Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 6 Issue 12 December 2022

Research Article

Mineral Composition of Black Sea Herbal Shrimp Meat *Palaemon Adspersus Rathke*, 1837

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Received: October 12, 2022

Published: November 21, 2022

Abstract

The qualitative and quantitative composition of macro-, microelements and radionuclides in the meat of the Black Sea grass shrimp in the pre-spawning and post-spawning periods of catch were investigated. And the following essential macro- and micro elements are identified: Ca, K, Na, Mg, Cu, Zn, Fe, Mn, Li; conditionally essential: B, Cd, Pb, Sr; as well as toxic or poorly underexplored: Ag, Al, Va, Bi, Cs. The level of essential mineral elements in the meat of the Black Sea shrimp is significantly lower than the recommended physiological needs for them for an adult. The amount of Cr and Ni exceeds the physiological needs of a person per day (140 and 34 times, respectively), but significantly below the threshold of toxicity for these elements. The content of heavy metals and radionuclides in shrimp meat does not exceed the permissible norms, which indicates its safety. The results of studies show the possibility of using shrimp meat in different fishing seasons for food purposes as an additional source of essential macro- and micronutrients.

Keywords: Essential; Conditionally Essential; Toxic Macro; Microelements; Shrimp Meat; Catch Seasons; Safety; Heavy Metals; Radionuclides

Introduction

Macro- and micronutrients of food products play a significant role in meeting the physiological needs of a person and contribute to the prevention of many diseases [1]. According to the modern classification, among the mineral components of food products, essential - vital elements for which an exceptional role in ensuring vital activity has been established and which enter the human body with food and water; conditionally essential, in respect of which data on their role in ensuring the life of the body are accumulated; and toxic or poorly studied.

The mineral components of nutrition are characterized by very diverse physiological functions and: play an important role in

plastic processes, the formation and construction of body tissues, which are necessary to maintain acid-base balance in the body, create a certain concentration of hydrogen ions in tissues and cells, interstitial and intercellular fluids, as well as to give them osmotic properties that ensure the normal course of metabolism.

Mineral substances are of great importance in the formation of protein, learning in enzymatic processes as activators and cofactors of enzymes, in the normalization of water metabolism in the body, in hematopoiesis, tissue respiration and metabolism. The study of minerals as an indispensable part of nutrition and the determination of their role in the body are closely related to the prevention of iron deficiency anemia, endemic goiter, osteoporosis, rickets, fluorosis, and a number of other diseases.

In this regard, their lack or excess in the diet of a modern person can adversely affect health. Therefore, the study of their content, as well as the assessment of compliance with the recommended physiological norms of consumption, poses an urgent task in determining the nutritional value of food raw materials.

The study of mineral components in the meat of hydro bionts is devoted to a significant number of works [2-4]. It is shown that marine hydro bionts are sources of essential macro-, microelements and make a significant contribution to the provision of physiological needs in them of a person. However, data on the mineral component of crustaceans are limited [4].

The 1837Arabian grass shrimp *Palaemon adspersus Rathke,*1837 is the most widespread commercial species among crustaceans living in the Black and Azov Seas [5].

In many countries since ancient times, this type of crustacean is used in boiled and boiled frozen form. Many questions concerning the features of biology, in particular, the various stages of the life cycle, migration, nutrition are covered in the works [6,7]. The chemical composition and biological value of this species of crustaceans have been studied only in the pre-spawning period according to the main indicators [8,9] and require significant addition. Spawning in the Black Sea grass shrimp falls on the spring and summer months and according to the fishing regime, a ban on catching this object in the Black Sea from June 1 to August 31 [10]. Stages of the life cycle significantly affect the nutritional value of hydro bionts [4], and the associated migrations at different depths and temperatures can affect the content of essential macro- and micro elements in, as well as the content of toxic ones.

The recommended consumption of peeled shrimp meat is on average 100g [11,12].

In this regard, it is interesting to assess the contribution of the recommended rate of consumption of shrimp meat to ensuring the physiological human need for essential, conditionally essential mineral elements, as well as the definition of safety.

The purpose of the work: assessment of the contribution of the mineral composition of the meat of the Black Sea grass shrimp *Palaemon adspersus Rathke,*1837 in the pre-spawning and post-spawning catch periods in meeting the physiological needs of a person per day in accordance with their commendations, as well as safety in the content of heavy metals and radionuclides.

