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The Effect of Magnetized Water on Some Essential Mineral Content of Nile Tilapia Fish (*Oreochromis Niloticus*)

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ABSTRACT

Twenty samples of Nile tilapia fishes were exposed to three treatments, treatment one with non-magnetized water treatment two with magnetized water (twice) and treatment three with magnetized water (three times). Some macro and micro-nutrients were determined in the samples using Atomic Absorption Spectrometer (AAS) and flame photometer. The results showed significant differences between treat-ments and the higher concentration was observed in treatments with magnetized water. The concentration of minerals determined were within FAO mean concentration ranges for fish.

Introduction

Minerals are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life. Minerals are chemical constituents used by the body in many ways, and they have important roles to play in many activities in the body (Malhotra, 1998; Erurbetine, 203). When these elements are not adequately provided to the body, mainly by dietary intake, the individual may suffer from mineral deficiency diseases for example anaemia, osteoporosis, goiter, stunted growth and genetic disorders (Bhanderi and Banjara, 2004; Fumio *et al*., 2012).

The World Health Organization reported that about a 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).

Fish is commonly found in natural water bodies and well known for its superior nutritional quality with a very good supply of essential minerals (Fawole *et al*., 2007; Kawarazuka and Bene, 2011). Food based strategies are considered sustainable and currently being evaluated for enhancing mineral intake. Fish has a big potential for this strategy because it can provide a variety of nutrients including essential elements to the body (Kawarazuka and Bene, 2011).

Tilapia culture has traditionally relied on extensive and semi-intensive systems in earthen ponds or cages. The expansion of tilapia culture across the world, together with the shortage of fresh water and competition for it with agriculture and with urban activities has gradually shifted tilapia culture from traditional semi-intensive system to more intensive production system (El-Sayed, 2006).

Tilapia culture in Sudan is widely diversified in terms of methods of production semi-intensive culture is practiced in certain areas in Wad Halfa, White and Blue Nile.

For recent years, studies have been done concerning the effects of magnetic field on microorganism, tissue, cell and sub-cellular structures of the plants and animals (Polk *et al.*, 1995).

In Sudan the experience concerning the use of magnetic water in animal production and especially in fish production is very limited, so this study is an attempt to prove that there are some advantages in using magnetic water in Nile tilapia production.

Material and Method

Sample Collection

The Nile tilapia samples used for this study were obtained from Elshagara Fisheries Research Centre (Elshagara, Khartoum).

Magnetic Device

The device used for water treatment was funnel shaped obtained from the local agent of Magnetic Technologies (L.L.C.) in Khartoum, Sudan.

Experimental Design and Treatments

The Nile tilapia samples were stocked in plastic tanks in a complete randomized design, with three replications. The samples were exposed to three treatments, the first one is the control with untreated water, the second treatment represents magnetized water (two times) and the third treatment represents magnetized water (three times). All the treatments were supplied with the same diet and fed twice a day. The fish were kept for 15 days.

Sample Preparation

Each fish samples were cleaned and homogenized with a blender and oven dried at a temperature 40-60^{o}C. The muscles of the dried samples were prepared into powdered form and labeled for analysis.

Mineral Analysis

Atomic Absorption Spectrometer (AAS) and flame photometer were used for determination of mineral content in fish flesh. All determinations content in mg/100g dry matter.

Statistical analysis of all data was conducted using analysis of variance (ANOVA) using SPSS version 19.

RESULTS AND DISCUSSION

Table (1) showed the effect of magnetized water on some macro-elements content of Nile tilapia in the year 2015 and 2016 respectively. The calcium in this study ranged from 448.66 mg/100g at T_1, 1422.66 mg/100 at T_2 and 1213.60 mg/100g at T_3 in the year 2015, however, in the year 2016 the values increased from 561.63 at T_2 to 1303.00 mg/100 at T_2. These results were within the values of FAO (2001) 19-881 mg/100g. Mohamed *et al*. (2010) found the calcium ranged from (107-588 mg/100g). These results showed significant differences between treatments and fishes reared in magnetized water showed higher content of calcium, this because the conditional water interacting with structural calcium in the cell membrane to make it more permeable, weak conditioning water gives a slight increase on permeability and allows the ingress of small amount of external calcium which activates the calcium signaling cascade and promotes growth (Goldsworthy *et al*., 1999).

As indicated in Tables (1 and 2) the phosphorus in treatments used magnetized water had higher values compared with non-magnetized water treatment (the control). The highest values 112.5 mg/100g was observed in treatment T_3 in the second year experiment, however, in the first year and second year experiment treatment T_1 showed 29.82, 28.17 mg/100g respectively which are lower than the FAO (2001) range 68-550 mg/100g. In treatments using magnetized water the values were within the range of FAO (2001). The content of phosphorus in Nile tilapia was high and this may be attributed to that phosphorus is a component of variety of organic phosphates, such as nucleotides, phospholipids, coenzymes, doxyribonuclei acid (DNA) and ribonucleic acid (RNA).

