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Seasonal variations of some heavy metals in common carp (*cyprinus carpio* l., 1758) collected from El Izdihar Dam of Sidi Abdelli (Tlemcen) in North-Western Algeria

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ABSTRACT

In the present study some of heavy metals (Zn, Pb, Cu, Fe, Cd and Ni) were seasonally determined from march 2008 to February 2009 in three different tissues (gonads, gills and muscle) of common carp (Cyprinus carpio L., 1758) from Izdihar dam of Sidi abdelli (Tlemcen department) which is an important water source for irrigation and drinking in northwest part of Algeria (Tlemcen). Heavy metals in fish samples were analyzed by atomic absorption spectrophotometry (AAS) after wet digestion by MALAIYANDI and BARETTE method. One-way ANOVA and principal component analysis (PCA) were used to compare the data among seasons_(level of 0,05). Mean concentrations were found to decrease in sequence of Cyprinus carpio samples, in gonads and gills as Zn > Fe > Pb > Ni > Cu > Cd, in muscle as Zn> Pb > Fe > Ni > Cu > Cd. In samples heavy metals concentrations exceeded the tolerable values provided by international institutions (AIEA-407). The highest metals concentrations were found in gills followed by gonads and muscle. Heavy metal levels in tissues of carp were decreased in winter. The obtained results showed that the average values of Zn (80,30 ± 21,00 mg.kg^{-1}) and Ni (6,95 ± 0,19 mg.kg^{-1}) were at the highest levels in spring. The highest Pb, Cu and Fe levels were measured in the winter as 7,53 ± 2 14, 5,31 ± 0,03 and 22,12 ± 16,06 mg.kg^{-1} respectively. The highest Cd levels were recorded in summer as 3,29 ± 0,69 mg.kg^{-1}. For each metal significant differences were found between different seasons (P < 0,05). The present study shows that precautions need to be taken in Izdihar dam in order to prevent heavy metal pollution that can occur in the future.

Key words: Heavy metal, pollution, *Cyprinus carpio*, Izdihar dam, Tlemcen.

INTRODUCTION

Contamination of aquatic ecosystems (e.g. Dams lakes, rivers, streams etc…) with metals has been receiving increased worldwide attention, and many publications on this topic could be found [1-12].

Fish species are widely used to biologically monitor variations in environmental levels of anthropogenic pollutants [7-12]. Fish are often at the top of the aquatic food chain and may concentrate large amounts of some metals from the water [9]. In fish, the toxic effects of heavy metals may influence physiological functions, individual growth rates, reproduction and mortality [9-13]. The concentrations of heavy metals in tissues are the result of uptake and release processes with characteristic kinetics for the elements and their biological halftime, influenced by the age and size of individuals, the feeding habits of the species, their life cycle and life history, and also the seasons [9, 14-

17]. Heavy metals may enter fish bodies in three possible ways; through the body surface, the gills or the digestive tract [18-19]. The gills are regarded as the important site for direct uptake from the water [18], [20-21], whereas the body surface is generally assumed to play a minor role in heavy metal uptake of fish [18-19, 22]. Food may also be an important source for heavy metal accumulation [18, 22], potentially leading to biomagnifications, the increase of pollutants up to the food chain [6].Muscle, gills and gonads were chosen as target organs for assessing metal accumulation. The concentrations of metals in gills reflect those of metals in the water. The metal content in the dorsal muscle was analyzed because of its importance for human consumption and that in the gonads.

The Izdihar Dam is located in Sidi abdelli on the east of Tlemcen (North West of Algeria). The dam was constructed to help alleviate the water problems of the Isser basin and many inhabitants of the area also carry out fisheries on the dam. The quality of this ecosystem has been degrading due to agriculture and humane activities. To the best of our knowledge, from literature survey, no work has been carried out on the environmental quality biota of the dam.

The present study has been conducted to determine zinc, lead, copper, iron, cadmium and nickel concentrations in the three different tissues (muscle, gonads and gills) of *cyprinus carpio* L., 1758 from the Izdihar dam since this fish is an important component of the humane diet in this zone. The results obtained from this study will provide information for the background levels of metals in common fish species of the dam.

MATERIALS AND METHODS

Area descriptions

Dam at Sidi abdelli (34°42´N, 35°10´E), located in the northwest of Algeria (Figure 1), is used for irrigation, drinking water supply and fisheries in the region. Its mean length, width and depth are about 736 m, 668 m and 60 m respectively. Its area and volume are about 669,15 ha and 106 hm^3, respectively. Recently, agricultural developments as well as increase in pollution substantially increased the contamination of fish with heavy metals.

