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STUDY ON SOME MINERALS CONTENT IN NILE FISH

ALAA IBRAHEM SAYED ALI; HUSSEIN YOUSSEF AHMED YOUSSEF AND SHERIEF MOHAMMED SAYED ABD-ALLAH

Meat Hygiene Group, Department of Food Hygiene, Safety and Technology, Faculty of Veterinary Medicine, Assiut University, Assiut, Egypt.

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ABSTRACT

Five fish species (*Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume*) "25 of each" were collected from Assiut fish markets between January and December 2021 to determine the proximate composition (moisture, dry matter, fat, and ash), as well as some minerals: macro (calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), potassium (K); and micro minerals (iron (Fe) and zinc (Zn). Results of proximate composition revealed moisture mean values were (79.40, 81.22, 80, 76.20, and 78.75%, respectively) in samples of *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume* , dry matter mean values were (20.60, 18.81, 19.29, 23.80, and 21.25%, respectively); fat mean values were (1.54, 1.48, 1.29, 2.28, and 3.28%, respectively), and ash mean values were (1.02, 0.91, 0.97, 1.32, and 0.93%, respectively). A noteworthy distinction ($P<0.05$) was discovered between the mean value (g/100g) of proximate items for some studied fish species. Results of minerals content declared that calcium mean values were (494.34, 156.34, 159.99, 249.85, and 187.11, respectively) in the investigated samples of *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume;* phosphorus mean values (mg/100g) were (151.41, 159.20, 133.98, 232.13, and 265.30, respectively); magnesium mean values were (22.04, 15.12, 19.37, 19.29, and 13.81, respectively); sodium mean values were 1462.47, 1465.27, 1395.11, 1993.46, and 1673.54, respectively); and potassium mean values were 217.21, 394.28, 151.88, 347.72, and 239.79, respectively), iron mean values were (2.70, 3.48, 4.58, 6.88, and 2.63, respectively), and zinc mean values were 4.57, 2.48, 3.67, 3.41, and 3.79%, respectively). A significant difference between some studied fish species was found regarding their macro and microelement content. In conclusion, fishes under investigation are an excellent source of vital minerals, and it was observed that *Claris gariepinus* displayed superior mineral content and proximal quality.

Keywords: Nile fish, Proximate, Fat, Ash, Minerals, Calcium, Phosphorus, Zinc, Iron.

Corresponding author: Alaa Ibrahem Sayed Ali
*E-mail address:*alaaibrahemmomtaz@gmail.com; alaaibrahem230@gmail.com
Present address: Meat Hygiene Group, Department of Food Hygiene, Safety and Technology, Faculty of Veterinary Medicine, Assiut University, Assiut, Egypt.

INTRODUCTION

Fishes come in a variety of sizes, forms, habitats, and biological characteristics. Usually, they are found close to the summit of the food chain (Parveen and Gaikwad, 2018).

Fish is one of the possible sources of animal protein and vital nutrients for the upkeep of a healthy physique in emerging nations (Fawole *et al.*, 2007).

Because of delicate flesh, low cholesterol, and good palatability fish is well accepted (Eyo, 2001). In addition, they are a significant source of calcium, iodine, iron, selenium, and other minerals as well as vitamins. There is a wealth of evidence supporting the importance of fish consumption for a child's brain development and learning, for maintaining eye health and eyesight, and for preventing certain cancers and cardiovascular disorders (Sanker *et al.,* 2013).

The assessment of fish's moisture, protein, fat, and ash levels; is referred to as its "proximate composition" (Rani *et al.*, 2016). A variety of factors, including food composition, feeding and eating habits, feeding rate, age, size, sex, habitats, genetic characteristics, and season/migration, may influence the proximate composition of various fish species (Begum *et al.*, 2012). To make the most of fish, one must be aware of its makeup. When it comes to giving children, patients, and the elderly easily accessible sources of low-fat, high-protein diets, nutritionists and dieticians can benefit greatly from knowledge about the mineral and chemical compositions of freshwater fish (Foran *et al.*, 2005). Approximately twenty different minerals are necessary for the human body to function effectively (Williams 2006). These components fall under the categories of macro and micro-minerals. The macro-minerals calcium (Ca), phosphorous (P), magnesium (Mg), sulfur (S), sodium (Na), chloride (Cl), and potassium (K) are required in doses more than 100 mg/day. Micro-minerals, which are required in less than 100 mg/day, consist of elements like iron (Fe), manganese (Mn), zinc (Zn), iodine (I), selenium (Se), and a few more (Mahan and Escott-Stump 2005). These components are necessary for the sustenance of life, development, and reproduction (Alsafwah *et al.,* 2007). Anemia, osteoporosis, goiter, stunted growth, and genetic problems are examples of mineral deficiency diseases that can occur when the body does not receive enough of these elements, primarily from food intake (Bhandari and Banjara, 2015).

The current study set out to look into the mineral content and proximate makeup of a few different species of Nile fish.

MATERIALS AND METHODS

1. Collection of specimens:

A total of 125 samples, 25 of each of the following species, were collected from fish markets in Assiut city: Al Weledya, Riad Street, and Al Magzob: *Oreochromis niloticus*, *Bagrus bayad*, *Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume*. The Laboratory of Meat Hygiene Section, Department of Food Hygiene, Safety and Technology, Faculty of Veterinary Medicine, Assiut University, received each sample individually packed in a polyethylene bag, collected in an icebox, and transferred for preparation and analysis. Samples that are thought to have been taken and examined while still fresh (with brilliant red gills, transparent eyes, and intact scales).

2. Preparation of samples (AOAC, 2000):

After the fish's head and fins were removed, they were deboned. We took about 40g of the fresh fish flesh and ground it up in a mortar.

Two separate analyses of the samples were conducted. Every sample underwent proximate analysis, which included measurements of moisture, dry matter, fat, and ash. Additionally, the samples' mineral contents, including phosphorus, calcium, sodium, magnesium, potassium, zinc, and iron, were examined.

3. Proximate composition analysis:

3.1. Moisture content determination (AOAC, 2000):

A 10 gram sample of the prepared wet sample was dried at 65°C for 24 hours and subsequently at 105°C for 6 hours in a hot air oven (Fine Tech, Shinsaeng, Korea).

