MedCrave
Step into the World of Research

Journal of Aquaculture & Marine Biology

Research Article

Open Access

CrossMark

Studying the accumulation of heavy metals (Fe, Zn, Cu and Cd) in the tissue (muscle, skin, gill and gonad) and its relation with fish (*Alosa braschinkowi*) length and weight in Caspian Sea coasts

Abstract

This research is done with aim of determining the accumulation of heavy metals (Fe, Zn, Cu and Cd) in different tissues of Caspian Marin shad (*Alosa braschnikowi*) in south area of Caspian Sea (Babolsar). Then 22 species of fishes were collected from commercial fishing, randomly. The density of samples' heavy metals after biometry (length and weight) and tissue isolation and chemical digestion was measured by the Flame atomic absorption. The concentration of Fe in the tissues was such as, gonad> gills > skin > muscle, the Zn is such as muscle < gills < skin <gonad, the Cd is such as gonad> skin > gills > muscle and Cu was such as Muscle <gonad< gills < skin. The results of spearman correlation test have shown that in the tissue of gills between weight and the amount of Cd absorption ($p<0.05$), in the tissue of gonad between fork length and the amount of Cu absorption, there is a negative and strong correlation ($p<0.01$). However, in the tissue of muscles there isn't any meaningful relationship. Also, the concentration of Zn in the skin and gonad was higher than FAO and UK (MAFF) standards and in all tissues the concentration of Cd was higher than all standards.

Keywords: caspian marin shad; fork long weight; heavy metals; caspian sea; *alosa braschnikowi*

Volume 7 Issue 6 - 2018

Zahra Falahnejad Astani,[1] Hasan Taghavi Jelodar,[1] Hasan Fazli[2]

[1]University of Mazandaran, Faculty marine science, Iran

[2]Member of the Institute of Ecology of the Caspian Sea, Sari, Iran

Correspondence: Hasan taghavi Jelodar, Associate professor marine biology, Faculty of marine science, University of Mazandaran, Iran, Email taghawi25@yahoo.com

Received: April 18, 2017 | **Published:** November 15, 2018

Introduction

Fish is an important source of animal protein, which is cheap for humans that have very significant importance because of economic value and sensitivity against pollutants. Metals, exists in the environment normally and some of them play an important role in biologic processes.[1] Natural processes (Volcanoes, weathering and stone erosion, sediments, firing) and industrial progresses and technology causes the increasing the pollution of different natural resourcesin the environment like water and soil.

Pollutants with influencing on aquatic life create significant losses for them and subsequent consumers.[2-5] Heavy metals because of toxic effects and high accumulation power in many species of aquatics is considered significant.[6-7] Among Zinc (Zn) cupper (Cu) and Iron (Fe) are essential for body a little, but high amount of them create deleterious effects for creatures.

There are other groups such as cadmium (Cd), lead (Pb) and Mercury (Hg) which is detrimental for body even a little.[3,8,9]

The most important bad effect of cadmium consumption in human is decease of Itay-Itay or the disease of joints and bonds that consequently leads to death.[3,10] Cadmium in the fish, affects the enzymatic routes of ascorbic acid synthesis.[10]

In addition, accumulation of cadmium causes decreasing the size of liver and losing the glycogen resources of liver and muscle in the fishes.[10]

Fishes in their environment cannot escape from these destructive harms of pollution and lead to polluting the food chain.[11–13] Age, length, weight, sexuality, food habits, ecologic requirements, the concentration of heavy metals in the water and sediment period of fish shelf life in aquatic environment, fishing season, water chemistry (salinity, intensity and temperature) are the effective reason in accumulation of heavy metals in different organs of fish.[14–16]

Fishes are more sensitive to available pollutions in the water rather than humans. As a result, the sample of accumulation trend and elements accumulation in the fish tissues can be used as a biological bio indicator to the changes in aquatic environments.[17–19] Caspian Marin shad (*A.brashnikowi*) from the family of clupeid that its length is 30 to 50cm. It is one of the bony fishes that because of having suitable length and weight is a commercial and economic species in the south area of Caspian Sea. [20,21] Several studies by researchers are done about amount of heavy metals in the fishes. In a research which was done by Yonesipour et al. on the *Cyprinus* fish of Caspian sea (*Cyprinusc arpio*), the average amount of density in (SD) Fe, Cu, Zn, Ni, Co and Mn in the muscles of this fish is 77/91±11, 12/11±17, 63/45±14, 121±14/3, 323/5±0/54µgr/gram of net weight respectively.

