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Estimation of the Essential Mineral Content in Biota Species from the Ionian and Adriatic Coastal Areas in Albania

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Abstract - Essential elements are critical components that facilitate the optimal functioning of the human body. To sustain optimal health, our body necessitates a diet abundant in components such as iron, zinc, selenium, calcium, magnesium, iodine, and phosphorus. Individuals typically obtain nutrients primarily through dietary intake; however, the current trend of utilizing supplements has emerged as a shortcut for nutritional provision. Dietary supplementation could serve as an effective strategy to address these inadequacies. Challenges related to restricted mineral solubility in the digestive system can obstruct proper dissolution and inhibit absorption, resulting in deficiencies and adverse gastrointestinal symptoms. From this viewpoint, fish constitutes a healthful diet rich in essential components. The levels of important essential elements, magnesium and calcium were determined in 51 marine biota species collected to Adriatic and Ionian Seas coastal areas. The maximum concentration of Ca (6213 mg/kg$_{ww}$; 5168 mg/kg$_{ww}$ and 4858 mg/kg$_{ww}$) was found in species *Dentex dentex*, *Zeus faber* and *Pagellus acarne*, respectively. Such values correspond to 10.6 - 13.5% of the recommended daily intake for people from 9-18 years and from 13.8-17.6 % of the RDI for ages 19-50. Species *Penaeus japonica* and *Patella vulgate* exhibited the highest concentration of Mg, respectively 997 mg/kg$_{ww}$ and 870 mg/kg$_{ww}$, corresponding to 6.2-8.1 % of the RDI for women and 7.2-9.4% for men.

Keywords: essential minerals, biota species, total daily dose, Adriatic and Ionian Sea, RDI

1. Introduction

Nutrients in human nutrition are those substances and elements necessary for the proper functioning of the human body [1]. Based on their specialized functions, they are categorized into two main categories: macronutrients (carbohydrates, proteins, and lipids) and micronutrients (calcium, magnesium, sodium, potassium, iron, zinc, copper, and manganese). Macronutrients serve as the primary source of calories, whereas vitamins, minerals, and water are categorized as micronutrients that do not provide energy but are vital for the body's healthy functioning [1,2].

Mikroelements such as Ca, Mg, Na, K, Fe, Zn, Cu, and Mn are involved in various biochemical reactions; calcium, magnesium, and phosphorus are essential for bone and tooth formation; sodium and potassium collaborate in nerve impulse transmission and maintaining electrolyte balance; zinc primarily acts as a cofactor in enzymatic reactions, while iron is a component of hemoglobin, facilitating oxygen transport throughout the body [2, 3]. Insufficient intake of these elements, primarily through diet, may lead to mineral deficiency conditions such as anemia, osteoporosis, stunted growth, and genetic problems [4].

The World Health Organisation reported that about 2 billion of the world's population is suffering from mineral and vitamin deficiencies and the majority of these are in the third world countries (FAO/WHO, 2001), [5].

Current solutions for alleviating nutritional deficiencies emphasize mineral supplementation and food fortification, which are helpful but ultimately unsustainable, particularly in developing nations. Magnesium oxide, although it has a high concentration of elemental magnesium, exhibits limited solubility and bioavailability, whereas alternatives such as magnesium citrate have superior solubility but contain lower amounts of elemental magnesium [2, 6, 7].

The distinctions occur because magnesium oxide is an inorganic magnesium salt, while magnesium citrate is an organic magnesium salt [2, 3]. Research demonstrates that organic magnesium salts possess superior solubility and bioavailability relative to inorganic magnesium salts. The solubility of a supplement directly influences its dissolution and absorption within the digestive system [7, 8]. Magnesium supplements that lack adequate solubility frequently exhibit restricted absorption and tolerability [9, 10]. Unabsorbed magnesium salts demonstrate significant osmotic activity in the large intestine, perhaps leading to gastrointestinal discomfort [9, 10]. Achieving a balance between providing sufficient elemental

magnesium in a supplement that dissolves effectively in the gastrointestinal tract and ensuring maximum absorption without adverse side effects is a significant problem [9].