Moisture percentage = (W 1-W2)/w1 x 100
W1= The sample's weight before drying
W2= The sample's weight following drying

Note: The dry matter percentage was determined using the following method:

Moist% – dry matter% = 100

3.2. Calculating the proportion of fat using "ether extract" (AOAC, 2000):

After weighing one gram of the dried sample, it was placed in the thimble of the Soxhlet apparatus and wrapped in filter paper with a given weight.

Petroleum ether (60/80) was used for the extraction, which lasted for 17 hours.

The following formula was used to get the fat percentage:

(W1-W2)/A x 100 = Fat%
W1 = Weight prior to extraction
W2 is the weight following extraction.
A = Sample weight

3.3. Ashes content determination (AOAC, 2000):

Porcelain crucibles that had been previously weighted and cleaned were used to weigh one gram of the dry material.

The crucibles were placed in a Muffle Furnace (Thermolyne, 6000 Furnace) and burned for six hours at 550°C, producing a grayish-white ash.

The following formula was used to get the ash content:
Ash% is equal to (ash weight) / (sample weight) x 100.

4. Determination of Element composition (ISO, 1996 and 1998):

4.1. Mineralization of sample (incineration method):

• One gram of the dry sample was taken in crucible and was ashed at 500-550°c for 6 hours, and after cooling, 10 ml Nitric acid 1+2 (v/v) (one volume from Nitric acid 65% with two volumes of double distilled water and mixed well) was added. The solution was covered with watch glass and heated in a boiling water bath for 30 minutes then cooled. The content was transferred to a 100 ml volumetric flask and diluted to the mark with water (deionized water) then mixed well. The dilution was filtered through filter paper and the first 5 - 10 ml of the filtrate was discarded. The filtrate was collected in a brown glass bottle and the sample was ready for minerals estimation.

4.2. Estimation of macro-elements

4.2.1. Calcium content:

According to procedures of Calcium O-CPC kits “Spectrum-diagnostics, Germany IFUFCC07”.

$$\text{Calcium conc. (mg/dl)} = \frac{A_{\text{sample}}}{A_{\text{standard}}} \times 10 \times \text{dilution}$$

4.2.2. Phosphorus content.

According to procedures of Phosphorus, Inorganic kits “Spectrum- Diagnostics, Germany IFUFCC34”.

$$\text{Phosphorus conc. (mg/dl)} = \frac{A_{\text{sample}}}{A_{\text{standard}}} \times 5 \times \text{dilution}$$

4.2.3. Magnesium content:

According to procedures of Magnesium kits “Spectrum-diagnostics, Germany IFUFCC94”.

Magnesium conc. (mg/dl) =

$$\frac{A_{sample}}{A_{standard}} \text{ x } 2.5 \text{ x dilution}$$

4.2.4. Sodium content:

According to procedures of Sodium kits "Spectrum-diagnostics, Germany IFUFCC94".

$$\text{sodium conc.}(\mathrm{mg/dl}) = \left(\frac{A_{sample}}{A_{standard}} \text{ x } 150\right) \text{x} \frac{\text{dilution x } 23*}{10** \text{ x } 1***}$$

Where: *23 = atomic weight of sodium.
**10 = conversion factor (L to dl)
***1 = the valence of sodium

4.2.5. Potassium content:

According to procedures of potassium kits "Spectrum-diagnostics, Germany IFUFCC53".

$$\text{Potassium conc.}(\mathrm{mg/dl}) = \frac{A_{sample}}{A_{standard}} \text{ x } 5 \text{ x } \frac{\text{dilution x } 39.098*}{10**}$$

Where: *39.098 = conversion factor, which relates to the molecular weight of potassium
**10 = conversion factor (L to dl)

4.3. Estimation of micro-element:

4.3.1. Iron content:

According to procedures of Iron kits "Spectrum-diagnostics, Germany IFUFCC94"

$$\text{Iron conc.}(\mathrm{mg/dl}) = \frac{A_{sample}}{A_{standard}} \text{ x } 200 \text{ x} \frac{\text{dilution}}{1000*}$$

Where: *1000 =conversion factor (g to mg).

4.3.2. Determination of zinc content:

According to procedures of Zinc kits "Spectrum-diagnostics, Germany IFUFCC94"

$$\text{Zinc conc.}(\mathrm{mg/dl}) = \frac{A_{sample}}{A_{standard}} \text{ x } 200\text{x} \frac{\text{dilution}}{1000*}$$

Where: *1000 = conversion factor (µg to mg).

N.B.

- The obtained results on a dry-weight basis were converted on wet wet-weight basis using the following equation according to Jurgens and Bregendahl (2007):

Nutrient wet basis%= (nutrient dry basis% X dry matter %)/ (100)

- The color absorption was measured at the central laboratory, Faculty of Veterinary Medicine, Assiut University using a spectrophotometer (Unic, UV-2100 Spectrophotometer).

5. Statistics:

All statistical analysis was performed using Graph Pad Prism version 8.0.2 (263). The data was analyzed using a one-way analysis of variance (ANOVA). The findings were shown as a mean SE. Group comparisons were conducted using Tukey's multiple-range tests when significant differences were detected at P<0.05.

RESULTS

Table 1: Average values of the fish species samples' proximate composition (n = 25 per sample).

Fish species	Moisture	Dry matter	Fat	Ash
Oreochromis niloticus	$79.40^{ab}\pm0.26$	$20.60^{b}\pm0.26$	$1.54^{b}\pm0.17$	$1.02^{b}\pm0.04$
Bargus Bayad	$81.22^{a}\pm0.24$	$18.81^{bc}\pm0.24$	$1.48^{bc}\pm0.17$	$0.91^{b}\pm0.05$
Lates niloticus	$80.72^{ab}\pm0.28$	$19.29^{b}\pm0.28$	$1.29^{c}\pm0.10$	$0.97^{b}\pm0.05$
Clarias gariepinus	$76.20^{c}\pm1.13$	$23.80^{a}\pm1.13$	$2.28^{b}\pm0.36$	$1.32^{a}\pm0.07$
Mormyrus kannume	$78.75^{b}\pm0.43$	$21.25^{b}\pm0.34$	$3.28^{a}\pm0.35$	$0.93^{b}\pm0.03$

The means in the same column show significant differences (P<0.05) with distinct superscripts.
Duplicate analysis on a wet basis.

