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# EFFECT OF COOKING METHODS ON HEAVY METALS CONTENT IN BOLTI FISH FROM DIFFERENT ENVIROMENTS

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## ABSTRACT

The levels and distribution of heavy metals (Cu – Zn – pb – Cd and Hg) in Bolti fish (Tilapia sp) and water collected from El-Manzalah Lake – Kafr El-Sheikh farm and local market of Talkha city were determined using atomic absorption spectrophotometer (AAS). The results showed that the concentration of pb and Cd were higher in samples from Kafr El-Sheik farm (4.282 and 0.062 mg/L in water, 5.008 and 1.095 mg/kg respectively in flesh of fish). It could noticed that the heavy metals accumulated in gills and viscera were higher amounts. Also Cu concentration of fried and grilled samples were higher than raw samples, Zn content of fried and grilled samples was low than raw samples, pb and Cd concentrations decreased by frying but increased by grilling. While Hg concentrations did not change using these methods. So, it is recommended that we should change our old habits conserving eating heads and viscera because there is no way to reduce heavy metals content using the previous common cooking methods.

## INTRODUCTION

Fish is widely consumed in many parts of the world by humans because it has high protein content, low saturated fat and also contains omega fatty acids known to support good health (USEPA, 2004). Fish are the major part of the human diet and it is not surprising that numerous studies have been carried out on metal accumulation in different fish species (Lewis *et al.*, 2002).

Fish are often at the top of the aquatic food chain and may concentrate large amounts of some metals forum the water. Accumulation patterns of contaminants in fish depend both of up take and eliminates rates (Hakanson, 1984).

Many elements, which are present in seafood are essential for human life at low concentrations but they can be toxic at high concentrations. Therefore, many consumers regard any presence of these elements in fish as a hazard to health (Oehlenschloger, 2002).

The aquatic environment with its water quality is considered the main factor controlling the state of health and disease in both man and animal. Nowadays, the increasing use of the waste chemical and agricultural drainage systems represents the most dangerous chemical pollution. The most important heavy metals from the point of view of water pollution are Zn, Cu, pb, Cd, Hg, Ni and Cr. Some of these metals (e.g. Cu, Ni, Cr and Zn) are essential trace metals to living organisms, but become toxic at higher concentrations. Others, such as pb, Cd and Hg have no known biological function but are toxic elements. (Rashed, 2004).

Zyadah (1999) found that, the concentration of Cu, Zn, Cd and pb in different organs of Tilapia Zillii collected from five sites of Lake Manzala during spring (1996) were 0.70 – 2.10; 19.23 – 49.60; 0.07 – 0.64 and 0.06 – 0.52 mg/kg wet weight in flesh; 0.70 - 1.92; 30.71 – 51.50; 0.09 – 0.51 and 0.10 – 0.55 mg/kg in gills and 1.20 – 5.60; 10.80 – 48.10; 0.19 – 0.57 and 0.19 – 0.42 mg/kg wet weight in liver, respectively.

Mansour and Sidky (2003) studied the content of Zn, Cu, Cd, pb and Co in water and Bolti fish samples collected from Lake Qarun and water and Bolti fish samples collected from farm they found that, the concentration of Zn, Cu, Cd, pb and co were 0.005 – 0.043; 0.047 – 0.294; 0.0 – 0.202; 0.0 – 0.053 and 0.0 – 0.041 ppm in lake's water; 0.008 – 0.185; 0.012 – 0.320; 0.0 – 0.016; 0.0 – 0.062 and 0.0 - 0.027 ppm in farm's water; 7.89 – 9.35; 1.65 – 1.72; 0.239 – 0.42; 0.163 - 7.25 and 0.0 – 2.75 ppm in whole body; 1.421 – 2.051; 0.285 – 0.455; 0.078 - 0.150; 0.059 – 1.653 and 0.0 – 0.294 ppm in flesh; 3.33 – 4.647; 0.494 - 0.736; 0.084 – 0.089; 0.070 – 4.212 and 0.0 – 1.465 ppm in Head; 2.509 - 3.282; 0.459 – 0.940; 0.072 – 0.176, 0.034 – 1.385 and 0.0 – 0.99 ppm in viscera (Lake's Bolti fish) and 9.31 – 24.6; 2.00 – 3.89; 0.019 – 0.25; 0.017 - 10.6 and 0.0 – 2.43 ppm in whole body; 2.839 – 8.29; 0.658 – 1.57; 0.011 - 0.095; 0.005 – 6.38 and 0.0 – 0.333 ppm in flesh; 4.115 – 9.05; 0.76 – 0.76; 0.008 – 0.051; 0.011 – 0.40 and 0.0 – 1.27 ppm in Head; 2.355 - 7.261; 0.586 – 3.504; 0.0 – 0.103; 0.0 – 3.82 and 0.0 – 0.83 ppm in viscera (farm's Bolti fisf) respectively.

