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SEASONAL VARIATIONS OF SOME BIOCHEMICAL PARAMETERS IN MUSCLES OF OREOCHROMIS NILOTICUS REARED IN LAKE MANZALAH FISH FARMS

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ABSTRACT

Six fish farms were selected, 3 farms (1, 2 and 3) in the eastern region of Lake Manzalah and 3 (4, 5 and 6) in the western region to represent the different environmental variations within the lake. Seasonally water and fish samples were collected from the farms throughout the period from autumn, 1999 to summer, 2000. Some biochemical studies of Nile Tilapia, O.niloticus, as water, fat, protein and heavy metals content (Zn, Cu, Fe, Pb and Cd) concentrations have been determined in water and fish flesh of Oreochromis niloticus. The results of the present study show that, the heavy metals concentration in the water was found in the following order: Zn (0.010—0.020 mg/L), Cu(0.013—0.063 mg/L), Fe (0.10—0.51 mg/L) Pb (0.14—1.07 mg/L), Cd (0.010—0.37 mg/L).

Heavy metals concentrations in the muscle of O.niloticus followed the order Zn(8.10-16.30 mg/kg), Cu(0.41-2.11 mg/kg), Fe(20.90-90.00 mg/kg), Pb(2.00-15.30 mg/kg), Cd(0.27-0.89mg/kg). The heavy metals concentrations in the fish muscle were above the recommended standards of the USEPA (1986) and the Egyptian laws that represent a potential human health hazard..

The present results showed also high levels of water content of muscles and accordingly low levels of protein and fats that reflect the negative effect of heavy metals pollution on the economic value of fish and human health.

INTRODUCTION

Lake Manzalah is economically the most important Delta Lake in Egypt. It is bounded by Mediterranean Sea to the north, the Suez Canal to the east, Damietta Province to the west, Dakahlia and Sharkia Province to the south. The lake receives heavy loads of organic and inorganic pollutants via several drains. In the end of the 20th century, public concern was greatly attracted to the problem of pollution. Pollution and its effect constitute one of man's greatest crimes against himself. Pollution is the introduction of substances by man, directly or indirectly into the environment, resulting into such deleterious effects causing harm to living organisms and hazard to aquatic habitats and human health. The determination of the concentration levels of heavy metals in natural water is a prime target in environmental research during the last years (Patterson and Passino, 1987).

The concentrations and effects of heavy metals in fish biology and physiology in Egypt and different parts of the world were previously mentioned by many investigators, among of which are: Dowidar et al. (1981); Beltagy (1982, 1985); Ghazaly (1985, 1988); Saleh et al. (1985); El-Sharnouby et al. (1986); Fouda (1987); Rifaat (1989); Rafael et al. (1990); Handy (1993); Abdel-Moneim et al. (1994); El-Shebly (1994); Abdel-Bakey et al. (1998) and Khallaf et al. (1998), and Ibrahim etal., (1999 a and b).

The distribution of heavy metals in the farm waters was determined to evaluate the impact of various types of effluents on water quality. The main concern of heavy metals study was to determine whether the water contains heavy metals in concentrations that might be harmful to humans or that might affect the aquatic biota. Therefore, it thought necessary to find out the concentrations of heavy metals in both fish farms water and muscles of the most cultured fishes (O niloticus) to study the adaptability of the environment for fish culture.

MATERIALS AND METHODS

Area of investigation:

In the present study, six fish farms were chosen along Lake Manzala to represent the different habitats in the lake. These farms were selected on the basis that they cover all the different varieties within the lake, with respect to the distance from the open lake, agricultural drainage water, sewage and industrial wastewater input. Throughout the period from autumn, 1999 to summer, 2000 analysis were carried out in both fish farms water and the muscle of the cultured *Oreochromis niloticus*. Each fish was dissected and the muscle was taken and frozen immediately to keep it for determination of lipid, protein, water and metal contents.

