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Some macro and trace elements in various tissues of Van fish variations according to gender and weight

[*Alguns macro elementos e traços em vários tecidos de variação de peixe Van de acordo com sexo e peso*]

A.Ç. *Yeltekin*, A.R. *Oğuz*

University of Yuzuncu Yil - Van, Turkey

ABSTRACT

Van fish is a fish that can live in soda water at pH 9-10. Van fishing area is a very important source of protein for the people. The variations in tissue metal levels according to gender and weight in Van fish (*Alburnus tarichi*, Güldenstadt 1814) were studied. This study was conducted for the first time in Van fish. Which it is very important for living organisms Calcium(Ca), magnesium(Mg), sodium(Na), potassium(K), cobalt(Co), chromium(Cr) and lithium(Li) elements levels in the muscle, liver, gill, gonad, and brain tissues of Van fish were investigated by using inductively-coupled plasma-optic emission spectroscopy (ICP-OES). The results were evaluated in two groups as macro-elements(Ca, Mg, Na, K) and trace-elements(Co, Cr, Li). Cobalt concentration in brain tissue was found to be higher than those in other tissues. Also, male fish had higher metal concentrations than female fish and their metal levels in brain and gonad tissues varied with their weight ($P<0.05$). This study shows that consumption of Van fish can be consumed to supply some necessary minerals required for a healthy nutrition.

Keywords: van fish, ICP-OES, macro elements, trace elements, van lake

RESUMO

Peixes van são a única espécie de peixe vivendo em pH 9-10 no mundo. A área de pescaria Van é uma fonte importante de proteína para a população. As variações de niveis de metal nos tecidos de acordo com sexo e peso do peixe Van (Alburnus tarichi, Güldenstadt 1814) foram estudadas. Esse é o primeiro estudo conduzido com peixes Van. São importantes para organismos vivos o Calcio (Ca), magnésio (Mg), sódio (Na), potássio (K), cobalto (Co), cromio (Cr), e lítio (Li) e foi investigado o nível desses elementos no músculo, fígado, brânquia, gônada, e tecido cerebral dos peixes Van utilizando espectrometria de emissão atômica por plasma acoplado indutivamente (ICP-OES). Os resultados foram avaliados em dois grupos como macro-elementos (Ca, Mg, Na, K) e traços (Co, Cr, Li). Concentração de cobalto em tecido cerebral foi mais alto que em outros tecidos. Peixes machos tinham concentração mais alta de metais que fêmeas e os níveis de metal no cérebro e gônadas variava com seu peso (P<0.05). Esse estudo mostra que o consumo de peixe Van pode suplementar alguns minerais necessários para uma nutrição saudável.

Palavras-chave: peixe van, ICP-OES, macroelementos, elementos traço, lago van

INTRODUCTION

Fish and other seafoods have been in the first line among the oldest nutritional sources for mankind. Fish, included in the staple-food protein group, plays a key role in a healthy and balanced diet. Studies have reported that the average life span is longer in communities consuming mainly fish than in other communities (Kremer, 1987; Baysal, 2002).

In general, the composition of fish resembles the composition of red meat, namely, of beef, mutton or pork, but fish is richer in fatty acids, minerals and vitamins than red meat (Cole *et al.,* 2005; Scarmeas *et al.,* 2006).

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E-mail: aslicyeltekin@gmail.com

Minerals are the basic nutritional elements that cannot be synthesized in the body, but should be supplied through other sources. These dietary elements are best supplied by ingesting specific foods rich in the chemical element(s) of interest. Minerals make up about 4% of the human body. Many trace elements act as co-factor or prosthetic group in enzymatic reactions (Patra *et al.,* 2001; Batra *et al.,* 1998; Castillo-Duran, 1999; Doğan, 2002).

In freshwater fish production in Turkey, Van fish is in the second in line, after the carp. Van fish is a major protein source for the regional communities and thus of important economic value (Terzi *et a.,l* 2008). In this study, the variations in tissue metal levels according to gender and weight in Van fish were investigated.