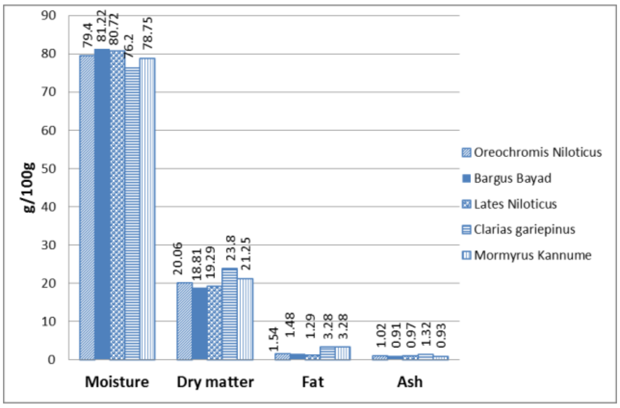

Chart 1: Average moisture, dry matter, fat, and ash percentages for the 25 fish samples from each species

Table 2: Average values of macro elements in fish species samples under examination (n = 25 per sample)

Fish species	Calcium	Phosphorus	Magnesium	Sodium	Potassium
Oreochromis niloticus	$494.34^{a}\pm60.94$	$151.41^{b}\pm5.19$	$22.04^{a}\pm2.23$	$1462.47^{b}\pm55.23$	$217.21^{c}\pm14.38$
Bargus Bayad	$156.34^{b}\pm26.41$	$159.20^{b}\pm9.52$	$15.12^{b}\pm0.68$	$1465.27^{b}\pm57.58$	$394.28^{a}\pm55.99$
Lates niloticus	$159.99^{b}\pm20.38$	$133.98^{b}\pm6.77$	$19.37^{ab}\pm1.30$	$1395.11^{b}\pm58.93$	$151.88^{c}\pm9.81$
Clarias gariepinus	$249.85^{b}\pm39.19$	$232.13^{a}\pm18.34$	$19.29^{ab}\pm2.03$	$1993.46^{a}\pm139.71$	$347.72^{ab}\pm37.34$
Mormyrus kannume	$187.11^{b}\pm29.30$	$265.30^{a}\pm19.83$	$13.81^{b}\pm1.61$	$1673.54^{ab}\pm78.16$	$239.79^{bc}\pm11.22$

The means in the same column show significant differences (P<0.05) with distinct superscripts.
Duplicate analysis on a wet basis.

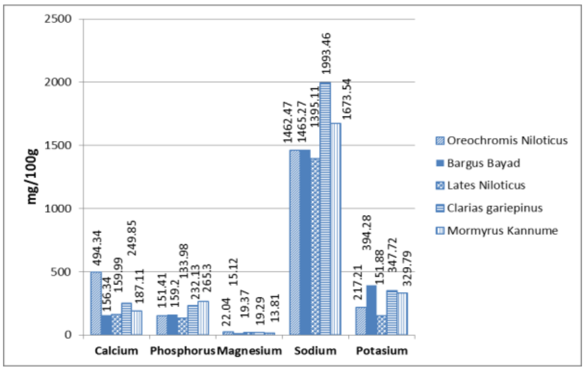

Chart 2: Average calcium, phosphorus, magnesium, sodium, and potassium content for the 25 fish samples from each species

Table 3: Micro element mean values of fish species samples analyzed (n = 25 per sample).

Fish species	Iron	Zinc
Oreochromis niloticus	$2.70^{c}\pm0.28$	$4.57^{a}\pm0.003$
Bargus Bayad	$3.48^{bc}\pm0.31$	$2.48^{b}\pm0.36$
Lates niloticus	$4.58^{b}\pm0.29$	$3.67^{ab}\pm0.28$
Clarias gariepinus	$6.88^{a}\pm0.66$	$3.41^{ab}\pm0.49$
Mormyrus consume	$2.63^{c}\pm0.22$	$3.79^{ab}\pm0.43$

The means in the same column show significant differences (P<0.05) with distinct superscripts.
Duplicate analysis on a wet basis.

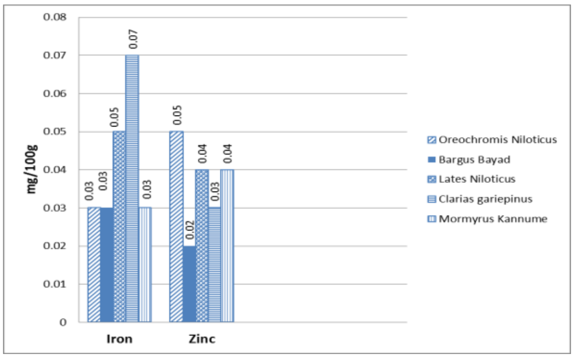

Chart 3: Average zinc and iron content for the 25 fish samples from each species

DISCUSSION

1) Proximate analysis:

The nutritional profile, which is derived from the proximate components of fish flesh, provides an initial indication of the fish's commercial criteria as needed by food regulations (Marichamy *et al.*, 2012).

1.1. Moisture:

Food's moisture content serves as a reliable gauge of its calorie, protein, and fat content. Fish with less moisture have more fat and protein in them, as well as more calories per unit (Barua *et al.*, 2012).

The achieved result in Table (1) and Chart (1) illustrated that the moisture mean values in the sample of *Oreochromis niloticus*, *Bagrus bayad*, *Lates niloticus*, *Clarias gariepinus*, and *Mormyrus kannume* were 79.40±0.26, 81.22±0.24, 80±0.28, 76.20±1.13, and 78.75±0.43 %, respectively. The significantly lower moisture content was recorded for the sample of *Clarias gariepinus* ($P<0.05$), while the highest value was estimated for *Bagrus bayad* fish samples.

These achieved results seem lower than that found by Gaber (2000), Premarathna *et al.* (2018), and Solomon and Oluchi (2018). However, nearly similar to Oluwaniyi *et al.* (2017), and Anarado *et al.* (2023). On the other hand, the obtained results were higher than Mohamed *et al.* (2010), Adeniyi *et al.* (2012) and Gana *et al.* (2020).

1.2. Dry matter:

The portion of the sample that remains after drying to a fixed weight at a specific temperature and after making up for volatile chemical losses in some feeds is known as dry matter, or DM (Åkerlind *et al.*, 2011).

The achieved result in Table (1) and Chart (1) showed that the dry matter mean values in *Oreochromis niloticus*, *Bagrus bayad*, *Lates* niloticus, *Clarias gariepinus*, and *Mormyrus* kannume were 20.60±0.26, 18.81±0.24, 19.29±0.28, 23.80±1.13, and 21.25±0.43%, respectively.

