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Korrespondenzadresse:
sebnem.tolasa@ege.edu.tr

Faculty of Fisheries, Department of Fish Processing Technology, Ege University, 35100 Bornova Izmir, Turkey

Evaluation of nutritional value of *Carassius gibelio* (Bloch, 1782)

Bewertung des Nährstoffgehaltes von Carassius gibelio (Bloch, 1782)

S. Tolasa Yilmaz, S. Cakli, T. Dincer, H. Sargin, C. Ucok

Summary

Carassius gibelio (Prussiona Carp) (Bloch, 1782) is an invasive species and is known for threat for native fish communities, as it is able to reproduce from unfertilized eggs. For this reason the nutritional quality of *Carassius gibelio* was investigated to enhance fishery and utilization. The protein of the studied *Carassius gibelio* was characterized by a high content of indispensable amino acids (IAA), such as lysine, leucine, isoleucine and threonine. DHA and EPA were the dominant fatty acids among PUFAs.

Carassius gibelio with high nutritional value could be safely utilized commercially by the processing industry and the fish population could be controlled.

Keywords: invasive species, vitamin content, amino acids profile, omega 3 fatty acids, heavy metal content

Zusammenfassung

Carassius gibelio (Giebel) (Bloch 1782) ist eine invasive Spezies und ist bekannt dafür lokale Fischbestände zu bedrohen, da er sich auch mittels unbefruchteter Eier fortpflanzen kann. In dieser Studie wurde der Nährstoffgehalt von *Carassius gibelio* untersucht, um die Fischerei und damit die wirtschaftliche Nutzung zu fördern. Die Proteine der untersuchten Giebel zeichneten sich durch einen hohen Gehalt an lebensnotwendigen Aminosäuren wie Lysin, Leucin, Isoleucin und Threonin aus. DHA und EPA wurden als die dominierenden mehrfach ungesättigten Fettsäuren bestimmt. *Carassius gibelio* weist hohe Nährstoffgehalte auf und könnte deshalb von der verarbeitenden Industrie ohne gesundheitliche Bedenken kommerziell genutzt werden. Überdies könnte die Fischpopulation dadurch unter Kontrolle gebracht werden.

Schlüsselwörter: Invasive Spezies, Vitamingehalt, Aminosäuren, Omega-3-Fettsäuren, Schwermetallgehalt

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Introduction

Carassius gibelio (Prussian carp) (Bloch, 1782) is a benthopelagic fresh water species which is a member of the family of *Cyprinidae* and known as one of the most hazardous fish species for native fish communities (Crivelli, 1995; Kalous et al., 2004). Because it is believed to be responsible for the decline of native fish, invertebrate and plant populations in different areas. It can strongly tolerate low oxygen concentrations and pollution and is able to reproduce from unfertilized eggs (Fishbase, 2015).

Usually considered as native from central Europe to eastward to Siberia or introduced to European waters from eastern Asia likely originated from accidental aquaculture escapees in the 1600s (Lever, 1996; Kalous et al., 2012; Erick et al., 2014). Since then, *Carassius gibelio* has exhibited secondary spread by natural dispersal through river and ditch systems (Grabowska, 2010), escape from aquaculture (Toth et al., 2005), and intentional introductions by anglers (Witkowski, 1996; Elgin et al., 2014). There were no confirmed published records of *Carassius gibelio* in open waters in North America until discovery in 2006 (Erick et al., 2014). Globally, aquaculture has become one of the leading vectors of aquatic species introductions (Naylor et al., 2001; Erick et al., 2014). Clear and definite data on original distribution in Europe are not available due to introduction, confusion with *Carassius auratus* and complex modes of reproduction (Fishbase, 2015). It has not appeared in some parts of Europe until the 20th century and appeared in the European part of Turkey (Lake Gala, Thrace) in 1986 (Baran and Ongan, 1988). *Carassius gibelio* are present in the Thrace region of Turkey. The path of entry is unknown although it is possible that the fish entered either through natural dispersal through river systems from Greece and Bulgaria, or were introduced by humans. Fishermen have admitted intentionally introductions from Kayali Dam to Büyükcekmece Dam Lake (Özulug et al., 2004). It has been spread very fast over the country included; several lakes, reservoirs and ponds in Thrace and Anatolian regions of Turkey and it is now considered a threat factor for native fish species in the inland waters Özuluğ, 1999; Balık 2003; Balık et al., 2003, 2004; Özuluğ et al., 2004; Şaşı and Ilhan et al., 2005; Özcan, 2007; Sarı et al. 2008; Innal, 2011; Aydin et al., 2011). Tarkan et al., (2012) observed a relative decrease in native cyprinid density when *Carassius gibelio* density increased. This was attributed to a combination of degrading environmental conditions and reproductive competition by *Carassius gibelio.* Nowadays it has not been reported in only four river basins (Ceyhan, Göksu, West and East Blacksea) in Turkey (Yerli et al., 2014; Uysal et al., 2015).

