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Determination of some nutrient minerals in the meats of three species of fishes brought from the Blue Nile and the White Nile, Sudan

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Abstract

Various fish species are found in fish-markets that trigger the need to evaluate the quality of various fish meat products to answer the consumer needs. This study evaluated some mineral elements in the meats of Baiad (B), Tilapia (T) and Nile Perch (NP) fish species. These fish species were brought from the fish market of Wad Medani City (Blue Nile Fishes; BN), and from Kosti fish market (White Nile Fishes; WN). The preparation of fish meat-ashes and the determination of minerals (through Atomic Absorption), were run in the Food Analysis Laboratory, and the Central Laboratory - University of Gezira. The results showed high concentration of Cu element in WN samples was high in B-meat (0.434 mg/L) and in BN sample in T-meat (0.115 mg/L). Mn element in WN samples was high in B-meat (0.282 mg/L) and in BN sample in T-meat (0.292 mg/L). Fe (0.788 mg/L) and Zn (0.950 mg/L) elements were high in NP-meat of WN, while Fe (3.261 mg/L) and Zn (5.123 mg/L) were high in B-meat of BN. WN samples were highly contaminated with Pb which was about 24-folds more than the maximum tolerable limit (0.025 mg/L), while BN samples were still about third that standard. It was cleared that, BN fish samples were relatively rich in Fe and Zn, while WN samples were relatively rich in Cu and Mn elements.The contamination of fish meat of WN with Pb should be seriously studied, and the meat quality of all fish species should be determined.

Keywords: Nutrient Minerals; Fish meats; Blue Nile; White Nile; Sudan

1. Introduction

Fish are aquatic, craniate, gill-bearing animals that lack limbs with digits. Fish are abundant in most bodies of water. They can be found in nearly all aquatic environments, from high mountain streams to the deepest oceans, although no species has yet been documented in the deepest 25% of the ocean [1]. With 34,300 described species, fish exhibit greater species diversity than any other group of vertebrates [2].

A mineral is a chemical element required as a secondary nutrient by organisms to perform functions necessary for life. The four major structural elements in the human body are: oxygen, hydrogen, carbon, and nitrogen, which represent about 96% of the weight of the human body [3].

Nutrient minerals, being elements, cannot be synthesized biochemically by living organisms. In a human diet, it comes from eating plants and animals or from drinking water [4]. The major minerals for human body are: Ca, P, K, Na, and Mg,

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although other elements have a specific biochemical function in the human body e.g., S, Fe, Cl, Co, Cu, Zn, Mn, Mo, I, and Se [5].

Cobalt is available for use by animals only after having been processed into vitamin B12 by bacteria. Minerals are used by animals and microorganisms for the process of mineralizing structures, called biomineralization, used to construct bones [6]. Calcium is contained in bones and teeth. Phosphorus makes up about 1% of a person's body weight. The other major minerals make up only about 0.85% of the weight of the body [7].

Globally, fish and fish products provide an average of only about 34 calories per capita per day. However more than as an energy source, the dietary contribution of fish is significant in terms of high-quality, easily digested animal proteins and especially in fighting micronutrient deficiencies [8].

The aim of this study was to determine some mineral elements in some fish species using Atomic Absorption techniques.

2. Material and methods

2.1 Study samples

Study samples included 3 different species of the most popular types from Blue Nile were brought from Wad Medani fish market, and the same 3 fishes species of the White Nile were brought from Kosti fish market.

The Blue and White Nile fish species (Plate, 1) used in this study were:

- Bajad (*Bagrus bajad*-سمك البياض),
- Tilapia (*Oreochromis niloticus*-سمك البلطي),
- Nile perch (*Lates niloticus*= سمك العجل).

2.2 Preparation of fish meats

The samples of whole fishes were first cleaned using tap water, then the meat from the caudal part (between caudal fin and pectoral fins) of each fish species was cut into small pieces. These pieces were burned individually (to obtain the fish meat-ash) in an electrical oven under 550^{o}C for 24 hours, at the Food Analysis Laboratory, Faculty of Engineering and Technology, University of Gezira.

2.3 Atomic Absorption analysis

The ash of each fish-meat was used to determine the mineral contents (Fe, Cu, Zn, Mn and Pb) using Atomic Absorption techniques (ASC-7000, Shimadzou; Atomic Absorption Spectrophotometer) at the Central Laboratory, University of Gezira.

2.4 Statistical analysis

The obtained data were subjected to an appropriate data analysis tools. Descriptive statistics and correlation were used to compare the values obtained from each fish samples with the others.

3. Results and discussion

3.1 Mineral contents in fish meat of the Blue Nile samples

Table (4.1) showed the concentration of some mineral (Cu, Mn, Fe, Zn, and Pb) in the meat samples of the selected fish samples brought from the Blue Nile (Wad Medani fish market). The higher concentration of Cu was detected in Tilapia (T) species (0.115 mg/L) whereas the lowest concentration was found in Baiad (B) meat (0.055 mg/L). Mn was also higher in T-meat (0.292 mg/L), but the lower concentration was noticed in Nile Perch (NP) meat (0.0340 mg/L). Fe was detected in higher concentration in B-meat (3.261 mg/L) whereas the lower concentration was noticed in T-meat (0.037 mg/L). Zn was noticed in higher concentration in B-meat (5.1231 mg/L), whereas the T-meat has a lowest concentration (0.186 mg/L). Pb was noticed in higher concentration in NP-meat (0.0119 mg/L), whereas B and T have a lower concentration (0.0048 mg/L).

