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Impact of Sex and Fishing Season on Fatty Acid Profile, Fat and Cholesterol Content in the Meat of Roach (*Rutilus rutilus* L.) from Brda River (Poland)

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The aim of this study was to determine fat and cholesterol content and the fatty acid profile in the meat of roach (*Rutilus rutilus* L.). Muscle samples for analyses were taken from the large side muscle of the fish body above the lateral line. The study involved 56 individuals caught in fall and spring. Analyses were carried out on 14 females and 14 males caught in each season. The percentage content of fat in the fish meat was determined with the modified method of FOLCH *et al*. (1957). The cholesterol content was determined with the modified Liebermann-Burchardt colorimetric method using a Shimadzu spectrophotometer (UV-VIS-NIR-3100). The fatty acid profile was determined with the gas chromatograph with a flame-ionization detector. Analyses indicated that the percentage content of fat was higher in the meat of roach caught in autumn (0.96% in females and 0.91% in males) than in the tissues of individuals from spring, which was 0.67% and 0.86%, respectively. The content of the total cholesterol was higher in autumn (64.17 mg $100g^{-1}$) than in spring (56.25 mg $100g^{-1}$), and these values significantly differed ($p<0.05$). Statistical analyses indicated that there were no significant differences in the content of fat and cholesterol between females and males caught in both seasons. The total amounts of SFA, MUFA and PUFA ranged from 30.05% to 33.57%, from 39.53% to 47.64% and from 19.96% to 27.42%, respectively. Analyses of correlations between fatty acids from the n-3 and n-6 group indicated a positive and statistically significant relationship between C20:4 n-6 and C22:4 n-6 (p= 0.000, R=0.9065) and C20:5 n-3 and C22:6 n-3 (p=0.000, r=0.8555). The ratio of n-3/n-6 was highest in the meat of roach caught in spring (0.50-0.81) than in autumn (0.50-0.77). The AI index ranged from 0.35 to 0.46 and the mean values of TI ranged from 0.41 to 0.54.

Key words: Fat, fatty acids, cholesterol, roach (*Rutilus rutilus* L.).

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The average per capita consumption of fish in Poland in 2001 was 5.6 kg $person^{-1}$ $year^{-1}$. The consumption of fish in Poland is lower than that of western countries and other countries from the Baltic region. The inland surface waters in Poland are inhabited by 83 fish species. Annual commercial fishing catches are about 4000 tones of fish from lakes and 1000 tones from rivers and water reservoirs.

Bydgoszcz is located near two rivers: Vistula and Brda. Fish available for consumption are caught in these rivers, including roach. Roach is a non-predatory fish and is a common species in Poland.

Early investigations have shown that freshwater fish have a high capacity for the transformation of C18 essential fatty acids (EFA): C18:3 n-3 (α-linolenic acid-ALA), C18:2 n-6 (linoleic acid-LA) to C20:4 n-6 (arachidonic acid-AA), C20:5 n-6 (eicosapentaenoic acid-EPA) and C22:6 n-3 (docosahexaenoic acid-DHA) (JANKOWSKA *et al*. 2010; STEFFENS & WIRTH 2005). EPA and DHA are found only in fish and seafood and have extremely beneficial properties for the prevention of human coronary artery disease, human breast cancer growth, asthma and others. The n-3 and n-6 PUFAs are very important for growth and development of children and they are precursors of

composite hormones known as eicosanoids (KALYONCU *et al.* 2009). The ratio of n-3/n-6 PUFAs in the diet should be reduced from the current levels between 10 to 20:1 to the traditional range of around 1 to 2:1 (DONMEZ 2009).

Today, one of the major concerns about food quality and nutrition in developed countries is the cholesterol content. According to the World Health Organization, the maximum cholesterol amount should be 300 mg day^{-1}. It is commonly known that the cholesterol content in fish meat doesn't correlate with the fat percentage concentration.

