



## Biochemical Composition, Physicochemical, Microbiological Properties and Heavy Metal Concentrations of Some Tilapia Fish Species

Abdelrahman S. Talab, Fify R. Anees \*, Maha E. Genina, Ghada S.

Abdelaziz, Dalia M. El-Gaar and Hala E. Ghannam

National Institute of Oceanography and Fisheries (NIOF), Egypt



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### Abstract

Tilapia fish species have been identified as excellent source of inexpensive protein for the nutritional benefit of human beings. This study was aimed to evaluate the nutritive value and healthy safe quality of some commercial fish species (*Oreochromis niloticus*, *Sarotherodon galilaeus* and *Coptodon zillii*) collected from some River Nile Islands (El-Qeratten, El-Waraq, El-Zamalek, and El-Manial) during July 2020. The results showed that, the mean values of moisture, protein, lipid and ash of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020 were (79.25, 18.28, 1.48, 0.73%); (79.46, 18.23, 1.37, 0.71%) and (78.56, 19.34, 1.12, 0.43%), respectively. On the other hand, the pH, TVBN, TMA and TBA values were ranged 6.01-6.18; 14.11-15.80 mg/100g; 1.01-1.22 mg/100g and 0.49-0.40 mg MDA/kg, respectively. Referring to healthy safe quality aspects of some commercial fish species collected from some River Nile Islands during July 2020 it could be concluded that, the analyzed fish samples didn't contained any *Salmonella* or *Staphylococcus aureus* bacteria, while total bacterial count and coliform bacteria were ranged 3.18-3.66 and 2.01-2.249 ( $\log_{10}$  cfu/g), respectively. The presents study shows that, the Sb, As, Cd, Se, Sn and V were below the detection limits. Whereas, the mean values of Al, Cr, Co, Cu, Fe, Pb, Mn, Ni and Zn of *O. niloticus* were 20.59, 3.06, 0.09, 4.54, 25.10, 0.21, 1.86, 1.53, 22.08 mg/kg ww, respectively, while it were ranged 19.01, 3.06, 0.10, 4.47, 20.90, 0.33, 1.87, 1.75, 20.96 mg/kg ww, respectively for *S. galilaeus* and it were recorded 18.87, 3.12, 0.10, 5.48, 21.38, 0.29, 1.85, 1.98, 23.26 mg/kg ww, respectively for *C. zillii*. Also, the results indicated that, heavy metals concentrations in collected fish samples didn't exceed the maximum permissible limit set by WHO/FAO (2011). Based on the obtained results it could be concluded that fish samples collected from River Nile Island during July 2020 were suitable for human consumption and didn't pose any hazards to human health.

**Keywords:** River Nile Islands, freshwater fish, nutritive value.

### 1. Introduction

Fish quality refers to the nutritional value contents and volatile compounds indicators, especially protein and fats, which directly affect the overall acceptability of different fish species by the consumer through distinguishing the flavor and aroma compounds resulting from the volatile compounds [1]. The quality and nutritional value of fish is also directly affected by many internal and external factors such as genetic factors, size and age of fish, food and nutrition of fish, living conditions, temperature, fish handling, post-harvest transactions, transportation, processing, storage, processing parameters, etc [2],[3].

River Nile contains many islands that extend from

Aswan to the Mediterranean, which have undergone morphological changes as a result of urban sprawl, which led to a lack of green spaces. The islands of the Nile River, especially in Greater Cairo, are considered among the islands of great economic importance due to their enormous potential, in addition to being a source of fresh water fish, which must be checked to know the extent of their quality and compliance with local and international standards. Great Cairo area has four large permanent islands: El-Qeratten, El-Waraq, El-Zamalek, and El-Manial. These islands were occupied by human activities such as cultivation, residential development, and industrialization [4]. Tilapia fish is the most important fish species in the

\*Corresponding author e-mail: Fify\_anees@yahoo.com

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River Nile, and there are many tilapia fish species namely *Oreochromis niloticus*, *Sarotherodon galilaeus* and *Coptodon zillii*. Nile tilapia is a native and the main culture fish species in Egypt that has become a popular species worldwide; which contributes about 65.15% of Egyptian fish production and this is mainly due to easy to breed and grow in a variety of aquaculture systems [5]. Many researcher's evaluated the nutritive value of tilapia fish species [3, 6-14]. Therefore, this study was aimed to evaluate the nutritive value and healthy safe quality of some commercial fish species collected from some River Nile Islands (El-Qeratten, El-Waraq, El-Zamalek, and El-Manial) during July 2020.