The mean values of mineral elements in fish samples, show that, Blue Nile fish were rich in Zn (mean = 3.298 mg/L), followed by Fe (mean = 1.554 mg/L), Mn (mean = 0.198 mg/L) and at last rank Cu (0.078 mg/L), while Pb was found in very small quantities (0.0072 mg/L) compared to other elements

The correlation analysis of the mineral elements detected in the Blue Nile fish-meats, showed that, Fe was positively correlated to Zn elements (0.87), while a negative correlation was noticed between Mn and Pb elements (-0.99), Zn and Cu (-0.99) and between Fe and Cu (-0.83).

Table 1 Some minerals (in mg/L) detected in the samples of Blue Nile Fish-meats

Sample	Cu (mg/L)	Mn (mg/L)	Fe (mg/L)	Zn (mg/L)	Pb (mg/L)
NP	0.057	0.034	1.364	4.559	0.0119
B	0.055	0.268	3.261	5.123	0.0048
T	0.115	0.292	0.037	0.186	0.0048
Descriptive statistics					
Mean	0.076	0.198	1.554	3.289	0.0072
SE	0.020	0.082	0.936	1.560	0.0024

Nile perch = NP; Bajad= B; Tilapia = T

Correlation analysis

Zn	Fe	Mn	Cu	
			0.54	Mn
		0.02	-0.83	Fe
	0.87	-0.48	-0.99	Zn
0.41	-0.10	-0.99	-0.47	Pb

3.2 Mineral contents in fish meat of the White Nile species

Table 2 Some minerals (in mg/L) detected in the samples of White Nile Fish-meats

Sample	Cu (mg/L)	Mn (mg/L)	Fe (mg/L)	Zn (mg/L)	Pb (mg/L)
NP	0.315	0.126	0.788	0.950	0.6131
B	0.434	0.282	0.579	0.376	0.6173
T	0.414	0.197	0.271	0.545	0.6090
Descriptive statistics					
Mean	0.388	0.202	0.546	0.623	0.6131
SE	0.037	0.045	0.150	0.170	0.0024

Nile perch = NP; Bajad= B; Tilapia = T

Correlation analysis

Zn	Fe	Mn	Cu	
			0.91	Mn
		-0.36	-0.70	Fe
	0.60	-0.96	-0.99	Zn
-0.29	0.59	0.55	0.16	Pb

Table (2) showed that, the higher concentration of Cu was detected in B-meat (0.434 mg/L) whereas the lowest concentration was found in NP-meat (0.315 mg/L). Mn was also higher in B-meat (0.282 mg/L), but the lower concentration was noticed in NP-meat (0.126 mg/L). Fe was detected in higher concentration in NP-meat (0.7881 mg/L) whereas the lower concentration was noticed in T-meat (0.271 mg/L). Zn was noticed in higher concentration in NP-meat (0.950 mg/L), whereas the B-meat has a lowest concentration (0.376 mg/L). Pb was noticed in higher concentration in B-meat (0.6173 m/L), whereas T has a lower concentration (0.6090 mg/L).

The mean values of mineral elements in fish samples, showed that, White Nile fish were rich in Fe (mean = 0.546 mg/L, about 3-folds less than that of Blue Nile (1.554 mg/L)), Zn (mean =0.623 mg/L, about 5-folds less than that of Blue Nile (3.298 mg/L)), Cu (0.434 mg/L, about 5-folds more than that of the Blue Nile samples (0.076 mg/L)), and at last rank Mn (mean = 0.202 mg/L, relatively similar to that of the Blue Nile (0.198 mg/L)), while Pb was found in relatively large quantities (0.613 mg/L, which was about 85-folds more than that of Blue Nile samples (0.007 mg/L) and about 245-folds more than the standard (0.0025 mg/L)) compared to other elements

The correlation analysis of the mineral elements detected in theWhite Nile fish-meats, showed that, Fe was positively correlated to Zn elements (0.60), while negative correlations were noticed between Cu and Zn elements (-0.99), Cu and Mn elements (-0.91), Mn and Zn (-0.96) and Cu and Fe elements (-0.70).

Minerals are secondary nutrients and they are essential for good health [7]. Copper (Cu), manganese (Mn), iron (Fe), and zinc (Zn) elements perform different functions. Insufficient levels of Fe and Cu increases the risk of developing neurological diseases. Deficiency of Zn can lead to skeletal and reproductive disorders and skin inflammations. Deficiencies of Mn are very rare, but excessive amounts are connected with Parkinsonism [9].

In a study conducted during 2017, female Nile Tilapia (*O. niloticus*) found to contain higher Ca and P as compared to male. Ca and Zn significantly decreased as age of fish increased but phosphorus significantly increased with increase in age of the fish. Sex had no significant effect on Fe and Zn content [10].

Mineral and level of contaminants in relation to capture site in Nile perch from Lake revealed significant variation of Pb and Ca with site [11].

The toxic elements As, Cd, Cr, and Pb through foods has been investigated in Najran area, Saudi Arabia. The As, Cd, Cr, and Pb concentrations were determined by inductively coupled plasma-mass spectrometry. Hazard Quotients for all elements did not exceed one. The amounts of all elements in the tested samples were below the provisional tolerable weekly intakes set by the WHO [12]. The provisional tolerable weekly intake of Pb is 25 µg/kg (0.025 mg/kg= ppm) body weight/week [13]. The toxicity of excess intake of Cu elements was cleared [14].

4. Conclusion

The determined elements with their concentrations among the tested fish-meats revealed that, this species can play an important role as main or complementary sources of this essential elements except Pb which indicate for a problem of chemical contamination, specially at White State that need to be investigate.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors (Tahany Abdel Gader; Mutaman Ali; Yasir Mohamed; Ayda Ali and Zahir Abbas) declare no conflicts of interest regarding the publication of this paper.

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