Water samples were collected during different seasons from the upper 0.5 m of the water column by plastic water sampler and were analyzed to determine the concentrations of some chemical and physical parameters. These parameters include the heavy metals; Zn (zink), Cu (copper), Fe (iron), Pb (lead) and Cd (cadmium). Analysis of heavy metal in both fish edible muscles and water were carried out according to Allen et al. (1979). Metal concentration was determined using Pye Unicom sp. 191 atomic absorption spectrophotometer. Water contents in fish muscles were performed according to the methods mentioned by Heller and Smirk, (1932). Fat contents were estimated by using the method of Zollner and Kirsch, (1962). For protein determination, the kjeldahl method suggested by Mchenzie and Wallace, (1954) was adopted.

RESULTS AND DISCUSSION

Heavy metals in water:

The determination of the concentration level of heavy metals in farm water is a prime target in environmental research today (Patterson and Passino, 1987). Five heavy metals namely; zinc, copper, iron, lead and cadmium were studied due to their dangerous to environment. The average concentrations of heavy metals in Lake Manzalah Farms Water (Table 1) were ranged from 0.010 to 0.020 mg/l for Zn; 0.013 to 0.063 mg/l for Cu; 0.10 to 0.51 mg/l for Fe; 0.14 to 1.07 mg/l for Pb and 0.010 to 0.37 mg/l for Cd. It is clear that zn, cu, and cd levels in water are within the allowable limits (Cu:1.0, Zn:1.0, Cd:0.01 mg/L) according to USEPA (1986) and the Egyptian laws. On the other hand, Pb concentration showed higher value above the permissible limit (0.05 mg/L) according to USEPA (1986). The high level of Pb in water may be attributed to the industrial and agricultural discharge.

The present values are nearly similar to those estimated by Ajmal and Khan (1987) in river Hinden. U. P. India. They recorded the following values of heavy metals (0.013 – 0.231 mg/l for Zn, 0.0165 – 0.175 mg/l for Cu, 0.0537 – 0.500 mg/l for Fe, 0.01 – 1.143 mg/l for Pb and 0.002 – 0.007 mg/l for Cd). The recorded results of lead and cadmium are higher than that mentioned by Ajmal and Khan, (1987) while they are lower than that recorded by Rafael et al. (1990) in the Pisura River sediments, Spain which is polluted by industrial and municipal effluents. They recorded the following values (245.49 for Zn, 66.53 for Cu, 18.77 for Pb and 1.05 for Cd, ppm. dry weight). Also, the present results are lower than that recorded by Nather Khan and Lim, (1991) in the linggi River Basin, Malaysia where they recorded Zn concentrations from 0.06 – 5.12 mg/l; Cu 2.88 mg/l and Fe from 0.47 – 12.1 mg/l. Ibrahim etal., (1999 b) studied the distribution of heavy metals (zn, cu, pb, and cd) in water in different sites of the north western region of lake Manxala and they found that the metal concentration in water (mg/L) followed an abundance of zn (0.095—0.61) > pb (0.03—0.19) > cu (0.012—0.063) > cd (0.01-0.005) demonstrating higher values than the international permissible ones for pb and cu only. Also, they stated that the metal concentration in water showed a seasonal variation in which the maximum value of cu and zn occurred during summer, cd values in winter, and pb reached its highest value during autumn.

The average values of heavy metals in Lake Manzalah Fish Farms attained their maximum during winter, except cadmium which showed its highest concentration during summer. These results agree with the observation of Beltagy (1985) on Lake Borollus, Egypt. He recorded high concentration of copper and iron values in winter. Maximum values of heavy metals were recorded in farms 3 and 5 except iron which were higher in farm 1. Minimum concentrations of metals, except zinc and iron were detected at farm 4. Iron is low in farm 5 as a result of intensive biological consumption due to phytoplankton blooming (Harvey, 1963). The lower values of iron in farms recorded during spring may be also due to the same previous reason. The high concentration of lead in farms 3 and 5 may be due to the modern urbanization of Port