Clarias gariepinus had the highest dry matter content, while *Bagrus bayad* had the lowest with a significant difference ($P<0.05$).

Close values were released by Gaber (2000), and Jim *et al.* (2017). On the contrary, lower dry matter content was recorded by Premarathna *et al.* (2018), while higher content was found by Fagbenro *et al.* (2005)

Variable dry matter content of 90.11, 91.24, 93.31, and 92.4, respectively for *Clarias gariepinus*, *Oreochromis niloticus*, *Lates niloticus*, and *Bagrus bayad* was represented by Effiong and Fakunle (2011); and of “88.80±0.73” for *Oreochromis niloticus* by Kefas *et al.* (2014).

1.3. Fat content:

The beneficial fatty acid profile of fish is largely responsible for its nutritional significance (Sidhu, 2003). Details regarding the oil content of specific species and how it changes depending on the time of year or the area where it is captured are needed (Namaga *et al.*, 2020).

The achieved result in Table (1) and Chart (1) represented that the fat mean values in *Oreochromis niloticus, Bagrus bayad, Lates niloticus*, *Clarias gariepinus*, and *Mormyrus kannume* were 1.54±0.17, 1.48±0.17, 1.29±0.10, 2.28±0.36, and 3.28±0.35%, respectively.

The highest fat mean value was recorded for *Mormyrus kannume,* while *Lates niloticus* showed the lowest mean value with a significant difference (P<0.05).

Gaber (2000), Mohamed *et al.* (2010), and Idowu *et al.* (2015) recorded lower values. Also, lower values were found by Oluwaniyi *et al.* (2017) for *Oreochromis niloticus* "11.00±1.21", and for *Clarias gariepinus* "11.00±1.21". However, Babji (2015); and Gana *et al.* (2020) displayed nearly similar results. On the other hand, higher values were recorded by Olopade *et al.* (2016), Premarathna *et al.* (2018); Solomon and Oluchi (2018); and Anarado *et al.* (2023).

Fish lipid composition and moisture content are inversely correlated, according to FAO (1999). This is consistent with the current study's findings; which declared that the lipid concentration decreases with increasing moisture.

1.4. Ash content:

Ash content, which is a measurement of the mineral makeup of all food, including fish, is affected by a variety of variables, including the water's biological, physicochemical, and seasonal characteristics at the time of fishing (Akande and Faturoti, 2005).

The data in Table 1 declared the ash mean values in *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume* were 1.02±0.04, 0.91±0.05, 0.97±0.05, 1.32±0.07, and 0.93±0.03 %, respectively. This suggests that the species is a reliable supplier of minerals.

Clarias gariepinus represented a significantly higher mean value (P<0.05), while no significant difference was found between the mean values of the other investigated species.

Close mean values of "1.24", and "1.48" for *Oreochromis niloticus* male, and female, respectively were released by Olopade *et al.* (2016). But, higher mean values of "2.92", "2.55", "5.88", and "5.50", respectively for *Clarias gariepinus, Oreochromis niloticus, Lates niloticus,* and *Bagrus bayad* was represented by Effiong and Fakunle (2011); and of "1.10±0.12" and "1.18±0.08", respectively for *Clarias gariepinus* and *Oreochromis niloticus* by Anarado *et al.* (2023).

According to Ogata and Shearer (2000), fish chemical composition can be influenced by a variety of factors, including species, environmental conditions, fish size, amount of protein in the diet, and feeding rate. The present study's findings regarding proximate composition revealed significant differences (P0.05) between the studied fish species.

2) Element (Minerals) composition in fish

2.1. Macro-elements:

2.1.1. Calcium content:

The body and its skeleton depend on the mineral calcium. Many metabolic processes, neuromuscular activities (heart in particular), and most importantly, the stiffness of the skeleton are all influenced by calcium. Insufficient calcium causes osteoporosis and decalcification of the skeleton. In pregnant women, it can also result in hypertension, preterm birth, or fetal mortality (Vilain and Baran, 2016).

According to the FAO, the calcium content of fish muscles ranges from 19 to 881 mg/100g. Adults should consume 1000–1300 mg of calcium daily (FAO/WHO, 2004).

The data in Table 2 and Chart (2) summarized the calcium mean values in *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and

Mormyrus kannume were 494.34±60.94, 156.34±26.41, 159.99±20.38, 249.85±39.19, and 187.11±29.30 (mg/100g), respectively.

Mohamed *et al.* (2010) and Adeniyi *et al.* (2012) found higher values. However, Effiong and Fakunle (2011); Mohammed (2011); Ihie *et al.* (2018); Gana *et al.* (2020); Olanrewaju *et al.* (2020); and Agbugui and Inobeme (2023) displayed lower values.

The achieved results seem within FAO statement. It was noted that the 100g flesh of *Oreochromis niloticus* can provide 19.7 – 100%, while *Bagrus bayad* can provide 2.2-33.5% of the calcium recommended daily intake.

2.1.2. Phosphorus content:
Along with calcium and magnesium, phosphorus is a key component of bones (Masamba *et al.*, 2015). The FAO states that the range of phosphorus in fish muscles is 68-550 mg/100. The recommended daily requirement for adults is 700 mg of P (FAO/WHO, 2004).

The data in Table 2 and Chart (2) that explained the phosphorus mean values (mg/100g) in *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume* were 151.41±5.19, 159.20±9.52, 133.98±6.77, 232.13±18.34, and 265.30±19.83, respectively.

Effiong and Fakunle (2011), Mohammed (2011), Ihie *et al.* (2018), Gana *et al.* (2020), and Olanrewaju *et al.* (2020) found lower values. While, Mohamed *et al.* (2010) found high levels.

Jim *et al.* (2017) declared that phosphorus content under three different ecosystems was 175.00, 58.33, 308.33 (mg/100 g) in flesh of *Oreochromis niloticus*.

The current phosphorus values fall within that stated by FAO. It could be assumed that the 100g flesh of *Mormyrus kannume* can provide 37.8%, while *Lates niloticus* can provide 19% of the phosphorus recommended daily intake.

2.1.3. Magnesium content:
Magnesium plays enormous roles in all aspects of life, including immunological, metabolic, neurological, psychological, cardiovascular, and nervous systems (Guerrero-Romero *et al.*, 2023).