The purpose of this study was to investigate the risk and benefits of consumption of *Carassius gibelio* which might be utilized commercially for profits by the processing industry, and control the population by encouraging fishing.

Material and Methods

Materials

Carassius gibelio (Prussian carp) caught in October, 2014 from Manisa Demirköprü Dam Izmir, Turkey (weight range from 350–400 g and body lengths range of 26–28 cm) (n = 10) were obtained from a local fish processing plant. *Carassius gibelio,* less than one day old from the time of catch, was transported in ice to the laboratory. The biometric parameters were taken with a caliper graded in millimeters (mm). After measuring of biometric parameters, they were beheaded and gutted then washed fish was subjected to filleted without skin on. Cooking loss, sensory properties, color measurement and pH value were determined. Some parts of fillets were packed and stored frozen at –20 °C for determination of fatty acid, amino acid profile, some vitamin and heavy metal content within two

FIGURE 1: *Prussian carp (Carassius gibelio), ♀ (Bloch, 1782).* *©: George Chernilevsky/wikipedia.de*

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FIGURE 2: *Prussian carp, ♂, head.* *©: George Chernilevsky/wikipedia.de*

0.25 mm i. d., 0.25 µm). The oven temperature was set at 140 °C for 5 min and later it was increased by 4 °C per min up to 240 °C, where it was maintained for 20 min, whereas the injector and detector temperatures were set at 250 and 260 °C, respectively. The carrier gas was helium (with a linear velocity of 1 mL/min and injection volume of 1 µL). The flow rate of hydrogen was 35 mL/min and of compressed air was 350 mL/min. The FAs were identifid by comparing their retention times to those of a standard mixture of FAs (Supelco 37 component FAME mixture). The GC analyses were performed in triplicate, and the results were expressed as % of total FAME area as the mean value of a percentage.

Determination of Vitamin Content

Vitamin D_3 was measured in samples by High-pressure liquid chromatography (HPLC) according to Horvli and Lie (1994). Vitamin A was determined according to the methos of AOAC (2000). Determination of vitamin B_{12} and vitamin B_6 were carried out by using method of Guggisberg,et al. (2012) and Morten (2003) respectively. All analysis were done in triplicate.

months. All chemicals of analytical grade were purchased from Merck Chemicals (Darmstadt, Germany).

Determination of pH

The pH value was recorded using a pH meter (HANNA precision model pH meter, Sigma, St. Louis, MO), with the glass electrode applied directly to the homogenate (5 g of fish/5 mL of distilled water) according to the method of Lima Dos Santos et al. (1981).

Determination of Color Measurement

The color measurement on fish samples trials were carried out with the spectral color meter Spectro-pen® (Dr. Lange, Dusseldorf, Germany). The color of three skinnles fillets were measured in 10 locations and the average values of the measurements were determined. In the CIE Lab system, L* denotes lightness on a 0–100 scale from black to white; a*, (+) red or (–) green; and b*, (+) yellow or (–) blue (Schubring, 2002).

Determination of Proximate Composition

The moisture content was determined by drying approximately 3-g samples in an oven at 105 °C until constant weight (AOAC, 1990). The percentage loss of weight was expressed as moisture content. Total lipid was determined by using the method of Bligh and Dyer (1959). Protein content was determined (N x 6.25) by the method of AOAC (1984). Ash content was obtained by heating the residue for 3 h at 550 °C (AOAC, 1998).

