Direct Research Journal of Agriculture and Food Science

Proximate composition of minerals and heavy metals contents of four commercial fresh water fishes of the Blue Nile

Vol.6 (7), pp. 161-165, July 2018
ISSN 2354-4147
DOI: https://doi.org/10.26765/DRJAFS.2018.1211
Article Number: DRJA52001211

Direct Research Journal of Agriculture and Food Science
http://directresearchpublisher.org/aboutjournal/drjafs

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Received 18 May 2018; Accepted 20 June, 2018

The fish species from Al-Mowrada fish market were purchased and transported to the Laboratory, Faculty of Science and Technology, Chemistry Department for the estimation of biochemical composition such as crude protein, crude fat, moisture, ash, carbohydrate and some heavy metals. Fresh water species (*Auchenoglaris biscutatus,. Hydrocynus forskali, Labeo niloticus, and Oreochromis niloticus*) were collected for this study. Biochemical changes in total protein, carbohydrate, lipid, moisture and ash content were estimated by the standard procedures. This investigation aimed to estimate the toxic impact of selected heavy metals such as Pb, Cd, Fe, Cr and Zn on the biochemical changes in certain freshwater fish, *A. biscutatus, H. forskali, L. niloticus and O. niloticus* . The measurement of heavy metals like, Pb, Cd, Fe, Cr and Zn were done by absorption spectrophotometry. The total protein content of these species was in the order of 21.36%, 22.19%, 22.60% and 22.46% respectively. The crude fat content and ash ranged between 2.69% and 5.40%, 82.11% and 84.85% of the wet weight, correspondingly. The carbohydrate ranged between 83.49% and 89.94%. The moisture ranged between 73.52% and 81.04%.The highest value of (Pb) was in *A. biscutatus* and the least was in *O. niloticus*. The highest value of (Cd) was in *A. biscutatus* and the least was in *L. niloticus*. The highest value of (Fe) was in *A. biscutatus* and the least was in *H. forskali*. For (Zn) the highest value was *L. niloticus* and the least was in *A. biscutatus*. For (Cr) it is only detected in two species which were *L. niloticus* and in *O. niloticus*. The amount of (K) contents for the different species was higher than other minerals, while (Ca) was the lowest in most species.

Keywords: *Auchenoglaris biscutatus,. Hydrocynus forskali, Labeo niloticus, Oreochromis niloticus.*, proximate analysis, Blue Nile, Sudan

INTRODUCTION

Fish is an important component in the diets of many people. It is a good source of protein for humans and animals (Holma and Maalekuu, 2013). Fish is also an important source of poly-unsaturated fatty acids and also contains omega-3, calcium, iodine, phosphorous, iron, trace elements like copper and a fair proportion of the B vitamins known to support good health (Tucker, 1997; USDA, 2010). Nutritionists recommend that human should eat fish every day (Sutharshiny and Sivashanthini, 2011). An increasing amount of evidences suggest that, fish and fish oil (contain high amount of polyunsaturated fatty acids) are valuable in decreasing the serum cholesterol to prevent a number of coronary heart diseases and increase neurological development (Turkmen *et al*., 2005). Eating of fish can reduce the risk of heart diseases and lower the risk of developing dementia, including Alzheimer's diseases (Kelly and Knopman, 2008). Fish contains significantly low lipids and higher water than beef or chicken and is favoured over other white or red meals (Grant, 1997). The major constituents of fish are moisture, protein and fat with minerals occurring in trace amount (Holland *et al*., 1993). Fish mineral and metal contents may vary according to the surrounding environment (Ogundiran *et al*., 2014). Pollution of the aquatic environment by inorganic chemicals has been considered a major threat to water quality and the aquatic organisms including fishes. Their direct toxicity to man and aquatic organisms and the indirect toxicity through their accumulations in the aquatic food chain are issues of serious concern (Adesuyi *et al*., 2016). The objective of this study is to investigate the proximate composition, heavy metal and minerals composition of the selected fresh water fishes from Al-Mowrada fish market.

MATERIALS AND METHODS

Proximate analysis

Fishes from both sexes were examined. *Auchenoglaris biscutatus,. Hydrocynus forskali, Labeo niloticus, and Oreochromis niloticus* were collected from Al- Maowrada fish market.