The FAO range of 4.5-452 mg/100 g is stated for fish flesh, and the recommended daily intake of magnesium for adults is 220-260 mg (FAO/WHO, 2004).

The data in Table (2) and Chart (2) represented the magnesium mean values in *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume* were 22.04±2.23, 15.12±0.68, 19.37±1.307, 19.29±2.03, and 13.81±1.61 (mg/100g), respectively. The levels fall within that stated by FAO.

Lower results were obtained by Effiong and Fakunle (2011), Mohammed (2011), Adeniyi *et al.* (2012), Ihie *et al.* (2018), Olanrewaju *et al.* (2020), and Agbugui and Inobeme (2023). Meanwhile, higher values were recorded by Mohamed *et al.* (2010),

Jim *et al.* (2017) declared that magnesium content under three different ecosystems was 24.17, 18.83, 46.00 (mg/100 g) for *Oreochromis niloticus* muscle tissue.

It was assumed that 100g of *Oreochromis niloticus* flesh can provide 3- 19%, and of *Bagrus bayad* can provide 4.5 - 9.6% of the magnesium recommended daily intake.

2.1.4. Sodium content:
Humans need sodium to keep their bodily fluid systems in balance as well as for the proper operation of their muscles and nerves. Each person's daily intake of salt

differs depending on their culture and particular needs (Munteanu *et al.*, 2019).

As stated by FAO sodium level was in the range of 30-134 mg/100 g in fish muscles (FAO/WHO, 2004).

The data in Table (2) and Chart (2) summarized the sodium mean values in *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume* was 1462.47±55.23, 1465.27±57.58, 1395.11±58.93, 1993.46±139.7, and 1673.54±78.16 (mg/100g), respectively. This seems higher than FAO statement.

Lower sodium levels were found by Mohamed *et al.* (2010) for *Lates niloticus*, *Bagrus bayad*, *Oreochromis niloticus*, Effiong and Fakunle, 2011, Adeniyi *et al.* (2012), Ahmed *et al.* (2017), Jim *et al.* (2017), Ihie *et al.* (2018), Gana *et al.* (2020), and Agbugui and Inobeme (2023).

The higher sodium content found in this investigation might suggest more sodium in the water with increasing water salinity in the areas of capture causing more trophic transfer and accumulation of this mineral in fish meat. The high sodium content is related to public health concerns for example raised blood pressure, increasing the risk of cardiovascular diseases, gastric cancer, obesity, osteoporosis, Meniere's disease, and kidney disease.

2.1.5. Potassium content:
Potassium is necessary for the contraction of muscles, nerve impulse transmission, and the metabolism of sugar (Alas *et al.*, 2014), as well as control of blood pressure (Vilain and Baran, 2016).

Fish muscle has a potassium content between 19 and 502 mg/100 g, which is the daily required amount. (RDA) of K is 800 mg for men in the 25–50 age range (FAO/WHO, 2004). The results in Table (2) and Chart (2) pointed out that the potassium mean values in *Oreochromis niloticus, Bagrus bayad, Lates niloticus, Clarias gariepinus,* and *Mormyrus kannume* were 217.21±14.38, 394.28±55.99, 151.88±9.81, 347.72±37.34, and 239.79±11.22 mg/100g), respectively. Current levels seem within the FAO statement.

The present results seem to be higher than that estimated by Effiong and Fakunle, (2011); Mohammed, (2011); Ihie *et al.* (2018); Adeniyi *et al.* (2012) for Clarias gariepinus "102.86±0.12". Ahmed *et al.* (2017); Olanrewaju *et al.* (2020); and Agbugui and Inobeme (2023).

The variable potassium content of 11550, 12100, and 9545 (µg /g dry weight) for *Lates niloticus, Bagrus bayad, and Oreochromis niloticus*, respectively was represented by Mohamed *et al.* (2010), and 2101.00±0.58, 2502.33±1.86, and 1503.33±2.03 (mg/kg) for *Lates niloticus, Oreochromis niloticus, and Clarias gariepinus*, respectively was estimated by Gana *et al.* (2020).
From the results, it could be seen that 100g of *Bagrus bayad* flesh can provide 49%, and *Lates niloticus* can provide 18% of the potassium recommended daily intake.

2.2. Micro-elements:
2.2.1. Iron content:
The primary role of iron is in the movement of oxygen from the lungs to the organs. Leukocytes' ability to fight microorganisms strengthens the immune system, while the manufacture of steroid hormones promotes bodily growth. Deficiency can cause altered bodily growth, compromised immunological, neurological, and cognitive systems, and even malfunctioning muscles (Vilain and Baran, 2016).

FAO stated that the iron content in fish muscle was in the range of 1-5.6 mg/100 g, The recommended nutrient intake of iron for female adults between the ages of 19-50 years is 24 mg/day (FAO/WHO, 2004).

The obtained data in Table (3) and Chart (3) brought out that the mean values of iron content were 2.70±0.28, 3.48±0.31, 4.58±0.29, 6.88±0.66, and 2.63±0.22 (mg/100gm), respectively in *Oreochromis niloticus*, *Bagrus bayad*, *Lates niloticus*, *Clarias gariepinus*, and *Mormyrus kannume*, which seems parallel with FAO statement except for *Clarias gariepinus* being higher.

Lower mean values of 0.086, 0.081, 0.009, and 0.014 (mg/100gm) for *Clarias gariepinus*, *Oreochromis niloticus*, *Lates niloticus*, and *Bagrus bayad*, respectively were revealed by Effiong and Fakunle, (2011), Olanrewaju *et al.* (2020), and Agbugui and Inobeme (2023). But, higher values were represented by Mohamed *et al.* (2010) and Adeniyi *et al.* (2012).

The results assumed that 100g flesh of *Clarias gariepinus* can provide 35.4%, and of *Mormyrus kannume* can provide 12% of the iron recommended daily intake.

2.2.2. Zinc content:

The body uses zinc extensively for immunity and growth. It is found in all six types of enzymes and plays a role in over 300 catabolic and metabolic activities in addition to a variety of catalytic, structural, and cellular regulatory roles. also engaged in the three-dimensional arrangement of proteins that gives rise to their biological activity. A zinc shortage can cause neuro-behavioral impairments (cognitive and memory problems), as well as skin or gastrointestinal concerns in infants. It is harmful and its expression varies with age (Vilain and Baran, 2016).