Fatty Acid Analysis

Lipid extraction was done according to the Bligh and Dyer method. Methyl esters were measured according to the method described by Ichihara et al. (1996). Fatty acid methyl esters (FAME) were obtained on an HP-Agilent 6890 (Santa Clara, CA, USA) model gas chromatographer (GC) equipped with a flame ionization detector and fited with a SUPELCO SP 2560 capillary column (100 m,

Determination of Amino acid composition

Crude protein content was calculated by converting the nitrogen content, determined by Kjeldahl's method (AOAC, 1995). For amino acid analysis, samples were hydrolyzed in 6N HC1 at 110 °C for 24 h (AOAC, 1984) in an evacuated sealed ampoule. The analysis was carried out using an Eppendorf Biotronic LC 3000 Amino acid Analyzer (Eppendorf-Biotronic, Hamburg, Germany), according to standard procedures. The results are given as means of triplicate values.

Determination of Mineral Composition

The mineral composition was determined by using ICPMS. USEPA, (1994) method 3051A protocol was employed to digest the sample material, using microwave-assisted HNO3 digestion. The mineral composition was determined in triplicate using an ion chromatography (Agilent 7500CE, Santa Clara, CA, USA) according to the method of AOAC (1980).

Sensory Evaluation

Sensory evaluation was conducted by a panel of five trained people. Fillets samples were cooked at 170°C for 15 min in a preheated conventional electric oven. After cooling for about 10 min at room temperature, the samples were served warm to the panelists. Texture, odor, flavor and overal acceptability were scored for their intensity using a 9-point scale (1: least, 5: moderate, 9: greatest).

Results and Discussion

Biometric measurements, proximate composition and pH

Total lenght, body hight, body width, head lenght were determined to be; 27.89 ± 2.07, 8.75 ± 0.36, 4.37 ± 0.15, 5.28

± 0.11 cm respectively. Fillet yield is the ratio between fillet weight and carcass weight and is a measure of the edible part of the body. The fillet yield of *Carrasius gibelio* was 35 % which was determined as the ratio of fillet weight to the total weight of the fish.

According to the results of proximate compositon of *Carassius gibelio;* moisture, crude protein, total lipid and ash contents were determined as; 79.48 ± 2.88 %, 17.42 ± 0.80 %, 0.86 ± 0.05 % and 1.24 ± 0.11 % respectively. Izci (2010) studied the utilization and quality of fish fingers from *Carassius gibelio* and reported that percentage value of moisture, crude fat, protein and ash were; 76.24 ± 0.39, 4.62 ± 0.32, 17.99 ± 0.33, 0.93 ± 0.02 respectively. Siddaiah et al. (2001) reported that percentage value of moisture, total lipid, total protein and ash content of silver carp (Hypophthalmichthys molitrix) were; 80.97 ± 1.18, 1.42 ± 0.08, 16.68 ± 0.42, 1.21 ± 0.04% respectively. These results are almost parallel to our results.

The pH value of the *Carassius gibelio* which was one day old from the time of capture was determined as 6.16 ± 0.00. Izci (2010) found the pH value as 6.14 ± 0.00 in raw *Carassius gibelio* which was captured in Egirdir, Turkey. Partially high pH values were determined in other carp species. Susanto et al., (2011) reported that the pH values of *Cyprinus carpio* was increased from 6.43 ± 0.13 to 6.55 ± 0.11 after 24 hour of chilled storage and also Puchała et al. (2005) has observed the pH, over the initial 24–h period following slaughter from 6.58 to 6.41. Low initial pH may associated with higher stress before slaughtering. This is caused by depletion of energy reserves, mainly glycogen.

Flesh Color

The lightness, redness and yellowness values of *Carrasius gibelio* were; 45.62 ± 1.09, 6.14 ± 0.41, 15.69 ± 0.88 respectively. There was no color values in *Carassius gibelio* fillets found in literature.