Collection and preparation of sample

The samples of the fish types were bought from Al-Mowrada fish market. The fishes were then cut open and immediately a portion was used in moisture content determination. The remaining fishes were dried in oven at 60°C for 30 min, the temperature of oven was reduced to 40°C because the initial higher temperature was to remove most of water that may lead to spoilage of the fish by microorganism, while the lower temperature was to ensure the volatile and vital nutrients in fishes were not lost along with bound water in the fishes flesh. They were then grounded with mortar and pestle into fine powder and stored in a dried plastic container with cover until when used for various analyses.

Moisture content

The moisture content of the fish species was determined using the air oven drying method using a known weight of the fillet at 105°C until a constant weight was obtained (AOAC, 2000).Then the moisture content was calculated using the following formula:

$$\text{Moisture \%} = \frac{\text{Wet weight} - \text{dry weight X 100}}{\text{Wet weight}}$$

Ash content

Ash content was determined by incineration of the dried sample obtained from moisture determination in a muffle furnace at 500°C for 4 h; the ash percentage was calculated by the following formula:

$$\text{Ash \%} = \frac{\text{Weight of ash X 100}}{\text{Weight of sample}}$$

Protein content

Crude protein content was calculated by converting the nitrogen content, determined by Kjeldahl's method (6.25 X N) (AOAC, 2000). The protein percentage was given by the following formula:

$$\text{Protein \%} = \frac{(V_2 - V_1) \times N \times 14/1000 \times 6.25}{1000 \times \text{wt}}$$

Where:
V_1= Volume of HCl used in titration
V_2= Volume of HCl used in blank titration
N= Normality of HCl used in titration
14/1000= Conversion ratio from ammonium sulphate to nitrogen
Wt. = Weight of sample
6.25= Conversion factor from nitrogen to protein.

Oil content

The fat was determined by extracting the sample with petroleum ether (boiling point 60---80 °C) for six hours in Soxhelt apparatus. The extract was then dried in an oven at 100—105 °C for removal of extra ether traces, following the method by (AOAC, 2000). The fat content was given by the following formula:

$$\text{Oil \%} = \frac{\text{Weight of ether extracted fat} \times 100}{\text{Weight of sample}}$$

Carbohydrates content

The edible fresh (2.5 gm) was stirred with distilled water (10ml) and 52% perchloric acid (13 ml) for 20 min. The contents were diluted to 100 ml, filtered into a 250ml volumetric flask and made up to the mark. The diluted filtrate (1.0ml) was heated with 1% w/v anthrone reagent in sulphuric acid for 20 min. and the absorbance at 630 nm was measured in a Shimadzu UV-160 spectrometer. The concentration of glucose in the sample was calculated using a standard curve.

Heavy metals analysis

Elements such as lead, cadmium, iron, chromium and zinc were determined using Atomic Absorption Spectrophotometric method. The content were done in triplicate and reported as mean heavy metal content in mg/L of dry matter.

Mineral analysis

The mineral content (Calcium, Sodium, and Potassium) were determined using Flame Photometric method. While other mineral elements such as lead, cadmium iron, chromium and zinc were determined using Atomic Absorption Spectrophotometric method. The content of the mineral were done in triplicate and reported as mean mineral content in ppm of dry matter.

Data analysis

The descriptive statistics (mean, standard deviation) were conducted while statistical significance of differences ($P \leq 0.05$) was determined by analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Proximate composition

This study was carried out to investigate proximate composition, mineral content and heavy metal levels in four commercially important fish species available in fish markets of Khartoum State. Results showed that moisture and ash contents of the four species showed no significant variations as shown in (Figure 1). As well the protein, fat and carbohydrates percentages showed no significant variations among the four fish species as shown in (Figure 2).The percentage of the moisture contents of fish muscle was in the range of (73.52-81.04%) in all of the sampled fish species. Adewumi *et al.* (2014) reported that the stable water level in the fillet of fish species were due to the stable water in the water body where the fish lives. Zmijewski *et al.* (2006) found a reverse correlation between the fat and water content to be common among fish species, and it was in the same line with the present results as shown in *A. biscutatus* fish having the highest value for moisture (81.04%) and the lowest value for fat (2.69%), the least value for moisture was in *O. niloticus* (73.52%) and this species has the highest content of fat (5.40%). The fat contents were 3.53% for *H. forskalii*, 3.13% for *L. niloticus*. The difference in the value of crude fat level in the fish species could be due to stage of life, environmental state, food type, and species (Zenebe, 2010; Fabiola and Martha, 2012).

