

Vitamin and mineral content of pike perch (*Sander lucioperca*), common carp (*Cyprinus carpio*), and European catfish (*Silurus glanis*)

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Abstract: The vitamin and mineral contents of pike perch (*Sander lucioperca*), common carp (*Cyprinus carpio*), and European catfish (*Silurus glanis*) were determined in this study. The lowest water content (76.79 g/100 g) and the highest ash (1.17 g/100 g) and fat (3.5 g/100 g) contents were determined in common carp. The highest water (81.81 g/100 g) and lowest protein contents (17.17 g/100 g) were found in European catfish sample. On the other hand, the fat content of pike perch (0.74 g/100 g) was significantly lower than common carp (3.5 g/100 g) and European catfish (1.12g/100 g). The mean vitamin contents across 3 species were in the range of 1.14-2.15 mg/100 g for vitamin C, 0.04-0.08 mg/100 g for thiamin, 0.03-0.10 mg/100 g for riboflavin, 12.13-33.23 µg/100 g for folic acid, 6.30-23.52 µg/100 g for vitamin A and 0.46-0.94 mg/100 g for vitamin E. The mean contents of Na, K, Mg, Mn, Cu, and Zn were found as 61.25-130.10, 305.90-358.10, 27.11-37.43, 0.85-1.36, 0.08-0.13, and 1.25-1.32 mg/100 g, respectively.

Key words: Vitamin, mineral, *Sander lucioperca*, *Cyprinus carpio*, *Silurus glanis*, proximate composition

Sudak (*Sander lucioperca*), sazan (*Cyprinus carpio*) ve yayın balığının (*Silurus glanis*) vitamin ve mineral içerikleri

Özet: Bu çalışmada, sudak (*Sander lucioperca*), sazan (*Cyprinus carpio*) ve yayın balıklarının (*Silurus glanis*) vitamin ve mineral içerikleri belirlenmiştir. En düşük su içeriği (76,79 g/100 g), en yüksek kül (1,17 g/100 g) ve yağ (3,5 g /100 g) içeriğinin sazanında olduğu belirlenmiştir. En yüksek su (81,81 g/100 g) ve en düşük protein (17,17 g/100 g) içeriği yayın örneklerinde bulunmuştur. Diğer yandan, sudağın yağ içeriği (0,74 g/100 g) sazan (3,5 g/100 g) ve yayından (1,12 g/100 g) önemli derecede düşüktür. Üç türün ortalama C vitamini 1,14-2,15 mg/100 g, thiamin 0,04-0,08 mg/100 g, riboflavin 0,03-0,10 mg/100 g, folik asit 12,13-33,23 µg/100 g, A vitamini 6,30-23,52 µg/100 g ve E vitamini 0,46-0,94 mg/100 g aralığındadır. Ortalama Na, K, Mg, Mn, Cu ve Zn içerikleri sırasıyla 61,25-130,10, 305,90-358,10, 27,11-37,43, 0,85-1,36, 0,08-0,13 and 1,25-1,32 mg/100 g olarak bulunmuştur.

Anahtar sözcükler: Vitamin, mineral, *Sander lucioperca*, *Cyprinus carpio*, *Silurus glanis*, besin kompozisyonu

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Micronutrient deficiency is known to be the most important problem of about one third of the world population. It has direct mental and physical affects on the population and lowers the productivity and the quality of life. To prevent nutrient deficiencies, many people consume dietary supplements beside their daily diet. However, the more scientists learn about nutrition and the human body, the more they realize the importance of eating whole foods. Fish has to be considered as a mineral and vitamin source in addition to that as a good source of protein and ω -3 fatty acids.

Pike perch (*Sander lucioperca*), common carp (*Cyprinus carpio*) and European catfish (*Silurus glanis*) are 3 of the most important fresh water fish owing to their desirable sensory properties. Pike perch, common carp and European catfish production of Turkey are 1656, 12,116, and 1245 t, respectively (1). According to FAO (2) reports, Turkey is one of the major producers of common carp in the world. These fish have an important commercial value both for consumption in Turkey and as an export commodity. It is necessary to know the quantity and quality of the nutritional composition of foods in order to avoid nutritional disorders and to set diet formulations. Although some papers have been published on the fatty acid and amino acid compositions of these species (3-5), limited data is available on the composition of vitamins and minerals of pike perch, common carp, and European catfish. Calcium and P are the most known and studied minerals in fish. However, there are not much data on Na, K, Mg, Mn, Cu, and Zn. The purpose of this study was to determine the proximate composition and vitamin and mineral contents of pike perch, common carp, and European catfish. It is anticipated that the determination of the vitamin and mineral contents of these fish will provide necessary information of the nutrient value of these food for both consumers and researchers who work on nutrient tables, and will also guide the farmers who cultivate these species in terms of their feeding requirements.