Another research which was done by Akan et al.,[22] the amount of Cu, Zn, Co, Mn, Fe, Cr, Cd, Ni and Pb maintained from 4species of Fishes (*Clarias anguillaris*, *Tilapia zilli*, *Synodentis budgetti* and *Oreochronmis niloticus*) from Beneu river of Nigeria. The highest amount of density was related to Fe in the gills of every 4 fishes and the lowest amount of Concentration of metals was maintained in the

tissue of gills>liver>Viscera> kidney> bones >Muscle respectively. In a research by Taghavi et al., [23] the concentration of heavy metals such as Fe,Cu, Zn, Cd, Ni, Cr, Hg and Zn in the tissue of liver, gills and muscles of golden mullet (*liza aurata*) which was collected from south of Caspian Sea were measured.

The concentration of Cu, Cd, Fe and Zn was done in the muscle<gills< Liver while, the density of Ni, Cr, Hg in the muscle<Liver<gills were maintained.

The aim of this study is analyzing the relationship between fork length and weight with the amount of absorption of heavy metals in the tissues of Caspian marine shad.

Materials and methods

Sampling in Babolsar is done with the geographic location of length and latitude 52.704365 and 36.719673 respectively 22 fishes were provided randomly in autumn and winter of 2014 (each season 11 pieces) during fishing in specified area. The samples after conveying to laboratory first were washed with double distilled water and were biometry. Fork length was measured by biometry board with 1 mm accuracy and samples weight with digital scale with 1gr accuracy. Then, from each fish, a sample of scale, girls, gonad and skin was isolated and provided in special package for digestion.

Sample digestion

Sample digestion was done by dry digestion, in order to digesting the samples, first 2 to 5gr of samples were put in Oven with 55˚C for 5 hours to samples become ash. Then, 10^{CC} Hcl, 6 molar was added to each sample and put on the heater until complete drying, after boiling, samples were passed from 42Micron filter paper with HNO_3, 0/1 Normal in volumetric flask 50^{cc}. The ready solution for measurement was collected in a container special for sterile.

For preparing the standard solutions of mentioned metals, pure Nitrate salts, which are related to Merc Company of Germany, were used, that after drawing the calibration curve, was maintained each metal's density by flame atomic absorption system made in Analytikjena company by model AA400. For analyzing the data, Excel software SPSS 19 was used, in order to studying the statistical tests Mann–Whitney U and determining the relationship between metal's concentration in the tissues and biological characteristics, spearman correlation test was used.

Results

The average (±SD) of general weight and fork length and standard length in under samples was 484.77±34.74 gr, 36.37±6.59, 32.33±7.07 and 30.54±7.07 cm that were in the ages between 3 to 5 years old (Table 1).

The amount of different heavy metals density in different tissues have shown that the maximum (63.49±16.73 gr) and minimum (1.47±0.44gr) respectively were related to Zinc and cadmium in the tissue of gonad and muscle. In addition, the arrangement concentration of heavy metals in several tissues was different. However the arrangement of Feconcentration in the tissues was such as gonad> gills > skin >muscle, Zn was such as muscle < gills < skin <gonad<Cd was such as gonad> skin > gills > muscle and Cu was such as muscle <gonad< gills< skin.

The metric relationship of spearman correlation test has shown that, in the skin tissues there is a negative correction between weight and the amount of cadmium absorption, and also there is a negative correlation between fork length and the amount of Cu and Cd absorption ($p < 0.05$), (Table 3). There is positive correlation between the amount of Zn and Cd absorption and between length and weight in the muscle tissue ($p<0.05$) (Table 4).