## 2. Materials and methods

### Fish samples

*Oreochromis niloticus*, *Sarotherodon galilaeus* and *Coptodon zillii* fish species were collected from four River Nile Islands (I) El-Qeratten, (II) El-Waraq, (III) El-Zamalek and (IV) El-Manial during July 2020. Fish samples were carefully washed with potable water, packed in ice boxes and transported to Fish Processing and Technology Laboratory, National Institute of Oceanography and Fisheries, El-Kanater El-Khiria Fish Research Station, Qalubia Governorate, Egypt within one hours. Upon arrival, fish samples were rewashed with potable water, gutted, and rewashed again carefully and drained, respectively.

### Analytical methods

Chemical composition analysis of the fish fillet, including total ash, moisture, crude protein and crude fat contents were analyzed according to the methods described in the Association of Official Analytical Chemists [15] with certain modifications. The pH values were measured using as described by **Olafsdottir et al.** [16]. Total volatile base nitrogen (TVB-N) and tri-methyl amine nitrogen (TMA-N) were determined according to the methods given in **AMC** [17]. Thiobarbituric acid (TBA) reactive substance value was measured according to **Tarladgis et al.** [18], The total bacterial counts were determined by pour plating 1 mL of sample on agar (plate count agar, Oxoid, Cambridge, UK) incubated at 37°C for 24–48 h [19]. The total coliforms and *fecal coliforms* were performed as described by **AOAC** [20]. *Salmonella spp.* were isolated and identified according to **HPA (Health Protection Agency)** [21]. *Staphylococci* count was carried out according to **ICMSF (International Committee on Microbiological Specification for Foods)** [22]. Heavy metals and

minerals concentrations were analysed using an inductively coupled plasma-optical emission spectrometer (ICP-OES; Optima 5300 DV, Perkin-Elmer, USA). The obtained results ( $n = 3$ ) were statistically analysed [23]. using LSD ( $p < 0.05$ ) and they were expressed as mean  $\pm$  standard deviation (SD).