Pike perch (135.67 ± 35.8 g), common carp (780.52 ± 50.3 g), and European catfish (690.78 ± 40.84 g) used in the present study were obtained from a local fish cooperative (Seyhan dam lake, Turkey). The fish samples were kept in ice until the fish were

transported to the laboratory. After that, 20 individuals from each fish species were beheaded, gutted, washed, filleted, and dried on paper. These fillets, which were completely boneless, were homogenized with meat grinder and immediately analyzed for the proximate analysis. The rest of the samples were stored at -18 °C in plastic bags for 1 month until they were used for vitamin and mineral analyses. High pressure liquid chromatography (HPLC, vitamins) and atomic absorption spectrophotometry (AAS, minerals) analyses were conducted in The Scientific and Technical Research Council of Turkey Food Institute (TUBITAK FI) laboratories. All determinations were carried out in triplicates.

Protein was determined by the Kjeldahl method (6). Fats were extracted by the method of Bligh and Dyer (7). Water and ash contents were determined in an oven at 103 °C and 550 °C in an ash furnace, respectively, until the weights were become constant. Vitamin B₁ (thiamin) and vitamin B₂ (riboflavin) were analyzed using HPLC according to Finglas and Faulks (8). Folic acid was analyzed using HPLC according to Dionex Vydac Application Note 9904. Vitamin C content was determined by the 2, 6-dichloroindophenol titrimetric method (9). Vitamin E and A (Vitamin A acetate) levels were analyzed using HPLC according to Manz and Philipp (10). Thiamine hydrochloride Calbiochem for thiamin, riboflavin Calbiochem for riboflavin, folic acid Applichem A2085 for folic acid, L-Ascorbic acid Fluka for vitamin C, DL- α -tocopherol Calbiochem for vitamin E and vitamin A Acetate Calbiochem for vitamin A were used as standards for the analysis. Mineral levels were determined with a Perkin-Elmer 700 atomic absorption spectrophotometer (Perkin Elmer Corporation, Norwalk, CT) using AOAC 985.35 (11) for magnesium (Mg), potassium (K), sodium (Na), manganese (Mn) and AOAC 999.11 (12) for copper (Cu). Microwave digestion system was used for mineral digestion.

All data obtained for each fish species were subjected to analysis of variance (one-way ANOVA), at 5% confidence level using the Duncan's multiple range test.

The proximate compositions of pike perch, common carp, and European catfish are shown in

Table 1. The fat content of pike perch (0.74 g/100 g) was significantly lower than common carp (3.5 g/100 g) and European catfish (1.12 g/100 g) ($P < 0.05$). While common carp had the lowest water content (76.79 g/100 g), the contents of ash (1.17 g/100 g) and fat (3.5g/100 g) were significantly higher than pike perch and European catfish ($P < 0.05$). On the other hand, it was found out that the highest water (81.81 g/100 g) and lowest protein contents (17.17 g/100 g) were determined in European catfish sample ($P < 0.05$). These data are comparable with the previous findings for pike perch (3,4), common carp (13), and European catfish (14). The chemical composition of fish varies widely depending on the fish species, gender, size, nutrition, fishing season, fishing techniques, seasonal and sexual variations, and the environmental conditions (15).

The vitamin composition of pike perch, common carp, and European catfish samples are given in Table 2. The vitamin C content of pike perch, common carp, and European catfish was identified to be 1.91 mg/100 g, 1.14 mg/100 g and 2.15 mg/100 g, respectively. These values were in the same range (1.0-5.1 mg/100 g) for white fish muscle reported by Lall and Parazo (16) but higher than some seafood of Pacific Northwest (0.3 mg/100 g) reported by Gordon and Martin (17). Thiamin (B_1) and riboflavin (B_2) ranges were 0.04-0.08 mg/100 g and 0.03-0.10 mg/100 g, respectively. Similarly, Souci et al. (18) reported that vitamin B_1 level for some marine and freshwater fish species were 0.02-0.2 mg/100 g. Vitamin B_2 content of pike perch was significantly higher than common