The FAO stated zinc level in the ranges of 0.23 - 2.1 mg/100 g in fish muscle. The zinc recommended dietary allowance for adults is 8-11 mg per day (FAO/WHO, 2004).

The results in Table 3 and Chart (3) declared that the zinc mean values in *Oreochromis niloticus*, *Bagrus bayad*, *Lates niloticus*, *Clarias gariepinus*, and *Mormyrus kannume* were 4.57±0.36, 2.48±0.24, 3.67±0.28, 3.41±0.49, and 3.79±0.43 (mg/100gm), respectively. This seems higher than the FAO statement.

The current values agreed with that found by were higher than those found by Mohamed *et al.* (2010) for *L. niloticus*, *M rume*, *O. niloticus*. On the other hand, lower levels obtained by Effiong and Fakunle, (2011) for *Clarias gariepinus*, *Oreochromis niloticus*, *Lates niloticus*, and *Bagrus bayad*, and Also Adeniyi *et al.* (2012) declared lower value of "38.24±0.02 mg/kg dry weight" for *Clarias gariepinus*.
Current results assumed that 100g flesh of *Clarias gariepinus* can provide 12.5 – 81.8%, and of *Lates niloticus* can provide 25 – 36.5% of the zinc recommended daily intake.

The rate at which these components are available in the water body and the fish's capacity to absorb and convert the necessary nutrients from their food or the water bodies where they reside could be the causes of the variations in the content of the various nutritional components in the fish species and samples that were examined. This is supported by the findings of Martino *et al.* (2002), Adewoye *et al.* (2003) and Fawole *et al.* (2007).

CONCLUSION

People with high blood cholesterol and those experiencing dietary deficits are recommended to eat fish meat. According to the study, fish under investigation are a good supply of important minerals, and the mineral content of fish varies greatly among species. When compared to the other species under investigation, *Claris gariepinus* had shown superior proximate and mineral content. The general order of mineral concentration in the five investigated species was: *Claris gariepinus*> *Oreochromis niloticus*>

Mormyrus kannume> Bargus Bayad> Lates niloticus.

REFERENCES

Adeniyi, S.A.; Orjiekwe, C.L.; Ehiagbonare, J.E. and Josiah, S.J. (2012): Nutritional composition of three different fishes (Clarias gariepinus, Malapterurus electricus and Tilapia guineensis). Pakistan Journal of Nutrition, 11 (9): 793.

Adewoye, S.O.; Fawole, O.O. and Omotosho, J.S. (2003): Concentrations of selected elements in some freshwater fishes in Nigeria. Science Focus, 4 (2): 106–108.

Agbugui, M.O. and Inobeme, A. (2023): Nutritional Value, and Heavy Metal Contents of Fish from the Lower River Niger at Agenebode, Edo State, Nigeria. International Journal of Fisheries and Aquaculture Research, 9 (1): 60–67.

Ahmed, E.O.; Ahmed, A.M.; Ebrahim, S.J. and Adm, H.H. (2017): Proximate and mineral composition of some commercially important fishes in Jebl Awlia reservoir, Sudan. International Journal of Fisheries and Aquaculture Research, 3 (1): 51–57.

Akande, G.R. and Faturoti, E.O. (2005): Technological properties and biochemical studies of bonga Ethmalosa fimhriata. Fishery Technology, 42 (1): 61–66.

Åkerlind, M.; Weisbjerg, M.; Eriksson, T.; Tøgersen, R.; Udén, P.; Ólafsson, B. L.; Harstad, O.M. and Volden, H. (2011): Feed Analyses and Digestion Methods. NorFor-The Nordic Feed Evaluation System, 41–54.

Alas, A.; Özcan, M.M. and Harmankaya, M. (2014): Mineral contents of the head, caudal, central fleshy part, and spinal columns of some fishes. Environmental Monitoring and Assessment, 186: 889–894.

Alsafwah, S.; LaGuardia, S. P.; Arroyo, M.; Dockery, B.K.; Bhattacharya, S.K.; Ahokas, R.A. and Newman, K.P. (2007): Congestive heart failure is a systemic illness: a role for minerals and micronutrients. Clinical Medicine and Research, 5 (4): 238–243.

Anarado, C.J.O.; Ekolie, E.; Iziga, C.G.; Anarado, C.E. and Eboatu, A.N. (2023): A Comparative Study of the Nutritional Composition, Fatty Acid Profiles and Organoleptic Evaluation of Clarias gariepinus (African Catfish) and Oreochromis nilotius (Nile Tilapia) Raised under Wild and Pond-Cultured Systems. European Journal of Nutrition and Food Safety, 15 (9): 118–126.

AOAC "Association of Official Analytical Chemists" (2000): Official Methods of Analysis of Association of Analytical Chemist. 17th Ed., AOAC International, Gaithersburg. MD. The USA.

Babji, A. S.; Nur 'Aliah D. and Nurul Nadia M. (2015): Nutritional value and potential of freshwater fish in rivers and mining pools of Malaysia. UTAR Agriculture Science Journal, 1 (4): 18-23

Barua, P.; Pervez, M.A.; Sarkar, D. and Sarker, S. (2012): Proximate biochemical composition of some commercial marine fishes from Bay of Bengal, Bangladesh. Mesopot Journal of Marine Science, 27: 59–66.

Begum, M.; Akter, T. and Minar, M.H. (2012): Analysis of the proximate composition of domesticated stock of pangas (Pangasianodon hypophthalmus) in laboratory condition. Journal of Environmental Science and Natural Resources, 5 (1): 69–74.

Bhandari, S. and Banjara, M.R. (2015): Micronutrient deficiency, a hidden hunger in Nepal: prevalence, causes, consequences, and solutions. International Scholarly Research Notices, 2015: 1-9. http://dx.doi.org/10.1155/2015/276469

Effiong, B.N. and Fakunle, J.O. (2011): Proximate and mineral composition of some commercially important fishes in Lake Kainji, Nigeria. Journal of Basic and Applied Scientific Research, 1(12): 2497–2500.

Eyo, A.A. (2001): Fish Processing Technology in the Tropics, National Instit. Fresh Water Fish. Res.(FIFR) New Bussa Nigeria, 66–130.

