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Determination of Copper, Zinc and Iron levels in Edible Muscle of Three Commercial Fish Species from Iranian Coastal Waters of the Caspian Sea

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Abstract: This study was undertaken to determine the concentrations of Copper (Cu) Zinc (Zn) and Iron (Fe) in edible muscle of 3 fish species, Mullet (*Mugil auratus*), Sefid (*Rutilus frisii kutum*) and Common Carp (*Cyprinus carpio*) collected from 4 fishing sites (Chaloos, Anzali, Roodsar and Fereidonkenar) of Iranian coastal waters of the Caspian Sea. The concentration of the metals was measured by Atomic Absorption Spectrophotometry (AAS) and reported as mg kg^{-1} dry weight of muscle. The mean concentrations of Cu in muscles of Mullet, Sefid and Common Carp were 3.14, 3.69 and 3.39 mg kg^{-1}, respectively. Zn levels in the same species were 43.46, 37.99 and 73.81 mg kg^{-1} and for Fe values were 81.11, 73.59 and 94.78 mg kg^{-1}, respectively. Concentrations of Zn and Fe were significantly ($p<0.05$) affected by the species and sites and were significantly higher in Common Carp. The measured elements of the investigated fish were in permissible safety levels for human consumption.

Key words: Copper, zinc, iron, fish, caspian sea, atomic absorption spectrophotometry

INTRODUCTION

Fish is an excellent source of protein, low fat and essential minerals since the consumption of fish and fishery products are highly increased all over the world. Fish lipids are rich in polyunsaturated fatty acids, particularly ω-3 fatty acids, which have an important impact in disease prevention and health promotion. Also, some trace elements may have therapeutic effects in preventing particular diseases (Alasalvar *et al*., 2002; Celik *et al*., 2008; Tuzen and Soylak, 2007).

Metals in marine ecosystems could be detected in solutions or suspensions and precipitate in sediments (Turkmen *et al*., 2005). Depending on their biological roles, they can be categorized as the following groups: essential elements, non-essential elements and toxic elements. Fish and other aquatic animals accumulate the metals in their body through the food chain and water. However, the concentration of metals in fish is depending on many factors such as biological differences, nutritional source, seasonal factors, environmental conditions (temperature, salinity, water chemistry and contaminants) and the method of food processing (Carvalho *et al*., 2005).

The Cu concentration in fish is comparable to meat of domestic animals and also, the fish is a recommended source of Zn. The concentration of Fe in fish flesh is varied between species, individuals and sampling periods (Carvalho *et al*., 2005). According to the international standards, the Recommended Dietary Allowance (RDA) for Zn is 15 mg day^{-1} and Maximum Acceptable Body Burden (MABB) is between 300-1000 μg kg^{-1} body weight/day. For Fe these values are 10-18 mg kg^{-1} and 800 μg kg^{-1} body weight per day, respectively. There is no RDA for Cu but the Estimate Safe and Adequate Intake (ESAI) and MABB for this element are between 1.5-3.0 mg day^{-1} and 50-500 μg kg^{-1} body weight/day, respectively (Sharif *et al*., 1993a, b).

The Caspian Sea is the largest inland body of water in the world, surrounded by Iran, Russia Azerbaijan, Kazakhistan and Turkmenistan (Mora *et al*., 2004). There is a little information about the accumulation of trace and toxic elements in fish of the Caspian Sea. In addition, fish has an important role as a source of protein in the diet of people in northern states of Iran. Therefore, the aim of this study was to determine the levels of Cu, Zn and Fe in edible muscle of 3 popular fish species from different sites of Iranian coastal waters of the Caspian Sea.

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MATERIALS AND METHODS

Collection of samples: Sixty fresh samples of 3 commercial fish species, namely Mullet (*Mugil auratus*), Sefid (*Rutilus frisii kutum*) and Common Carp (*Cyprinus carpio*) were collected during spring 2007 from 4 sites (Chaloos, Anzali, Roodsar and Fereidonkenar) of Iranian coastal waters of the Caspian Sea. Muscle samples were taken, packed in polyethylene pouches and stored at -18°C prior to analysis.