Food-based solutions are regarded as most sustainable and are now being assessed for their potential to improve mineral consumption. Fish possesses significant promise for this technique as it offers a diverse array of nutrients, including important minerals for the body. Fish flesh typically contains minerals such as sodium, potassium, calcium, magnesium, phosphorus, sulfur, iron, manganese, zinc, copper, and iodine [10, 11].

Magnesium and calcium are essential minerals that are involved in numerous physiological processes in the human body. The are over 300 enzymatic reactions that include Mg, DNA synthesis, energy production, muscle and nerve function, while calcium plays a critical role in blood clotting, muscle contraction, nerve function, and bone health. In the European Union (EU), the recommended daily intake for magnesium is 300 mg/ day for women and 350 mg/day for men, while the recommended calcium intake is 1000 mg/day for adult men and women [12, 13].

The aim of this study was first to determine the nutritional value of some of the most commonly consumed sea food in Albania, due to Ca and Mg content. Taking into consideration the edible portion of each food and the mean consumption of each species per person per day in Albania, we have calculated the daily dietary intake of magnesium and calcium per healthy adult in the region. The data can help us to determine the extent of Ca and Mg supplementation due to sea food consumption.

2. Materials and methods

2.1. Map of sampling sites

Sea food samples were collected in the main fishing regions of Adriatic and Ionian seas in Albania. Respectively, Samples were collected in cities such as Durresi, Shkodra and Fieri located in the Adriatic Sea coast and in Saranda city, located in the Ionian Sea coast. In Figure 1 it is presented the map of sampling sites.

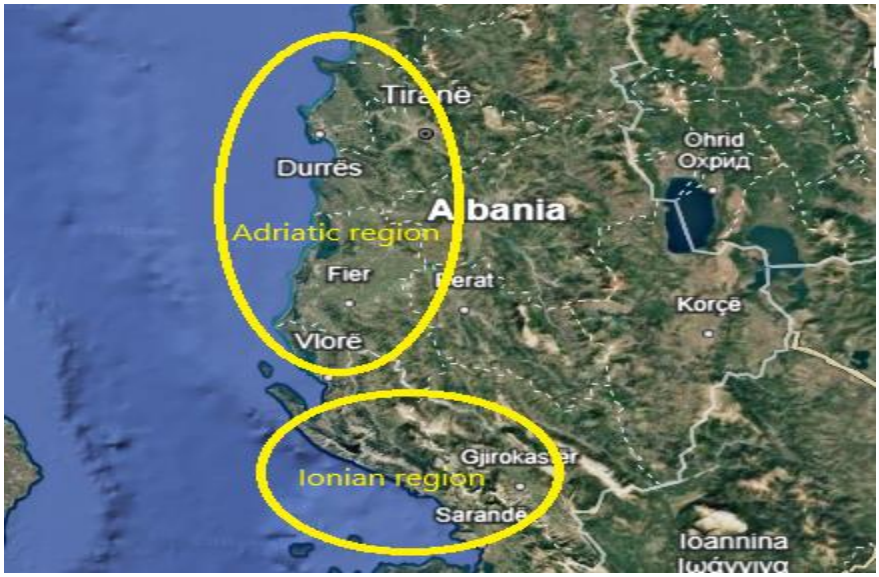


Fig.1 Map of sampling sites

2.2 Sample treatment and analytical procedure

Samples digestion was carried in closed Teflon vessels, where about 1.0 g of homogenized sample was first treated with HNO_3 65% for 24 h in room temperature and then temperature was raised up to 200°C, for 5 h. Then, digestion was continued in open vessels, until the volume of sample reached to 1-2 ml. At the end, 1-2 ml HCl 37% was added aiming to remove the excess of HNO_3. After cooling, samples were diluted to 50 ml with deionized water.

Determination of the concentration of Ca and Mg in selected samples was performed by linear regression method. For this purpose, standards and blanks were prepared from ultra pure standards of Ca and Mg, in 1% nitric acid. Measurements

were performed by using the Analytic Jena 800 F atomic absorption spectrometer, equipped with HCL for Mg and Ca,. Optimum wavelengths for each element were respectively 285.2 and 422.7 nm for Mg and Ca.