MATERIALS AND METHODS

A total of 70 Van fish was obtained from the lake fishermen for the study. After the determination of weight (g), fork height (cm) and sex under laboratory conditions, they were stored in a freezer at -20℃ until the muscle, liver, gills, gonads and the brain tissue analysis process. Age determination is made on the operculum sample taken from each fish. The study was approved by Yuzuncu Yıl University Animal Researches Local Ethic Committee (2015/08 decision number and 25/06/2015 date).

Approximately 1g of the tissues of the frozen fishes were weighed. The tissues were prepared according to the Alam *et al.* (2002) method and were placed into the glass tubes and 65% HNO_3 (Merck, Germany) was added. The tissues were kept in the incubator for 3 hours at 200℃ for breakdown of the tissues.

1N 2mL of solution prepared with 65%HNO_3 was added to the completely dry tubes and the drying process was repeated at the 200℃ incubator. This process should be repeated until there is no remnant left in the tubes. At the last stage, after the dried tubes were cooled, 2.5mL of 1N HNO_3 was added and the volume was completed to 10mL with deionized distilled water and got ready for analysis. Prepared tissues were analysed with ICP-OES (Thermo scientific ICAP 6000 Series) (0.005ppm detectable limit) and the levels of Ca, Mg, Na, K, Co, Cr, and Li elements were determined.

After the analysis of the metal levels in the samples obtained from Van fish, the confidence intervals were formed by determining the standard deviations of the results obtained. One-way analysis of variance (One-way ANOVA) and Duncan's multiple comparison tests were applied to the data, and the difference between the data was determined ($P<0.05$).

RESULTS AND DISCUSSION

The levels of Ca, Mg, Na, K, Co, Cr and Li in the muscle, liver, gill, gonad, and brain tissues of Van fish were assessed.

These minerals are found at milligram levels in the tissues and are involved in all metabolic processes. Calcium has major functions particularly in the composition of bones, in blood circulation and muscle and nerve conduction. Likewise, magnesium is a structural component of bones, muscles, and nerves (Ası, 1995).

The Ca values in gill tissue were higher than Ca levels in other tissues, which may be due to the presence of cartilage in the gills. The brain tissue was the next in line as having the highest concentration of Ca (Table 1). This finding can be associated with the important role of Ca in nerve conduction. Calcium has been found at a concentration of 38.3% in the muscle tissue of red snapper fish (Sturgeon *et al.,* 2005). Like Ca, magnesium was found to be highest in the the gill tissue of Van fish when compared with other tissues. On the other hand, the average Mg levels in the muscle tissue were lower than those in other tissues (Table 1). Statistical evaluation in terms of gender showed that tissue Mg levels in female fish were higher than those in male fish, except in the muscle and gill tissues ($P<0.05$). This finding may be due to different metabolism of female fish, supported by the finding of higher concentrations of Mg in the female gonad. In the classification of tissue mineral levels according to fish weight, the results from the brain tissue were variable ($P<0.05$) Table 1). The group with of 100<weight demonstrated higher mineral levels in brain tissue, a finding which may be due to more feeding of the fish in this group. Consistent with the results of our study, Visnjic-Jeftic *et al.,* (2010) have found higher levels of Mg in male ringa fish than in female ones. Furthermore, Mg at a level of 23.6ppm has been found in the muscle tissue of red snapper fish (Sturgeon *et al.,* 2005).