Chemical analysis: The analysis of Cu, Zn and Fe was done according to the method of Tuzen (2003) with some modifications. The muscle samples of each fish were weighed and dried at 65°C in acid-washed Petri dishes inside an oven until a constant weight was obtained and then homogenized.

A dried sample 0.5 g was placed in a porcelain crucible and ashed at 450°C for about 5 h until a white or gray ash residue was obtained and then cooled at room temperature. The residue was digested in 4 mL concentrated nitric acid (65%, v v^{-1}) and transferred to a graduated 10 mL test tube and diluted to volume with deionised water. A blank digest was prepared in the same way. The concentrations of Cu, Zn and Fe in the solution were carried out by flame atomic absorption spectrophotometry (SHIMADZU AA-6800, Japan). The accuracy of analytical procedure was evaluated using standard reference material (LUTS-1 National Research Council, Canada).

Statistical analysis: All data were statistically analyzed using the 1-way ANOVA procedure of the SPSS software for windows version 15.0 and mean values±SD were reported. Tukey's test was carried out to estimate whether the measured metals varied significantly between species and sites. The differences among means at $p<0.05$ were considered significant.

RESULTS

The accuracy of analytical procedure and calculation of recovery is presented in Table 1. The concentrations of Cu, Zn and Fe in 3 fish species from the Iranian coastal waters of the Caspian Sea are presented in Table 2. The Fe concentration in edible muscles was higher than Cu and Zn. Moreover, Common Carp had the highest concentration of Fe. With respect to Cu concentration, there was no significant differences ($p>0.05$) between the species. However, the maximum and minimum Cu concentrations were found in Sefid and Mullet, respectively. The significant differences ($p<0.05$) were observed in Zn concentration between Common Carp and 2 other species.

Table 1: Metal concentrations in certified reference material (n = 3)

Elements	Certified value (mg kg^{-1})	Our value (mg kg^{-1})	Recovery (%)
Cu	1.7	1.5 ±0.15	98
Zn	82.9	85.2±0.90	102
Fe	77.8	76.8±2.12	98

Table 2: Metal concentrations in fish species from Iranian coastal waters of the Caspian sea (mg Kg^{-1})

Type of fish	No. samples	Cu	Zn	Fe
Mullet	20	3.14±1.17	43.46±14.01a	81.11±1799a
Sefid	20	3.69±2.24	37.99±15.06a	73.59±16.59a
Common carp	20	3.39±1.24	73.81±21.14b	94.78±20.13b

a, b: Means±SD in a column for each element with different letters are significantly different ($p<0.05$)

Table 3: Metal concentrations in fish species from different sites of Caspian sea (mg kg^{-1})

Type of fish at different sites	No. samples	Cu	Zn	Fe
Mullet				
Chaloos	5	2.24±0.83	37.46±20.20	73.41±18.41
Anzali	5	3.54±1.42	47.70±11.52	74.53±18.38
Roodsar	5	3.49±1.23	52.07±50.70	99.41±14.61
Fereidonkenar	5	3.30±0.95	36.59±11.82	77.10±9.02
Sefid				
Chaloos	5	3.46±1.29	19.97±5.80a	82.28±11.92
Anzali	5	3.11±1.63	40.93±9.08b	68.17±21.62
Roodsar	5	3.47±2.40	46.52±8.19b	70.59±15.00
Fereidonkenar	5	4.74±3.43	44.53±18.24b	73.36±18.18
Common carp				
Chaloos	5	4.57±1.10b	69.88±11.01a	114.28±9.07b
Anzali	5	2.78±0.81a	103.48±17.63b	105.92±8.82b
Roodsar	5	3.59±1.25a	56.81±5.50a	87.51±14.36a
Fereidonkenar	5	2.62±0.94a	65.06±9.18a	71.41±13.41a

a,b: Means±SD in a column for each species with different letters are significantly different ($p<0.05$)

