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Investigation of macroelements in the muscle of four marine fish species

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Abstract
For performing the investigation were taken six pieces from different species from the fish market in Varna during the period May 2017. The purpose of this study was to compare the content of macroelements Ca, K, P, Na and Mg in the muscle of the most consumed marine species in Bulgaria - mackerel *(Scomber scombrus*); European sprat (*Sprattus sprattus*); horse mackerel (*Trachurus mediterraneus ponticus*) and bluefish (*Pommatomus saltatrix*). Their amount (mg/kg) was measured by Atomic Absorption Spectrophotometer (AAS) at the Scientific Laboratory at Trakia University. Horse mackerel and mackerel have the highest levels of K and Ca (3384.81±43.12 mg/kg and 195.96±3.93 mg/kg) and P and Na (2436.68±24.74 mg/kg and 833.76±21.40 mg/kg), respectively, compared with these ones of the rest investigated species. The lowest amount of Ca (115.84±1.21 mg/kg), K (2635.63±13.58 mg/kg), P (2202.31±0.81 mg/kg), Na (527.99±19.73 mg/kg) and Mg (205.70±1.12 mg/kg) have mackerel, European sprat, bluefish, European sprat and bluefish, respectively. When comparing the mean values of each of the macronutrients depending upon the degree of accumulation in the meat samples of the tested fish, their concentration can be arranged in the following order: K (3007.64 mg/kg)> P (2314.51 mg / kg)> Na (625.24 mg/kg)> Mg (245.93 mg/g)> Ca (144.64 mg/g). The investigated and analised elements, according to their accumulation in the muscles of the studied fish were in the following order: K> P> Na> Mg> Ca. Research in this area provide the necessary information on the nutritional value of fish products in relation to healthy human nutrition.

Keywords: *Scomber scombrus; Sprattus sprattus; Trachurus mediterraneus ponticus; Pommatomus saltatrix;* mineral content, AAS

1. Introduction
The shortage of micronutrients is an important problem for one-third of the population [11, 16]. Many people in their daily lives take supplements, but according to researchers in this area is an important nutritional value of products, consumed by man for his health. Fish accumulate minerals in the head and intestines, so consumption of small fish that is consumed the whole can contribute significantly to the intake of trace elements [21]. They are one of the most valuable foods for humans because of the well-balanced high protein content, the significant content of minerals, vitamins and essential fatty acids, low fat and cholesterol [7, 2, 31, 15]. In the last decade their consumption is steadily increasing. The content of minerals, especially calcium, phosphorus, magnesium, potassium, and vitamin D are in large quantities in the fish [6, 4, 12, 26, 16]. Studies on the mineral elements in living organisms have biological significance since most of these elements are involved in the metabolic processes of the body and are essential for all living beings [30; 16]. The most important mineral elements are calcium, magnesium, potassium, phosphorus, iron, and chlorine [1]. The deficiency of these essential elements slows blood clotting, causing a number of diseases, such as osteoporosis, anemia, etc. [30, 20, 36, 13, 34, 5]. The macroelements magnesium, calcium, potassium and sodium are essential to human health [35], but all elements are harmful at excessive levels [22]. The fish muscles contain a high level of phosphorus (210-280 mg/100 g), but it is incompletely absorbed by the human body because of the low content of calcium and magnesium elements that help to absorb it. In fish, muscle has high water content and fewer minerals as compared to that in the bones, fins, and scales [9]. The differences in the content of macronutrients and nutritional value of fish depend on the species belonging, size, age, sexual maturity, water quality, feed, the season and possible contaminants [17, 24, 19, 32, 8, 1, 28].

According to the Executive Agency for Fisheries and Aquaculture (NAFA), the annual consumption of fish by the population in Bulgaria is an average of 5.1 kg. Marine fish are supplied by imports from different countries or taken from the coast of Bulgaria. According to a report NAFA [22] most consumed marine fish in Bulgaria, are: mackerel – 62.4%, European sprat– 14.8%, horse mackerel - 5.1% and bluefish - 0.8%.

The purpose of this study was to compare the content of macroelements Ca, K, P, Na and Mg in the meat of the most consumed marine species in Bulgaria - mackerel *(Scomber scombrus*); sprat (*Sprattus sprattus*); horse mackerel (*Trachurus mediterraneus ponticus*) and bluefish (*Pommatomus saltatrix*). The measured mineral content in these fish species provides useful information about their nutritional value, which is important to consumers and nutritionists. Since the macroelements contained in the fish Ca and P are most studied, there is insufficient information on the Na, K and Mg contents in the literature.

2. Materials and Methods

A total four fish species were used in current research: mackerel (Scomber scombrus), European sprat (*Sprattus sprattus*), horse mackerel (*Trachurus mediterraneus ponticus*), and bluefish (*Pommatomus saltatrix*). For performing the study were taken six pieces from different species from the fish market in Varna, transported in polystyrene icebox to the Aquaculture section of Faculty of Agriculture, Trakia University. Then the specimens were rinsed with deionized water, placed in polyethene bags and stored at -20 °C, until the performance of the respective tests. The samples for analysis were taken from dorsal muscular tissues by the methodology described in Periago *et al.* [25] (Fig. 1).