Fatty Acid Composition

Fatty acid composition of *Carassius gibelio* are shown in Table 1. The average level of saturated fatty acids (SFAs) was 34.98 %. Among them 14:0, 16:0, 18:0 and 23:0 was dominated. Monounsaturated fatty acids (MUFAs) were in average 33.96 %. 18:1ω9 was the prominent monounsaturated fatty acid (21.45 %). Stansby and Hall (1967) reported that freshwater fish generally contain lower proportions of ω3 PUFAs than marine fish. The percentage of polyunsaturated fatty acids with four, five or six double bonds is slightly lower in the polyunsaturated fatty acids of lipids from freshwater fish (approximately 70 %) than in the corresponding lipids from marine fish (approximately 88 %). However, the composition of the lipids is not completely fixed but can vary with the feed intake and season. They also mentioned that recent reports show that freshwater fish contain relatively large amounts of ω3 polyunsaturated fatty acids (PUFAs). In our study we also determined high value of PUFAs with an average of 29.67 %. Docosahexaenoic acid (DHA, 22:6ω3) and eicosapentaenoic acid (EPA, 20:5ω3) were the dominant species among PUFAs and their concentrations were determined as; 9.80 % and 5.44 % respectively. Özparlak (2013) determined the percentage value of fatty acid composition of muscle of *Carassius gibelio* caught in Apa Dam Lake which is located in the Central Anatolia Region of Turkey in summer and winter season and reported that highest n-3/n-6 ratios were observed in *Carassius gibelio* in winter which is economically important species considering n-3 fatty acids and n-3/n-6 ratios. The ratio of ω3/ω6 PUFAs in total lipids of freshwater fish changes mostly between 0.5 and 3.8, whereas it changes between 4.7 and 14.4 in marine fish (Henderson and Tocher, 1987; Cengiz et al., 2010). In our study the ratio of ω3/ω6 was 2.13. It was shown that ratio of ω3/ω6 depends on trophic positions of fish e. g., the optimal ω3/ω6 ratio in the carnivorous-benthivorous freshwater fish is 3.8, for carnivorous-piscivorous fish the ratio is 2.6, and for herbivorous-omnivorous fish is 2.0 (Ahlgren et al., 2009; Rogozin et al., 2011). Thus, ω3/ω6 ratio of *Carassius gibelio* from Manisa Demirköprü Dam Izmir, corresponds with the ratio for herbivorous-omnivorous fish. This result is in good agreement with the study of Izci (2010) which the ratio of ω3/ω6 in *Carassius gibelio* caught from Eğirdir, Turkey was determined as 2.22. Rogozin et al. (2011) reported that, ω3/ω6 ratio was 2.8 in *Carassius gibelio* from the Shira Lake located in the northern part of the Republic of Khakassia, South Siberia (Russian Federation) which was corresponded with the ratio for carnivorous-piscivorous fish. Altair et al. (2001) reported that the best ω3/ω6 PUFAs ratio of wild freshwater species was 1.79. The ω3/ω6 ratio has been suggested to be a useful indicator for comparing relative nutritional values of fish oils. An increase in the human dietary ω3/ω6 fatty acid ratio is essential to help prevent coronary heart disease by reducing plasma lipids and to reduce the risk of cancer (Kinsella et al., 1990; Cengiz et al., 2010; Kris-Etherton et al., 2002). The present study suggests that *Carassius gibelio* may be preferable as a result of its high C20:5ω3 and C22:6ω3 content.

Amino Acid Composition

Protein content of *Carassius gibelio* was 17.42±0.80 % and the total amino acid was 16.604 mg/100g. The essential amino acids (EAAs) of *Carassius gibelio* constituted approximately 48 % of total amino acids. Lysine, leucine, isoleucine and threonine were determined as the major EAAs. Based on individual functions, essential amino acids have different recommended daily intake (RDI). WHO/FAO/UNU Expert Committee recommends, in the case of adult humans, the use of revised indispensable amino acid requirement values (WHO, 2007), which are about two to three times higher than the earlier international recommendations (WHO/FAO/UNU, 1985). Table 2 shows the essential amino acids in *Carassius gibelio* and also a summary of the adult essential amino acid requirements concerning to the WHO/FAO/UNU (1985, 2007). According to the revised WHO/FAO/UNU Expert Committee recomendation lysine, leucine, isoleucine and threonine requirements for adults is 30 mg, 39 mg, 20 mg and 15 mg amino acid/kg body weight per day respectively. Lysine, leucine, isoleucine and threonine level was determined as 24.88 ± 0.04 mg/g, 10.58 ± 0.03 mg/g and 8.40 ± 0.03 mg/g and 9.32 ± 0.01 mg/g protein respectively, so an adult can provide conveniently more than the daily requirement, while consumption of one porsion of prussian carp (250 g).