carp and European catfish ($P < 0.05$). Compared to some marine and freshwater fish species referred by Souci et al. (18), vitamin B_2 content of common carp and European catfish samples were lower than reported for mackerel (0.36 mg/100 g), herring (0.22 mg/100 g), European eel (0.32 mg/100 g), rainbow trout (0.08 mg/100 g), and carp (0.053 mg/100 g). In the present study, folic acid content of pike perch, common carp, and European catfish samples was 12.13 $\mu\text{g}/100\text{ g}$, 33.23 $\mu\text{g}/100\text{ g}$, and 12.23 $\mu\text{g}/100\text{ g}$, respectively. Common carp have significantly higher folic acid content than the others ($P < 0.05$). Lall and Parazo (16) reported that the average folic acid content of fish and shellfish was 0.5-10 $\mu\text{g}/100\text{ g}$ in flesh. For this reason, pike perch, common carp, and European catfish can be a good source for folic acid.

Fat-soluble vitamins in the flesh of fish are affected by the level of fat. Vitamin A levels could not be identified in pike perch sample because of LOD of the analytical method (0.273 mg/kg). The flesh of the lean fish contains from 7.5 to 15 $\mu\text{g}/100\text{ g}$ vitamin A, while in the fatty species vitamin A ranges from 30 to about 1350 $\mu\text{g}/100\text{ g}$ (19). In this range, common carp (23.52 $\mu\text{g}/100\text{ g}$) and European catfish (6.30 $\mu\text{g}/100\text{ g}$) can be classified in medium and low content of vitamin A, respectively. The contents of vitamin E in the edible parts of fish range from 0.2 to 270 mg/100 g wet weight (19). Vitamin E content of species evaluated was on the low level (Table 2). This may be due to low fat level in the muscle tissue of these species, since vitamin E is a fat-soluble vitamin.

Table 1. Proximate compositions of pike perch, common carp, and European catfish.

Scientific name	<i>Sander lucioperca</i>	<i>Cyprinus carpio</i>	<i>Silurus glanis</i>
Original name, Turkish	Sudak	Sazan	Yayın
English name	Pike perch	Common carp	European catfish
Water (g/100 g)	80.23 \pm 0.12 ^b	76.79 \pm 0.05 ^a	81.81 \pm 0.08 ^c
Ash (g/100 g)	0.98 \pm 0.01 ^a	1.17 \pm 0.01 ^b	0.97 \pm 0.03 ^a
Protein (g/100 g)(N \times 6.25)	18.01 \pm 0.47 ^b	18.34 \pm 0.04 ^b	17.17 \pm 0.1 ^a
Fat (g/100 g)	0.74 \pm 0.02 ^a	3.5 \pm 0.06 ^c	1.12 \pm 0.04 ^b

*Means followed by different letters are significantly different ($P < 0.05$)

The values are expressed as mean standard deviation, n = 3

Table 2. Vitamin compositions of pike perch, common carp, and European catfish.

	Vitamin C (mg/100 g)	Vitamin B ₁ (mg/100 g)	Vitamin B ₂ (mg/100 g)	Folic acid (µg/100 g)	Vitamin A (µg/100 g)	Vitamin E (mg/100 g)
Pike perch	1.91 ± 0.15 ^b	0.04 ± 0.003 ^a	0.10 ± 0.007 ^c	12.13 ± 1.09 ^a	–	0.94 ± 0.01 ^c
Common carp	1.14 ± 0.04 ^a	0.08 ± 0.0005 ^c	0.04 ± 0.002 ^b	33.23 ± 0.61 ^b	23.52 ± 0.19 ^b	0.46 ± 0.01 ^a
European catfish	2.15 ± 0.07 ^c	0.08 ± 0.001 ^b	0.03 ± 0.001 ^a	12.23 ± 0.39 ^a	6.30 ± 0.16 ^a	0.80 ± 0.01 ^b

*Means followed by different letters are significantly different (P < 0.05)

The values are expressed as mean standard deviation, n = 3

Mineral compositions of pike perch, common carp, and European catfish are shown in Table 3. The average Na content (60 mg/100 g) for freshwater and marine fish was reported by Gökoğlu (13). Similarly, in the present study, Na contents of pike perch (66.51 mg/100 g) and common carp (61.25 mg/100 g) were found in the same ranges with the findings of Gökoğlu (13). Na content of European catfish (130.10 mg/kg) was significantly higher than the others (P < 0.05), but had similarities with blue whiting (136 mg/100 g) reported in Martínez-Valverde et al., (20). In general, K level is usually higher than sodium in both marine and freshwater fish species. In the present study, K levels were also higher than Na levels in all fish samples and in the same range (269-371 mg/100 g) with fresh water fish species reported by Otitologbon et al. (21). In the context of healthy nutrition, a good balance between the levels of K (high) and Na (low) were found in the samples.