Table 1**.** The distribution of Macro elements (Ca, Mg, Na, K) levels in some tissues of Van fish according to gender and weight (µg/g wet weight)

	Tissue	Male	Female	80> Wght	80-100Wght	100<Wght
Ca	Muscle	251,52±516,68	217,13±649,29	238,68±515,47a	251,64±690,03a	113,99±143,47a
	Liver	401,25±1311,61	103,08±50,19	468,95±1397,31a	89,63±27,88a	79,12±25,64a
	Gill	4596,07±3661,77	3700,35±3539,81	4076,86±3699,27a	4432,08±3427,37a	2784,22±4510,68a
	Gonad	91,59±78,08	159,00±57,52	113,81±81,62a	132,08±71,17a	178,18±48,50a
	Brain	733,25±1585,77	602,00±1026,73	836,74±1740,37a	560,99±1039,64a	547,73±508,26a
Mg	Muscle	76,27±32,83	77,93±40,29	80,46±32,73a	72,74±37,48a	87,69±50,67a
	Liver	185,64±71,95*	210,84±60,72*	187,89±70,71a	180,24±55,60a	212,97±99,52a
	Gill	320,98±144,10	301,93±124,14	373,48±106,35a	290,06±124,39a	240,18±185,59a
	Gonad	158,56±58,26*	175,78±59,25*	166,22±48,84a	156,31±63,94a	179,35±62,65a
	Brain	83,13±11,65*	93,99±21,36*	81,20±12,83a	92,61±15,21ab	99,42±37,39b
Na	Muscle	244,45±119,27	250,44±141,68	257,16±128,34a	230,43±111,89a	301,43±224,68a
	Liver	1112,61±407,42*	1207,36±378,94*	1107,01±410,72a	1221,35±282,61a	1113,12±751,55a
	Gill	1779,34±619,06	1730,49±747,20	2040,30±440,74a	1679,06±706,59a	1345,56±933,47a
	Gonad	515,17±232,84*	667,20±214,86*	623,47±211,53a	541,26±243,77a	571,22±247,90a
	Brain	1561,03±288,88*	1745,80±420,27*	1481,17±296,29a	1765,00±351,52a	1785,66±555,90a
K	Muscle	813,07±524,70	788,95±703,61	842,18±566,42a	715,15±615,49a	1081,41±876,50a
	Liver	2769,02±1103,09*	3116,13±1045,10*	2660,47±978,70a	3239,83±996,98a	2734,91±1622,98a
	Gill	2136,98±844,40	2142,12±586,82	2386,94±633,64a	2071,19±652,53a	1813,50±1038,58a
	Gonad	3909,52±1467,81*	1860,18±693,79*	3500,58±1679,14b	2323,45±1268,93ab	1933,51±710,32a
	Brain	1448,27±210,11*	1539,05±242,55	1373,44±234,63a	1589,80±166,37b	1471,86±326,67ab

Mean±standard deviation. *P<0.05.

Sodium and potassium are closely associated elements. The highest concentrations of Na in the organism are found in the cartilage and skin, and of K in liver, kidneys, and the spleen. In particular, Na plays the major role in balancing osmotic pressure (Ası, 1995). Compatible with this data, we found the highest concentration of Na in the gills and quite high levels of Na in the brain tissue. Statistically, there were differences between Na levels in liver, gonad, and brain tissue, and these levels were higher in females than in males (P<0.05) Table 1 Figure 1).

Potassium levels were generally higher in liver tissue groups (Table 1). Parallel to each other, K and Na levels were lower in muscle tissue than those in other tissues (Table 1). The results obtained in the liver, gonad, and brain tissue were statistically different in terms of classification according to gender (P<0.05) (Table 1 Figure 1). As with Mg and Na, these differences may be due to gender difference, as well as to metabolic preparation for breeding of the female fish since this study was carried out in March and April. The female gonads showed high concentration of Na, whereas the male gonads demonstrated a high concentration of K. In the classification in terms of weight, the results in gonad and brain tissues were found to be significant (P<0.05) Table 1). Consistent with our study, Sturgeon et al. (2005) found the Na level as 2594ppm. In muscle, liver, and skin specimens obtained from *Triglia lucerna, Lophius budegassa,* and *Solea lascaris,* the levels of macro-elements have been determined, but the Na and K values have been found to be lower than those determined in our study (Yılmaz *et al.,* 2010).