Said and Damietta cities that lie in the neighborhood of these farms. Also, may be due to the process of establishment of ships in Damietta City where the painting liquids of ships contain lead in their constituents. The present results show also the effect of drainage water on the concentration of heavy metals in the farms water. Irregular fluctuation of heavy metals in the farms is due to the irregular discharge of industrial waste products into the lake. The lower concentrations of heavy metals in farm 4 is due to that it receives only agricultural drainage water and doesn't receive sewage or industrial drainage water. All values of Zn, Cu and Fe were well below the recommended standard values, while Pb and Cd were higher in the farms water, indicating its concentration which forms a public health problem.

Heavy metals in fish muscles:

The present results show that the heavy metal concentration (Zn, Cu, Fe, Pb and Cd) in muscles of *Oreochromis niloticus* reared in some fish farms at lake Manzala are closely associated with metal content of water (Tables 1,2). Fish analysis was only carried out on muscles because muscles are the edible part of fish. The annual average concentration of heavy metals in fishes reared in the studied farms ranged from 8.10 to 16.30 mg/kg for Zn, 0.41 to 2.11 mg/kg for Cu, 20.90 to 90.00 mg/kg for Fe, 2.00 to 15.30 mg/kg for Pb and 0.27 to 0.89 mg/kg for Cd.

The previous concentrations of heavy metals in fish muscle were higher than its corresponding values in the water. This agree with the findings of Saleh(1982) and Saleh etal. (1985). They mentioned that aquatic animals could accumulate high and ultimately lethal concentrations of heavy metals over long period from extremely low water concentrations. The present values of heavy metals estimated for the muscle tissue of fishes are similar to those recorded for many species in different environments (Ajmal and Khan, 1987 India and Rifaat, 1989 in some Red Sea fishes).

The seasonal variations of heavy metals in fish tissues were reported by many authors. Fouda, (1987) recorded Zn concentration of 19.8 mg/kg for *Oreochromis niloticus* which are higher than those recorded during the present study . Some authors stated that there is no constant relationship between fish age and concentration of heavy metals in their muscles (Cross et al. 1973 and Cutshall et al. 1977). Also, Rifaat (1989) found that there is no clear trends of increasing or decreasing of the metal concentrations in fish tissue with site or season changes. Falandysz, 1992 found that the concentration of Zn, Fe and Cd in muscle decreased with the body length of fish, but the concentration of Cu remained constant. Evans et al. (1993) found that, Pb and Cd concentrations increased with length where they are poorly regulator and only slowly exceeded, but this increase is uncommon for the biological essential elements (Zn, Cu and Fe) which are under homeostatic control. On the other hand Ibrahim etal(1999a) showed that heavy metals accumulation in the muscle of *O.aureaus* inhabiting Damietta Nile Estuary is followed the order: zn(20.96-45.40) > cu(2.57-6.55) > pb(0.34-0.53) > cd(0.12-0.46) mg/kg wet weight.

The present results agree with Saad, (1987) and Cossa et al., (1992). They recorded a direct proportionality between the concentrations of heavy metals in the water and their concentration in aquatic organisms. The present results showed high concentration of heavy metals in farms water during winter except cadmium that was maximum in summer. The concentration of heavy metals in fish muscles showed that Zn and Fe were maximum in winter, while Cu, Pb and Cd concentrations were maximum in summer which indicate a positive relation between concentration of metals in water and fish. The lower values of Fe and Cd accompanied by high Cu and Pb in the same season is due to the fact that the presence of one heavy metal deletes the accumulation of another metal, (El-Sharnouby et al. 1986).

The effect of drainage water and industrial waste products disposal on the concentration of heavy metals in fish muscle is obvious, where the irregular discharge of drainage water leads to variations in heavy metal concentrations in fish edible part, muscles.

