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BIOCHEMICAL EVALUATION FOR THREE FISH TYPES COLLECTED FROM DIFFERENT WATER SOURCES IN EGYPT

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ABSTRACT: *Currently, the aquatic ecosystem of Egypt is faced with acute environmental problems due to heavy metals pollution; therefore, it is very important to determine the cause for accumulation of heavy metals in water and fish tissues. The aim of this study was to determine the levels of selected heavy metals in water and fish samples collected from different water sources in Egypt and evaluate the proximate composition for these fishes.*

Water samples and fillet fish species [Nile tilapia (Oreochromis niloticus L.), catfish (Clarias garipinus L.) and common carp (Cyprinus carpio L.)] collected from different water sources in Egypt (River Nile, Lakes and farmed fish) were analyzed quantitatively for the presence of cadmium (Cd), arsenic (As), lead (Pb) and mercury (Hg) using Atomic Absorption Spectrophotometer. The concentrations of 4 elements in water samples (ppb) were: Cd (5 – 84); As (3.14 – 16.14); Pb (1 – 20) and Hg (0.0037 – 0.0105), while concentration of Cd, As, Pb and Hg (µg element/Kg dry mass) in different fillet fishes were ranged between (ND – 79); (ND – 5.528); (ND – 16) and (0.175 – 0.539) respectively.

Proximate composition of Nile tilapia, catfish and common carp were (75.2 – 76.8%; 74.3 – 74.6% and 66.9 – 71.8%) moisture, (76.9 – 77.52%; 68.83 – 68.94% and 68.7 – 71.72%) total protein, (18.08 – 18.8%; 25.8 – 26.99% and 23.58 – 26.78%) crude lipids and (4.1 – 4.4%; 4.18 – 5.3% and 4.25 – 4.52%) ash, respectively.

The results indicate that Nile tilapia, catfish and common carp have a high nutritional values and the Cd, As, Pb and Hg concentrations in all fish tissues were less than the permissible limits recommended by E.O.S.Q.C. (1993)

Key words: *Nile tilapia – Common carp – Catfish – heavy metals – Proximate composition.*

INTRODUCTION

Water pollution is one of the most principal environmental and public health problems in river Nile (Ibrahim *et al*., 2013). In a previous study, the water samples collected from different sites along the whole course of the river Nile, showed a contamination with three important heavy metals: lead (Pb), cadmium (Cd) and mercury (Hg) (Osman and Kloas , 2010). Heavy metals concentration in the Lake Mariout and reference aquaculture indicated that lead, cadmium, copper, zinc and iron values (mg/l) were 0.46, 0.27, 0.09, 0.04 and 0.08 respectively (Arafa and Ali, 2008).

Fish are an important member of aquatic ecosystems and an important source of human food. However, fish distribution data in Egypt indicate a reduction in the commercially desirable fish species as a result of the water conditions deteriorates (Ibrahim, 2013). Fish are a healthy food because of their nutritional benefits related to their proteins of high biological quality, desirable lipid composition, valuable mineral compounds and vitamins as indicated by (Vieira *et al.,* 2011).

Rupinder *et al.,* (2014), reported that Nile tilapia is tropical specie that prefers to live in shallow water. Sales and maia (2012), indicated that the approximate composition of tilapia showed an average of 76.0 % moisture, 19.3 % total protein, and 2.0 % ash.

Concentrations of some heavy metals (Pb, Cd, and Hg) were determined in water, and tissues of tilapia fish and it has been found that heavy metals in the edible parts of tilapia were within the safety permissible level for human use (Edem *et al*., 2009 and Abdel-Baki *et al.,* 2011), while in another study Saeed and Shaker, (2008) found that the edible parts of Nile tilapia showed higher levels of Cd (in Lake Edku and Manzala) and Pb (in Lake Manzala). Nile tilapia caught from these two Lakes may pose health hazards for consumers.

Pouomogne (2008), reported that Catfish *Clarias gariepinus* appears as the most promising specie on account of its faster growth, so it has interesting features for aquaculture. Salihu-Lasisi *et al*.,(2013), showed that Catfish samples contain 72.72 % moisture in wet weight, while total protein and fats were 57.61% and 12.10 % in dry weight.