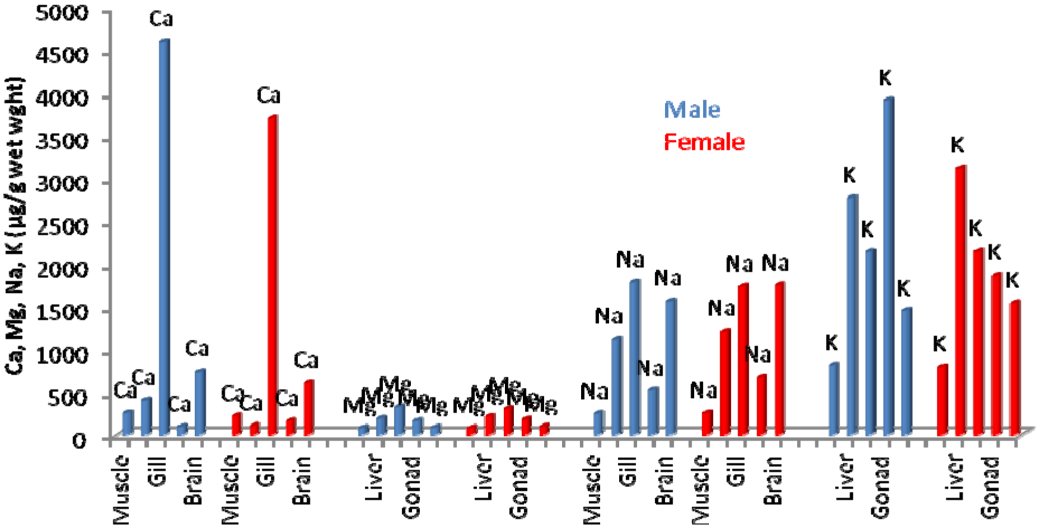

Figure 1. The distribution of Macro elements (Ca, Mg, Na, K) levels in some tissues of Van fish according to gender and weight (µg/g wet weight).

Cobalt is a requisite for the synthesis of Vitamin B12. In vivo, cobalt deficiency lowers breeding performance and thus causes functional impairment in ovaries and low pregnancy numbers and decreases in seed yield (Gal *et al.,* 2008).

Oğuz and Yeltekin (2014) found the level of Co in the Van Lake water as 0.122mg/L. We found that the levels of Co were higher in the brain tissue of Van fish than those in other tissues. In the classification according to weight, statistically, there were variations in Co levels in the brain tissue specimens ($P<0.05$) Table 2, Figure 2). This result may demonstrate that during binding to plasma proteins, Co is bound to a higher degree to nervous system proteins. Medeiros *et al.,* (2012) reported the lowest concentration of Co in *Mugil cephalus* as 0.007 (mg/kg, wet wt) and highest concentration of Co as 0.02 (mg/kg, wet wt) in *Caranx crysos.* Merciai *et al.,* (2014) found the highest level of Co as 1.472 (mg/kg) in *Gobio occitaniae* and the lowest level of Co as 0.039 (mg/kg) in *Lepomis gibbosus,* the levels which are consistent with our values. The values of Co in the muscle tissue of *Capoeta trutta* (Heckel, 1843) show seasonal changes ranging between 0.07 and 0.001 (µg/g), a range compatible with the range determined in our study (Kırcı *et al.,* 2013).

Chromium, also known as glucose tolerance factor, is an essential trace element in the nutrition of living beings and acts as a physiological enhancer of insulin activity, binding to insulin and potentiating its action. Chromium, in optimal levels, reduces the quantity of insulin metabolically required by increasing the number of insulin receptors (Kroliczewska *et al.,* 2004, Yıldız *et al.,* 2004).