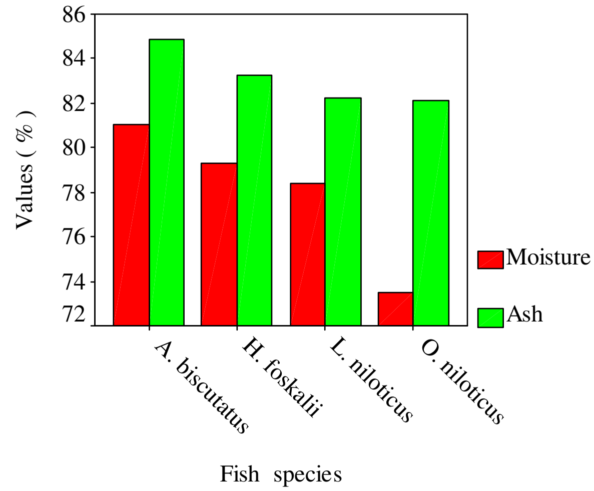

Figure 1. Ash and Moisture (%) for the different fish species collected from Al-Mowrda fish market during January-March 2018.

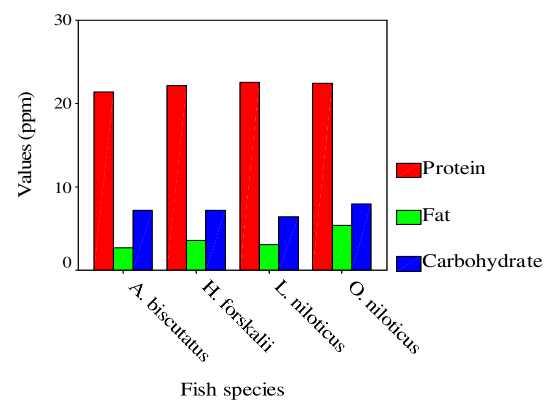

Figure 2. Protein, fat and carbohydrate values (ppm) in different fish species collected from Al-Mowrda fish market during January-March 2018.

Mineral contents

The mineral contents namely (Ca, Na, and K) detected in the four species showed no significant variation except for (Ca) that showed a significantly higher content in *O. niloticus* when compared to *L. niloticus*, *H. forskali* and *A. biscutatus* as clearly shown in (Figure 3).The highest values of (Ca) were in *O. niloticus* (11.032 ppm) and the lowest was in *A. biscutatus* (1.535 ppm). But *O. niloticus* has the lowest values in (K) (16.227 ppm). For (Na) the highest values were in *A. biscutatus* (10.913 ppm) and the lowest was in *H. forskali* (9.572 ppm).The variation observed in the content of minerals in the fish fillets could be due to the different in amount of the minerals in the water bodies (Ali et al., 2001), the physiological state of the fish or the ability of the fish to absorb the elements

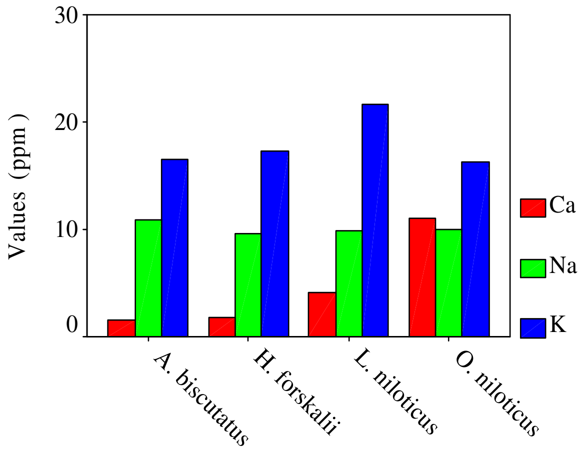

Figure 3. Minerals (ppm) for the different fish collected from Al-Mowrda fish market during January-March 2018.