African catfish inhabiting El-Rahawy drain were found to accumulate high concentrations of heavy metals in their muscles and that their meat quality is deteriorated to the point that they could be hazardous to humans (Ibrahim and Omar, 2013).

Carp is reared in a variety of grow out systems, including conventional pond culture, duck cum fish, cage culture, aquaculture in irrigated areas, fish culture in rice fields, village fish farms and large-scale commercial farms as indicated by Vilizzi (2012). Sakineh *et al.,* (2012), found that proteins were ranged from (15.9 – 17.6 %) in farmed carp and (17.9 – 18.2 %) in wild carp, while lipids were varied from (1.5 – 5.1 %) in farmed carp and (2.8 – 3.8 %) in wild carp and moisture content was diverged from (76.7 – 81.4 %) in farmed carp and (75.5 – 78.5 %) in wild carp. The combined means for whole common carp fish carcass protein, lipids, moisture and ash were 11.84%, 2.43%, 74.63% and 3.00% respectively Yola (2014).

Sobhanardakani and Jafari (2014), reported that the metal ranges in common carp were (µg/ g): Cd 0.044-0.093, Hg 0.03-0.011 and As 0.004-0.006. While in another work the concentrations of heavy metals in Common Carp flesh (mg /kg) were: Cu, Pb, Cr, Cd ,Mn, Co, Fe, Ni and Zn 1.40, 1.24, 0.65, 0.53, 1.79, 1.50, 49.59, 0.36, and 46.08 respectively Abraha *et al.,*(2012).

The aim of this study is the evaluation of chemical composition, heavy metal contamination in Nile tilapia, common carp and catfish collected from different water sources in Egypt.

MATERIALS AND METHODS.

1. MATERIALS

1.1 Collection and preparation of fish

Undissected fish samples were identified and labeled catfish (*Clarias garipinus L.*), Nile tilapia (*Oreochromis niloticus L.*), and common carp (*Cyprinus carpio L.*) with the age of 4-months and body weight of 0.5–1.8 kg/Fishes were collected from the sites which were selected as follows:

a) River Nile:-
   1- Assiut.
   2- Kafr El-Sheikh.
b) Lakes:-
   1- Borollus Lake.
   2- Qarun Lake.
c) Private farms:-
   1- Kafr ElSheikh farm.
   2- El fayoum farm.

Fish were identified by the exterior shape in the department of Poultry production, Faculty of Agriculture, Minufiya University.

The muscles parts of catfish, Nile tilapia and common carp were cut into small pieces, allowed to dry in a hot air oven at 65 °C for 10 days, grounded into a powder state using commercial blender, and finally used for the preparation of different extracts.

1.2. Water samples collection and preparation

Water samples were obtained from the

subsurface layer, at water depth (60 cm), using polyvinyl chloride Van Dorn plastic bottle (1 L) water sampler. Samples were preserved immediately after collection by acidifying to pH 2 by conc. HNO_3 for 1 L water sample. Water samples were kept in an ice box till analyzed in the laboratory. Water samples were digested using nitric acid to extract metals according to APHA (American Public Health Association), and stored cool at 4 °C before metal analysis.

1.3 Heavy Metals Included in the Study.

The heavy metals included in the study were cadmium (Cd), lead (Pb), mercury (Hg), and arsenic (As).

2.METHODS:

2.1.Chemical compositions:

2.1.1 Extraction and determination of crude lipid:

A known dry weight of the samples (10 gm) was extracted with n-hexane 6 hours in Soxhlet apparatus. The solvent was evaporated and the residue was dried to constant weight and the percentage of total lipid was calculated, according to A.O.A.C. (2000).

2.1.2 Determination of total proteins

Total nitrogen was determined according to the modified micro-Kjeldahl method as described in A.O.A.C. (2000). The total protein contents were calculated using the conversion factor 6.25.

2.1.3 Determination of moisture content:

An appropriate amount of fresh fish samples were weighed (ca.10g) and dried in oven at 105°C until a constant weight was reached. The samples were weighed before and after drying and the moisture content was determined (A.O.A.C, 1990).