Material and Methods

The material was collected in Mae (pre-spawning period) and in September (post-spawning period) in the Hadzhibey estuary of the Odessa region. Shrimp fishing was carried out by venters with a cell size of 2.8 to. Its total8 ммnumber of analyzed individuals wasabout6,50 specimens. Shrimp meat was isolated and in the middle sample the total ash content was determined by weight method after mineralization of the hinged in a muffle oven at a temperature of 500-600 ° C, the content of macro- and microelements (Ag, Al, B, Ba, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Pb, Sr, Tl, Zn, Be, Mo, Se, Ti, V, As, Hg, S, P)- on an atomic emission spectrometer with inductively bound plasma IRIS Interpid II XSP (Termo Fisher Scientific, USA) and radionuclides(^{90}Sr) ^{137}Cs)on the spectrometer of beta radiation energies SEB-01, SEB-02 (NPP «Atom Complex Pribor», Ukraine, Kiev). Studies were conducted in 3 repetitions. The reliability of the results of the studies was assessed according to the Student's criterion at a confidence interval of ≤0.05.

Results and Discussion

Analysis of the results of our studies shows that shrimp meat in the spring and autumn catch periods (pre- and post-spawning periods, respectively) in terms of the content of minerals and elements does not reveal significant differences - 1.85 ± 0.21 and 1.92 ± 0.34 (on average - 1.88 ± 0.27). The mineral composition of shrimp meat is represented by the following vital essential macro- and microelements: Ca, K, Na, Mg, Cu, Zn, Fe, Mn, Cr, Ni, Li, Co, As; conditionally essential: B, Pb, Cd and toxic or poorly studied Ag, Al, Va, Bi (Table 1).

Item name	Shrimp Life Cycle Period		Physiological requirement mg/day[13, 14]	Exceeding physiological needs, times	Not meeting physiological needs, times
	Pre-spaying	Post-sparsath			
Essential macro-and microelements, mg/100g					
Are	1,89 ± 0,20	1,19 ± 0,10	1200	-	634,92
K	0,33 ± 0,01	0,34 ± 0,03	2500	-	7575,75
On	0,33 ± 0,07	0,27 ± 0,01	1300	-	4333,33
Mg	90,10 ± 7,78	66,10 ± 0,06	400	-	4,44
With	0,29 ± 0,00	0,19 ± 0,00	1,00	-	4,16
Zn	0,25 ± 0,00	0,19 ± 0,00	12,00	-	54,54
Fe	0,09 ± 0,00	0,08 ± 0,00	15	-	166,66
Mn	0,06 ± 0,00	0,03 ± 0,00	2,00	-	40
Cr	0,78 ± 0,03	0,63 ± 0,08	0,005	140	
Nor	0,46 ± 0,01	0,22 ± 0,02	0,01	34	
Li	1,20 ± 0,05	0,41 ± 0,03	-	-	-
Co	<0.01	<0.01	-	-	-
As	0,002 ± 0,00	0,002 ± 0,00	0,005		2,5
Conventionally essential mineral elements, mg/100g					
B	<0.01	<0.01	-	-	-
Cd	0,17 ± 0,01	<0.01	-	-	-
Pb	<0.01	<0.01	-	-	-
Toxic or poorly underset studied, mg/100g					
At the	0,03 ± 0,003	0,02 ± 0,004	-	-	-
To the	0,04 ± 0,006	0,03 ± 0,003	0,0003	113,33	-
Va	6,36 ± 1,10	3,58 ± 0,43	-	-	-
Would	<0.01	<0.01	-	-	-

Table 1: Assessment of the contribution of 100 g of shrimp meat to the recommended levels of provision of essential, conditionally essential and other mineral elements.

The recommended values of the physiological needs of the daily intake of macro- and micronutrients are averaged indicators and reflect the estimated necessary amount to maintain a normal healthy state of a person.

Analysis of the data shows significant differences in the quantitative content of all groups of mineral elements depending on the stage of the biological cycle: in the pre-spawning period, statistically significant higher concentrations of most of the essential elements compared to the post ≤ sponastic period (P ≤ 0.05) were revealed. The exception was such elements as K, Cr, As, the content of which does not reveal significant differences depending on the stage of the life cycle. From the group of conditionally essential elements, higher concentrations of Cd were revealed in the pre-spawning period; from the group of toxic ones - Ag, Al, Va. A significant accumulation of these elements in the spring period (May) compared to the autumn period (September) can be caused by their absorption from sea water. Studies by S.E. Dyatlov and co-authors showed high chemical pollution of water and bottom sediments in the area of the Odessa Black Sea coast in the spring period of the year [15]. After intense cover rains, rivers carry into the sea a huge amount of suspended solids with elements adsorbed on their surface, which can accumulate in the meat of hydrobionts.

These differences can also be due to the preparation of the body of shrimp for spawning - the maturation of gonads.