Water, fats and protein contents in muscles:

The present results showed high levels of water content of muscles (Table 3) which confirm those finding reported by Marais and Erasmus (1977) who found that the smaller size fish were lower in fat and contain high moisture. It is worth mentioning that the majority of fishes of Lake Manzalah are small in size (Essa and Abuel Wafa, 1996). The inverse relationship between fat and water content has been reported by Michail et al. (1982) and Abdo, (1986). The present results revealed that low fish muscle fat content was accompanied higher muscle moisture content. Stansby, (1962) considered the protein content of fish is low if it is less than 15 % and high if it is between 15 % and 20 %. The present values of protein content are lower than the limits mentioned by Stansby, (1962) and Jimbin et al. (1980) due to high levels of heavy metals content in fish muscles. The low protein content in fish muscles coincide with the findings of Jana et al. (1986) where they found decreased contents of protein in muscles in fish after treatment with heavy metals as compared to control values.

The present results showed also variable correlation between protein and water contents in muscles of the studied fishes. Abdo, (1986) found a negative correlation between protein and water contents of two sardine species in Egyptian Mediterranean waters. El-Ghobashy, (1990) recorded that protein content ranges from 13.22 to 16.20 % and lipid ranges from 0.49 to 1.77 % for *Lates niloticus* in High Dam Lake. Sena et al., (1991) recorded that protein content range from 43.98 to 68.40 % and fat from 30.40 to 53.82 % dry weight for red tilapia.

The present results nearly agree with the findings of Sena, et al. (1991) in terms of protein contents taking into consideration dividing the dry weight results by the factor (about 4.5) to change from dry to wet weight for comparison, while the present results agree only with Gaber (1980) in terms of fat content and disagree with other investigators where the present results are lower.

The effect of drainage water and variation in water quality on body composition of fish in the studied farms were obvious, where the fishes in farm 4 had a lower content of protein and fat than the other farms. This may be due to the lower density of zooplankton and nutrients in this farm than the other farms. On the other hand, fishes in the farms 1, 2 and 5 that had high density of zooplankton and nutrients contain higher fat and protein contents. The lower protein content in farm 3 may be due to the high salinity in this farm neighboring El-Gamil inlet, which are unfavorable for them. The lower percentage of protein and fat for fishes reared in the farms under investigation is due to the high concentration of heavy metals in the water. The high concentration of heavy metal can affect the physiological parameters of fish and thereby reducing the protein and fat content of fish tissue (James et al., 1991). Gwozddzinki (1992) stated that heavy metals decreased membrane fluidity. Also, Abdel-Moati, (1992) mentioned that dry body weight of fish decrease with increasing metal concentration. He found that the increase in metal concentrations reduced the soluble protein in muscle which reflects either a reduction in synthesis and / or an increase in its utilization under metal stressed conditions.

Table (1): Seasonal variation of heavy metals (Zn, Cu, Fe, Pb and Cd mg/L) in farms water, lake Manzalah,Egypt.

Farms	(1)					(2)					(3)				
Season	Zn	Cu	Fe	Pb	cd	Zn	Cu	Fe	Pb	cd	Zn	Cu	Fe	Pb	cd
Aut.	0.013	0.046	0.28	0.30	0.016	0.13	0.026	0.25	0.59	0.016	0.020	0.03	0.15	0.70	0.02
Win.	0.02	0.023	0.51	0.38	0.023	0.016	0.04	0.27	0.61	0.01	0.02	0.04	0.51	0.91	0.02
Spr.	0.011	0.53	0.19	0.17	0.013	0.16	0.036	0.13	0.22	0.01	0.013	0.046	0.14	0.32	0.02
Sum.	0.02	0.3	0.21	0.18	0.019	0.015	0.036	0.18	0.19	0.03	0.15	0.035	0.12	0.33	0.037