Al-Afify (2006) studied the content of Zn, Cu, pb and Cd in Oreochromis niloticus and Tilapia zillii samples collected from the Nile Damietta branch during 2001 – 2002. He found that, the concentration of Zn, Cu, pb and Cd were 14.0 – 36.0; 1.0 - 5.3; 7.7 – 30 and 2.7 – 5.0 (mg/kg dry wt.) in Oreochromis niloticus and 23.0 – 46.0; 1.9 – 6.0; 8.4 – 22.4; 209 - 5.0 mg/kg dry wt. in Tilapia Zillii respectively.

Because of the previous data, we plan to study heavy metals content in Bolti fish and its environment, Also, we investigated effect common cooking methods (grilling, frying) in heavy metals content.

## MATERIALS AND METHODS

**Materials:**

**- Fish and water samples:**

Bolti fish (Tilapia Sp.) and water samples collected from different locations (El-Manzala Lake – Kafr El-Shekh farm – Markte of Talkha City, Egypt).

**- Fish samples preparation and cooking:**

Each sample of fresh fish was washed with tap water several times to remove slime, then fish were divided into three groups. The first group was uncooked fish (raw), second group prepared for frying and the other group prepared for grilling.

- Fish was fried in fresh sunflour oil for 8 min.
- Fish was grilled in oven for 20 min.

- After cooking process, the cooked fish were cooled at room temperature. Then raw and cooked fish samples were homogenized using a kitchen blender to produce a uniform sample and analyzed to determine heavy metals.

**Method of analysis:**

**- Determination of heavy metals:**

Samples were prepared for heavy metals determination by digestion in percholoric acid and nitric acid according to Pupsa et al., 1994.

Cadmium; lead; zinc; copper and mercury contents were determined by using atomic absorption spectrophotometer (AAS,) [Perkins – Elmer, Model 2380].

**Table (1): The conditions of current lamps, wave length, slit and flame used in the heavy metals determination by the AAS.**

| Element | Current lamp MA | Wave length nm | Slit nm | Flame |
|---|---|---|---|---|
| Cd | 4 | 228.8 | 0.7 | air acetylene |
| Pb | 10 | 217 | 0.7 | air acetylene |
| Zn | 10 | 213.9 | 0.7 | air acetylene |
| Cu | 15 | 324.8 | 0.7 | air acetylene |
| Hg | 4 | 253.7 | - | Hydrate (nitrous air) |

According to Pupsa et al., 1994.

**Statistical analysis:**

Data were analyzed according to statistical analysis system, SAS (1996).

## RESULTS AND DISCUSSION

Data in Table (2) show heavy metals content in water samples from El-Manzalah Lake and Kafr El-Sheik farm. The concentrations of heavy metals in farm water were higher than the lake water where these concentrations were Cu 1.943, Zn 8.116, pb 4.282, Cd 0.062 and Hg 0.004 mg/L. These results were similar with (Zyadah, 1995).

**Table (2): Concentration of heavy metals mg/L in water samples:-**

| Place | Heavy metals content (mg/L) | | | | |
|---|---|---|---|---|---|
| | Cu | Zn | Pb | Cd | Hg |
| A | 1.637 | 4.783 | 0.512 | 0.049 | 0.003 |
| B | 1.943 | 8.116 | 4.282 | 0.062 | 0.004 |
| TTEST | 3.1981 | 61.4255 | 58.0399 | 7.1813 | 8.6603 |
| Pr | 0.0702 | 0.0001 | 0.0003 | 0.0188 | 0.0131 |

A: El-Manzalah Lake B: Kafr El-Sheik farm

These results show that the concentrations of heavy metals are higher than the permissible limits level as recommended by Egyptian organization for standardization (1993 who reported that the limits levels were

1.0, 5.0, 0.01 and 0.05 mg/L for Cu, Zn, pb and Cd respectively. This increase in heavy metal concentrations is a result of high pollution loads in the lake and farm from agricultural wastes, which include chemicals, pesticides and fertilizers.