2.1.4 Determination of ash:

Ashing process was carried out in a muffle furnace by heating at 550°C until a constant weight was obtained (A.O.A.C., 1990)

2.1.5 Determination of heavy metals.

Concentrations of some heavy metals were determined in water and fish samples. The samples analyzed were prepared according to the methods described by Association of Official Analytical Chemists (A.O.A.C., 2000). Fish samples were prepared as edible (flesh or muscles) parts prior to analysis. A Perkin-Elmer 2380 atomic absorption spectrophotometer was employed for the analysis.

RESULT AND DISCUSSION

1. Heavy metals concentration in water samples:

The results of heavy metals concentration in water samples of the selected areas are given in Table (1). The values of arsenic (As) levels were ranged between (3.14 to 16.24 ppb); Borollus water was the most polluted with such metal compared to the rest of the tested areas. The lead (Pb)concentrations were ranged between (1 – 20 ppb) and the highest level was found in River Nile K. Elsheikh water. On the other hand cadmium (Cd) concentrations were ranged between (1.5 – 8.4 ppb) with highest level in River Nile K. Elsheikh water too. Finally mercury (Hg) showed very low concentrations in all water samples under investigation (0.0037 – 0.0845 ppb).

Our results are in line with those of (Osman and Kloas, 2010; El Zokm *et al.,* 2012 and Mahmoud and Abu Taleb, 2013) who confirmed the existence of a significant differences in the concentration of heavy metals in different places from which water samples were collected. Such variation in metal concentrations can be explained by the diversity of human activities and life style, from one area to another.

Table (1): Heavy metal concentrations in water samples in all areas under investigation.

No	Site	As (ppb)	Pb (ppb)	Cd (ppb)	Hg (ppb)
1	River Nile Assiut	3.14	6	1.5	0.0091
2	El fayoum farm	14.21	5	5	0.004
3	River Nile K.Elsheikh	10.09	20	8.4	0.0105
4	Qarun lake	11.27	4	2.8	0.0845
5	K.ElSheikh farm	14.33	1	6.3	0.0037
6	Borollus lake	16.24	2	6.1	0.0337

2. Heavy metals concentrations in fillet fish samples:

Results tabulated in Table (2) showed the heavy metals, (cadmium [Cd], arsenic [As], lead [Pb] and mercury [Hg]) contents of flesh fishes.

The values of Cd content were ranged between (ND to 79 µg/Kg) in all three fish types collected from different places; while As concentrations were aligned from (ND to 5.53 µg/Kg) in the previous samples. Pb were not detected in four fish samples and showed different levels in the other five samples which ranged between (10 – 16 µg/Kg); while Hg showed very low concentrations in all tested fishes (0.175 – 0.539 µg/Kg).

It can be noticed in Table (2) that the Cd, As, Pb and Hg concentrations in all fish tissues were less than the permissible limits recommended by E.O.S.Q.C. (1993).

In a previous study that are designed to determine lead and cadmium concentration in Nile tilapia muscles it has been found that lead and cadmium concentrations were (0.062 ppm) (0.017 ppm) respectively Edem *et al*., (2009); while in another study Kaoud and El Dahshan (2010), indicated that bioaccumulation of heavy metals were as follows: lead (1.52 ppm), mercury (3.5 ppm) and cadmium (1.21 ppm) in fish muscles.

Hashim *et al.,* (2008), indicated that the obtained mean values of common carp were as follows: mercury 0.040 ppm, lead 0.045 ppm and cadmium 0.033 ppm.

The variation between heavy metals concentrations in different samples may be due to the diversity of water contamination from one area to another.

The low concentration of heavy metals in fish muscles may be due to their high concentration in other fish organs such as liver, gills and kidney (Oladimeji and Offem, 1989; Kaoud and El Dahshan, 2010).

3. Chemical composition of fishes.

The chemical composition of Tilapia, Catfish and Common carp fishes were exhibited in Table (3).The moisture content in fresh fillet tilapia, catfish and common carp fishes expressed on weight basis (g/100 g fresh fillet) were ranged from 75.2 – 76.8 %, 74.3 – 74.6 % and 66.9 – 71.8 % respectively.

Our data are in line with those of (Gamal *et al*., 2011; Sales and Maia, 2012; Ayeloja *et al*., 2013) who found that the moisture contents in tilapia were ranged between 74.99 to 78.32%.