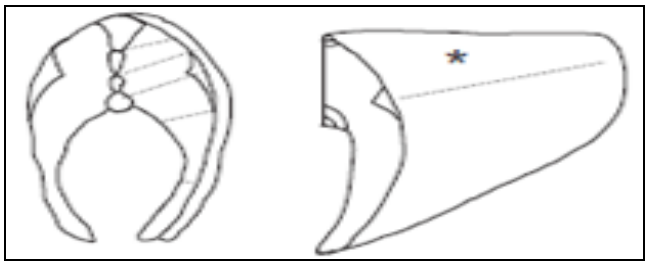

Fig 1: Muscle samples by Periago *et al.* [25]

The macromineral analysis (Ca, K, P, Na and Mg in mg/kg) were carried out in the Scientific Laboratory at Trakia University. The sample preparation for mineral analysis was made by wet digestion in the microwave (Perkin Elmer Multiwave 3000). Muscle samples prepared and investigation by atomic absorption spectrophotometry and were determined for mineral content, according to BDS11374-86. The concentrations were calculated with the help of standard curves. For each element, a standard set of solutions were prepared to determine the content of each mineral in tested muscle samples.

2.1 Statistical Analysis

Mean concentration of analized macroelements (mg/kg) and their standard deviation (SD) in wet weight were calculated. One way analysis of variance (ANOVA) was used for determination of statistically significant differences in received data (MS Office, 2010).

3. Results and Discussion

The results in Table 1 show the content of macroelements in the meat of the studied fish species.

Table 1: Content of macroelements in the muscle fish samples (mg/kg)

Fish species	n	Ca	K	P	Na	Mg
		$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD
Horse mackerel	6	195.96±3.93	3384.81±43.12	2362.21±34.23	546.668±20.51	236.88±16.24
Mackerel	6	115.84±1.21	3242.14±18.79	2436.68±24.74	833.76±21.40	336.86±28.20
European sprat	6	136.70±1.34	2635.63±13.58	2256.84±19.41	527.99±19.73	204.29±1.35
Bluefish	6	130.09±0.67	2767.97±23.82	2202.31±0.81	592.56±4.05	205.70±1.12
Concentration range of macroelements in fish muscles, mg/100g (FAO 2001)		19-881	19-502	68-550	30-134	4.5-452

Calcium is important for the formation of bones. It is well known that fish is a good source of this macroelement, as small fish are reported to have a greater presence [18, 28, 16]. In the current study, calcium ranged from 195.96 to 115.84 mg /kg. The highest Ca content was recorded in the muscle of horse mackerel (195.96±3.93 mg/kg), which is corresponding to the minimum amount, given by the FAO concentration range for this element - 19-881 mg/ 100 g. The rest investigated species – mackerel, European sprat and bluefish have 115.84±1.21, 136.70±1.34 and 130.09±0.67, respectively, amounts lower than these ones given by FAO/WHO [11]. The potassium concentration in the study varied between 2635.63 and 3384.81 mg/kg, which is in correspondence with a range, given by FAO - 19 – 502 mg/100g. The highest content of K was also found in samples of horse mackerel, which is with 22.1% higher than the value of this parameter in sprat muscle. For the element P the highest value was in the mackerel (2436.68 ± 24.74 mg / kg.), which is 9.6% more than this one of the bluefish result (2202.31 ± 0.81 mg / kg). The results obtained from the analysis of this element coincide with the FAO values of 68-550 mg/100g. Sodium is good for the functioning of muscles [3]. The concentration measured in the study was from 527.99 to 833.76 mg/kg, which coincided with the data for this element represented by the FAO - from 30 to 134 mg/100 g. The value of Na content was highest in mackerel muscle (833.762 ± 21.401 mg / kg), which is 36.7% more than this one in sprat samples (527.99 ± 19.73 mg/kg). Studies in the field of healthy human nutrition indicate that a balance between K (high level) and Na (low level) is needed. The results obtained coincide with the values reported by the authors to the higher level of K as compared with that one of Na in studied of marine and freshwater fish [24, 19, 14]. Magnesium is needed for bone and new cell formation, vitamin B activation, muscle relaxation, blood clot formation and energy metabolism, maintenance of the electrical potential of nervous tissues and cell membranes RNA and DNA synthesis [10, 27]. Fish are weak sources of magnesium

according to Lall [17], it was also confirmed in the recent study. Mg in mackerel samples (336.867 ± 28.204 mg / kg.) was 39.2% higher than the value of this parameter in sprat muscle (204.29 ± 1.35 mg kg). The reported results for magnesium in this research were within 204.29-336.86 mg/kg, which coincides with the data specified by FAO - 4.5-452 mg/100g.

Potential health benefits of fish for human consumption are the presence of high protein content, ω3 fatty acids and vitamin and optimized mineral composition of muscle. In conclusion, the results of this study can be used in studies of human nutrition and food composition.

4. Conclusion

Horse mackerel and mackerel have the highest levels of K and Ca and P and Na, respectively, compared with these ones of the rest investigated species. The lowest amount of Ca, K,P, Na and Mg have mackerel, European sprat, bluefish, European sprat and bluefish, respectively. When comparing the mean values of each of the macronutrients depending upon the degree of accumulation in the meat samples of the tested fish, their concentration can be arranged in the following order: K > P > Na> Mg > Ca. Research in this area provide the necessary information on the nutritional value of fish products in relation to healthy human nutrition.

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