In the gills tissues, there was a negative correlation between weight and the amount of cadmium absorption and between fork length and the amount of cadmium absorption. ($p<0.05$). However, there was a high and positive correlation between the amount of Zinc and copper absorption ($p<0.01$)(Table 5).

In the gonad tissues there was a high negative correlation between weight and the amount of Cd absorption ($p<0.01$). But between fork length and the amount of Cd absorption there was a negative correlation ($p<0.05$). Similarly between fork length and weight with the amount of Cu absorption, there was a high negative correlation ($p<0.01$).

However; between the amount of Cd and Cu absorption in gonad tissues there was positive correlation ($p<0.05$) (Table 6).

Table 1 Biometry indexes in 22 pieces of Caspian marine shad (*Alosa braschnikowi*)

Biological index	Average (±SD)	Min	Max
Total Length(cm)	36.37±6.59	28.0	44.5
Fork length(cm)	32.33±7.07	28.0	39.5
Standard length(cm)	30.54±7.07	24.5	37.0
Weight(gr)	484.77±34.74	234.34	1022.34
Age (year)	4.16±0.57	3	5

Table 2 The average of (±SD) heavy metals in different tissues of *Alosa braschnikowi*

Tissues	Cd	Cu	Zn	Fe
Skin	2.29±1.24	3.70±2.95	59.77±28.87	22.38±11.31
Muscle	1.47±0.44	1.93±1.19	7.02±6.53	14.26±15.23
Gill	2.11±0.57	3.04±2.55	20.12±8.46	28.15±7.23
Gonad	2.96±2.18	2.98±1.41	63.49±16.73	35.99±8.59
Total	2.21±1.11	2.91±2.02	33.10±15.14	25.19±10.59

Table 3 Metrics relationship resulted by spearman correlation in the sample's skin tissues of *Alosa braschnikowi*

	weight	Fork length	Cu	Cd	Zn	Fe
Fe	-0.392	-0.2	0.196	0.441	0.021	1.000
Zn	0.336	0.399	0.142	-0.105	1.000	
Cd	-0.664*	-0.669*	0.266	1.000		
Cu	-0.517	-0.634*	1.000			
Fork length	0.918**	1.000				
weight	1.000					

*Correlation in confidence level, %95 **Correlation in confidence level, %99

Citation: Astani ZF, Jelodar HT, Fazli H. Studying the accumulation of heavy metals (Fe, Zn, Cu and Cd) in the tissue (muscle, skin, gill and gonad) and its relation with fish (*Alosa braschinkowi*) length and weight in Caspian Sea coasts. *J Aquac Mar Biol.* 2018;7(6):308–312. DOI: 10.15406/jamb.2018.07.00226

Table 4 Matrices relationships maintained by spearman correlation in the sample muscle tissue of *Alosa braschnikowi*

	Weight	Fork length	Cu	Cd	Zn	Fe
Fe	-0.035	0.182	0.000	0.049	0.224	1.000
Zn	-0.245	-0.060	-0.280	0.601*	1.000	
Cd	-0.280	-0.109	-0.287	1.000		
Cu	-0.021	-0.095	1.000			
Fork length	0.918**	1.000				
weight	1.000					

*Correlation in confidence level, %95 **Correlation in confidence level, %99

Table 5 Metrics relationship maintained by spearman correlation in gills tissues of *Alosa braschnikowi*

	Weight	Fork length	Cu	Cd	Zn	Fe
Fe	-0.329	-0.203	0.168	-0.035	0.517	1.000
Zn	-0.399	-0.511	0.846**	0.014	1.000	
Cd	-0.699*	-0.627*	0.028	1.000		
Cu	-0.273	-0.399	1.000			
Fork length	0.918**	1.000				
weight	1.000					