Fagbenro, O.A.; Akinbulumo, M.O.; Adeparusi, O.E. and Raji, A.A. (2005): Flesh yield, waste yield, proximate and mineral composition of four commercial West African freshwater food fishes. -0706120961209Journal of Animal and Veterinary Advances, 4 (10): 848-851.

FAO (1999): World Production of Fish, Crustaceans and Molluscs by Major Fishing Areas. Food and Agriculture Organization of the United Nations, Rome, Italy, pp: 33.

FAO/WHO (2004): Vitamin and Mineral Requirements in Human Nutrition. Rome, Italy. World Health Organization and Food and Agriculture Organization of United Nations

Fawole, O.O.; Ogundiran, M.A.; Ayandiran, T.A. and Olagunju, O.F. (2007): Proximate and mineral composition in some selected freshwater fishes in Nigeria. Internet Journal of Food Safety, 9: 52–55.

Foran, J. A.; Carpenter, D.O.; Hamilton, M. C.; Knuth, B.A. and Schwager, S.J. (2005): Risk-based consumption advice for farmed Atlantic and wild Pacific salmon contaminated with dioxins and dioxin-like compounds. Environmental Health Perspectives, 113 (5): 552–556.

Gaber, M. (2000): Growth response of Nile tilapia fingerlings (Oreochromis niloticus) fed diets containing different levels of clove oil. Egyptian Journal of Aquatic Biology and Fisheries, 4 (1): 1–18.

Gana, A.B.; Ibrahim, R.; Iriobe, T.; Jega, I. S. and Mohammed, K.S. (2020): Proximate and mineral compositions of different fish species from Yamama Lake in Kalgo local government Area of Kebbi State, Nigeria. Journal of Agriculture and Food Environment, 7 (2): 17–25.

Guerrero-Romero, F.; Micke, O.; Simental-Mendía, L.E.; Rodríguez-Morán, M.; Vormann, J.; Iotti, S.; Banjanin, N.; Rosanoff, A.; Baniasadi, S. and Pourdowlat, G. (2023): Importance of Magnesium Status in COVID-19. Biology, 12 (5): 735.

Idowu, T.A.; Umar, A.B.; Jidauna, S.B. and Sogbesan, O.A. (2015): Nutritive values of Mormyrus rume and Protopterus annectens in Lake Gerio, Yola. BAOJ Food Sciences and Technology, 1(1): 4–9.

Ihie, I.S.; Gabriel, S.S. and John, E.-I. (2018): Proximate and macro element composition of four fish species from lower River Benue Makurdi Benue state Nigeria. Journal of Nutritional Health and Food Science, 6 (2): 1-6

ISO "International Organization for Standardization" (1996): Meat and Meat products - Determination of Total Phosphorus Content – spectrophotometric method, ISO 3730:1996 (E). Geneva Switzerland.

ISO "International Organization for Standardization" (1998): Meat and Meat products - Determination of Total Ash Content, ISO 936: 1998 (E). Geneva Switzerland.

Jim, F.; Garamumhango, P. and Musara, C. (2017): Comparative analysis of the nutritional value of Oreochromis niloticus (Linnaeus), Nile tilapia, meat from three different ecosystems. Journal of Food Quality, 8:1-8

Jurgens, M. H. and Bregendahl, K. (2007): Animal Feeding and Nutrition. 10th Ed Kendall/Hunt Publishing Company, Iowa, USA.

Kefas, M.; Michael, K. G.; Abubakar, K. A.; Edward, A. and Wahide, J. A.

(2014): Proximate and mineral contents of flesh and body parts of *Oreochromis niloticus* and *Synodontis clarias* in Mubi, Nigeria. Global Journal of Biology, Agriculture and Health Sciences, 3 (3): 116–121.

Mahan, K.L. and Escott-stump, S. (2005): Krause's Food, Nutrition & Diet Therapy, Philadelphia: Saunders, n. 12, 13520 p.

Marichamy, G.; Badhul Haq, M.A.; Vignesh, R.; Sedhuraman, V. and Nazar, A.R. (2012): Assessment of proximate and mineral composition of twenty edible fishes of Parangipettai coastal waters. International Journal of Pharma and Bio Sciences, 3 (2): 54–64.

Martino, R.C.; Cyrino, J.E.P., Portz, L. and Trugo, L.C. (2002): Effect of dietary lipid level on nutritional performance of the surubim, Pseudoplatystoma coruscans. Aquaculture, 209 (1–4): 209–218.

Masamba, W.R.L.; Mosepele, K. and Mogobe, O. (2015): Essential mineral content of common fish species in Chanoga, Okavango Delta, Botswana. African Journal of Food Science, 9(9): 480-486.

Mohamed, H.A.E.; Al-Maqbaly, R. and Mansour, H.M. (2010): Proximate composition, amino acid and mineral contents of five commercial Nile fishes in Sudan. African Journal of Food Science, 4(10): 650–654.

Mohammed, M.O. (2011): Mineral composition of some marine and freshwater fishes. Agriculture and Biology Journal of North America, 2 (7): 1113-1116

Munteanu, C.; Munteanu, D.; Hoteteu, M. and Dogaru, G. (2019): Balneotherapy–medical, scientific, educational and economic relevance reflected by more than 250 articles published in Balneo Research Journal. Balneo Research Journal, 10 (3): 174–203.

Namaga, W.M.; Yahaya, B. and Salam, M. A. (2020): Proximate composition of male and female African catfish (Clarias gariepinus) and tilapia (Tilapia zilli) in Jega River, Kebbi state. Nigeria. Journal of Fisheries, Livestock and Veterinary Science, 1: 28.

Ogata, H.Y. and Shearer, K.D. (2000): Influence of dietary fat and adiposity on feed intake of juvenile red sea bream Pagrus major. Aquaculture, 189 (3–4): 237–249.

Olanrewaju, A.N.; Kareen, O.K. and Oforishe, P.O. (2020): Proximate and micronutrient composition of Bayad (Bagrus bajad) and upside-down catfish (Synodontis resupinatus) from Lake Alau, Nigeria. Animal Research International, 17 (2): 3706–3712.

Olopade, O.A.; Taiwo, I.O.; Lamidi, A.A. and Awonaike, O.A. (2016): Proximate composition of Nile tilapia (Oreochromis niloticus) (Linnaeus, 1758) and tilapia hybrid (red tilapia) from Oyan Lake, Nigeria. Bulletin UASVM Food Science and Technology, 73(1): 19–23.

