DETERMINATION OF SELENIUM IN CHICKEN AND EGGS USING MICROWAVE DIGESTION AND HYDRIDE GENERATION ATOMIC ABSORPTION SPECTROMETRY

ОПРЕДЕЛЕНИЕ УРОВНЯ СЕЛЕНА В КУРИНОМ МЯСЕ И ЯЙЦАХ С ИСПОЛЬЗОВАНИЕМ МИКРОВОЛНОВОЙ ОБРАБОТКИ И АТОМНО-АБСОРБЦИОННОЙ СПЕКТРОМЕТРИИ С ГЕНЕРАЦИЕЙ ГИДРИДОВ

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In this study, the concentrations of Se were determined in muscle and liver of chickens, white part of eggs, and yellow part of eggs by using Microwave digestion and Hydride Generation Atomic Absorption Spectroscopy (HG-AAS). The samples of farm chickens, village grouse chickens, and eggs of them were collected from the Mugla region of Turkey. To confirm the accuracy of this method, DOLT 5 Dogfish Liver was used as standard reference material. The concentrations of Se in muscle and liver from samples of chicken and village grouse chicken were found as the lowest not determined and the highest 1.88 mg/kg. The average concentrations of Se in the samples of the yellow part of the farm chicken eggs and the village grouse chicken eggs were determined as 0.44 and 0.88 mg/kg, respectively.

В этом исследовании с использованием микроволновой обработки и атомно-абсорбционной спектрометрии с генерацией гидридов была определена концентрация селена в куриной печени и мышцах, яичном белке и желтке. В провинции Мугла (Турция) были собраны образцы куриного мяса, яиц птицефабрик и фермерских хозяйств. Для подтверждения точности данного метода, в качестве стандартного эталонного материала был использован DOLT 5 Dogfish Liver. Самая низкая концентрация селена в мышцах и печени взятых образцов не определена, а самая высокая 1.88 мг/кг. Средний показатель концентрации селена в образцах желтка куриных яиц птицефабрик и фермерских хозяйств составил 0.44 и 0.88 мг/кг соответственно.

Keywords: HG-AAS, chicken, egg, Se determination.

Ключевые слова: HG-AAS, куриное мясо, яйцо, определение уровня селена.

https://doi.org/10.46646/SAKH-2022-2-135-137

Introduction. Determination of essential and toxic metalloids such as Se, which is only found in ng /g levels in foods, is important for human health and the environment. Se is known to be an essential element in biological systems, but the high concentrations of Se are toxic [1]. These two roles of Se in biological systems have interested the attention of researchers. Se has important roles for the human body such as increasing immunity, preventing free radical damage, participating in antioxidant activity that defends against inflammation, and enhancing the quality of blood flow [2]. While Se intake per day (120–134 µg / L) is considered sufficient in normal nutrition, 200 µg selenium supplements have a very immuno-enhancing effect. The upper limit for safe intake by adults is set at 400 µg per day. Se does not contain high concentrations in food [1]. Therefore, it is important to be able to analyze Se.

There are many spectroscopic methods used to determine selenium in foods. In the last decade, significant instrumental and methodological advances have led to the widespread application of HG-AAS to a wide variety of metal sample types such as As, Sb, and Se that are evaporated into volatile hydrides [3–4]. This analysis method is one of the most preferred methods due to its simplicity, sensitivity, and speed [5]. The use of a closed microwave digestion system has been developed as a rapid procedure with the advantage of minimizing the potential loss of analyte due to open system mineralization [4].

The purpose of this study is the determination of Se in muscle and liver of village grouse chickens (VGCs) and farm chickens (FCs) in Mugla (Turkey). Also, it is determined of Se in eggs of VGCs and FCs in there. The results of Se are compared.