The sodium value reached 12.0 mg/100g in treatment T_1, 37.5 mg/100g in treatment T_2 and 45.5 mg/200 in treatment T_3 in the first year experiment, however in the 2nd year experiment the values were 13.3, 40.10 and 51.00 mg/100g at treatments T_1 T_2 and T_3 respectively. These results were within the range of FAO (2001).

The results of potassium content in Nile tilapia showed significant difference between the treatments where magnetized water was used (T_1) and the untreated water treatment T_1 the control, the results in both years were within the range of FAO (20010. Mohamed *et al*. (2010) reported that potassium was observed to dominate other minerals in their study of River Nile fish species. Effiong and Fakunle (2011) reported that the highest value in minerals in fish samples were sodium and calcium. The high levels of these two elements may be attributed to the rate in which they available in the water body and the ability of the fish to absorb these inorganic elements from their diet and the environment where they live (Adewoye and Ontosh, 1997; Ibiyo *et al*., 2006).

The concentration levels of magnesium in the two years experiment ranged from 17.6-53.4 mg/100g, these results were within the FAO (2001) range 4.5-4.52 mg/100g.

Micro-Nutrients

Tables (2 and 3) showed the concentration for manganese in Nile tilapia which ranged from 0.1548-0.2054 mg/100g in the first year experiment and from 0.1287-0.2155 in the second year experiment which were within the range of FAO (2001). The highest cocnentration0.2054 was observed in T_2 in the first year experiment (in the first experiment) and 0.2156 in the second experiment. Alas *et al*. (2014) found 0.028-0.040 mg/100g in fleshy part of fish in Turkey, and Kwansa-Ansah *et al*., 2012) obtained 0.30-0.41 mg/100g in Ghana.

Table1. *The effect of magnetized water on some macro-elements of Nile tilapia, 2015 and 2016*

	Treatment	Ca	K	Na	P	Mg
2015	T_1	448.66	66.56	1.21	298.23	17.66
	T_2	142.66	352.13	3.75	832.26	48.07
	T_3	1213.60	132.33	2.44	572.43	30.47
2016	T_1	561.63	118.30	1.33	281.70	18.20
	T_2	1303.00	331.86	4.01	722.66	42.10
	T_3	1982.33	324.80	5.10	1125.00	55.41

Table2. *The effect of magnetized water on the concentration of micro-nutrients of mg/100g of Nile tilapia, 2015*

	T_1	T_2	T_3
V	0.2395	0.1877	0.4115
Cr	0.0802	0.0608	0.0791
Mn	0.1548	0.2054	0.1742
Fe	2.8460	3.5560	2.1370
Co	0.0368	0.0600	0.0375
Ni	0.0669	0.0689	0.0792
Cu	0.1106	0.2051	0.1956
Zn	1.0260	2.4860	1.9230
Sr	47400	11.6260	9.2080
Mo	0.411	0.5750	0.3607
Cd	0.402	0.0403^{NS}	0.0407
Pb	0.0580	0.0768	0.0790

Table3. *The effect of magnetized water on the micro-elements of Nile tilapia, 2016*

	T_1	T_2	T_3
V	0.2245	0.2062	0.1667
Cr	0.0773	0.0780	0.0809
Mn	0.1287	0.2081	0.2156
Fe	2.2960	2.520	2.3070
Co	0.0374	0.0482	0.0398
Ni	0.0725	0.0630	0.0684
Cu	0.1335	0.2301	0.1840
Zn	0.9060	2.4780	2.4710
Sr	4.2970	9.6560	9.2080
Mo	0.04018	0.04972	0.4064
Cd	0.0406	0.0392	0.0398
Pb	0.0725	0.0630	0.0684

The iron concentration was 2.137-3.556 mg/`00g in the first year experiment and 2.296-2.512 mg/100g in the second year experiment. These values were within the range of FAO (2001), however, the high content of iron may be decreased by the presence of physic acid and oxalic acid as they formed iron phytate and iron oxalate (Malhotra, 1998). Similar results were obtained by Mohamed *et al*. (2010), 1.7-6.1 mg/100g

The concentration of copper in Nile tilapia varies between 0.1106– 0.2051 mg/100g, in the first year experiment, and between 0.1335-0.2301 mg/100g. These results were within the range of FAO (2001) mean ranges of 0.001-3.7 mg/100g. Mohamed *et al*. (2010) reported a range of 0.09-0.14, in Nile fish in Sudan. The concentration of copper showed a significant difference (P=0.05) between treatments, and this may be attributed to the effect of magnetized water, which has higher absorption tendency.

The concentration of zinc in Nile tilapia ranges between 1.026-2.486 mg/100g in the first experiment and between 0.906-2.478 mg/100g in the second experiment. The results of this study showed a higher concentration in zinc than the FAO (2001) mean range of 0.23-2.10 mg/100g. Guerin *et al*. (2011) found a range of 0.13-2.5 mg/100g, which is similar to this study. A higher concentration of zinc Nas also by

Mohamed *et al*. (2010) range of 4.6-8.8 mg/100g. The significant difference (P=0.05) between the treatments T_2, T_3 and the control may be attributed to the effect of the magnetized water, which affects the absorption of minerals.

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