By statistical analysis the effect of places was high significant for Zn and pb, significant for Cd, Hg but non significant for Cu.

Data in table (3) show heavy metals concentration in flesh, grills and viscera of Bolti fish collected from El-Manzalah Lake, Kafr El-Sheik farm and local market of Talkha city. The highest level of Cu was observed in gills samples from Kafr El-Sheik farm (5.105 mg/kg) but the highest levels of Zn was observed in El-Manzalah Lake samples (55.252 mg/kg) while the concentration of Cu, Zn was 2.936, 39.12 mg/kg in flesh samples which collected from Manzala Lake and 3.651, 36.674 mg/kg in flesh for Kafr El-Sheik farm samples respectively.

These results were within levels as reported by Al-Afify (2006) who, found that the concentrations of Cu and Zn in Tilapia Zillii samples were 1.9 – 6.0 and 23.0 – 46.0 mg/kg respectively. The obtained results for Cu and Zn in all samples were within the permissible limits as recommended by Egyptian organization for standardization (1993). Who reported the limit levels of Cu and Zn were 20, 40mg/kg respectively.

The highest levels of pb and Cd were observed in gills samples from Kafr El-Sheik farm 7.809 mg/kg for pb and 3.141 mg/kg for Cd while gills samples from local market was given 0.466 mg/kg for Hg.

By statistical analysis the main effect of places, part and place and part was high significant for Cu, Zn, pb, Cd and Hg.

**Table (3): Concentrations of heavy metals mg/kg (D.W) in Bolti fish organs from different areas.**

| Place | part | Heavy metals content (mg/Kg sample) | | | | |
|---|---|---|---|---|---|---|
| | | Cu | Zn | Pb | Cd | Hg |
| A | Flesh | 2.936 | 39.120 | 1.985 | 1.008 | 0.196 |
| | Gills | 5.080 | 55.252 | 4.023 | 2.020 | 0.221 |
| | Viscera | 4.306 | 49.819 | 3.401 | 1.281 | 0.262 |
| B | Flesh | 3.651 | 36.674 | 5.008 | 1.095 | 0.258 |
| | Gills | 5.105 | 47.390 | 7.809 | 3.141 | 0.402 |
| | Viscera | 4.875 | 41.839 | 6.801 | 2.982 | 0.354 |
| C | Flesh | 1.346 | 37.194 | 0.512 | 0.165 | 0.165 |
| | Gills | 2.101 | 45.145 | 1.909 | 0.890 | 0.466 |
| | Viscera | 1.900 | 40.160 | 0.933 | 0.613 | 0.359 |
| Place | | ** | ** | ** | ** | ** |
| Part | | ** | ** | ** | ** | ** |
| Place*part | | ** | ** | ** | ** | ** |

-A: El-Manzalah lake ; B: Kafr El-Sheik farm; C: Talkha market.
-All values are means of three replicates.

These results were lower than Al-Afify (2006) who reported that the concentrations ranged from 8.4 – 22.4 mg/kg for pb and 2.9 – 5.0 mg/kg for

Cd, in Tilpia Zilii, but the level of pb and Cd in the present study were higher than Zyadah (1999) who reported that the level of pb and Cd 0.06 – 0.52 and 0.07 – 0.64 mg/kg in flesh respectively. Level of Cd was within the levels as reported by Amoo et al., (2005). They found that the concentration of Cd was 0.00 – 1.12 mg/kg in fish. These results show the content of Hg and Cd within the permissible limits but pb was higher, which recommended by FAO (1983) who reported that the level limits of Cd, Hg and pb were 2.0, 0.3 and 1.5 mg/kg fish respectively. But these levels of Cd and pb were higher than the permissible limits as recommended by Egyptian organization for standardization (1993) who reported that the level of Cd and pb were 0.5 and 2.0 mg/kg for fish respectively.