Aspartic acid, glutamic acid have been found as the major amino acids in sea food products (Oladapa et al., 1984) and these amino acids were also dominat in *Carassius gibelio* which were determined as 26.39 mg/g, 25.36 mg/g respectively. There is not any data about the amino acid composition of *Carassius gibelio* in literature. Skibniewska et al. (2013) also mentioned that although information on

TABLE 1: *Fatty Acid Composition (%) of Carrasius gibelio.*

C04:0	01-butyric acid ME	0.00 ± 0.00
C06:0	02-caproic acid ME	0.00 ± 0.00
C08:0	03-caprylic acid ME	0.00 ± 0.00
C10:0	04-capric acid ME	0.00 ± 0.00
C11:0	05-undecanoic acid ME	0.00 ± 0.00
C12:0	06-lauric acid ME	0.00 ± 0.00
C13:0	07-tridecanoic acid ME	0.00 ± 0.00
C14:0	08-myristic acid ME	3.68 ± 0.34
C15:0	10-pentadecanoic acid ME	1.43 ± 0.11
C16:0	12-palmitic acid ME	15,90 ± 0.68
C17:0	14-heptadecanoic acid ME	0.83 ± 0.00
C18:0	16-stearic acid ME	6.86 ± 2.52
C20:0	21-arachidic acid ME	0.26 ± 0.06
C21:0	25-heneicosanoic acid ME	0.00 ± 0.00
C22:0	27-behenic acid ME	0.00 ± 0.01
C23:0	32-tricosanoic acid ME	6.02 ± 0.55
C24:0	34-lignoceric acid ME	0.00 ± 0.00
ΣSFA		**34.98**
C14:1	09-myristoleic acid ME	0.93 ± 0.12
C15:1	11-cis-10 pentadecanoic acid ME	0.00 ± 0.00
C16:1	13-palmitoleic acid ME	10.11 ± 0.82
C17:1	15-cis-10 heptadecanoic acid ME	0.00 ± 0.00
C18:1n9t	17-trans-oleic acid ME	0.17 ± 0.00
C18:1n9c	18-oleic acid ME	21.45 ± 1.42
C20:1	23-gondoic acid ME	1.30 ± 0.9
C22:1n9	29-erucic acid ME	0.00 ± 0.00
C24:1	36-nervonic acid ME	0.00 ± 0.00
ΣMUFA		**33.96**
C18:2n6t	19-trans-linoleic acid ME	0.00 ± 0.00
C18:2n6c	20-linoleic acid ME	4.57 ± 0.77
C18:3n6	22-trans-linolenic acid ME	0.00 ± 0.00
C18:3n3	24-linolenic acid ME	2.92 ± 0.25
C20:2	26-cis-11.14-eicosadienoic acid ME	2.41 ± 0.65
C20:3n6	28-cis-8.11-14-eicosatrienoic acid ME	0.00 ± 0.00
C20:3n3	30-cis-11.14.17 eicosatrienoic acid ME	0.00 ± 0.00
C20:4n6	31-arachidonic acid ME	3,96 ± 0.47
C22:2	33-cis-13.16-docasadienoic acid ME	0.57 ± 0.05
C20:5n3	35-cis-5.8.11.14.17eicosapentaenoic acid ME	5.44 ± 0.41
C22:6n3	37-cis-4.7.10.13.16.19docasahexaenoic acid ME	9.80 ± 1.54
ΣPUFA		**29.67**

the nutritive values of fish protein is widely known, there are a few papers devoted to its composition and papers concerning carp are scarce. He studied the nutritional value of the protein of *Cyprinus carpio* from breeding technologies currently employed in Poland (semi-extensive, low-intensive and high-intensive ones). According to the their study the carps was characterised by a high content of essansial amino acids, compared to the standard protein, irrespective of the area of breeding or the production intensity level and reported that the lysine, leucine, aromatic amino acids (phenylalanine and tyrosine), sulphur amino acids (methionine and cysteine) as well as histidine were dominant amino acids. According to the WHO (2007) recommendation; aromatic and total sulpfur amino acids requirement for adults is 25 mg/kg and 15 mg/kg per day, respectively. In our study phenylalanine+ tyrosine (10.33 mg/g) and methionine (3.56 mg/g) were determined in high value.

Summarizing the results of this study, *Carassius gibelio* can be concluded to serve as significant sources of essential amino acids, in terms of both quantity and quality, especially good sources of lysine, which is severely restricted in cereals.