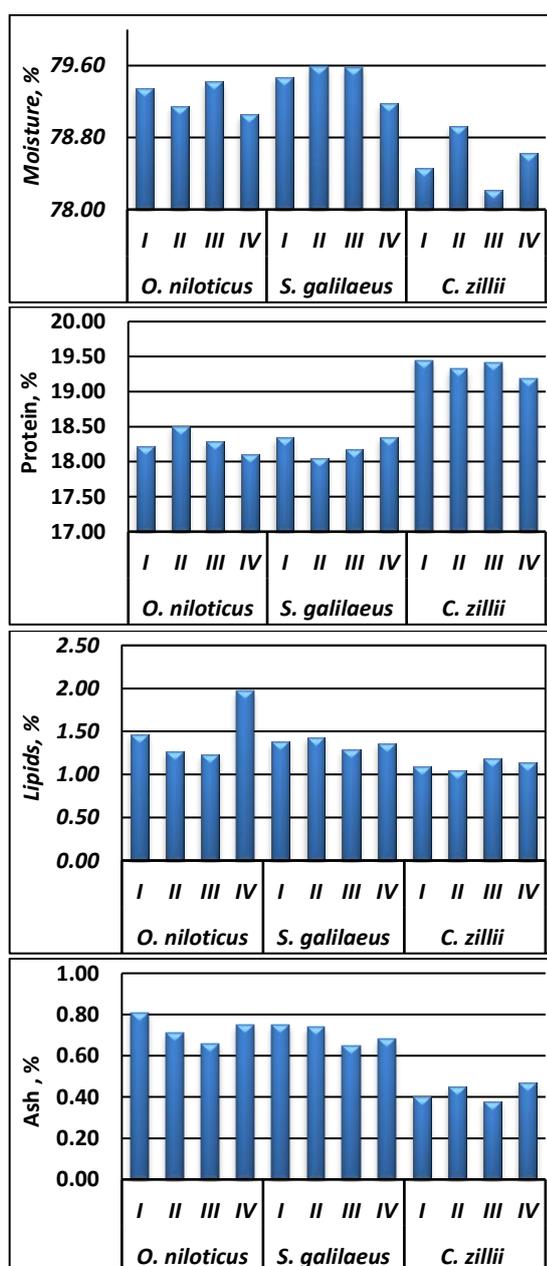
## 3. Results and Discussion

### Chemical composition of tilapia fish samples

The chemical composition is one of the most important indicators of the fish's quality and its nutritional values, and on the basis of it, the suitable processing method is selected for each fish species, such as smoking, canning, salting, or ready to eat fish products. The chemical composition varies according to the type of fish, breeding and seasons, age, location, sex and physiological status [24]. **Fig. (1)** shows the chemical composition of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020. From obtained results it was be clear that the mean values of moisture, protein, lipid and ash of *O. niloticus*, *S. galilaeus* and *C. zillii* were (79.25, 18.28, 1.48, 0.73%); (79.46, 18.23, 1.37, 0.71%) and (78.56, 19.34, 1.12, 0.43%), respectively. The results revealed that, there is no significant differences in chemical composition for the same fish species collected from different site, however, there was a significant differences between different collected fish samples *O. niloticus*, *S. galilaeus* and *C. zillii*. On the other hand, the higher values of moisture (79.59%) content was recorded in *S. galilaeus* fish samples collected from station II, while the lowest values (78.22%) was recorded at station III for *C. zillii*. The higher protein value (19.45%) was observed in *C. zillii* at station I, while the lowest value (18.05%) was found in *S. galilaeus* at station II. Also, the higher value of lipid (1.97%) was observed in *O. niloticus* fish samples collected from station IV, while the lowest value (1.05%) was recorded in *C. zillii* at station II. Also, the higher value (0.81%) of ash content was recorded in *O. niloticus* at station I, while the lowest value (0.38%) was recorded in *C. zillii* at station III. Similar results were reported by **Bombata Fashina et al.** [25] whom concluded that, the moisture, protein, lipid and ash contents of *S. galilaeus* were 79.93, 18.34, 0.65 and 1.75%, respectively.

**Adewumi et al.** [26] revealed that, the moisture, protein, lipid and ash of both *C. zillii* and *S. galilaeus* were (77.71, 19.32, 2.54, 0.43%) and (80.43, 17.75, 1.39, 0.43%), respectively. **Ghannam et al.** [10] reported that, *O. niloticus* had 80.55% moisture,

16.50% protein, 1.40% lipid and 1.25% ash. Also, the moisture, protein, lipid and ash contents of *O. niloticus* were 81.39, 13.66, 0.54 and 1.36%, respectively [27]. **Daniel et al.** [28] found that, *O. niloticus* had 77.03% moisture, 9.03% protein, 4.33% lipid and 6.51% ash. However, **Talab et al.** [3] stated that, moisture, protein, lipid and ash contents of Nile tilapia were 80.39, 16.97, 1.30, 1.19%, respectively. **Jim, et al.** [29] stated that, *O. niloticus* had 13.86% protein, 1.73% lipid and 1.76% ash. **Premarathna et al.** [30] stated that, *O. niloticus* had 89.51% moisture, 7.85% protein, 0.07% lipid and 0.46% ash.



**Fig. (1).** Chemical composition of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020.

Also **Hammed et al.** [31] stated that, the moisture, protein, lipid and ash of both *C. zillii* and *S. galilaeus* were (24.82, 49.08, 5.43, 4.21%) and (22.45, 47.49, 3.42, 5.73%), respectively. **Attalla et al.** [32] whom revealed that, moisture, protein, lipid and ash of *S. galilaeus* were 72.40, 54.01, 23.59 and 19.37%, on dry weight basis, respectively.