*Correlation in confidence level, %95 **Correlation in confidence level, %99

Table 6 Metrics relationship maintained by spearman correlation in sample gonad tissues of *Alosa braschnikowi*

	weight	Fork length	Cu	Cd	Zn	Fe
Fe	-0.559	-0.417	0.098	0.455	0.413	1.000
Zn	-0.329	-0.273	-0.056	0.538	1.000	
Cd	-0.804**	-0.708*	0.587*	1.000		
Cu	-0.720**	-0.792**	1.000			
Fork length	0.918**	1.000				
weight	1.000					

*Correlation in confidence level, %95 **Correlation in confidence level, %99

Table 7 International standards for heavy metals ($g.gu^{-1}$)

Organization	CU	Zn	Fe	CD
WHO	10	100	-	0.2
FAO	20	50	-	0.3
UK(MAFF)	20	50	-	0.2

Discussion

Nowadays, many researches are done about the heavy metals absorption in aquatic creatures that represent the increasing trend of these metals in the aquatic environment because of human activities. Then, extra increasing the normal concentration of these metals damages the ecosystem.

The results of this research have shown that the concentration of heavy metals in different tissues of fish is different with each other. This difference may be (1) because of some reasons such as food diet, body length, age, habitation and tissue type in metals distribution between different tissues is influential[24,25] (2) Heavy metals, select their target organs based on its metabolic activity.[22,26] (3) Result in being variable the power of heavy metals in terms of overcoming on proteins metallic bonds like metalotionins (4) Because of difference in ecologic requirements and fishes' metabolic activities.[27] (5) Difference of organs 'physiologic performances.

With respect to the important role of muscle in nutrition and healthy can be selected as target organ. In the present study muscle as target organ, has shown the lowest concentration of metals rather than other tissues. Being low the concentration of heavy metals in the muscle by other researchers[28] is reported that its reason is the presence of metalotion in proteins responsible for removing and neutralizing the heavy elements and their toxic traces. In addition, being low the concentration of heavy metals in the muscle rather than other tissues is because of this tissues low metabolic activity. This study, there was a positive correlation between the amount of Zn and Cd absorption in the muscle which is parallel with Zauke et al result in 1999($p<0.05$).

The average of Fe, Zn and Cd in the gonad is more than other tissues which is correspondence with Wang, et al. The reason of high metal's accumulation in the gonad is because of fish's defensive mechanism in moderating the metals and pollutants. In this process, some of organic and mineral pollutants in order to rebuffing is transferred from body to eggs than evacuate from body. The results maintained from Yilmaz et al.,[30] on the *Penaeus semisulcatus* tissues, have shown that; the concentration of Cu in gonad is more than other tissues. It may, being high the essential metal in gonad is because if it's important role in cellular division and growth process.[31]

In the study there was a meaningful and negative relationship between Cd and Cu density with weight and length which is correspond with Alti and Canli[27] results that was maintained in Mediterranean Sea on *Scomberesox saurus*. Its reason is that with increasing the length and weight, the concentration of metals will be reduced.[32]

Gills and skin are the first tissues that are in direct contact with available pollutants in water. Gill tissue has an important role in transmitting and receiving oxygen from the surrounding environmentGills play an important role in oxygen transmission and reception from around environment, needs to high density of essential blood and metals, and can absorb the materials in direct contact of

water and indirect contact of foodstuffs. In addition, because of its role was selected in breathing and osmosis balance as target organ. In the present study, the amount of metals in gills is such as Fe>Zn>Cu>Cd. Which is correspondence whit Nwani & Ozturk et al[9] results.

This study has shown that, gills have the highest Fe concentration rather that skin and muscle. Being high the concentration of mental in the gills can be related to its settling and sediment on this gills. He emphasizes that iron sedimentation on gills can lead to iron bacteria's growth on it, then useful level of gills breathing will be reduced. In addition, one of indirect harmful influences of Fe is producing the sediment of Hydroxide Iron II. This compound causes fishes and fetus-bearing eggs of other aqueous suffocation.