Vitamin Content

There is not any information about the vitamin content of *Carassius gibelio* in literature. According to the information of FAO/WHO (1988) Expert Consultation daily requirement of Vitamin A for an adult women and men is; 270, 300 µg RE respectively. In current study vitamin A content was determined as; 20.47 ± 0.90 µg/100g. Özyurt et al. (2009) reported that vitamin A content of common carp *(Cyprinus carpio)* was 23.52 ± 0.19 µg/100g which is almost closed to our result. On the other hand Steffens (2006) determined higher vitamin A content (44 µg/100 g) in *Cyprinus carpio.*

Vitamin D content of *Carassius gibelio* was determined as; 3.14 ± 0.12 µg/100 g which is good enough for taking sufficient amount of daily requirement of vitamin D. Recommended daily intakes for vitamin D is 5 µg (FAO, 2002). Bogard et al. (2015) reported that vitamin D_3 in silver carp *(Hypophthalmichthys molitrix)* was 0.24 µg/100 g which is highly lower than prussian carp (*Carassius gibelio*).

B_6 content of *Carassius gibelio* was; 140 ± 0.00 µg/100 g. Recommended daily intakes of vitamin B_6 is, 1.3 mg (FAO/WHO, 2001). Consuming one porsion (250 g) of *Carassius gibelio* is sufficient for about one third of the daily requirement. Steffens (2006) reported that vitamin B_6 content of *Cyprinus carpio* were determined as 0.15 mg/100 g, which is very close to our data.

Vitamin B_{12} was determined as; 2.58 ±0.04 µg/100g in *Carassius gibelio.* Average requirement of B_{12} for an adult is about 2.0 µg/day (FAO/WHO, 2001). Consumption of 100 g of *Carassius gibelio* is exceedingly satisfying for daily requirement of B_{12}. Bogard et al., (2015) reported that very limited data on vitamin B_{12} in fish and seafood is available for comparison in the literature. So they studied the nutrient profiles of common fish in Bangladesh and according to the their results vitamin B_{12} in silver carp *(Hypophthalmichthys molitrix)* was 0.55 µg/100 g which is lower than prussian carp as well as vitamin D.

Heavy Metal Content

The metals of particular concern in relation to harmful effects on health are: lead (Pb), mercury (Hg), arsenic (As), and cadmium (Cd). Lead and mercury often being referred to as "heavy metals" because of their high atomic weight. Heavy metals are considered the most important form of pollution of the aquatic environment because of their toxicity and accumulation by marine organisms. JECFA (2000) (Joint FAO/WHO Expert Committee on Food

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TABLE 2: *Indispensible amino acids in Carrasius gibelio and a summary of the adult indispensable amino acid requirements (FAO/WHO/UNU, 1985; 2007).*

Amino acid protein[a]	2007 FAO/WHO/UNU mg/kg per day	mg/g protein[a]	mg/g protein in *Carassius gibelio*	1985 FAO/WHO/UNU mg/kg per day	mg/g protein[a]
Histidine	10	15	**5.74 ± 0.02**	8–12	15
I soleucine	20	30	**8.40 ± 0.03**	10	15
Leucine	39	59	**10.58 ± 0.03**	14	21
Lysine	30	45	**24.88 ± 0.04**	12	18
Methionine + cysteine	15	22	**3.56 ± 0.02**	13	20
Methionine	10	16		–	–
Cysteine	4	6		–	–
Phenylalanine + tyrosine	25	38	**10.33 ± 0.01**	14	21
Threonine	15	23	**9.32 ± 0.01**	7	11
Tryptophan	4	6		3.5	5
Valine	26	39	**6.69 ± 0.02**	10	15
Total indispensable amino acids	184	277	**79.5**	93.5	141

[a]: Mean nitrogen requirement of 105 mg nitrogen/kg per day (0.66 g protein/kg per day).

Additives) currently recommends calculating the provisional tolerable weekly intake (PTWI) of individual heavy metals instead of the acceptable daily intake (ADI) to compare their pollution levels considering their toxicity accumulated in the human body. The Joint FAO/WHO (2010) Expert Committee on Food Additives established a provisional tolerable weekly intake (PTWI) for lead as 0.025 mg/kg bw which is equivalent to 0.214 mg/ day for an individual of 60 kg. Lead concentration determined in our study (0.05 ± 0.03 mg/kg^{-1}) was lower than those limit and also lower to recently reported data (2.51 ± 0.30 mg/kg^{-1}) by Özparlak et al. (2012) in *Carassius gibelio* caught from Beysehir Lake, Turkey. In the study of Trojnar et al. (2013) Lead concentration (0.72 ± 0.06 mg/kg^{-1}) in *Carrasius gibelio* from fish farm in Poland, exceeded the limit more than three times. Castro-Gonzales et al. (2008) reported that lead concentration in common carp caught from Lower Nitra River, Slovak Republic was 0.30–0.49 mg/kg^{-1}.