In the classification according to gender, the Cr results in muscle, liver, gill, and gonad tissues demonstrated differences ($P<0.05$) (Table 2, Figure 2). Higher levels of Cr in all tissues in male fish may indicate a higher use of Cr in male metabolism. Türkmen and Ciminli (2007) investigated the levels of trace elements in muscle, liver, gill, and skin tissues of *Clarias gariepinus, Carasobarbus luteus, Unio terminalis,* and *Potamida littoralis,* and determined the highest and lowest levels of Cr in the liver of *Carasobarbus luteus* (0.125µg/g wet wt) and in the muscle tissue of *Potamida littoralis* (0.01µg/g wet wt), respectively. Qin *et al.* determined the highest (0.196mg/kg wet wt) and lowest (0.059mg/kg wet wt) levels of Cr in the muscle specimens of *Ctenopharyngodon idellus* and *Cyprinus carpio*, respectively (Qin *et al.* 2015). These findings are consistent with our relevant findings.

Table 2. The distribution of trace elements (Co, Cr, Li) levels in some tissues of Van fish according to gender and weight (µg/g wet weight)

	Tissue	Male	Female	80> Wght	80-100Wght	100<Wght
Co	Muscle	0,02±0,03	0,01±0,01	0,01±0,03a	0,01±0,01a	0,01±0,01a
	Liver	0,06±0,06	0,13±0,42	0,21±0,53a	0,05±0,02a	0,04±0,03a
	Gill	0,03±0,01	0,04±0,06	0,03±0,02a	0,04±0,06a	0,03±0,01a
	Gonad	0,05±0,08	0,05±0,05	0,07±0,08a	0,05±0,06a	0,02±0,02a
	Brain	0,62±0,55	1,10±1,58	0,72±0,53a	0,67±1,18a	2,58±2,14b
Cr	Muscle	0,06±0,04*	0,04±0,03	0,04±0,05a	0,05±0,03a	0,04±0,02a
	Liver	1,23±1,43*	0,63±3,23*	1,72±3,91a	0,37±0,83a	1,23±2,29a
	Gill	0,49±0,73*	0,24±0,09*	0,31±0,09a	0,42±0,68a	0,19±0,10a
	Gonad	0,24±0,10*	0,17±0,09*	0,23±0,09a	0,16±0,09a	0,23±0,13a
	Brain	0,18±0,17	0,17±0,22	0,17±0,24a	0,19±0,18a	0,11±0,10a
Li	Muscle	0,05±0,03	0,06±0,04	0,05±0,07a	0,05±0,03a	0,06±0,07a
	Liver	0,23±0,11	0,22±0,09	0,22±0,12a	0,22±0,07a	0,20±0,18a
	Gill	0,58±0,24	0,57±0,30	0,67±0,19a	0,55±0,28a	0,42±0,38a
	Gonad	0,16±0,05*	0,06±0,39*	0,06±0,02a	0,17±0,41a	0,07±0,04a
	Brain	2,73±11,46*	0,17±0,01*	3,19±12,43a	0,17±0,09a	0,13±0,12a

Mean±standard deviation. *P<0.05

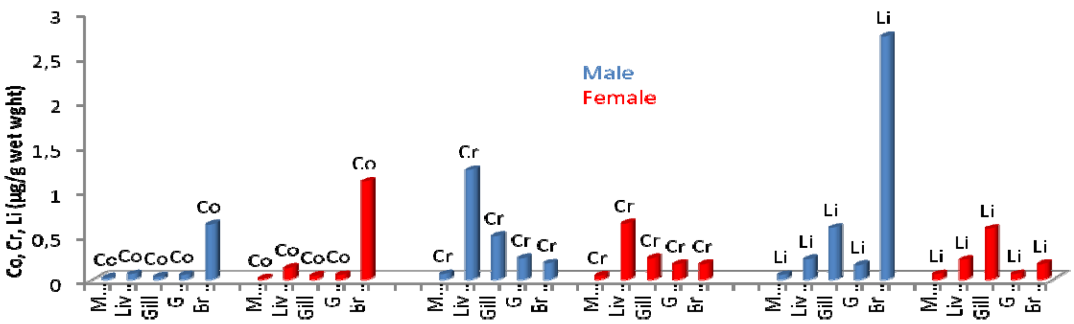

Figure 2. The distribution of trace elements (Co, Cr, Li) levels in some tissues of Van fish according to gender and weight (µg/g wet weight).