The fat content and the fatty acid profile in fish meat are not constant and depend on: diet, size, age, reproductive cycle, salinity and temperature of water, season of catch and geographical location (GULER *et al*. 2008; KALYONCU *et al*. 2009; LUZIA *et al*. 2003; LUZZANA *et al*. 1996).

Knowledge on the fat concentration and fatty acid profile in the meat of many common fish species is desirable. Therefore, the aim of this study was to determine fat and cholesterol content and the fatty acid profile in the meat of roach (*Rutilus rutilus* L.) – a freshwater fish which is commonly caught from the Brda River. An additional aim of this work was to compare the fat and cholesterol content and fatty acid profile in males and females caught in different seasons. Lipid quality indices (atherogenic index – AI and thrombogenicity index – TI) and correlations between fatty acid percentage content were calculated.

Material and Methods

The study involved 56 individuals of roach caught in fall and spring. The experimental fish were collected from the Brda River, located within Bydgoszcz, near Iławska Street. Analyses were carried out on 14 females and 14 males caught during spring and autumn. Measurements of the mass of the fish body (BW) (± 0.01 g) and body length (Lc) (± 0.1 cm) and the total length (Lt) (± 0.1 cm) were taken from each individual. Muscle samples for analyses were taken from the large side muscle of the fish body above the lateral line. Individuals with similar biometric measurements were selected for analysis (Table 1).

The samples of fish muscle tissue were frozen immediately after preparation and kept in a deep freezer (ca -20°C) before analysis. All frozen samples were freeze dried in a Finn-Aqua Lyovac GT2 freeze drier (parameters: temperature -40°C, pressure 6 10^{-2} mbar, duration at least 48h).

The percentage content of the fat in the fish meat was determined with the modified FOLCH *et al.* (1957) method. About 2 g of freeze-dried tissue was weighed. The total fat was extracted in duplicates from muscle using 60 cm^3 (2×30 cm^3) of a mixture of chloroform-methanol (2:1). After shaking, filtering and solvent removal, the percentage content of fat in the tissue was determined (% content of wet weight).

The cholesterol content was determined with the modified Liebermann-Burchardt colorimetric method (STRZEŻEK & WOŁOS 1997) using a Shimadzu (Japan) spectrophotometer (UV-VIS-NIR-3100). The cholesterol was extracted from samples of 0.25 g of freeze-dried tissue with 15 cm^3 of chloroform. After filtration, the solution was supplemented with chloroform in the measurement container to a volume of 25 cm^3. One cm^3 of acetic anhydride and 0.25 cm^3 of sulphuric acid (VI) were added to 2 cm^3 of the obtained filtrate. After 5 minutes the absorbance value was measured against a blank sample at a wavelength of 620 nm. The results are presented as mg 100 g^{-1} of wet weight.

After fat extraction with the method of Folch *et al.* (1957), methylization was performed with a solution of sodium methanolate (0.5 mol dm^{-3}) for 22 hours at a temperature of 37°C. Isooctan was added to extract methyl esters from the fatty acids. The fatty acid profile was determined with the gas chromatograph HP 6890N using a flame-ionization detector provided by Hewlett-Packard (USA). The temperature of the injector was 230°C, and that of the detector was 250°C. The volume of the injected sample was 1 μl (split 1:50). The analysis involved the use of column Supelcowax10 30 m × 0.32 mm × 0.25 μm. The carrier gas was helium at a flow rate of 1.5 cm^3 min^{-1}. The analyses were performed at a program temperature range of 90 to 225°C (11°C min^{-1}), 225°C for 6 min, and then an increase from 225 to 240°C (6°C min^{-1}) and 240°C for 19 min. The groups of fatty acids analyzed included saturated acids (SFA) (C14:0, C16:0, C17:0, C18:0, C21:0, C22:0, C24:0), monounsaturated acids (MUFA) (C16:1, c17:1, C18:1 9c, C24:1n9) and polyunsaturated acids (PUFA) (C18:2 n6, C18:3 n6, C18:3 n3, C20:4 n6, C20:5 n3, C22:4 n6 i C22:6 n3). Methyl esters of fatty acids were identified by applying the model and Supelco 37 component FAME Mix (Supelco, USA).