Materials and methods

The samples collection and preparation of analysis. 15 FCs, 15 VGCs, 15 eggs of FC, and 15 eggs of VGC were collected in the Mugla region. Muscle and liver tissues were taken from chicken samples. In chicken egg samples, the yellow and white parts of the egg were separated. Muscle and liver of chicken samples, white and yellow parts of egg

samples were homogenized. 0.5 g of each yellow part of egg samples and 1.0 g of each muscle and liver of chicken samples were weighed. 10 mL of concentrated HNO3 was added to each sample. All samples were digested using a microwave digestion unit (CEM, Mars 6 Microwave Digestion System). "Food Program" was used for egg samples and "Animal Tissue Program" was used for muscle and liver samples. All dissolved samples were filtered on filter paper (Sartorius-Stedim, particle size = 2–3 μm). The total volume of each filtered sample was completed to 50.0 mL with ultrapure water (Milli-Q Millipore 18.2 MΩ/cm resistivity).

Analysis in HG-AAS. Se standard solutions and samples were sent from a tubing to the system, as well as 10 mol / L HCl was sent to the system from a different tubing. In the HG-AAS technique, NaBH4 was used as the hydride source. Also, NaBH4 acted as a reducing agent. NaBH4 reacts with sample solutions to form volatile species of Se. The reaction of the volatile Se hydride formed is as follows (Eq. 1).

$$3H^{+} + 3BH_4^{-} + 4H_2SeO_3 \rightleftharpoons 4H_2Se\,(g) + 3H_3BO_3 + 3H_2O. \quad (1)$$

NaOH was added to the $NaBH_4$ solutions as a protective. Argon gas (99.9999%), which does not react, is generally used as a carrier in HG-AAS. Argon gas drags the Se hydride formed in the hydride system into the quartz T tube. The remaining liquid part is removed from the system as waste thanks to the gas-liquid separator. The gas-liquid separator is one of the most important parts of the hydride system. Thanks to this separator, only elements that can form hydride such as selenium hydride are carried to the quartz T tube.

Standard solutions of Se ranging from 4.0 μg / L to 70.0 μg / L were prepared. In the created calibration graph, the first value and the last two values were removed from the calibration graph because they deviated from the linearity range. The linearity range for Se analysis with the HG-AAS method was determined as 5.0–50.0 μg / L. Limit of detection (LOD) and limit of quantification (LOQ) values were calculated as 1.32 and 4.39 μg/L, respectively. To determine the accuracy of the HG-AAS method developed for Se determination in chicken egg and chicken samples, DOLT 5 Dogfish Liver certified reference material (CRM) was used. The comparison of the analysis results of the obtained values in the HG-AAS method and the values of certified reference materials is given in Table 1.

Table 1 *– Quality control of Se analysis in HG-AAS (mg/kg)*

CRM	Certified values	Obtained values	Accuracy (%)
DOLT 5	8.30 ± 1.8	8.27 ± 1.2	99.6

Results. The values obtained in the study are summarized in Table 2.

Table 2 – The concentrations of Se in the samples (mg/kg) (n=15)

Samples	Maximum	Minimum	Average	SD[1]
The muscle of FCs	1.88	0.02	0.63	0.75
The muscle of VGCs	0.43	nd	0.30	0.08
The liver of FCs	0.24	nd	0.08	0.10
The liver of VGCs	0.40	nd	0.08	0.12
The yellow part of egg in FC	2.78	nd	0.44	0.88
The yellow part of egg in VGC The white part of egg in FC	2.92 nd[1]	nd nd	0.88 nd	1.30 nd
The white part of egg in VGC	nd	nd	nd	nd

[1]*SD: Standart deviation*
[2]*nd: not determined*

Discussion and conclusion. The muscle and liver of FC samples was determined to be quite rich in Se. In this case, it was thought that chickens might have been fed with Se diet feed in some farms. When the concentrations of Se in muscle and liver of the FC samples were evaluated within themselves, it was seen that there were found differences between the maximum and minimum in Se concentrations. This suggests that some chicken farms may apply the Se diet too much and Se diet is insufficient in some chicken farms.