#### Physicochemical quality characteristics of tilapia fish samples

Table (1) shows physicochemical quality characteristics of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020. The present study shows that, the pH value varied in the ranges of (6.01-6.11), (6.07-6.18), (6.09-6.25) of *O. niloticus*, *S. galilaeus* and *C. zillii*, respectively, while TVB-N contents changed between (14.11-14.30), (14.19-14.89) and (15.14-15.80), mg/100g sample, respectively. On the other hand, TMA contents in *O. niloticus*, *S. galilaeus* and *C. zillii* fluctuated between (1.01-1.22), (1.00-1.09), (1.01-1.08), respectively. In the same manner the TBA values were found in the ranges of (0.45-0.48), (0.42-0.49), (0.40-0.43) mg MDA/kg sample. Generally, the obtained results revealed that, the pH values, TVBN, TMA and TBA values of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020 were within the **Egyptian Standard Specification** [33] and it's values didn't exceed the maximum permissible limits, so tilapia fish samples collected from these Island were safe for human consumption and didn't pose any hazards for human health. Similar results were reported by **Ghannam et al.** [10] whom stated that, *O. niloticus* had 6.85 pH value, 17.20 mg/100g TVBN and 0.95 mg/100g TMA. Also, **Talab et al.** [3] reported that, the mean values of pH value, TVBN, TMA and TBA contents of *O. niloticus* were 6.55, 17.73 mg/100g, 0.66 mg/100g and 0.75 mg MDA/kg, respectively.

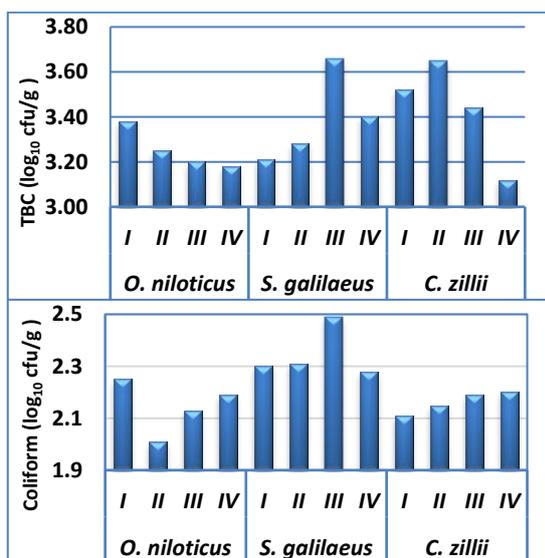
#### Healthy safe quality criteria of tilapia fish samples

##### Microbiological quality of tilapia fish samples

Microbiological quality characteristics ( $\log_{10}$  cfu/g) of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020 are shown in Fig. (2).

**Table (1).** Physicochemical quality characteristics of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020.

Stations	pH value	TVBN (mg/100g)	TMA (mg/100g)	TBA (mg MDA/kg)
<i>O. niloticus</i>				
I	6.01±0.04	14.30±0.03	1.15±0.05	0.44±0.03
II	6.05±0.05	14.11±0.03	1.12±0.02	0.48±0.03
III	6.09±0.01	14.13±0.03	1.01±0.03	0.47±0.04
IV	6.11±0.05	14.25±0.01	1.22±0.11	0.45±0.01
Average	6.07±0.03	14.20±0.02	1.13±0.04	0.46±0.02
<i>S. galilaeus</i>				
I	6.13±0.04	14.19±0.03	1.09±0.04	0.46±0.03
II	6.14±0.05	14.35±0.02	1.08±0.03	0.48±0.02
III	6.07±0.04	14.89±0.03	1.00±0.04	0.49±0.04
IV	6.18±0.01	14.22±0.03	1.03±0.02	0.42±0.03
Average	6.13±0.02	14.41±0.01	1.05±0.03	0.46±0.02
<i>C. zillii</i>				
I	6.25±0.03	15.14±0.04	1.08±0.02	0.41±0.05
II	6.09±0.05	15.19±0.05	1.05±0.01	0.40±0.01
III	6.18±0.04	15.45±0.04	1.04±0.02	0.42±0.03
IV	6.14±0.01	15.80±0.05	1.01±0.03	0.43±0.04
Average	6.17±0.03	15.40±0.03	1.05±0.01	0.42±0.02



**Fig. (2).** Microbiological quality characteristics (log<sub>10</sub> cfu/g) of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020.