Magnesium is needed for bone, protein, and fatty acid formation, formation of new cells, B vitamin activation, muscle relaxation, blood clot formation, and energy metabolism. Aquatic food products, like other animal products, are poor sources of magnesium (22). The magnesium content of freshwater fish species was reported as 18–36 mg/100 g by Otitologbon et al. (21) and 16-113 mg/100 g by Lall (22). In this study, Mg contents of European catfish (27.11 mg/100 g) were significantly lower than that of pike perch and common carp (P < 0.05). The levels of Mn were found as 0.85, 1.13, and 1.36 mg/100 g for pike perch, common carp, and European catfish, respectively. The Mn content was reported as 0.1–4.6 mg/100 g in pink salmon, 0.1– 0.4 mg/100 g in red salmon, and 0.8–6.3 mg/100 g in tuna (23).

The levels of copper were determined between 0.08 and 0.13 mg/ 100 g in this study. Cu levels in fish samples have been reported in the range of 0.004-

Table 3. Mineral compositions of pike perch, common carp, and European catfish. (mg/100 g).

	Pike perch	Common carp	European catfish
Sodium (Na)	66.51 ± 5.00 ^a	61.25 ± 2.66 ^a	130.10 ± 16.12 ^b
Potassium (K)	354.70 ± 6.42 ^b	358.10 ± 9.68 ^b	305.90 ± 13.16 ^a
Magnesium (Mg)	37.43 ± 2.09 ^b	34.21 ± 1.35 ^b	27.11 ± 1.74 ^a
Manganese (Mn)	0.85 ± 0.05 ^a	1.13 ± 0.09 ^b	1.36 ± 0.05 ^c
Copper(Cu)	0.13 ± 0.004 ^b	0.08 ± 0.004 ^a	0.08 ± 0.001 ^a
Zinc (Zn)	1.32 ± 0.07 ^a	1.25 ± 0.12 ^a	1.31 ± 0.10 ^a

*Means followed by different letters are significantly different (P < 0.05)

The values are expressed as mean standard deviation, n = 3

0.5mg/100 g in Iskenderun Bay, northeast Mediterranean Sea, Turkey (24), 0.006-0.4 mg/100 g in Black Sea and Aegean Sea, Turkey (25). Our results were in agreement with these findings. The high intakes of Cu could cause health problems such as liver and kidney damage. Food and Agricultural Organization permits Cu for human consumption up to 0.3 mg/100 g in fish and fishery products (26). Cu contents of pike perch, common carp, and European catfish were found to be lower than the legal limit of FAO.

Zn, in low to moderate amounts, is of very low toxicity in its ordinary compounds and, in low concentrations, is an essential element in plant and animal life. The Zn contents were found to be 1.25-1.32 mg/100 g for pike perch, common carp, and European catfish in the present study. These values were in the similar range (0.2-30 mg/kg) for freshwater fish muscle as reported by Lall (22). The maximum Zn level permitted for fishes were 5 mg/

100 g, according to the Turkish Food Codex (2002/63) (27). Uluözülü et al. (25) reported in their study that zinc levels in 3 marine species (*Sparus aurata*, *Scorpaena porcus*, and *Mullus barbatus*) from Black Sea and Aegean Sea, Turkey were found to be higher than the legal limits. Zn levels in the analyzed fish samples in this study were in the legal limits.

It is known that the concentrations of vitamin and mineral in aquatic organisms were influenced by several factors such as seasonal and biological differences (species, size, age, sex, and sexual maturity), food source, environment (water chemistry, salinity, temperature, and contaminants), and method of food processing (16,21). The potential health benefits of fish for human consumption are the presence of high protein contents, ω 3 fatty acids, and vitamin and mineral composition. In conclusion, the results of this study can be used in the studies on human nutrition and food composition.

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