Sampling and sample preparation

79 specimens of fish species (*Cyprinus carpio*) were collected from Izdihar dam during the four seasons from March 2008 to February 2009 using a motorized boat put at our disposal by the administration of the dam and also using a tri mesh net. Fish species were kept in a cooler and transported to the laboratory, where their age total body length and total wet weight were recorded (Table 1).

The age of carp was determined from scales, which were removed from the left side between the posterior end the pectoral fin and the anterior one of the dorsal fin. Three parts, gills, gonads and muscle were removed by plastic knife, weighted, and kept in polyethylene bags, closed and labeled at low temperature until digestion. The determination of the sex (males, females) is made after the dissection.

Digestion was conducted according to MALAIYANDI and BARETTE method [23]. One gram of every organ was placed in a ball containing a volume of nitric acid concentrated HNO_3 (1N). The ball was put under a temperature of 95°C during 1:30 am min. Once digestion was ended, the content of the ball were cooled to room temperature, diluted to 20 ml with double-distilled water, filtered by using a filter paper of 0,45 µm of porosity and a swinex, then packed in polyethylene bags and kept in the refrigerator until analysis. The metal analyses of samples (Zn, Pb, Cu, Fe, Ni and Cd) were carried out by using a Rayleigh wfx-130 atomic absorption spectrometer. The concentrations of heavy metals are expressed as $mg.kg^{-1}$ wet weight of tissue. The absorption wavelengths were 213,9 nm for Zn, 283,3 nm for Pb, 324,8 nm for Cu 248,3 nm for Fe, 213,9 nm for Zn, and 228,6 nm for Cd, 232 nm for Ni respectively.

Statistical procedures

Statistical analysis of data was carried out using Minitab 15 statistical package programs. One way ANOVA test was used to compare the data among seasons at the level of 0,05 and also we performed principal component analysis (ACP) on the mean of the metal concentrations in carp's organs of each season