The results showed that, the collected fish samples didn't contain *Salmonella* or *Staphylococcus aureus* bacteria. Also, the mean values of total bacterial count of *O. niloticus*, *S. galilaeus* and *C. zillii* collected from four River Nile Island during July 2020 were 3.25, 3.39, 3.43 (log<sub>10</sub> cfu/g), respectively, while the mean values of coliform counts were ranged 2.15, 2.35 and 2.16 (log<sub>10</sub> cfu/g), respectively. The results also indicated that, there was significant differences between collected fish samples which may be due to handling, harvesting, environmental conditions, transportation and storage temperature [3,34].

### Heavy metal concentrations of tilapia fish samples

Heavy metals concentrations of *O. niloticus*, *S. galilaeus* and *C. zillii* muscles collected from four River Nile Island during July 2020 are illustrated in Fig. (3). The presents study shows that, the Sb, As, Cd, Se, Sn and V were below the detection limits. Whereas, the mean values of Al, Cr, Co, Cu, Fe, Pb, Mn, Ni and Zn of *O. niloticus* were 20.59, 3.06, 0.09, 4.54, 25.10, 0.21, 1.86, 1.53, 22.08 mg/kg ww, respectively, while it were ranged 19.01, 3.06, 0.10, 4.47, 20.90, 0.33, 1.87, 1.75, 20.96 mg/kg ww, respectively for *S. galilaeus* and it were recorded 18.87, 3.12, 0.10, 5.48, 21.38, 0.29, 1.85, 1.98, 23.26 mg/kg ww, respectively for *C. zillii*. Generally, the concentrations of the analyzed metals were within the FAO/WHO [35] and they were in the following order Fe>Zn>Al>Cu>Cr Mn>Ni>Pb>Co. Similar results were reported by Adewumi et al. [26] who stated that, the concentrations of Na, Fe, Mn, Zn, Cu of both *C. zillii* and *S. galilaeus* were (0.84, 0.20, 0.10, 0.02, 0.03) and (0.80, 0.23, 0.11, 0.02, 0.02 mg/kg ww), respectively. Also, Ghannam et al. [10] found that Zn, Cu, Mn, Cd and Pb concentrations of *O. niloticus* collected from Abu Za'baal lakes during summer 2012 to spring 2013 were ranged (24.91-30.50), (1.01 and 3.41), (12.41- 13.25), (0.65 and 0.96) and (4.51 and 5.41 µg/g dry weight), respectively.

On the other hand Talab et al. [3] stated that, Fe, Mn, Zn, Cu, Pb and Cd of *O. niloticus* collected from the Nile rayahs from spring 2014 to winter 2015 were as follows: 33.89, 11.16, 15.75, nd, 0.92 and nd, respectively. Finally, Hammed et al. [31] reported that, Fe, Pb, Cd and Ni concentrations of *C. zillii* muscles were 2.83, 0.14, 0.14 and 0.06 mg/kg ww, respectively, while *S. galilaeus* muscles had 1.32, 0.21, 0.01 and 0.001 mg/kg ww respectively, for the same metals.

### Conclusion

The present study revealed that, physicochemical, microbiological and heavy metal concentrations of *Oreochromis niloticus*, *Sarotherodon galilaeus* and *Coptodon zillii* collected from some River Nile Islands (El-Qeratten, El-Waraq, El-Zamalek, and El-Manial) during July 2020 didn't exceed the maximum permissible limit set by national and international organizations. Based on the obtained results it could be concluded that fish samples collected from River Nile Island during July 2020 were suitable for human consumption and didn't pose any hazards to human health.

