It is reported that Se concentrations in milk and cheese are adversely correlated with their fat content (Navarro-Alarcon & Cabrera-Vique, 2008). Differences between Se levels in milk produced in different regions and countries have been observed. Furthermore, there can be Se concentration differences between adjacent farms, pasteurised and homogenised milk and milk produced in different seasons of the year (Reilly, 2006).

There are differences in Se levels in meat (16-46 µg/g), fish (0.19-36.8 µg/g), chicken (0.17-0.91 µg/g) and egg (0.10-0.29 µg/g). In aquatic systems, fish are considered as bioindicators of heavy metal pollution. Moreover, Se compounds are capable of protecting against toxicity of cadmium and mercury (Hg) (Can et al., 2012). Accumulation of toxic Hg in its organic form, is a well-recognised problem in populations that includes high intake of fish in their diet. Se health benefit value (Se-HBV) is a quality index that facilitates interpretation of risk and benefit assessments of Se and Hg concentrations. This value is used to identify fish species that have high content of Se and low content of Hg. Positive Se-HBV indicates health benefits, while negative Se-HBV indicates health risks (Ulusoy, Mol, Karakulak, & Kahraman, 2019). Turkey's main export fish species are considered safe in terms of Hg toxicity risk. Regular monitoring of heavy metals and Se in fish must be continuously carried out, given their great importance in human health (Yabanlı, Yozukmaz, Alparslan, & Acar, 2014). There is no information on maximum levels of Se in fish samples in TFC (Turkish Food Codex); however, Se concentrations in Turkish fish species have been reported to be within the specified ranges. Vegetarians and lactovegetarians may suffer substantially decreased daily intake of Se (Navarro-Alarcon & Cabrera-Vique, 2008).

Se concentration in bread is relatively low (0.41-2.02 µg/g). There can be differences in Se levels between brown, white, and other bread types. Brown bread seem to be a much richer source of Se (Navarro-Alarcon & Cabrera-Vique, 2008). In recent years, the import and export of wheat, corn and other food ingredients has increased; nevertheless, Se monitoring remains insufficient. Moreover, Se is being added to fertilisers used in growing wheat and this is difficult to control. Other factors that affect for Se levels may be pertained to soils rich in copper in the Black Sea region of Turkey (Gülfen, 2012).

Most plants do not have the ability to accumulate Se. Allium family that includes garlic are recognised as Se accumulators, especially when grown on Se-rich soils, The differences in Se concentrations among garlic bulb samples may be due to type of soil, use of irrigation as well as climatic conditions. It could be stated that mineral composition and genetic properties of garlic bulb may have an effect on Se concentration (Turan, Taban, Türkmen, & Taban, 2010). Some mushrooms have also been shown to provide significant amounts of Se in diet, since mushrooms have high number of sulphur-containing compounds. When consumed in areas that are Se-deficient, these foods can be important sources of Se (Navarro-Alarcon & Cabrera-Vique, 2008).

Turkey is among the leading countries in walnut and pistachio production in the world. Higher level of Se can be attributed to seleniferous or non-seleniferous soils as well as the region's climate and ecological conditions (Özrenk, Javidipour, Yarilgac, Balta, & Gündoğdu, 2012). Hazelnuts have an advantage of providing bioavailable amounts of Se (Simsek & Aykut, 2007). Turkish hazelnut varieties may serve as excellent sources of Se (Özkutlu et al., 2011) which plays a major antioxidant role (Alasalvar, Shahidi, Liyanapathirana, & Ohshima, 2003).

Se content of vinegar in Turkey is lower than those produced in Spain. This may be due to environmental factors (Alasalvar, Amaral, Satır, & Shahidi, 2009). Se level in bee pollen is related to flower varieties and genetic compositions, climate and environmental conditions, geography, fertilisation, and apicultural processes (Sema Sandikci Altunatmaz, Tarhan, Aksu, Barutcu, & Or, 2017). Turkey ranks world's second largest honey producing country. Honeys and pollens can be contaminated with miscellaneous elements i.e. caring chemicals, feeding syrups, containers used in beekeeping, packaging materials. Based on this data, bee pollens may be considered as a good source of Se (S. S. Altunatmaz et al., 2019). Honey can be considered as a reliable biological marker for assessment of heavy metals pollution (M Tuzen, Silici, Mendil, & Soylak, 2007).

Conclusion and Recommendations

Se has a narrow range of safety. From a geographical perspective, there is a large variation in Se content of fruits and vegetables because of soil pH, presence of ions that complex with Se, sensitivity of apparatus and extraction methods employed. Also, it was shown that low protein foods are poor sources of Se. Vegetables and fruits contain trace amounts of Se compared to grains, seafood, meat, cereals and grains, milk and milk products (Munzuroglu, Karatas, & Geckil, 2003). Bioavailability of Se in food samples is affected by total protein, fat, heavy metal contents, and its chemical form (Saracoglu, Tuzen, & Soylak, 2009). Further studies are necessary to evaluate the concentrations of Se in a greater variety of foods, in addition to assess the seasonal differences across different regions in Turkey. It is recommended that foods should be monitored for trace elements to minimise and prevent future health issues.

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