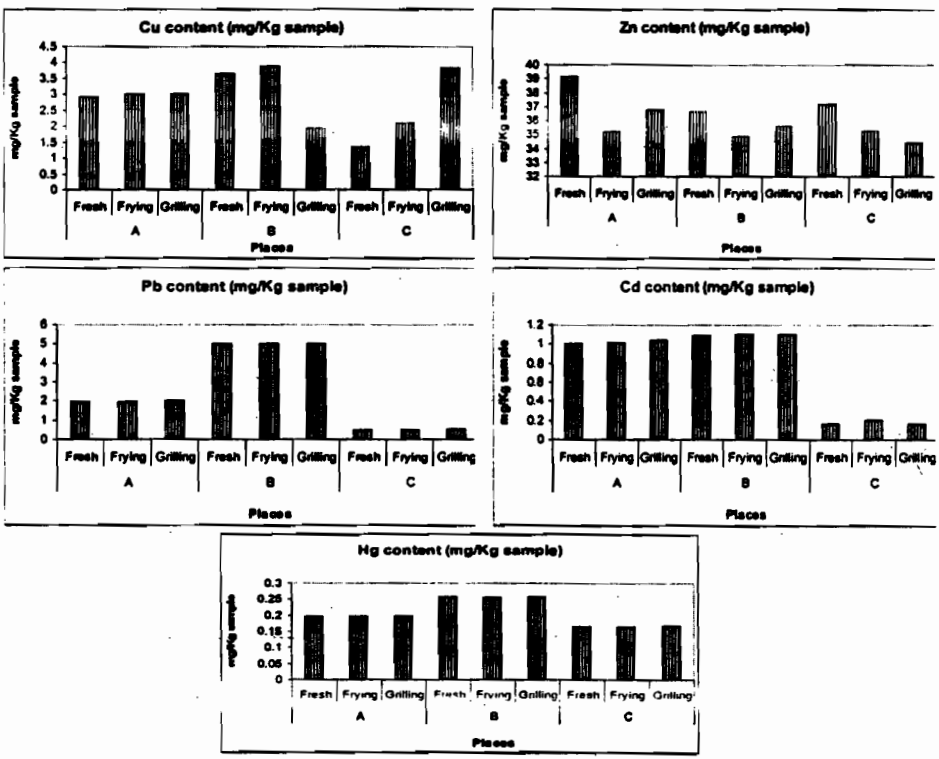


**Fig. (3): Concentrations of heavy metals mg/kg (D.W) In Bolti fish organs from different areas.**

The heavy metals accumulation in fish depends on both the structure of tissues and organs and the interaction of heavy metals in the environment Cicik and Karayakar 2004. Results recorded in table (3) show that the gills samples of Bolti had the highest values of Cu, Zn, pb, Cd and Hg as they ranged from 2.101 – 5.105, 45.145 – 55.252, 1.909 – 7.809, 0.890 – 3.141 and 0.221 – 0.466 mg/kg respectively. These results were in similar to those given by Zyadah (1999) and Shakweer (1999). From aforementioned data, it

could be born in mind that pollution loads play an important role in heavy metals accumulation in fish. Also respiratory system "Gills" in fish help for heavy metals accumulation in specific organ like gills and viscera.

Results in table (4) show heavy metals concentration in fresh, fried and grilled fish flesh samples. The Cu content high significant increased in all fried and grilled samples, but the Zn content high significant decreased by frying and grilling methods.

These results were in agreement with Nalan et al., (2004) who reported that Mg, P, Zn and Mn contents of fish cooked by almost all methods significantly decreased but the Cu content increased in fried samples and added that baking and grilling were found to be the best cooking method for healthy eating.