Most toxic form of mercury, methylmercury, is found at significant levels only in fish and seafood. Individuals consuming a diet containing a high content of predatory fish and/or shellfish may exceed the Provisional Tolerable Weekly Intake for methylmercury established by JECFA (2003) of 1.6 µg/kg body weight and may therefore be at risk. According to our results methylmercury was determined as 0.04 ± 0.00 mg/kg^{-1} which is below the Provisional Tolerable Weekly Intake.

The Joint FAO/WHO Expert Committee on Food Additives (JECFA, 2003) established a provisional tolerable weekly intake (PTWI) for inorganic arsenic as 0.015 mg/kg of body weight/week or 0.12 mg/day for a person of 60 kg adult (FAO/WHO, 2005). In the literature, the percentage of inorganic As in fish and shellfish has been reported to be between 0.02 and 11 %, whereas the maximum acceptable daily load for As, set by the WHO in 1989 is; 3 mg for a person of 60 kg body weight (FAO/WHO, 1989). Taking this into account, in the current study the intake of As (0.08 ± 0.02 mg kg-1) would not be of concern.

FAO/WHO (2005) has recommended the provisional tolerable weekly intake (PTWI) as 0.007 mg/kg bw for cadmium (420 g/week for a 60-kg person); the committee evaluated the impact of different maximum levels of cadmium on the overall intake. In our study cadmium concentration in *Carassius gibelio* was below detection limits in contrast to study of Castro-Gonzales et al. (2008) in which cadmium concentration was very high (0.23–1.81 mg kg^{-1}) in common carp caught from Lower Nitra River, Slovak Republic.

Sensory Evaluation

Flavor represents one of the most important quality attributes contributing to consumer acceptability (Chiang et al., 2007) and the score of flavor was scored as 6.8 ± 2.16. Texture and odor score were determined as 6.4 ± 2.50; 6.6 ± 2.70 respectively and the overall acceptability score of 6.6 ± 2.07, "like moderately" on a 9-point hedonic scale. Izci et al. (2010) reported that nugget made from *Carassius gibelio* got mean sensory score of 8.471 ± 0.1, which is higher than our result, this may be because of flavor effect of batter-breaded and frying steps of nugget processing. Hence several different types of parasitic infections (Thelohanellus and Posthodiplostomatosis) causing disease are associated with the *Carassius gibelio* (Ondračková et al., 2002; Marković et al., 2012). In the case of existing of parasits, heat inactivation (thickest part of the product should reach a minimum of 63 °C (145 °F) for 15 seconds or longer) is an effective method for eliminating the risk of parasitic infections (Adams et al., 1997). For this reason appliying of frying process offers a promising alternative for eliminating of related parasits and also enhacement of flavor. Hence the heavy metal content of *Carassius gibelio* is suitable to safely consume, it can be a good alternative to produce value added mince based products from *Carassius gibelio* with higher sensory acceptability.

Conclusion

In this study *Carassius gibelio* caught from Manisa Demirköprü Dam, Izmir was found to be important sources of nutrients without having any risk of heavy metal contamination. We confirm that it has a sufficient supply of indispensable AAs, polyunsaturated omega-3s and vitamin D and B_{12}. Although it has a good nutritional value, it is important to test the water quality in its biotope before using it for an industrial application. In the case of existing of several different types of parasitic infections in this speceies, it is important to overcome this problem through developing an efficient cooking method.

Hence this species leads to decreases in the population of all native fish species, fish eggs, invertebrates, plants and all animals in the ecosystem. Fishing of *Carassius gibelio* will be encouraged if effective fishing and utilization of this species become available for the fishing and seafood industries. For this purpose *Carassius gibelio* can be consumed through production of value-added mince based seafood products like fish nugget, fish ball etc. for promoting good health, prevention and healing of diseases for well beings.

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Conflict of interest

The authors declare that they have no conflict of interest.

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Address of corresponding author:
Dr. Sebnem Tolasa Yilmaz
Ege University Fisheries Faculty
Dept of Fish Processing Technology
Ege University,
35100 Bornova Izmir,
Turkey
sebnem.tolasa@ege.edu.tr