Based on the reports of some researchers, skin is an organ, which is influential in removing the superfluous materials resulted in body metabolism and harmful chemical material. As a result, it can be considered as one of target organs. In this study, Cd has a negative relationship with length and weight but Cu has a negative relationship only with fork length ($p<0.05$). A negative and meaningful relationship between heavy metals with length in some fishes of Caspian Sea is registered by pouring et al.,[33]

On the basis of comparing the present results with international standards (Table 7) it is specified that the amount of Zn density in the tissue of skin and gonad is more than FAO standard and UK (MAFF) but less than WHO standards. The amount of Fe, Cu and Zn concentration in muscle and gills was less than international standards but the amount of Cd concentration in under study tissues was higher than all standards. Heavy metals accumulation in different tissues can be affect by some processes such as detoxification and fish different tissues need to metals.[34–46]

Acknowledgements

None.

Conflict of interest

Author declares that there is no conflict of interest

References

1. Mohammadnabizade S, pour khabbaz A. Biological inspecting of heavy metals in (*Smelt–whitings and Platycephalusindicus*)tissues in Hara reserve. *Iran veterinary Magazine ninth period*. 2013. p. 63–75.
2. Askari sari A, Javaheri Baboli M, Mahjoob S, et al. The amount of heavy metals (Hg, Cd, pb) in the muscle of (*Otolithesruber*)in fishing ports of Abadan and Bandar Abbas. *Fisheries scientific magazine*. 2012. p. 99–106.
3. Ebrahimiseyrizi Z, Sakizade M, Esmaeli Sari, et al. Stuaying the heavy metals of Cd, pb, Cu and Zn in the muscles of duck fish (*Esoxlucius*) of Anzali international pond, accumulation and evaluation the dangers. *Mazandaran medical Science university magazine, period 22*. 2010;22(87):57–63.
4. Pakzadtouchahi S. Analyzing the sample of heavy metals accumulation (Zn, Cu, pb, Ni) in the tissues of muscle, Liver, kidney, gills and scale of (*Hipophthalmichthysmolitrix*) of Systan. *the oceanography magazine*. 2013. p. 21–28.
5. Yi YJ, Zhang SH. The relationships between fish heavy metal concentrations and fish size in the upper and middle reach of Yangtze River. *Procedia Environmental Sciences*. 2012;13:1699–1707.
6. Javid Golshan Abadi A, Taqavi Jelodar H, Fazli H. Measuring the concentration of heavy metals (Cu, Zn, Fe and Cd) in the tissues of gills, muscle, skin and gonad of *Rutilusrutilus caspia* in the southern area beaches of Caspian Sea, the thesis of MA in chemistry. 2015.
7. Usero J, Izquierdo C, Morillo J, et al. Heavy metals in fish (*Solea vulgaris Anguilla* and *Liza aurata*) from salt marshes on the southern Atlantic Coast of Spain. *Environ Int*. 2003;29:949–956.
8. JavidGolshan Abadi A, Taghavijelodar H, Fazli H. Studying the concentration of heavy metals (Fe, Zn, Cu and Cd) in different tissues of (*Rutilusrutiluscaspia*) in the southern areas of Caspian Sea, veterinary publication in research and productivity. 2015;107:9–16.
9. Ozturk M, Ozozen G, Minareci E. Determination of heavy metals in fish, water and sediments of Avsar Dam Lake in Turkey. Iranian *Journal of Environment and Health Science*. 2009;6(2):73–80.
10. Velayatzadeh M, Askari sari A, Khodadadi, et al. Measuring and comparing the concentrations of heavy metals mercury, lead and cadmium in fish (*Liza abu*) tissues Karoon and Dez River in Khuzestan province, the science and technology Science of environment. *Sixteenth period*. 1933;51–56.
11. Mansouri B, Ebrahimpour M, Babaei H. Determination of some heavy metals in different textures black fish (*Capoetafusca*) in the central part of the aqueduct of Birjand. *Veterinary Journal*. 2010;89:45–52.
12. Bat L, Sezgin M, Ustun F, et al. Heavy Metal Concentrations in Ten Species of Fishes Caught in Sinop Coastal Waters of the Black Sea, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*. 2012;12:371–376.
13. Olaifa FG, Olaifa AK, Onwude TE. Lethal and sublethal effects of copper to the African Cat fish (*Clariasgariepnus*). *African Journal Biomed Reserch*. 2004;7:65–70.
14. Beheshti M, Askari sari A, Velayatzadeh M. Assessment of Heavy Metals Concentration of Fish (Liza abu) in Karoon River, Khouzestan Province, Water and Wastewater. 2012;(3):125–133.
15. Demirak A, Yılmaz F, Tuna AL. Heavy metals in water, sediment and tissues of *Leuciscuscephalus* from a stream in southwestern Turkey. *Chemosphere*. 2006;63(9):1451–1458.
16. Nwani CD, Lakra WS, Nagpure NS, et al. Mutagenic and genotoxic effects of carbosulfan in freshwater fish *Channapunctatus* (Bloch) using micronucleus assay and alkaline single–cell gel electrophoresis. *Food and Chemical Toxicology*. 2010;48(1):202–208.
17. Vinodhini R, Narayanan M. Bioaccumulation of heavy metals in organs of fresh water fish *Cyprinuscarpio* (Common carp). *International Journal of Environmental Science Technology*. 2008;5(2):179–182.
18. Tekin–Ozan S, Kir I. Seasonal variations of heavy metals in some organs of carp (*Cyprinuscarpio L*. 1758) from Beyşehir Lake (Turkey). *Environ. Monit. Assess*. 2007;138(1-3):201–206.
19. Agah H, Leermakers M, Elskens M, et al. Accumulation of trace metals in the muscle and liver tissues of five fish species from the Persian Gulf. Environ Monit Assess. 2009;157(1-4):499–514.
20. Hosseini S, Jeyran A, Aghili K. Studying the merphometric and mercetic in identifying the sexuality species of Alosa (clupeidae) in the Gilan beaches (western south of Caspian Sea, aquatic and fisheries magazine, second year. 2011;7:9–17.
21. Sattani M, shahsevani D, shafii SH. systematic ichthyology, second volume, first edition haqshenas publication 2004. p. 165–168.
22. Akan. JC, Mahmoud S, ShettimaYikala B. Bioaccumulation of Some Heavy Metals in fish Samples from River Benue in Vinikilang, Adamawa state, Nigeria. *American journal of Analytical Chemistry*. 2012;(3):727–736.