Farms	(4)					(5)					(6)				
Season	Zn	Cu	Fe	Pb	cd	Zn	Cu	Fe	pb	cd	Zn	Cu	Fe	Pb	cd
Aut.	0.02	0.026	0.28	0.26	0.01	0.013	0.023	0.27	0.68	0.023	0.016	0.028	0.15	0.50	0.013
Win.	0.020	0.033	0.20	0.27	0.016	0.03	0.063	0.12	1.07	0.016	0.10	0.036	0.21	0.72	0.016
Spr.	0.10	0.033	0.22	0.68	0.10	0.01	0.036	0.11	0.28	0.010	0.01	0.026	0.10	0.36	0.02
Sum.	0.013	0.020	0.02	0.14	0.016	0.011	0.013	0.14	0.20	0.023	0.013	0.021	0.11	0.18	0.036

Table (2) : Seasonal variation of heavy metals (Zn, Cu, Fe, Pb and Cd) concentrations (mg/kg) in muscles of *O. niloticus* reared in some fish farms at lake Manzalah, Egypt.

Farms	(1)					(2)					(3)				
Season	Zn	Cu	Fe	Pb	cd	Zn	Cu	Fe	Pb	cd	Zn	Cu	Fe	Pb	cd
Aut. SD	14.1 7.4	1.1 0.67	20.9 8.9	4.2 1.4	0.32 0.17	10.9 2.7	1.5 0.3	33.7 12	8.4 1.9	0.38 0.10	9.5 1.1	1.4 0.6	26.4 10.0	15.3 3.9	0.38 0.10
Win. SD	20.3 8.7	1.5 0.	68.8 12.0	3.2 1.5	0.43 0.2	15.8 4.9	0.72 0.3	67 17	4.8 2.2	0.41 0.2	12.1 5.1	0.7 0.2	77 0.15	2.0 0.6	0.27 0.18
Spr. SD	9.6 4.2	0.60 0.3	43 6.6	2.6 1.2	0.43 0.1	11.9 7.2	1.2 0.2	67 9	4.1 2.5	0.71 0.5	16.3 5.8	0.41 0.2	61.7 23	3.2 1.2	0.3 0.14
Sum. SD	10.4 6.2	0.45 0.3	43.6 9.1	2.8 1.2	0.43 0.3	9.7 3.1	0.7 0.2	57 10	4.9 1.9	0.76 0.4	10.5 3.2	0.8 0.01	90 24	3.2 1.4	0.43 0.16

Cont. Table (2) : Seasonal variation of heavy metals (Zn, Cu, Fe, Pb and Cd) concentrations (mg/kg) in muscles of *O. niloticus* reared in some fish farms at lake Manzalah, Egypt.

Farms	(4)					(5)					(6)				
Season	Zn	Cu	Fe	Pb	cd	Zn	Cu	Fe	pb	cd	Zn	Cu	Fe	Pb	cd
Aut. SD	8.1 3.6	1.03 0.30	73 22	3.3 1.2	0.28 0.14	11.1 2.8	2.11 1.30	41.3 20	4.1 1.9	0.50 0.14	9.7 1.9	1.9 0.7	28 14	12.1 6	0.37 0.08
Win. SD	13.8 6.1	1.01 0.9	50 0.15	2.8 1.7	0.45 0.25	15.1 4.2	0.7 0.3	60 .27	2.9 0.7	4.8 0.22	11.7 5.1	0.98 0.3	78 22	4.2 2.3	0.57 0.4
Spr SD.	10.1 2.9	0.6 0.3	63 19	3.2 1.3	0.53 0.18	12.6 2.2	0.66 0.2	58 21	3.6 1.7	0.37 0.22	10.1 3.1	0.8 0.3	80 21	6.4 2.5	0.51 0.19
Sum. SD	9.7 2.7	0.8 0.01	69 18	2.2 0.5	0.89 0.13	9.9 1.9	0.71 0.35	64 17	2.9 1.4	0.38 0.18	9.2 1.8	0.41 0.2	82 15	3.4 1.4	0.59 0.2

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