When the concentrations of Se in muscle and liver of VGC samples were evaluated, there were found no major differences as in farm chicken muscle samples. The concentrations in muscle and liver of VGC were determined to be close to each other. It is considered to be an expected result that these concentrations are close to each other since the feeding areas of the chickens were the same in the VGCs.

The concentrations of Se in the white part of eggs in FC samples and VGC samples were found below the analysis limit. The concentrations of Se in yellow part of eggs in VGC samples were found higher than the concentrations of Se in than the yellow part of eggs in FC samples. Se content is found in very low concentrations (ppb - μg / L) in food samples such as chicken and eggs. Therefore, spectroscopic methods (ICP-MS, ICP-OES, GC-MS) with higher sensitivity are used or enrichment methods are used for analysis in AAS. In this study, it was determined that Se concentrations in chicken samples and chicken egg samples could be determined by the HG-AAS technique.

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МОНИТОРИНГ ГЕЛЬМИНТОФАУНЫ МЕЛКИХ ГРЫЗУНОВ, НАСЕЛЯЮЩИХ БЕРЕГА МЕЛИОРАТИВНЫХ КАНАЛОВ НА ПАХОТНЫХ ЗЕМЛЯХ БЕЛОРУССКОГО ПОЛЕСЬЯ

MONITORING OF THE HELMINTH FAUNA OF SMALL RODENTS LIVING ON THE BANKS OF DRAINAGE CHANNELS ON ARABLE LANDS OF BELARUSIAN POLESIE

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Мониторинг гельминтофауны мелких грызунов, населяющих берега мелиоративных каналов на пахотных землях, проводился в 2017 г. в Брестском Полесье (западная часть Белорусского Полесья). Было отработано 1000 ловушко-суток и поймано 190 зверьков 6-ти видов. Доминировала обыкновенная полевка, субдоминант – полевая мышь. Общая зараженность грызунов гельминтами составила 76,8 %. Обнаружено 24 вида гельминтов. Нематода *Syphacia nigeriana* Baylis, 1928 чаще инвазировала обыкновенных полевок и полевок-экономок, нематода *Heligmosomoides polygyrus* (Dujardin, 1845) – полевых и желтогорлых мышей, нематода *Heligmosomum mixtum* Schulz, 1954 – рыжих полевок. Трематода *Psilotrema spiculigerum* (Mühling, 1898) (хозяин: обыкновенная полевка) и акантоцефал *Moniliformis moniliformis* (Bremser, 1811) (хозяин: полевая мышь) у грызунов на берегах каналов раньше не отмечались. Четыре вида гельминтов имеют медико-ветеринарное значение.

Monitoring of the helminth fauna of small rodents living on drainage channel banks on arable lands was carried out in 2017 in Brest Polesie (western part of Belarusian Polesie). 1,000 trap-days were worked out and 190 animals of 6 species were caught. The common vole was dominant, the striped field mouse was the subdominant. The total infection of rodents with helminths was 76.8%. 24 species of helminths were found. The nematode *Syphacia nigeriana* Baylis, 1928 more often invaded common and root voles, the nematode *Heligmosomoides polygyrus* (Dujardin, 1845) – stripped field and yellow-necked mice, the nematode *Heligmosomum mixtum* Schulz, 1954 – red-backed voles. The trematode *Psilotrema spiculigerum* (Mühling, 1898) (host: common vole) and the acanthocephalan *Moniliformis moniliformis* (Bremser, 1811) (host: striped field mouse) were not previously recorded in small rodents on channel banks. Four species of helminths have medical and veterinary significance.

Ключевые слова: мониторинг, гельминты, мелкие грызуны, мелиоративные каналы, пахотные земли, Брестское Полесье.

Keywords: monitoring, helminths, small rodents, drainage channels, arable lands, Brest Polesie.

https://doi.org/10.46646/SAKH-2022-2-137-140

Начиная с 1996 года, нами в юго-западной части Беларуси на территории Белорусского Полесья периодически проводятся исследования зараженности гельминтами мелких грызунов, населяющих берега мелиоративных