**Table (4): The effect of processing methods on the heavy metals content in Bolti fish from different places.**

| places | treatments | Heavy metals content (mg/Kg sample) | | | | |
|---|---|---|---|---|---|---|
| | | Cu | Zn | Pb | Cd | Hg |
| A | Fresh | 2.936 | 39.120 | 1.985 | 1.008 | 0.196 |
| | Frying | 3.004 | 35.218 | 1.984 | 1.011 | 0.196 |
| | Grilling | 3.022 | 36.791 | 1.992 | 1.040 | 0.197 |
| B | Fresh | 3.651 | 36.674 | 5.008 | 1.095 | 0.258 |
| | Frying | 3.875 | 34.882 | 5.003 | 1.098 | 0.257 |
| | Grilling | 3.806 | 35.620 | 5.017 | 1.100 | 0.258 |
| C | Fresh | 1.346 | 37.194 | 0.512 | 0.165 | 0.165 |
| | Frying | 1.967 | 35.266 | 0.512 | 0.206 | 0.165 |
| | Grilling | 2.089 | 34.450 | 0.520 | 0.163 | 0.166 |
| Place | | ** | ** | ** | ** | ** |
| Treat | | ** | ** | N.S. | ** | N.S. |
| Place × treat | | ** | ** | N.S. | N.S. | N.S. |

**A: El-Manzalah lake ; B: Kafr El-Sheik farm; C: Talkha market.**
**All values are means of three replicates.**

The data obtained show that frying method did not cause clear changes in pb and Cd content, while grilling method lead to an increase. Also these results were in similar with Beyza et al., (2006) who reported that the concentration of pb in raw, fried and grilled fish were 0.278, 0.277 and 0.284 mg/kg respectively. These results may be due to change occurred in moisture and fat content during frying and grilling.

Fish accumulate substantial concentrations of Hg in their tissues and thus can represent a major dietary source of this element for humans. (Inskip and Piotorwsiki, 1985). The present study show that, the content of Hg did not clearly change by the pervious cooking mehods. These results were in agreement with Chiciourel et al., (2001) and Morgan et al., (1997), they reported that, fish accumulate methyl mercury in their tissues, where it becomes strongly bound methyl mercury is not removed from fish tissue by any practical cooking method.

By statistical analysis of the data in the same table revealed that, the main effect of treatments were high significant for (Cu, Zn and Cd) but non significant for (pb and Hg) and interaction effect between place and treatment were high significant for (Cu, Zn and Cd) but non significant for (pb and Hg).

Finally, it could be concluded that our Bolti fish in Egypt content high levels of heavy metals as the high pollution occurred especially in gills and viscera. And there was no effective method to reduce these levels. So, we should try to prevent eating gills and viscera where it was an old load habits.

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## تأثير طرق الطهي على محتوى سمكة البلطي من المعادن الثقيلة

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**قسم الصناعات الغذائية – كلية الزراعة – جامعة المنصورة – مصر**

تم تقدير محتوى سمكة البلطي والمياة التي جمعت من مناطق مختلفة (بحيرة المنزلة – مزرعة كفر الشيخ – سوق مدينة طلخا) من المعادن الثقيلة (النحاس – الزنك – الكادميوم – الرصاص – الزئبق) بواسطة جهاز الإمتصاص الذري. وأظهرت النتائج أن مياه وأسماك مزرعة كفر الشيخ كان محتواها عالي من الكادميوم والرصاص (٠,٠٦٢، ٤,٢٨٢ ملجم/لتر في المياه و ٥,٠٠٨، ١,٠٩٥ ملجم/لتر في الأسماك على التوالي). وكذلك أكدت النتائج أن أعلى تركيز للمعادن في أجزاء السمكة كان في الخياشيم يليها الأحشاء. وتم دراسة تأثير عملية الشي والتحمير على محتوى الأسماك من المعادن. والنتائج أكدت أن نسبة النحاس تزداد بهذه الطرق بينما نسبة الزنك تنخفض عن الموجود بالسمك الطازج ووجد أيضا أن نسبة الرصاص والكادميوم تكاد لا تتأثر بعملية التحمير ولكن تزداد بعملية الشي ووجد أيضا أن الزئبق لا يتأثر بدرجة ملحوظة بكل من عملية الشي والتحمير ولذلك نوصي بالإبتعاد عن تناول كلا من الخياشيم والأحشاء والإهتمام بعدم تلوث الأسماك بهذه المعادن نظرا لعدم وجود طرق طهي تؤدي إلى إنخفاضها.