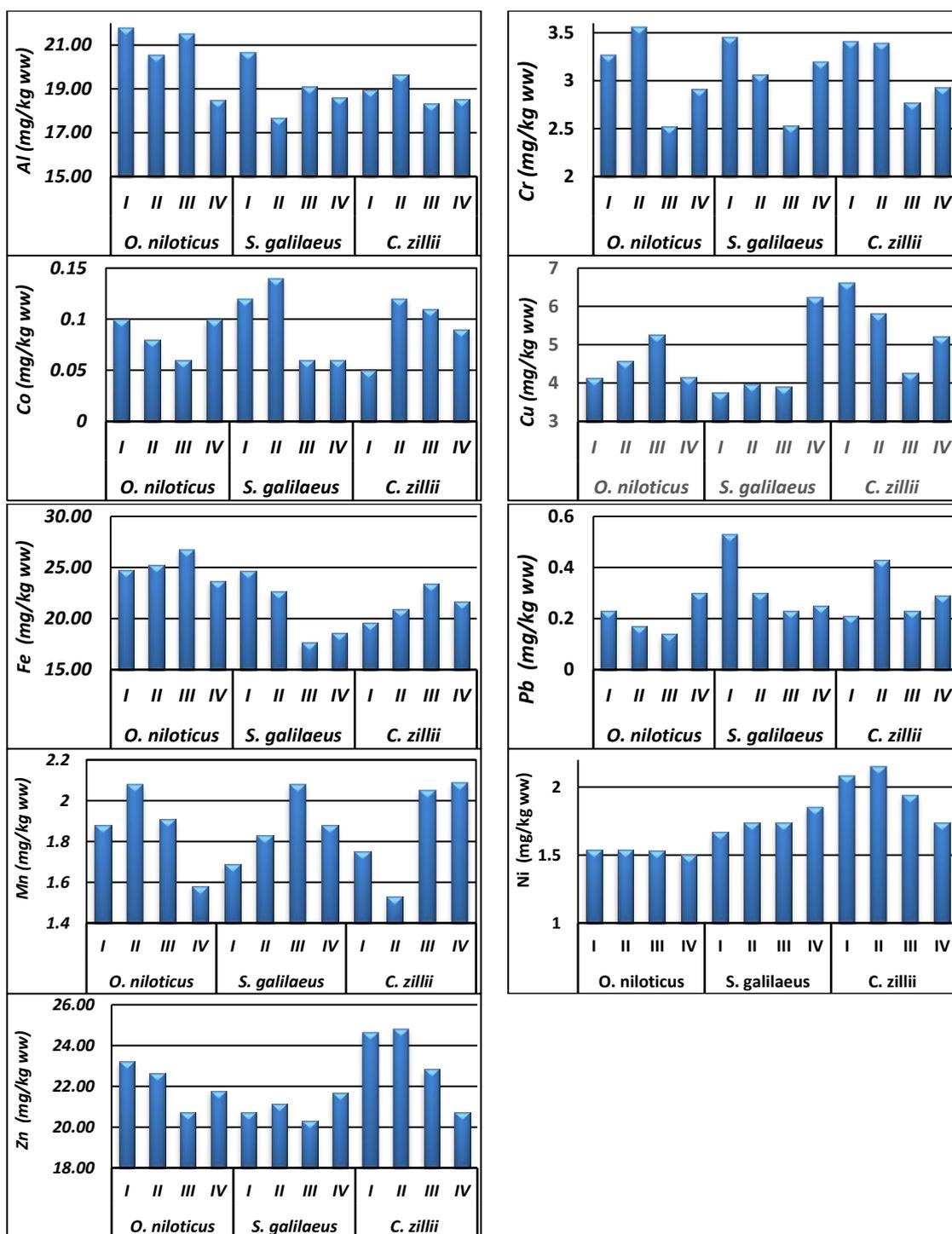


Fig. (3). Heavy metals concentrations of *O. niloticus*, *S. galilaeus* and *C. zillii* muscles collected from four River Nile Island during July 2020.

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