Lithium replaces Na and K in metabolic processes. Lithium is an element used for the therapy of major affective and bipolar disorders. Overdosage of Li may be fatal. Blood levels of Li should be regularly controlled and should not surpass 2mEq/L (Trace..., 1996).

In the classification according to gender, we found statistically significant differences between Li levels in the gonad and brain tissue specimens (P<0.05) Table 2, Figure 2). In terms of gender, Visnjic-Jeftic *et al.* (2010) found the highest Li level (4.413µg/g dry wt) in male liver tissue and the lowest Li level (0.137µg/g dry wt) in female muscle tissue of *Alosa immaculata* Bennet 1835. In the present study, we found higher levels of Li in the male gonad and brain tissues Table 2, Figure 2). High brain levels of Li may be due to more active use of Li in the nervous system. Qin *et al.*(2015) found the highest (0.015mg/kg wet wt) and lowest (0.007mg/kg wet wt) concentrations of Li in *Ctenopharyngodon idellus* and *Crucian carp*, respectively, which are lower than the Li levels found in the present study.

The variations in tissue metal levels according to gender and weight in Van fish were investigated in this study. The metal concentrations found were consistent with metal concentrations in other fish species. The results were evaluated in two groups as macro-elements and trace-elements. The investigated macro-elements included Ca, Mg, Na, and K the levels of which were compatible with levels stated in the literature. The investigated trace-elements included Co, Cr, and Li. Cobalt demonstrated a higher concentration in brain tissue than in other tissues. The metal concentrations were generally higher in male fish, and, in terms of weight, there were significant differences in Li levels particularly between brain and gonad tissues ($P<0.05$). This study shows that consumption of Van fish can be used to supply some necessary minerals required for a healthy nutrition.

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REFERENCES

ALAM, M.G.M.; TANAKA, A.; ALLINSON, G. *et al.* A comparison of trace element concentrations in cultured and wild carp (Cyprinus carpio) of lake Kasumigaura, Japan. *Ecotoxicol. Environ. Safety*, v.53, p.348-354, 2002.

ASİ, T. With table biochemistry cilt 1. Available in: <http://veterinary.ankara.edu.tr/fidanci İstanbul>. Accessed in: 23.11.1995.

BATRA, N.; NEHRU, B.; BANSAL, M.P. The effect of zinc supplementation on the effects of lead on the rat testis. *Reprod. Toxicol.*, v.12, p.535-540, 1998.

BAYSAL A. *Nutrition*. Ankara: Hatipoglu Publications, 2002.

CASTILLO-DURAN C. Trace minerals in human growth and development. *J. Pediatr. Endocrinol. Metab*., v.12, p.589-601, 1999.

COLE, G.M.; LIM, G.P.; YANG, F. *et al.* "Prevention of Alzheimer's disease: omega-3 fatty acid and phenolic antioxidant ınterventions". *Neurobiol. Aging*, v.26, p.133-136, 2005.

DOĞAN M. The chemistry of a healthy lifestyle. *Popular Sci. J.,* v.1, p.32-36, 2002.

GAL, J.; HURSTHOUSE, A.; TATNER, P. *et al.* Cobalt and secondary poisoning in the terrestrial food chain: data review and research gaps to support risk assessment. *Environ. Int.*, v.34, p.821-838, 2008.