Quality control of the results was provided by the analysis of blanks, replicates and the analysis of the certified reference material, fish homogenate IAEA 407. Statistical software MINITAB 2023 was used for statistical treatment of the obtained results.

2.3. Estimation of daily intakes, EDI

For estimating dietary intakes of both elements, magnesium and calcium concentrations measured in seafood samples were considered. Based on the obtained results and in the data that exist regarding the seafood consumption in Albania (8.68 kg/year equaling for 23.8 mg/day), the daily dietary intake of magnesium and calcium was calculated on a daily basis, using the formula:

$$\mathrm{EDI} = \mathrm{DFC} \times \mathrm{MC}$$

where the DFC is the daily food consumption of sea food, (mg) and MC is the concentration of each element in sea food (mg/kg).

3. Results and discussions

3.1 Descriptive statistics

In presents study, 55 marine biota species were analyzed for the content of Ca and Mg in the edible part. The main aim was to identify species which can exhibit the highest content of each element by calculating also the extent of dietary levels that they can provide due to consumption. In Table 1 it is presented the descriptive statistics of the obtained results.

It was observed that the concentration of Ca varied between 237.9 - 6213.4 mg/kg in species collected in the Ionian Sea region, while in species collected in the Ardiatic Sea region the range was between 37.4 - 1379.0 mg/kg. Regarding Mg concentration, the ranges of concentration were respectively 151.4-613.9 mg/kg for Ionian Sea region and 30.0 - 996.7 mg/kg in the Adriatic Sea region. The highest concentration of Ca was recorded in Ionian Sea species while the highest concentration of Mg in species collected in the Adriatic Sea region.

Table 1. Descriptive statistics of results

Parameter	Ca - I	Mg - I	Ca - A	Mg - A
Mean	1606.2	312.5	265.7	435.3
Standard Error	279.4	17.9	61.0	45.4
Median	945.9	298.8	141.5	375.8
Standard Deviation	1504.4	96.3	311.2	231.6
Range	5975.5	462.5	1341.6	966.7
Minimum	237.9	151.4	37.4	30.0
Maximum	6213.4	613.9	1379.0	996.7
Confidence Level(95.0%)	572.2	36.6	125.7	93.6

3.2 Total concentration and Estimated Daily Intake, EDI

In the Fig. 2 we have presented the variation of Ca concentration in selected species of the Ionian and Ardiatic Sea, in mg/kg. Among the selected marine biota species, four of them are distinguished for the highest concentration of Ca. Both species belong to Ionian Sea region and respectively species *Callinectes sapidus*, (3117.2 mg/kg Ca); *Pagellus acarne* 4858.8 mg/kg Ca and *Zeus faber* 5168.2 mg/kg Ca; *Dentex dentex* 6213.4 mg/kg Ca.

A photo of each species with the highest content of Ca is presented in Fig. 3.

With regard to Mg, three species that have exhibited the highest concentration are respectively: *Mytilus galloprovincialis* (770.3 mg/kg Mg), *Patella vulgate* (870.3 mg/kg Mg) and *Penaeus japonicus* (996.7 mg/kg/mg),

belonging to Adriatic Sea region (Fig. 4). In Fig. 5 there are presented photos of the species exhibiting the highest content of Mg.