In different studies on catfish, Foline *et al.,*(2011); Osibona (2011); Salihu-Lasisi *et al*.,(2013); Taiwo *et al.,* (2014) and Obany *et al*., (2016), found that the moisture percentages of the freshwater species of catfish were (72.72 %- 78.70%) in wet weight.

Table (2): Heavy metals (µg/Kg) in fillet of tilapia, catfish and common carp fishes dry weight.

No	Site	Species	Cd	As	Pb	Hg
1	River Nile Assiut	Tilapia	ND*	ND*	16	0.219
2	El fayoum farm	Tilapia	27	2.89	14	0.192
3	Nile K. ElSheikh	Tilapia	79	2.43	10	0.243
4	K. ElSheikh farm	Catfish	75	3.81	ND*	0.175
5	Borollus lake	Catfish	52	5.11	11	0.303
6	Qarun lake	Catfish	18	2.74	14	0.539
7	K. ElSheikh farm	C.carp	16	1.13	ND*	0.211
8	Borollus lake	C.carp	22	5.53	ND*	0.466
9	El fayoum farm	C.carp	ND*	ND*	ND*	0.323

Table (3): Chemical composition (%) of tilapia, catfish and common carp fishes

No	Site	Species	Wet weight	Dry weight		
			% Moisture	% Total Protein	% Crude Lipids	% Ash
1	River Nile Assiut	Tilapia	76.5	77.1	18.8	4.1
2	El fayoum farm	Tilapia	75.2	77.52	18.08	4.4
3	Nile K. ElSheikh	Tilapia	76.8	76.9	18.71	4.39
4	K. ElSheikh farm	Catfish	74.4	68.94	26.16	4.9
5	Borollus lake	Catfish	74.3	68.9	25.8	5.3
6	Qarun lake	Catfish	74.6	68.83	26.99	4.18
7	K. ElSheikh farm	C.carp	66.9	71.72	23.85	4.43
8	Borollus lake	C.carp	69.0	70.43	25.32	4.25
9	El fayoum farm	C.carp	71.8	68.7	26.78	4.52

On the other hand Bahar *et al.,* (2006); Cirkovic *et al.,* (2012); Ullah *et al.,*(2014); Yola (2014) and Mahboob *et al.,* (2015), reported that the amount of moisture in common carp fish diverges between (65.09 - 75.68 %).

In tilapia, total protein showed the highest contents (76.90 – 77.52 %) compared with catfish and common carp. In this context Salihu-Lasisi *et al*., (2013), showed that tilapia fishes samples contain protein percentage 62.04 % on dry weight basis; this difference may be due the type of tilapia fish which used in such study.

Protein content in common carp varied from (68.70 – 71.72 %); these data are similar with those of Ullah *et al.,*(2014) and Jabeen *et al.,* (2015) who found that crude protein contents in common carp ranged from (65.9 to 75.25 %) on dry weight basis.

Catfish showed the lowest protein content which ranged between (68.83 – 68.94%) in dry weight basis; results agree with those of Foline *et al.,*(2011) and Adeosun *et al*., (2015) who reported that the values of crude protein in farmed catfish ranged from 49.35 %-68.4%

From data tabulated in Table (3), total lipid contents in tilapia were ranged between (18.08 – 18.8%), these results are higher than those found by Gamal *et al*., (2011), who indicated that the values of crude lipids for dried tilapia fillets were ranged from (14.73 to 15.62%).

While in catfish, lipid contents varied between (25.8 – 26.99 %). These results are much higher than those found by Chukwu and Shaba (2009) and Obaroh *et al*., (2015) who investigated that the fat contents in catfish were ranged from 14.28 to 19.39%.

In common carp, lipid contents were diverged from 23.85 to 26.78 %; these findings are less similar to that detected by Ullah *et al.,*(2014) and Jabeen *et al.,* (2015),who illustrated that fat contents were ranged from (18.9 -19.52 %) in dry weigh of common carp.

On the other hand, total ash amounts were ranged between (4.1 – 4.4%) for tilapia. On different studies on tilapia fish carried out by Gamal *et al*.,(2011) and Ayeloja *et al*., (2013), they showed that tilapia ash contents were ranged from (4.953-7.85 %).