KIRCI, M.; TAYSI, M.R.; BENGÜ, A.Ş. *et al.* Determınatıon of some metal concentratıons ın capoeta capoeta umbla (Heckel, 1843) caugth from Murat River. *Iğdır Univ. J. Inst. Sci. Technol*., v.3, p.85-90, 2013.

KREMER J.M. "Fish oil fatty acid suppliementation in active rheumatoidrthrits''. *Ann. Intern Med*., v.106, p.497-503, 1987.

KROLICZEWSKA, B.; ZAWADZKI, W.; DOBRZANSKI, Z. *et al.* Changes in seleccted serum parameters of broiler chicken fed supplemental chromium. *J. Anim. Physiol. Anim. Nutr,.* v.88, p.393-400, 2004.

MEDEIROS, R.; SANTOS, L.M.; FREIRE, A.S. *et al.* Determination of inorganic trace elements in edible marine fish from Rio de Janeiro State, Brazil. *Food Control,* v.23, p.535-541, 2012.

MERCİAİ, R.; GUASCH, H.; KUMAR, A. *et al.* Tracemetalconcentrationand fish size: variationamong fish species in a Mediterranean river. *Ecotoxicol. Environ. Safety,* v.107, p.154-161, 2014.

OĞUZ, A.R.; YELTEKIN, A. Metal levels in the liver, muscle, gill, ıntestine, and gonad of lake Van fish (Chalcalburnus tarichi) with abnormal gonad. *Biol. Trace Element. Res.,* v.159, p.219-223, 2014.

PATRA, R.C.; SWARUP, D.; DWİVEDİ, S.K. Antioxidant effects of alpha tocopherol, ascorbic acid and L-methionine on lead induced oxidative stress to the liver, kidney and brain in rats. *Toxicology,* v.162, p.81-88, 2001.

QİN, D.; JİANG, H.; BAİ, S. *et al.* Determination of 28 trace elements in three farmed cyprinid fish. *Food Control.,* v.50, p.1-8, 2015.

SCARMEAS, N.; STERN, Y.; MAYEUX, R. *et al.*"Mediterranean diet, Alzheimer disease, and vascularmediation". *Arch. Neurol.,* v.63, p.1709-1717, 2006.

STURGEON, R.E.; WILLIE, S.N.; YANG, L. *et al.* Certification of a fish otolith reference material in support of quality assurance for trace element analysisw. *J. Anal. At. Spectrom.*, v.20, p.1067-1071, 2005.

TERZI, G.; ÇELIK, T.H.; NISBET, C. Determination of benzo[a]pyrene in Turkish döner kebab samples cooked with charcoal or gas fire. *Irish J. Agric. Food Res.,* v.47, p.187-193, 2008.

TRACE elements in human nutrition and health. Genova: WHO, 1996. 361p. 1996. Available in: <http://www.who.int/nutrition/publications/micronutrients/9241561734/en/>. Accessed in: 15.01.1996.

TURKMEN, M.; CIMINLI, C. Determination of metals in fish and mussel species by inductively coupled plasma-atomic emission spectrometry. *Food Chem*., v.103, p.670-675, 2007.

VİSNJIC-JEFTIC, Z.; JARIC A.I.; JOVANOVIC, L. *et al.* Heavy metal and trace element accumulation in muscle, liver and gills of the Pontic shad (Alosa immaculata Bennet 1835) from the Danube River (Serbia). *Microchem. J.,* v.95, p.341-344, 2010.

YILDIZ, A.Ö.; PARLAT, S.S.; YAZGAN, O. The effects of organic chromium supplementation on production traits and some parameters of laying ouails. *Rev. Med. Vet*., v.155, p.642-646, 2004.

YILMAZ, A.B.; SANGUN, M.K.; YAĞLIOĞLU, D. *et al.* Metals (major, essential to non-essential) composition of the different tissues of three demersal fish species from Iskenderun Bay, Turkey. *Food Chem.,* v.123, p.410-415, 2010.