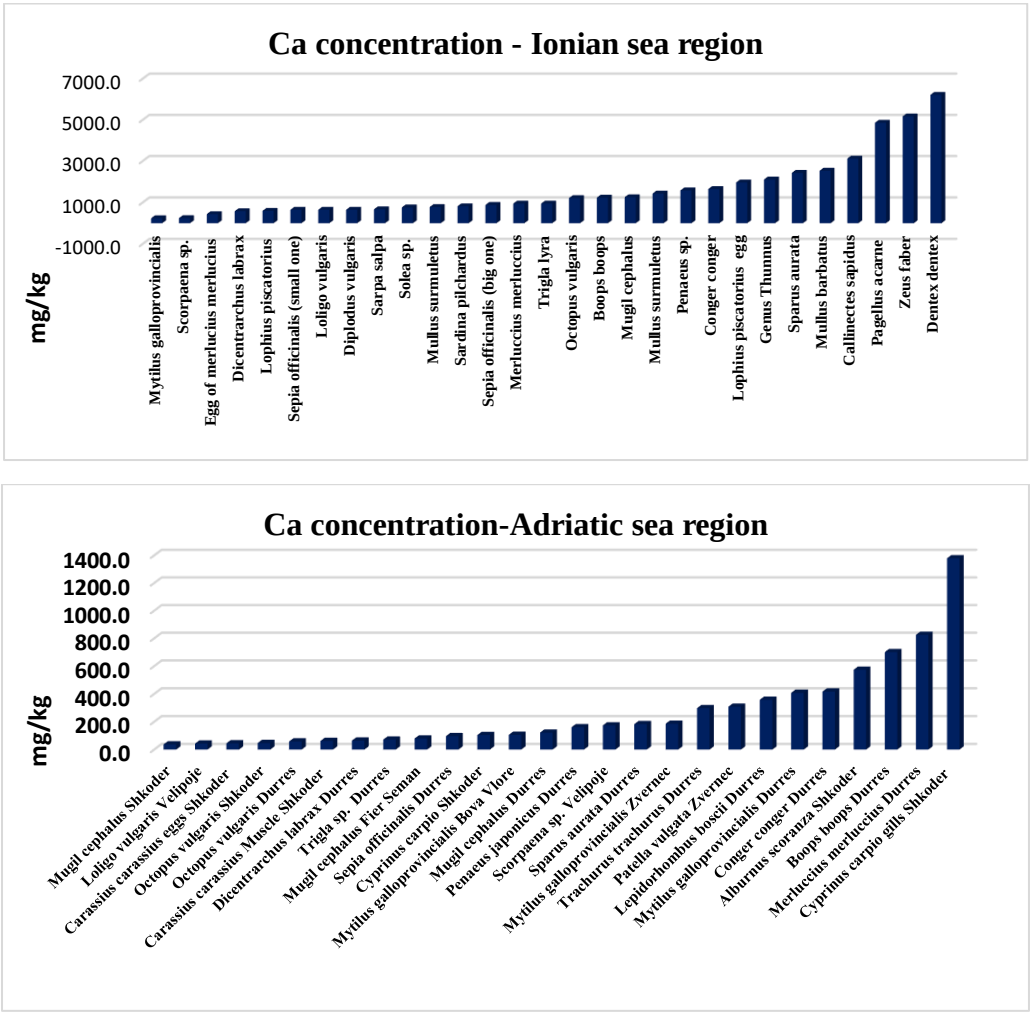
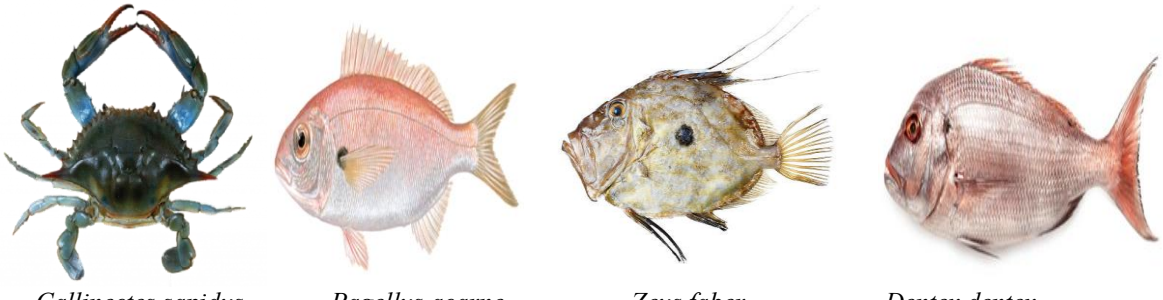