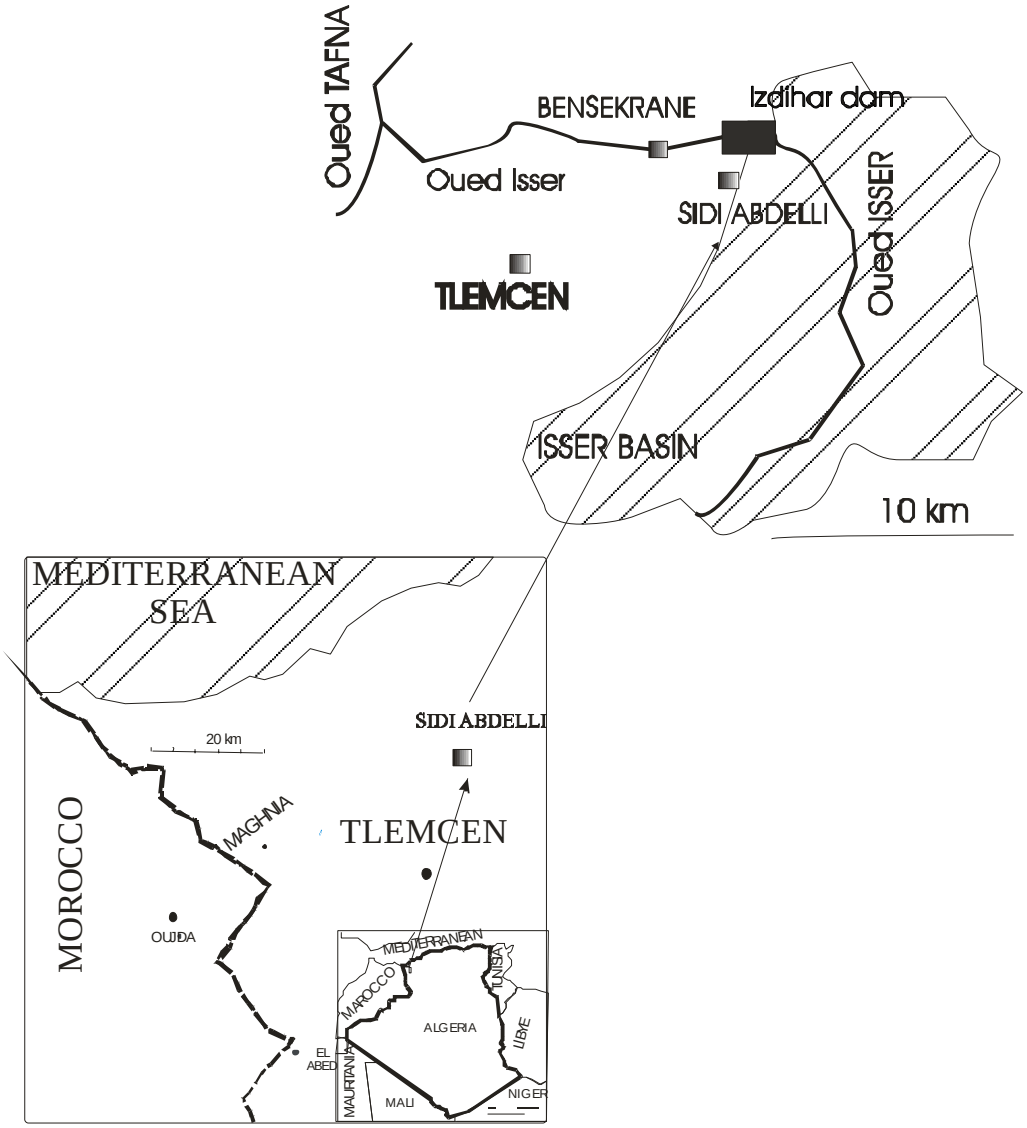

Figure1: Map of the studied area showing Izdihar dam where samples were collected

RESULTS AND DISCUSSION

Table 1 shows length, weight ranges and their relationships. The levels of Zn, Cu, Fe, and Cd measured in *Cyprinus carpio* tissues (gonads, gills, and muscle) during four seasons are presented in Table 2.

Table 1: The relationships between weight (W) (g) and total length (L) (mm) of *Cyprinus carpio* from the Izdihar dam at Sidi Abdeli (Algeria)

Saisons	L ranges	W ranges	Equation	R value
Spring	23 - 50,8 33,9 ± 8,9	78-1280 420,1 ± 300,4	Y = 0,029 X + 21,55	0,99
Summer	26,5 -59,0 33,9 ± 7,5	225-1310 393,1 ± 259,6	Y = 0,028 X + 22,83	0,98
Autumn	27,8- 35 30,96 ± 2,20	233-451 307,80 ± 61,54	Y = 0,032 X + 21,10	0,90
Winter	25-33 27,7 ± 4,6	126-426 249,3± 157,0	Y = 0,028 X + 20,63	0,98

Y is total fish length (mm) and X is total weight (g)

Table 2: Mean heavy metal concentrations (mg kg^{-1} wet weight) in muscles, gonads and gills of *Cyprinus carpio* from Sidi Abdeli dam, Algeria.

Organs	Metals	Zn	Pb	Cu	Fe	Cd	Ni
Gonads	**Spring**	63,90 ± 33,80	8,38 ± 2,23	5,18 ± 0,06	11,01 ± 5,43	3,50 ± 3,47	6,94 ± 0,53
	Summer	68,21 ± 28,24	9,68 ± 1,42	5,24 ± 0,05	12,52 ± 8,99	2,98 ± 3,62	6,10 ± 0,97
	Autumn	82,90 ± 49,84	8,73 ± 2,33	5,26 ± 0,08	14,58 ± 5,15	1,77 ± 2,99	7,76 ± 1,51
	Winter	41,59 ± 35,23	9,80 ± 0,73	5,27 ± 0,03	19,56 ± 24,46	2,14 ± 1,89	5,84 ± 0,77
Gills	**Spring**	107,19 ± 29,99	3,02 ± 1,89	5,23 ± 0,05	18,22 ± 5,40	3,59 ± 3,35	6,94 ± 0,53
	Summer	101,80 ± 25,59	4,72 ±2,39	5,26 ± 0,05	15,64 ± 7,99	5,23 ± 2,79	5,42 ± 0,66
	Autumn	95,95± 24,41	10,70 ± 3,15	5,26 ± 0,06	24,07 ± 13,64	1,28± 1,81	4,76± 0,71
	Winter	91,52 ± 28,51	11,9 ± 1,83	5,32 ± 0,03	41,22 ± 27,91	1,21 ± 2,10	4,35 ± 0,38
Muscle	**Spring**	69,80 ± 41,33	12,57 ± 2,25	5,24 ± 0,08	9,15 ± 2,57	2,68 ±3,03	6,97 ± 2,24
	Summer	23,96 ± 22,51	10,57 ± 2,03	5,27 ± 0,08	5,86 ± 1,98	4,28 ± 3,64	8,28 ± 1,59
	Autumn	19,47 ± 6,11	9,47 ± 2,44	5,32 ± 0,11	5,66 ± 1,88	4,02 ± 3,02	7,34 ± 0,84
	Winter	13,51 ± 5,15	8,84 ± 6,35	5,34 ± 0,03	5,60 ± 0,97	0,60 ± 0,81	5,82 ± 0,68