Oluwaniyi, O.O.; Dosumu, O.O. and Awolola, G.V. (2017): Effect of cooking method on the proximate, amino acid and fatty acid compositions of Clarias gariepinus and Oreochromis niloticus. Journal of the Turkish Chemical Society Section A: Chemistry, 4 (1): 115–132.

Parveen, I. and Gaikwad, J.M. (2018): Diversity of fish parasites from freshwater fishes of Masooli Reservoir of Parbhani District. International Journal of Scientific and Research Publications, 8 (10): 371–376.

Premarathna, A.D.; Kumara, A.; Jayasooriya, A.P.; Satharasinghe, D.A. and Pathirana, E. (2018): Proximate analyses of Nile tilapia (Oreochromis niloticus) and Black tiger prawn (Penaeus monodon) from

Sri Lanka. Oceanography & Fisheries Open Access Journal, 7 (5): 129–133.

Rani, P.; Kumar, V.P.; Rao, K.R. and Shameem, U. (2016): Seasonal variation of proximate composition of tuna fishes from Visakhapatnam fishing harbor, east coast of India. International Journal of Fisheries and Aquatic Studies, 4 (6): 308–313.

Sankar, T.V; Anandan, R.; Mathew, S., Asha, K.K.; Lakshmanan, P.T.; Varkey, J.; Aneesh, P.A. and Mohanty, B.P. (2013): Chemical composition and nutritional value of Anchovy (Stolephorus commersonii) caught from Kerala coast, India. European Journal of Experimental Biology, 3 (1): 85–89.

Sidhu, K.S. (2003): Health benefits and potential risks related to consumption of fish or fish oil. Regulatory Toxicology and Pharmacology, 38 (3): 336–344.

Solomon, R.J. and Oluchi, A.R. (2018): Proximate analysis and nutritional value of African catfish (Clarias gariepinus) fed with local (Telferia occidentales and Moringa olefera) and industrial feed (coppens). Journal of Fisheries and Livestock Production, 6 (2): 265–267.

Vilain, C. and Baran, E. (2016): Nutritional and Health Value of Fish: The Case of Cambodia. Inland Fisheries Research and Development Institute, Cambodia.

Williams, M. (2006): Dietary supplements and sports performance: metabolites, constituents, and extracts. Journal of the International Society of Sports Nutrition, 3: 1-5.

دراسة عن بعض العناصر المعدنية في الأسماك النيليه

آلاء ابراهيم سيد على ، حسين يوسف أحمد يوسف ، شريف محمد سيد عبدالله

Email: alaaibrahem230@gmail.com Assiut University web-site: www.aun.edu.eg

اجريت الدراسه الحاليه لتعيين ومقارنة التركيب الكيميائي ومستوي بعض العناصر المعدنيه في لحوم خمسة أنواع من الأسماك النيليه المتداوله في مدينة اسيوط وهي : البلطي ,البياض ,قشر البياض ,القرموط ,و البويزه حيث تم جمع عدد مائه وخمسة وعشرون عينة من الاسماك بواقع 25 عينة من كل نوع في الفترة من يناير الى ديسمبر 2021 من اسواق مدينة أسيوط .تم نقل العينات مُبَردةَ الى المعمل مباشرة، حيث تم تجهيزها لإجراء التحليلات المختلفة :تحليل نسبة المكونات الأساسية) الرطوبه ,الماده الجافه ,الدهون ,والرماد (، ونسبة بعض العناصر المعدنية) الكالسيوم ,الفوسفور ,الماغنسيوم، الصوديوم، البوتاسيوم ,الحديد ,الزنك .(أظهرت النتائج ان متوسط قيم الرطوبة في عينات البلطي ,البياض ,قشر البياض , القرموط ,البويزه هو 79.40 ± 0.26، 81.22 ± 0.24، 80.72 ± 0.28، 76.20 ± 1.13 ، و 78.75 ± 0.43, على التوالي ,المادة الجافة 20.60 ± 0.26، 18.81 ± 0.24، 19.29 ± 0.28، 23.80± 1.13 ، و 21.25 ± 0.43, محتوى الدهن 1.54 ± 0.17، 1.48 ± 0.17، 1.29 ± 0.10، 2.28 ± 0.36 ، و 3.28 ± 0.35, الرَّماد 1.02 ± 0.04 ، 0.91 ± 0.05، 0.97 ± 0.05، 1.32 ± 0.07 ، و 0.93 ± 0.03 على التوالي .أظهرت نتائج قياس محتوي عنصر الكالسيوم ان متوسط قيمه هو 494.34 ± 60.94، 156.34 ± 26.41، 159.99 ± 20.38، 249.85 ± 39.19 ، و 187.11 ± 29.30 مجم100/جم , بينما متوسط مستويات عنصر الفوسفور 151.41 ± 5.19، 159.20 ± 9.52، 133.98 ± 6.77 ، 232.13 ± 18.34، و 265.30 ± 19.83 مجم100/جم .بالنسبه لعنصر الماغنسيوم 22.04 ± 2.23 ، 19.37 ± 1.307، 15.12 ± 0.68، 19.29 ± 2.03 ، و 13.81 ± 1.55 مجم100/جم ,وعنصر الصوديوم 1462.47 ± 55.23 ، 1465.27 ± 57.58، 1395.11 ± 0.59، 1993.46 ± 139.7 ، و 1673.54 ± 78.16 مجم100/جم .و كان متوسط قيم عنصر البوتاسيوم 217.21 ± 14.38، 394.28 ± 55.99، 151.88 ± 9.81، 347.72 ± 37.34 ، و 239.79 ± 11.22 مجم100/جم ,علي التوالي .أما بالنسبه لعنصر الحديد فكانت متوسط قيمه 2.70 ± 0.28، 3.48 ± 0.31 ، 4.58 ± 0.29، 6.88 ± 0.66 ، و 2.63 ± 0.22 مجم100/جم .و لعنصر الزنك كان 4.57 ± 0.36، 2.48 ± 0.24 ، 3.67 ± 0.28، 3.41 ± 0.49 ، و 3.79 ± 0.43 مجم100/جم ,علي التوالي في عينات اسماك البلطي ,البياض ,قشر البياض , القرموط ,و البويزه .وقد لوحظ أن عينات اسماك القرموط كانت الأفضل من حيث التركيب الكيميائي و مستوي معظم العناصر المعدنيه محل الدراسه.