Our data showed that ash contents for catfish were (4.18 – 5.3 %), these results are in agreement with those obtained by Chukwu and Shaba (2009), Foline *et al.,* (2011) and Ayeloja *et al*., (2013) who reported that the proximate composition of dried catfish ash was ranged between (3.0 - 6.4 %).

Ash contents in common carp were ranged (4.25–4.52 %) which in line with those of Ullah *et al.,*(2014), Yola (2014), and Jabeen *et al.,* (2015), who found that the combined mean for whole common carp fish ash was ranged from (3.0 – 4.97%).

CONCLUSION

As, Cd, Pb and Hg concentrations in water from different water sources indicate that the levels of these heavy metals in all water samples were very low. However, long-term bioaccumulation through food chain is a major concern. Our findings have shown that Nile tilapia, catfish and common carp have a high nutritional values and the Cd, As, Pb and Hg concentrations in all fish tissues were less than the permissible limits recommended by E.O.S.Q.C. (1993).

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التقييم الكيميائى الحيوى لثلاثة أنواع من الأسماك مجمعه من مصادر مائية مختلفة فى مصر

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[2] قسم المعامل – مستشفى شبين القناطر – وزارة الصحة

الملخص العربي

تواجه البيئة المائية المصرية مشاكل كبيرة لتعرضها للمعادن الثقيلة، لذا فمن المهم تقدير مدي تراكم هذه المعادن في المصادر المائية المتنوعة وكذلك في الأسماك الموجودة بهذه المصادر المائية. وتهدف هذه الدراسة لتقدير مستوي عناصر ثقيلة محددة في الماء وفي عينات الأسماك المجمعة من مصادر مائية مختلفة في مصر بالاضافة إلي تقدير محتوي هذه الأسماك من المكونات الرئيسية (رطوبة – بروتين – دهون – رماد).

تم تجميع عينات من أنواع (البلطي النيلي – القرامبط – المبروك) من مصادر مائية مختلفة (نهر النيل – البحيرات – المزارع السمكية) وتم تقدير محتواها من المعادن الثقيلة (الكادميوم – الزرنيخ – الرصاص – الزئبق) بواسطة جهاز الامتصاص الذري.

وكان تركيز المعادن الثقيلة المحددة في عينات الماء بوحدات الجزء في البليون (ppb) كالتالي: الكادميوم (5 – 84ميكروجرام/كجم وزن جاف)، الزرنيخ (3,14 – 16,14)، الرصاص (1 – 20) والزئبق (0,0037 – 0,0105) في حين كان تركيز هذه العناصر في عينات الأسماك المختلفة ميكروجرام/كجم وزن جاف كالتالي: الكادميوم (غير موجود – 79)، الزرنيخ (غير موجود – 5,528)، الرصاص (غير موجود – 16) والزئبق (0,175 – 0,539).

وأظهر التحليل الكيميائي للأسماك المختلفة (البلطي – القرامبط – المبروك) أن محتواها من المكونات المختلفة كالتالي: الرطوبة تتراوح بين (75,2 – 76.8%) في البلطي، في حين تتراوح بين (74,3 – 74,6%) في القرامبط وأخيرا تتراوح بين (76.9 – 77.52%) في المبروك.

البروتين يتراوح بين (76,9 – 77,52%) في البلطي، في حين يتراوح بين (68,83 – 68,94%) في القرامبط وأخيرا تتراوح بين (68.7 – 71.72%) في المبروك.

الدهون الكلية تتراوح بين (18,08 – 18,8%) في البلطي، في حين تتراوح بين (25,8 – 26,99%) في القرامبط وأخيرا تتراوح بين (23,58 – 26,78%) في المبروك.

الرماد يتراوح بين (4,1 – 4,4%) في البلطي، في حين تتراوح بين (4,18 – 5,3%) في القرامبط وأخيرا تتراوح بين (4.25 – 4.52%) في المبروك.

وتشير النتائج السابقة إلي أن أسماك البلطي والقرامبط والمبروك التي تم تجميعها وفحصها تحتوي علي قيمة غذائية عالية لارتفاع محتواها من البروتين والدهون، كما أنها تحتوي علي كميات من المعادن الثقيلة (الكادميوم – الزرنيخ – الرصاص – الزئبق) أقل من الحدود المسموح بها في المواصفة المصرية (1993).