23. TaghaviJelodar H, Sharifzadeh Baei M, Najafpour SH, et al. The Comparison of heavy metals concentrations in different organs of (*Liza aurata*) inhabiting in Southern part of Caspian Sea. *World Applied Sciences Journal*. 2011;14:96100.

24. Jalali K, Abtahi B, Samiei K, et al. Studying the influence of (total length) and sexuality in accumulation of pb in liver and muscle tissues of *Platycephalusindicus* aqueous ecology magazine. 2016;(4):11–17.

25. Amini Ranjbar Q, Sotoude Niya F. Accumulation of heavy metals in golden mullet *(Mugliauratus*) of Caspian Searelated to some biometric characteristics (standard length, weight, age and sexuality). *The scientific magazine of Iran fisheries*. 2005;3:1–18.

26. Filazi A, Baskaya R, Kum C. Metals concentration in tissues in black sea fish (*Mugilauratus*) from Sinup–Ikliman, Turkey. *Human and Experimental Toxicology*. 2003;22(2):85–87.

27. Canli M, Atli G. The relationship between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. *Environmental Pollution*. 2003;121(1):129–136.

28. Mashroofeh A, Riyahi Bakhtiyari A, Pour kazemi M. The Concentration of Cd, Ni. And V the muscle and Caviar(*Acipenserpersicas*)withemphasis on evaluating the risk of consuming the muscle, health magazine and environment. *Scientific and research quarterly*. 2013;1:63–75.

29. Forughi Fard R, Esmaeil sari A, Ghasempouri SM. Studying the correlation of *(Rutiluskutum)*length and weight in central beach of Southern khazar with accumulation of Zn and Cu in the tissue of liver and muscle. *Iran fisheries scientific magazine*. 2007;121:4–128.