Different tissues showed different capacities for accumulation of heavy metals. Concentrations of heavy metals were highest in gills and gonads, and lowest in the muscles. Zinc concentrations in gonads, gills and muscle of *Cyprinus carpio* ranged from 41,59 to 82,90 $mg.kg^{-1}$, 91,52 to 107,19 $mg.kg^{-1}$, and 13,51 to 69,80 $mg.kg^{-1}$, respectively (Table 2), The highest zinc concentrations were recorded in gills in spring. Lead levels in gonads, gills and muscle of carp ranged between 8,38-9,80 $mg.kg^{-1}$, 3,03-11,76 $mg.kg^{-1}$ and 8,84-12,57 $mg.kg^{-1}$ (Table 2). In muscle, lead concentrations were found to be highest during spring season. Copper levels in gonads, gills and muscle of *Cyprinus carpio* ranged between 5,18-5,27 $mg.kg^{-1}$, 5,23-5,32 $mg.kg^{-1}$ and 5,24-5,34 $mg.kg^{-1}$ (Table 2). In muscle copper concentrations were found to be highest during winter season. Concentrations of iron, in gonads, gills and muscle of the carp ranged from 11,01 to 19,56 $mg.kg^{-1}$, and 15,64 to 41,22 $mg.kg^{-1}$, 5,60 to 9,15 $mg.kg^{-1}$ respectively (Table 2). The highest iron concentrations in gills were found in winter. Cadmium levels in gonads, gills and muscle of *Cyprinus carpio* ranged between, 0,17 to 0,31 $mg.kg^{-1}$ and 0,05 to 0,4 $mg.kg^{-1}$ 0,06 to 0,35 $mg.kg^{-1}$ (Table 2). The highest cadmium concentrations were recorded in gills in summer. Nickel levels in gonads, gills and muscle ranged between 5,84 to 7,76 $mg.kg^{-1}$, 4,35 to 6,94 $mg.kg^{-1}$ 5,82 to 6,97 $mg.kg^{-1}$ (Table 2), and reached the highest level in muscle in summer. Lead and cadmium concentrations varied highly significantly ($P < 0,005$), and zinc, lead, iron and nickel varied significantly ($P<0,05$), from season to season in organs of all carp samples. Mean concentrations in gonads, gills and muscle of common carp followed the sequences Zn > Pb > Fe > Ni > Cu > Cd.

Knowledge of heavy metal concentrations in fish is important for both human consumption and nature management. In this study, we examined metals in tissues of carp, to evaluate heavy metal concentrations in Izdihar dam. It was also aimed to investigate whether metal concentrations varied seasonally in the study. The target organs, such as gills have tendency to accumulate heavy metals in high values, as shown in many species of fishes in different areas [22, 24]. In this study, highest concentrations of Zn were observed in gills of *Cyprinus carpio*, followed by gonads and muscle. The concentrations of metal in gills reflect the concentrations of metal in waters where the fish species live [25]. Their accumulation in gills could be due to element complexion with the mucus, which is impossible to be completely removed from the lamellae, before tissues are prepared for analysis. The adsorption of metals onto the gills surface, the first target for pollutants in water, may also influence the total metal levels of the gill [26].

Heavy metal concentrations were lower in the muscle compared to gonads and gills. Similar results were reported from a number of fish species that the muscle is not an active tissue in accumulating heavy metals [27-28]. The maximum concentrations of lead, copper and iron were reached in winter, while their lowest concentrations were in spring**.** The maximum concentrations of zinc and nickel were reached in spring, while their lowest concentrations were in winter. For cadmium the maximum concentration was reached in summer and the lowest was in winter. The relatively high concentrations of heavy metals in winter were also found in *cyprinus car*pio in Karakaya dam lake [25], in *stizostedion luciperca* and *Tinca tinca in Kovada kake* [29-30]. The increase of heavy metal levels in summer and winter could be related to increasing physiological activity of fish during summer, primarily caused by the increasing water temperature and decrease in waste water from agricultural activities during winter. For all seasons we found zinc, lead cadmium and nickel concentrations higher then the IAEA-407 values [31], exception for Fe and copper, Zn: 67,1 $mg.kg^{-1}$, Pb: 0,12 $mg.kg^{-1}$, Cu: 3,28 $mg.kg^{-1}$, Fe: 146 $mg.kg^{-1}$, Cd: 0,189 $mg.kg^{-1}$, Ni: 0,6 $mg.kg^{-1}$).