Lipid quality indices (atherogenic index – AI and thrombogenicity index – TI), were calculated according to Ulbricht and Southgate (1991). AI = [12:0 + (4×14:0) + 16:0]/[(PUFA n-6 + n-3) + 18:1 + other MUFA]; TI = [14:0 + 16:0 + 18:0]/[0.5×18:1 + 0.5×other MUFA + 0.5×n-6 PUFA + 3×n-3PUFA + (n-3 PUFA/n-6 PUFA)].

Statistical Analysis

Data analyses were performed using Statistica 8.0 software (StatSoft, USA). Significance of differences in the average content of fat and cholesterol was calculated by two-way analysis of variance. Tukey's test was used to compare the mean values. The normality of the data was tested using the Shapiro-Wilk's test and the homogeneity of variance by means of Levene's test.

The Kruskal-Wallis test was applied to analyze fatty acid composition (SFA, MUFA, PUFA, n-3, n-6 and n-3/n-6, because the data didn't meet the assumption of normality and homogeneity of variance required for parametric tests. Data was expressed as median and quartiles 25%-75%. The correlation between fatty acids from n-3 and n-6 series was analysed using the Spearman rank correlation coefficient (R).

Results and Discussion

Analyses indicated that the percentage content of fat was higher in the meat of roach caught in autumn (0.96% in females and 0.91% in males) than in the tissues of individuals from spring, which was 0.67% and 0.86%, respectively. There were no statistically significant differences between females and males collected within each season (Table 1).

Fat content was higher in the meat of fish caught in autumn (0.94±0.30%), than in spring (0.77±0.15%), and these values differed significantly ($p<0.05$) (Table 1). In the meat of roach caught in June from the Masurian Great Lakes, total lipids amounted to 0.64% (ŁUCZYŃSKA *et al*. 2008). The fat content in the meat of roach from the Vistula Lagoon was 0.79% (POLAK-JUSZCZAK & KOMAR-SZYMCZAK 2009). As many reports show, the fat content of some fish species might vary by approximately 10% according to the season of capture (LUZIA *et al*. 2003). GULER *et al*. (2008) carried out analyses of carp (*Cyprinus carpio* L.) from Beyeshir Lake caught in summer, winter, spring and autumn. The total lipid content in winter was higher than in other seasons (4.45% wet weight). This was due to the known seasonality of the fat content in fish, and higher levels of fat during the cold season. The fat content changed seasonally and ranged from 3.13% (wet weight) in the meat of roach caught during spring from lake Dąbie to 9.01% (wet weight) in roach caught during autumn from Pomeranian Bay (WIĘSKI 2002). The meat of perch caught from Włocławski Reservoir in autumn had slightly higher fat content (2.17% ww) in comparison to the fish caught in spring (1.94% ww) (STANEK *et al*. 2008). Analyses of perch caught from Lake Gopło indicated that there were no statistically significant differences in the mean value of fat in the meat of females (0.38% dw) and males (0.34% dw) caught in spring. The mean value of fat in the females and males caught in autumn was 0.50% and 0.48% dw, respectively. Differences were not statistically significant (STANEK *et al*. 2009).

Content of the total cholesterol was higher in autumn (64.17±7.21 mg 100 g^{-1}) than in spring (56.25±6.06 mg 100g^{-1}), and these values differed significantly ($p<0.05$) (Table 1). Statistical analyses indicated that there were no significant differences in cholesterol content between females and males caught within each season (Table 1). Total cholesterol content in the meat of males was 54.59 mg 100g^{-1} in individuals caught during spring, and 65.20 mg 100g^{-1} in fish caught during autumn, and these values differed significantly. The mean value of the total cholesterol in the meat of perch caught from Włocławski Reservoir in autumn and spring was 53.91 and 44.74 mg 100g^{-1}, respectively. The differences between these values were statistically significant (STANEK *et al*. 2008). Analyses of the fish samples carried out by