Calculated data on average indicators in the content of essential elements showed that when eating 100 g of shrimp meat, the content of elements such as Ca is less than the physiological need of 634.92; K - at 7575.75; Na - 4333,33; Mg - 4,44; Cu - 4,16; Zn - 54,54; Fe - 166,66; Mn - 40; As - 2.5 times, respectively. The amount of Cr and Ni exceeds the physiological needs of a person by 140 and 34 times. Thus, the content of most of the essential macro- and

microelements in the meat of the Black Sea grass shrimp will not contribute to ensuring the daily physiological need for them of an adult.

Exceeding the recommended physiological norm, we have established for such essential trace elements as Cr (140 times) and Ni (34 times).

It is shown that rum refers to biogenic elements, is contained in the tissues of plants and animals, and is necessary for the normal development and functioning of the body. Its most important physiological role is to regulate the synthesis of fats, carbohydrate metabolism and blood glucose levels [16,17]. Cr is part of a low-molecular organic complex - a factor of glucose tolerance, which ensures the maintenance of normal blood glucose levels and, together with insulin, exhibits properties of a regulator of blood sugar levels, ensuring normal insulin activity. Chromium also helps to remove toxins, heavy metal salts, radionuclides from the body. It is established that chromium regulates carbohydrate and fat metabolism, protects against the development of atherosclerosis and diseases of the heart and blood vessels, normalizes blood pressure, breaks down and removes cholesterol from the body; strengthens bone tissue, prevents the development of osteoporosis. It is established that iodine deficiency chromium can be its replacement itetel. However, an excess in the diet of chromium is prone to acute allergic reactions, nervous disorders, ulcers, anemia, malfunction of the liver, kidneys, decreased immunity [17].

The threshold of chromium toxicity is 5 mg/day. Taking into account the fact that the toxicity of Cr is almost completely limited to hexavalent chromium compounds, and in food to occur in a biologically active form, it is obvious that very high doses are required to cause a toxic effect with trivalent chromium. Based on these data, it can be concluded that the amount of chromium in the meat of the Black Sea shrimp will not show a toxic effect.

The content of nickel in the pre-spawning period of the shrimp fork is 2 times higher compared to the post-spawning period and 34 times higher than the recommended physiological needs of a person in this element (see Table 1). It is known that the bottom of the main functions of nickel is an indirect participation in the process of hematopoiesis through the mechanism of penetration of iron into the blood [18]. It has been established that nickel is a cofactor (activator) of bioligand, capable of binding iron and transferring it from the insoluble form of Fe^{3+} to the easily digestible Fe^{2+}. Iron is further used by the body to form hemoglobin. Therefore, in cases of large blood loss, patients in clinics are injected with nickel to stimulate the process of hematopoiesis. Nickel is part of blood cells - erythrocytes.

Nickel is involved in the activation of certain enzymes, takes part in the redox processes of the body. The same concentration is higher in those organs in which metabolic reactions constantly occur muscles, liver, lungs, kidneys, pancreas, brain, thyroid gland. The role of nickel in providing the necessary conformation and shape of molecules in the structural organization and functioning of DNA, RNA, protein in. Also, with the help of nickel in our body stepping into the human body x vitamins like B12 and C are also associated with this element. When it enters the gastrointestinal tract under the influence of hydrochloric acid, nickel forms coordination compounds and thus enters the bloodstream. It was found that nickel is able to enter the cells through the formation of a triple complex with histidine and a transport protein located on the surface of the cell membrane [19]. The negative effect of nickel is manifested by inhibition of enzymes due to a variable oxidation state. At high concentrations of nickel in the body, the ions of this metal destroy the process of post translation glycosylation of β-dopamine hydroxylase, which is involved in the formation of norepinephrine from dopamine. Norepinephrine, in turn, is a hormone - a neurotransmitter with which the neurons of the brain transmit information to each other. Accordingly, with a lack of this hormone, a person has a feeling of anxiety, anxiety, chronic fatigue syndrome, the possible development of Parkenson's disease, etc.

The influence of nickel on the violation of the biosynthesis of proteins, DNA and RNA, which is manifested by its ability to break the sequence of nucleic acids in these molecules at the locations of adenine and guanine (with which it interacts) has been established. The effect of high concentrations of nickel on a decrease in immunity, the manifestation of allergic reactions and inhibition of the cardiovascular system is also shown.

In the gastrointestinal tract of a person, from 1 to 10% of the incoming nickel is absorbed. According to our data, when nickel enters the body, an average of 0.33 mg with the use of 100 g of shrimp and the absorption of 10% in the human body will be

absorbed 0.03 mg (see Table 1). At the established threshold of toxicity for this element 20 mg/day and a toxic dose for humans of 50 mg, the nickel content when eating 100 g of shrimp will not show a negative effect on the human body. Moreover, nickel is excreted mainly with feces (up to 95%) and in small quantities with urine and sweat.