PCA was applied using as variables the mean of the metal concentrations in organs of carp caught seasonally, in order to verify possible bioaccumulation patterns in organs and to detect possible different contamination levels among seasons in the area of study. PCA indicated that both organs and seasons explained significantly 72,72 % of the total variance (39,97 % for factor 1 and 32,76 % for factor 2) of the metal concentration (Figure 2).

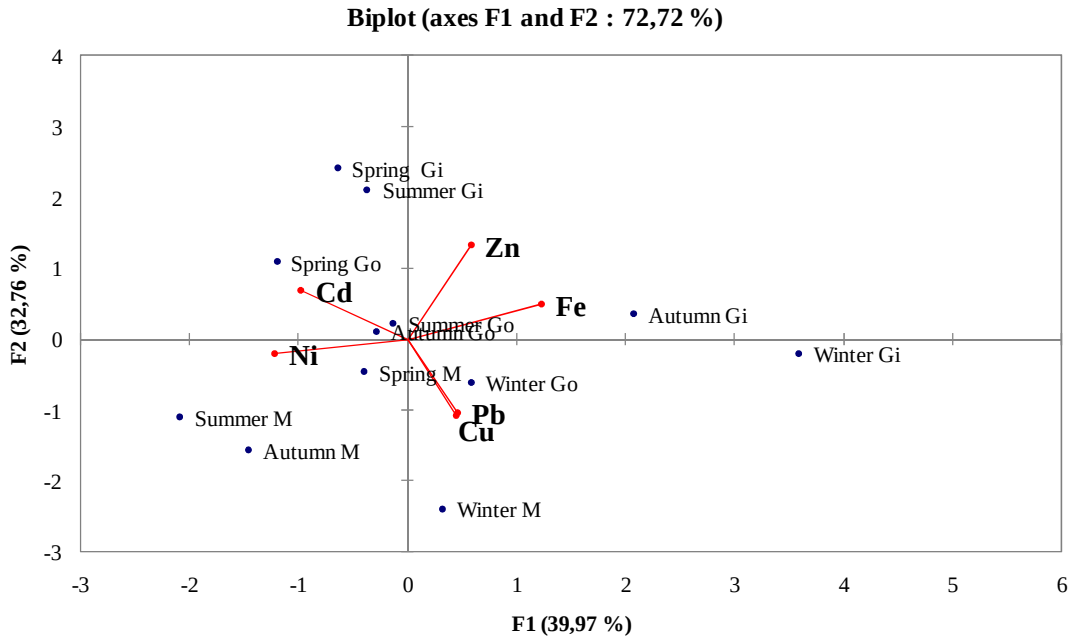

Figure 2: Biplots for first and second axis of the PCA bases on mean values of metal concentrations (Zn, Pb, Cu, Fe, Cd, Ni) in organs of *Cyprinus carpio* from Sidi Abdeli dam, Algeria (Go: gonads, G: gills, M: muscle)

CONCLUSION

The dam's water which was potable before 2006, has been observed to deteriorate in quality very rapidly because of the anthropogenic activities. Agricultural wastes are additionally discharged to dam. These may be the possible causes of the high metal amounts mainly dam sediment and biotic components. Levels of heavy metal varied depending on different tissues.

In this study, the effects of the seasons on heavy metal accumulation in organs of *Cyprinus carpio* were determined. In general, the concentration of zinc was observed to be higher in all seasons. For all seasons we found zinc, lead cadmium and nickel concentrations higher then the IAEA-407 values [31]. The maximum concentrations of all metals were reached in spring. The present data showed that metal concentrations in gills were generally higher then gonads, than muscle.

From above mentioned result it is clear that the concentration of heavy metals of Izdihar dam is high. We can conclude there should be effort to protect dam from pollution to reduce environmental risks. They are alarming high in the fish samples studied, a potential danger may occur in the future depending on the agricultural and industrial development in this region.

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