Fig. 2. Total concentration of Ca in selected species



Callinectes sapidus *Pagellus acarne* *Zeus faber* *Dentex dentex*

Fig. 3. Biota species exhibiting the highest Ca concentration

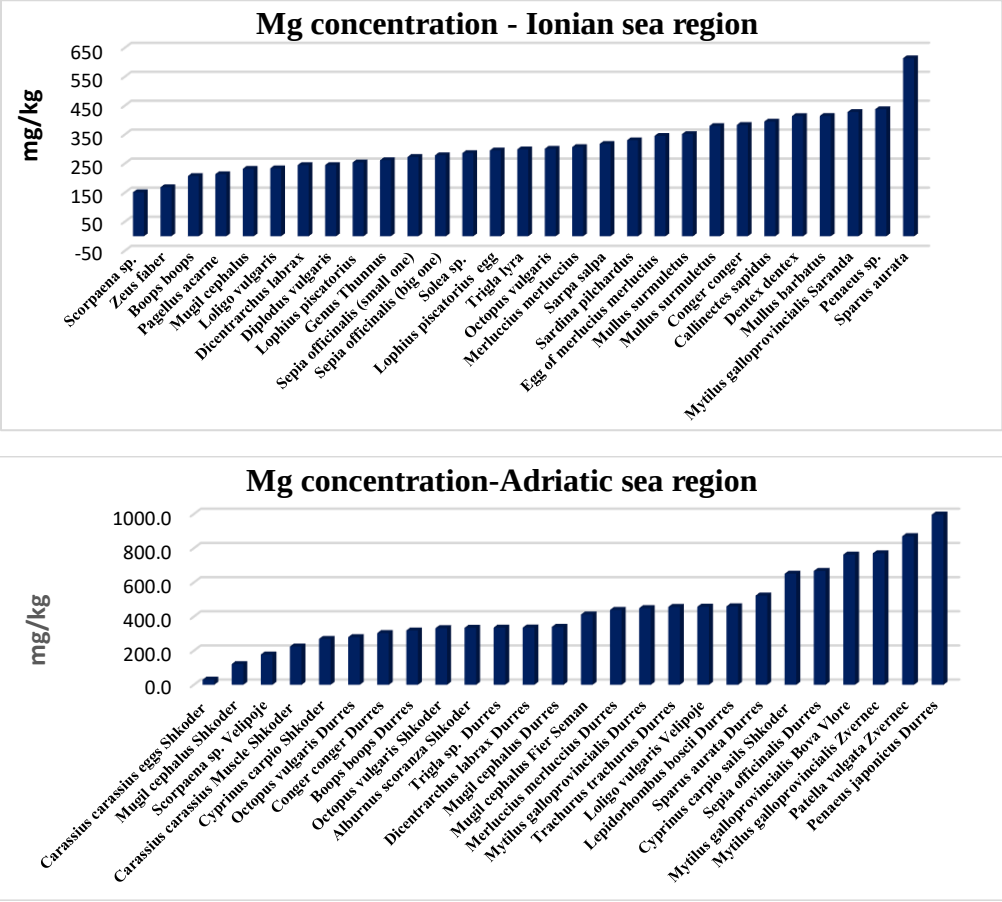


Fig. 4. Total concentration of Mg in selected species

Mytilus galloprovincialis *Patella vulgata* *Penaeus japonicas*

Figure 5. Biota species exhibiting the highest Mg concentration

Nutritional properties that sea food can provide due to its consumption with regard to Ca and Mg was calculated by means of the EDI value. Daily intake was calculated based on the concentration of Ca and Mg in the edible part of a certain species and the average quantity of sea food consumed by Albanian population, According to FAO (2020) consumption of seafood per capita in Albania is 8.68 kg per year, equating to around 23.8 g per day. Obtained results are expressed as the percentage of the recommended daily intake for both Ca and Mg.