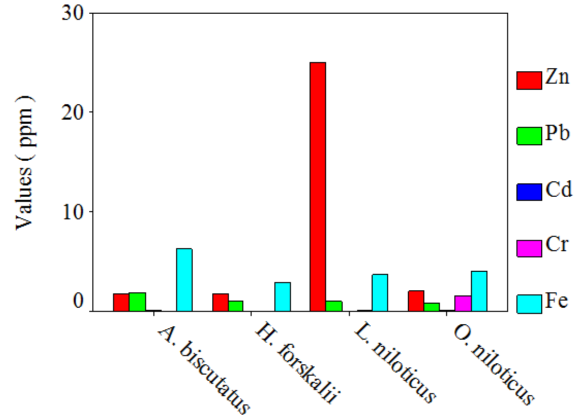

Figure 4. Heavy metals (ppm) for the different fish species from Al-Mowrda fish market.

from the diets and the water bodies (Ako and Salihu, 2004). The mineral content of omnivorous fish species is higher than that of carnivorous species. This agrees with the report of Farkas et al. (2003) that the concentrations of element in fish body could be related primarily to their feeding habits, that our species the only carnivorous was *H. forskali* and the other species were omnivorous. Adewumi et al. (2014) reported that microbiological activities in the aquatic environment, feeding habits and age of fish have also been found to determine elemental concentrations in fish and even within a species of fish, mineral retention depends mainly on the feed and the feeding rate and interaction with the water environment. Pirestani et al. (2009) reported that amount of several elements analyzed from different fish species collected from different areas differ significantly.

Heavy metal contents

The heavy metal levels varied from species to species, the levels of (Pb, Cd and Fe) were highest in *A. biscutatus* whereas (Cr) was highest in *O. niloticus* and (Zn) level was highest in *L. niloticus* as shown in (Figure 4).For heavy metals the highest values of Pb, Cd and Fe were in *A. biscutatus* (1.920 ppm , 0.114 ppm and 6.319 ppm respectively), for Zn the highest values were in *L. niloticus* (24.95 ppm),where Cr is detected only in *L. niloticus* and *O . niloticus* (0.140 ppm and 1.523 ppm respectively).Comparing the levels of heavy metals investigated with the international permissible levels, this study showed that (Pb, Fe and Zn) levels were by far exceeding the permissible levels in the four fish species, as depicted in (Table 1). (Cr) was above acceptable limit in *O. niloticus,* while (Cd) level was within acceptable levels in the four studied fish species, (Table 1).

Table 1. Heavy metals content (ppm) in flesh of four commercial species collected from Al-Mowrada local fish market during Jan-March 2018.

Fish species	Pb	Cd	Fe	Cr	Zn
A. biscutatus	1.920	0.114	6.319	N. D	1.771
H. forskali	1.050	0.046	2.933	N. D	1.808
L. niloticus	0.998	0.026	3.686	0.140	2.495
O. niloticus	0.906	0.090	4.104	1.523	2.069
FAO permissible levels(FAO,1984)	0.02	0.5	0.8	0.5	1

Conclusion

Proteins, lipids and moisture contents as well as carbohydrate were the major constituents, which had been considered in evaluating the nutritional value of the species studied. The nutritional elements showed variable values in the species analyzed; with crude protein recording the highest values and lipid recording the lowest. This makes the Nile fishes important living resources of dietary protein as other sea and freshwater fish Likewise, the species examined also contained appreciable concentrations of calcium, sodium and potassium, suggesting that these species could be used as good sources of minerals. Potassium was observed to dominate other minerals in all species. Heavy metals on the other hand varied in concentration among the studied species Pb,Fe and Zn were exceeding acceptable levels.

It is highly recommended to monitor levels of heavy metals in water bodies to minimize human health risks upon consumption of these species. In view of this study and the importance of fish in human diet, it is recommended that biological monitoring of fishes meant for consumption from this water body be carried out regularly to ensure human safety.

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