30. Yilmaz F. The comparison of heavy metal concentrations (Cd, Cu, Mn, Pb, and Zn) in tissues of three economically important fish (*Anguilla anguilla, Mugilcephalus and Oreochromisniloticus*) inhabiting Köycegiz Lake Mugla (Turkey). Turkish Journal of Science and Technology. 2009;4: 7–15.

31. Uluturhan E, Kucuksezgin f. Heavy metal contaminants in Red Pandora (*Pagelluserythrinus*) tissues from the Eastern Aegean Sea,Turkey. *Water Research*. 2007;41(6):1185–1192.

32. Elder JF, Collins JJ. Freshwater mollusks as indicators of bioavailability and toxicity of metals in surface systems. Bull Environm. contam. *Toxicol Vol*.1991;122:37–79.

33. Foroghifard R, Esmaili Sari A, Qasem pour SM. Studying the correlation of *(Rutiluskutum)*length and weight of central beach of southern khazar with accumulation of Zn and Cu metals in muscle and liver, Iran fisheries scientific magazine. 2005;121:4–128

34. FAO (Food and Agriculture Organization). *Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products*. FAO Fisheries. 1983:5–100.

35. Farakiyan N, mohammadi Q, Askari sari A. The amount of mercury in the muscle (*Argyrosomushololepidotus*) in the different age group of in fishing the Persian Gulf eastern north waters, scientific magazine of sea biology research. 2012;19:25–34.

36. Farkas A, Salanki J, Varanka I. Heavy metal concentrations in fish of Lake Balaton, Lakes and ReserVoirs. *Research and mamagement*. 2000;5:271–279.

37. Freedman B. *The impact of pollution and other stresses on ecosystem structure and function*. London: Academic press; 1989.

38. Huang WB. Heavy Metal Concentration in the Common Benthic Fishes Caught from the coastal Waters of Eastern Taiwan. *Journal of Food and Drug Analysis*. 2003;11(4):324–330.

39. Jalali K, Abtahi B, Samiei K. Studying the influence of (total length) and sexuality in accumulation of pb in liver and muscle tissues of *Platycephalus indicus. Aqueous ecology magazine*. 2016;(4):11–17.

40. Khoshnamvand M, kaboodv pour SH, Ghiyasi F. *Comporing the biologic accumulation of mercury in the tissue of muscle of two species of ordinary carp and silver of Sanandaj winter dam, environment*. 2010:47–54

41. Krishnamurti AJ, Nair VR. Concentration of metals in fishes from Thane and Basseincreks of Bomloay, India. *India J Mar Sci*. 1999;28:39–44.

42. Rouhani M. diagnosis, prevention, diseases treatment and fish poisoning (translation), publication of administration of education and propagation. *Assistance of reproduction and breeding Iran fisheries*. 1992:1–256.

43. Wang W, Batterman S, Chernyak S, et al. Concentrations and risks of organic and metal contaminants in Eurasian caviar. *Ecotoxicology and Environmental Safety*. 2008;71(1):138–148.

44. WHO, Environmental Health Criteria 108: Nickel. International Programmer on Chemical Safety. *World Health Organization*. 1989.

45. Wirth M, Kirschbaum F, Gessner J, et al. Chemical and biochemical composition of caviar from different sturgeon species and origins. *Nahrung*. 2000;44(4):233–237.

46. Yonsei pour H, Nasrollahzadeh Saravi H, Sadati pour MT. Studying bioaccumulation of heavy metals essential (iron, copper and zinc) and semi–essential (nickel, cobalt and manganese) in the edible tissues of (*Cyprinuscarpio*) Caspian Sea, aquaculture development magazine, the first issue. 2014:95–106.

Citation: Astani ZF, Jelodar HT, Fazli H. Studying the accumulation of heavy metals (Fe, Zn, Cu and Cd) in the tissue (muscle, skin, gill and gonad) and its relation with fish (*Alosa braschinkowi*) length and weight in Caspian Sea coasts. *J Aquac Mar Biol.* 2018;7(6):308–312. DOI: 10.15406/jamb.2018.07.00226