Regarding Ca, the values recommended for different ranges of age of the population is considered, being respectively 1300 mg/day for ages 9-18 years and 1000 mg/day for age 19-50 years [12, 13, 14, 15]. With regard to Mg, recommended values are set for women and male, being respectively 350 mg/day for women to 300 mg/day for men [12, 13, 14, 15]. Obtained results are illustrated in Fig. 6.

Based on the obtained results, it can be concluded that the percentage of the dietary requirement for Ca that can be provided by consuming seafood ranges from 0.1-11.5 % for group of population of 9-18 years and from 0.6-15 % for the group of 19-50 years of age.

With regard to Mg, the percentage of the dietary requirement for Mg that can be provided by consuming seafood ranges from 1.2-6.8 % for women and from 1.2-8.0 % for men. These results assume that seafood consumption is not sufficient to provide the recommended quantity of Ca and Mg, if calculated based on the average consumption quantity. When seafood is consumed, it can range from 250-500 g for adults and sometimes even 1000 g, which is 10 – 50 times higher than the average value 23.8 mg/day. This means that in average, the Daily intake for Ca will vary from 2.5 – 750 % of the RDI and for Mg 12 – 400 % of the RDI.

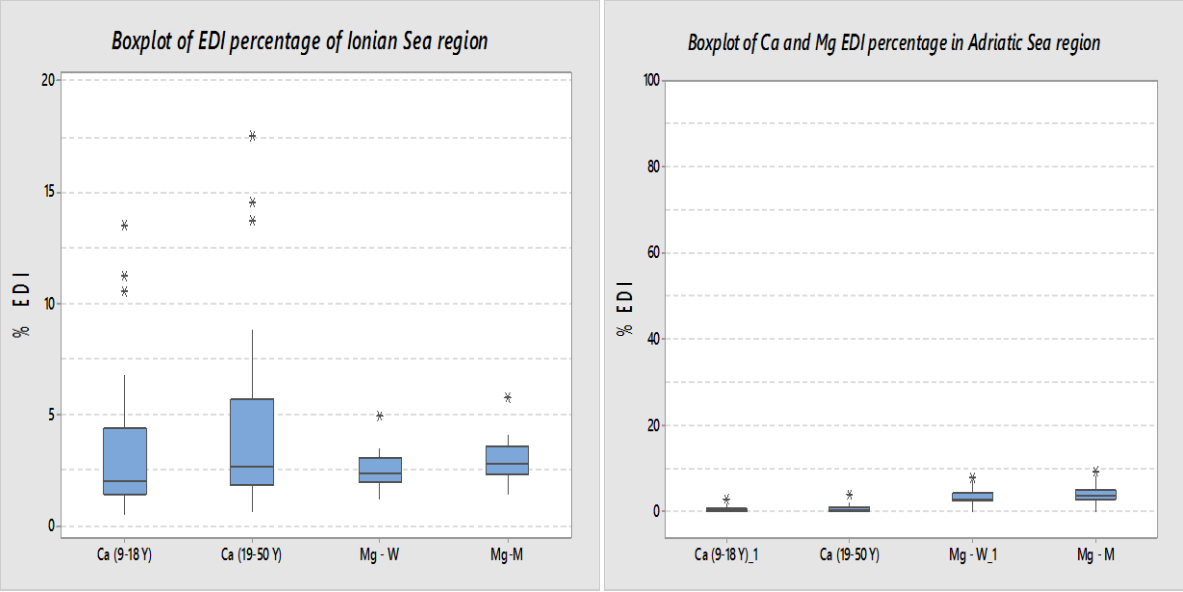


Fig. 6. EDI values of Ca and Mg provided from selected seafood

4. Conclusions

In this study, the nutritional properties of some selected biota species, collected in the fishing regions of Adriatic and Ionian seas in Albania were evaluated. Obtained results revealed that species of Ionian sea were characterized by higher content of Ca while species of Adriatic sea were characterized by higher content of Mg.

Estimated daily intake for Ca resulted to be lower than 16% and for Mg lower than 8%, based on the average quantity of sea food consumption. Considering the seafood intake in a usual meal, the EDI can reach values up to 700% of the RDI for Ca and up to 400% of the RDI for Mg.

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