During the shrimp catch periods we studied, higher concentrations of Al were established - 113.33 times more compared to the recommended physiological needs (see Table 1). Aluminum refers to toxic elements, the action of which can be manifested in hydronephrotic transformation of the kidneys, expansion of the urinary ducts, difficulty urinating and/or the formation of cameos, as well as in the genotoxic effect on the chromosomes of bacterial cells, cells of warm-blooded animals and neurotoxic effects [20,21].

It is shown that with the union of aluminum when it enters the acidic environment of the stomach dissolving yut sya with the release of freex ionov Al^{3+}. As I pass through the duodenum, where the pH is higher, $Al^{3+\ ions}$ are deposited as insoluble aluminum hydroxide, a significant amount of which is excreted in feces [22]. Studies conducted first in animals and then in humans have shown that the absorption of various aluminum compounds in the intestine is at the level of 0.01 to 0.3% of the amount consumed. For aluminum, citrate at the absorption level was 0.5%, for aluminum citrate, for aluminum hydroxide - 0.01% and in the case of their joint use - 0.1% [23]. Taking into account the ehteh dannyx when the recommended portion of shrimp meat in the amount of 100 g is rubbed, the absorption level will be 0.35^{-2} mg, which is significantly less than the permissible values of this element.

According to an expert assessment by the World Health Organization, the intake of aluminum into the human body from all possible sources (water, food, packaging, air) averages from 11 to 136 mg per person per week. For European countries, this figure is 11 - 91 mg per person per week. A combined effect was established when exposed to temperature and pH in the preparation of food products. So, when cooking fish without the use of salt and grape vinegar, the aluminum content in the food product increased by 4 times and reached about 0.4 mg of aluminum/kg of product. In the case of adding salt and vinegar to fish, the aluminum content in the food product increased by 68 times and reached about 5 mg of aluminum/kg of finished fish [24].

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has set a new level of safe and edible consumption of PTWI aluminium, which is 0-2.0 mg/kg body weight in terms of aluminum [25]. That to them the image contained in the meat of the shrimp with the structure of the established level of safety and, is within the permissible values.

Also in the meat of the Black Sea grass shrimp, such trace elements as Ag, Va, and Bi were identified, the physiological role of which is currently insufficiently clarified and their number is not regulated.

One of the most important indicators of raw materials is the content of heavy metals and radionuclides. The results of our research indicate that according to these indicators, the meat of the Black Sea shrimp in the pre-spawning and post-spawning periods does not detect differences and meets the established safety criteria for fish products and, in particular, for crustaceans (Table 2) [26].

In the meat of pre-spawning shrimp, we found higher concentrations of cadmium and strontium compared to its post-spawning state. This can be explained by the fact that in the pre-spawning period with the onset of heat, shrimp migrate to shallow water, where the concentration of these elements is high. At the same time, the forage period takes place at great depths, where the concentration of this element is lower. The content of radionuclides was also at a level significantly below the permissible values. It was found that in the post-spawning period, the cesium content - 137 is twice as high compared to the pre-spawning state, and strontium - 90 - 1.5 times more in the meat of pre-spawning shrimp. Such differences can be explained by seasonal changes in the content of radionuclides in seawater and spawning migrations of this animal.

Conclusion

The mineral composition of the meat of the Black Sea grass shrimp is characterized by the presence of a significant number of essential, conditionally essential, toxic and poorly studied macro- and microelements. The pre-spawning period of the annual cycle is characterized by large amounts of these elements, especially toxic, compared with post-spawning. The content of essential elements

Item name	The content of black sea shrimp in the muscle tissue		Acceptable levels, not more than [26]
	Pre-sparing	Post-sparstic	
Heavy metals, mg/kg			
Pb	< 0.01	< 0.01	2,0
Cd	0,17 ± 0,01	< 0.01	0,5
As	0,24 ± 0,02	0,24 ± 0,02	0,5
Hg	< 0.01	< 0.01	0,1
Radionuclides, Bq/kg			
^{137}Cs	0,1 ± 0,001	0,2 ± 0,001	100
^{90}Sr	257,11 ± 30,20	172,03 ± 14,95	1000

Table 2: Assessment of the safety of the Black Sea grass shrimp on the content of heavy metals and radionuclides in the pre-spawning and post-spawning periods.

is much less than the recommended physiological needs of an adult in them when using an average recommended rate of 100 g of shrimp per day. Poorly studied elements, such as A g, Ba, Bi, the physiological role of which is in the research stage, have also been identified.

The results of the research give grounds to recommend the meat of the Black Sea grass shrimp as an additional source of existential and other macro- and microelements to enrich the diet.

Further research will be related to the study of heat treatment regimes for the mineral status of the meat of the Black Sea grass shrimp.

Financing

The work was carried out at the expense of a subsidy for the implementation of the state task.

Conflict of Interest

The authors declare the absence of a conflict of interest.

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