The concentration of the metals in fish species from different sites are depicted in Table 3. With regard to Cu concentration, no significant differences ($p>0.05$) were observed between species from different sites. The lowest and highest of Cu concentrations were found in fish from Chaloos and Fereidonkenar, respectively. About the Zn concentration, except Mullet significant differences ($p<0.05$) were observed in 2 other species among the sites. The Fe concentrations in Mullet and Sefid showed no significant differences ($p>0.05$) between the sites but in the Common Carp significant differences ($p<0.05$) were observed. The maximum and minimum concentrations of Fe were observed in fish from Chaloos and Fereidonkenar, respectively.

DISCUSSION

Trace metals such as Cu, Zn and Fe are classified as essential elements because of their important role in

biological systems. These elements could be toxic when ingestion of them dramatically increased (Tuzen, 2003; Uluozlu *et al*., 2007). Trace elements would have useful or destructive effects on living organisms according to their concentration level. On this basis many plant or animal species are used as bioindicators for monitoring of some pollutants i.e. fish is used as bioindicator for determination of pollutants level in aquatic ecosystems (Mendil and Uluozlu, 2007; Turkmen *et al*., 2005).

Anan *et al.* (2005) measured various trace elements in some fish from the Caspian Sea. Their results for Cu and Zn in Caspian sprat from the Iranian coastal area were 1.94 and 57.5 μg g^{-1} dry weight, respectively. Begum *et al.* (2005) reported that the concentrations of Cu and Zn in *Clarius batrachus* from the Dhanmondi lake in Bangladesh were 5.07 and 60.1, respectively. In another study, the concentrations of Cu and Zn in *Chupisoma pseudeuropius* (Batashi), a freshwater fish of Bangladesh, were 3.45 and 64.96 μg g^{-1} dry weight, respectively (Sharif *et al*., 1993a). The results of our study are in agreement with aforementioned previous studies. As considered above our values were in the range of freshwater fish because like freshwaters, the water of the Caspian Sea contains less cholor compounds and high sulfate and carbonate compounds (Kouchakian, 1989; Mora *et al*., 2004).

Considering the Zn concentrations, the results of Tuzen (2003), Agusa *et al*. (2004), Turkmen *et al*. (2005), Mendil *et al*. (2005) and Carvalho *et al*. (2005) were less than our results, but their Cu concentrations were in agreement with our study. Turoczy *et al.* (2000) reported that the mean concentrations of Cu and Zn in various sharks from the waters of Western Victoria, Australia were 8.37 and 0.26 mg kg^{-1}, respectively. Also, Dalman *et al.* (2006) found that the mean concentrations of these elements in various fish from Gulluk bay in southeastern Aegean sea were <0.01 and between 0.5-7.2 mg kg^{-1} dry weight, respectively. The results of both cases were lower than our results.

Alasalvar *et al.* (2002) reported that the Fe concentration in *Dicentrarchus labrax* (sea bass) was 63.1 μg g^{-1}. Mendil *et al.* (2005) found that the Fe concentrations in various fish from lakes in Tokat, Turkey were in the range of 64.3-197 μg g^{-1}. In another study, the concentration of Fe in the other fish species from Tokat were 69.3-167 μg g^{-1} (Mendil and Uluozlu, 2007). The aforementioned results were in agreement with our study.

Dural *et al.* (2007) reported the Fe concentrations in some fish from Tuzla lagoon were between 7.15-16.5 μg g^{-1} dry weight. Turkmen *et al.* (2005) found that the range of this element in fish species from Iskenderun bay, northeast Mediterranean Sea was between 0.82-27.35 mg kg^{-1} dry weight. Also, Tuzen (2003) reported a range of 9.52-32.4 in fish from the Black Sea. In all cases, the results were lower than the results of the present study.

CONCLUSION

Apart from some variations in Cu, Zn and Fe concentrations in fish between the different sites, regarding to the present standards the values of measured elements in the present study are in acceptable range and the fish are suitable for human consumption.

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