Table 1

The total cholesterol (mg 100 g^{-1}) and fat (%) content in the meat of roach (*Rutilus rutilus* L.), caught in spring and autumn from Brda River

Catch period	Sex	n	Body weight (g) range (mean)	Body length (cm) range (mean)	Fat (%) mean value ± SD		Cholesterol (mg 100 g^{-1}) mean value ± SD	
spring	females	14	95.20-154.80 (138.48)	16.0-18.5 (17.5)	0.67 ± 0.13	0.77 ± 0.15^{a}	57.90 ± 7.68^{a,b}	56.25 ± 6.06^{a}
	males	14	90.85-125.48 (110.25)	15.5-17.5 (16.5)	0.86 ± 0.10		54.59 ± 3.66^{a}	
autumn	females	14	96.35-149.54 (131.60)	16.0-18.5 (17.5)	0.96 ± 0.27	0.94 ± 0.30^{b}	63.13 ± 7.97^{a,b}	64.17 ± 7.21^{b}
	males	14	80.38-126.54 (106.49)	15.0-17.5 (16.0)	0.92 ± 0.34		65.20 ± 6.75^{b}	

Values in column marked with different letters (a, b) differ significantly (Tukey's test, $p<0.05$)

MATHEW *et al*. (1999), MOREIRA *et al*. (2001) and PIIRONEN *et al*. (2002), indicated that cholesterol content is genetically determined and it's content is constant within a family. MATHEW *at al*. (1999) observed some increase in the cholesterol content in the case of female mackerel, but this was due to seasonal and not sexual differences. The fat was higher in many fish during the month of October. The fat and cholesterol content in fish meat depend on age, sex, spawning cycle and season of capture. As reported by DONMEZ (2009) fish caught during the spawning season or in waters having sparse food supplies have a lower fat and cholesterol content than usual. But lipid and cholesterol content were not affected by the climate in *Pandalus borealis* and *P. jordani shrimps*, although the winter lipid contents were slightly higher than summer contents (LUZIA *et al*. 2003).

Many studies were carried out on the impact of season of capture on fatty acid profile in fish meat (LUZZANA *et al*. 1996; LUZZIA *et al*. 2003; GULER *et al*. 2008; STANEK *et al*. 2008; KALYONCU *et al*. 2009). A comparative analysis of the fatty acid profiles in different tissues (liver and muscle) of females and males was carried out by AKPINAR *et al*. (2009).

Analyses of fatty acid profile indicated that in the SFA group, a higher percentage was recorded for C16:0 and a lower percentage was found for C17:0 and C24:0 (Table 2). The total amounts of SFA ranged from 30.05% to 33.57%.

Table 2

Fatty acid content (% of total acids; median; quartiles 25%-75%) in the meat of roach (*Rutilus rutilus* L.) caught from the Brda River

Fatty acids	Catch period			
	spring		autumn	
	females	males	females	males
SFA				
C14:0	1.77 (0.90-3.98)$^{a.b}$	2.08 (1.74-2.24)^{a}	1.28 (1.17-1.51)$^{a.b}$	1.15 (1.01-1.32)^{b}
C16:0	22.93 (21.09-25.74)	22.37 (21.67-22.75)	20.03 (17.06-23.37)	22.28 (20.52-24.81)
C17:0	0.59 (0.55-0.66)	0.55 (0.48-0.61)	0.62 (0.55-0.64)	0.57 (0.35-0.69)
C18:0	5.31 (4.47-5.55)	4.65 (4.38-4.95)	4.61 (4.12-5.05)	4.92 (4.61-5.15)
C21:0	1.21 (0.42-2.23)	1.15 (0.98-1.35)	1.55 (1.15-1.91)	1.53 (1.38-1.78)
C22:0	0.86 (0.07-1.38)	0.68 (0.57-0.75)	0.92 (0.68-1.05)	1.00 (0.80-1.23)
C24:0	0.25 (0.01-0.49)$^{a.b}$	0.17 (0.14-0.24)^{a}	0.37 (0.290.50)^{b}	0.28 (0.13-0.35)$^{a.b}$
∑SFA	33.57 (31.90-35.47)^{a}	31.46 (29.91-33.13)$^{a.b}$	30.05 (25.92-32.81)^{b}	31.89 (28.57-35.25)$^{a.b}$
MUFA				
C16:1	7.90 (5.58-15.58)	11.02 (9.55-11.57)	7.49 (6.72-10.17)	7.48 (6.77-9.23)
C17:1	0.52 (0.43-0.69)	0.58 (0.54-0.65)	0.56 (0.48-0.64)	0.51 (0.35-0.58)
C18:1 9c	32.27 (26.32-39.90)	34.70 (33.06-40.07)	34.99 (30.55-37.70)	29.37 (26.93-32.64)
C24:1 n9	1.54 (1.35-1.66)^{a}	0.75 (0.68-0.89)^{b}	1.45 (1.26-1.84)^{a}	1.03 (0.79-1.45)$^{a.b}$
∑MUFA	42.27 (33.74-60.13)$^{a.b}$	47.64 (45.26-52.51)^{a}	44.04 (40.40-48.08)$^{a.b}$	39.53 (36.04-43.24)^{b}
PUFA				
C18:2 n6	7.41 (2.03-9.37)	8.78 (6.64-9.10)	8.47 (7.02-12.89)	10.11 (8.86-12.27)
C18:3 n6	0.41 (0.24-0.59)	0.45 (0.41-0.50)	0.51 (0.39-0.61)	0.50 (0.37-0.61)
C18:3 n3	2.23 (1.50-2.51)^{a}	3.41 (2.93-3.51)^{b}	3.31 (2.90-3.89)^{b}	3.47 (3.11-3.92)^{b}
C20:4 n6	4.19 (0.29-7.98)	2.72 (1.93-3.66)	4.75 (3.51-5.86)	5.19 (3.72-6.11)
C20:5 n3	1.62 (0.22-3.05)	1.58 (0.60-2.01)	1.22 (0.84-1.96)	2.15 (1.40-3.00)
C22:4 n6	1.05 (0.15-1.40)	0.66 (0.35-0.82)	0.71 (0.53-0.93)	0.96 (0.69-1.21)
C22:6 n3	5.16 (0.31-7.22)	3.27 (1.94-3.61)	4.78 (3.32-5.73)	4.88 (3.91-6.74)
∑PUFA	24.52 (4.43-34.37)$^{a.b}$	19.96 (17.81-21.62)^{a}	27.42 (23.93-29.97)$^{a.b}$	27.07 (24.81-31.76)^{b}
n-3	9.66 (2.02-12.00)	8.19 (6.16-9.35)	9.70 (7.73-11.42)	11.03 (10.35-13.04)
n-6	14.41 (2.71-20.68)	11.81 (11.15-13.18)	17.47 (11.82-18.71)	16.81 (15.05-18.25)
n-9	33.89 (28.01-41.13)	35.44 (33.92-40.80)	36.62 (32.11-38.97)	30.49 (27.84-33.49)
n-3/n-6	0.67 (0.58-0.83)	0.65 (0.50-0.81)	0.61 (0.50-0.75)	0.67 (0.60-0.77)
AI	0.44 (0.38-0.65)^{a}	0.46 (0.41-0.47)$^{a.b}$	0.35 (0.30-0.43)^{b}	0.40 (0.34-0.45)$^{a.b}$
TI	0.50 (0.40-0.90)^{a}	0.54 (0.52-0.56)^{a}	0.41 (0.39-0.51)^{b}	0.46 (0.43-0.50)^{b}

Values in the same row marked with different letters (a, b) differ significantly ($p<0.05$).

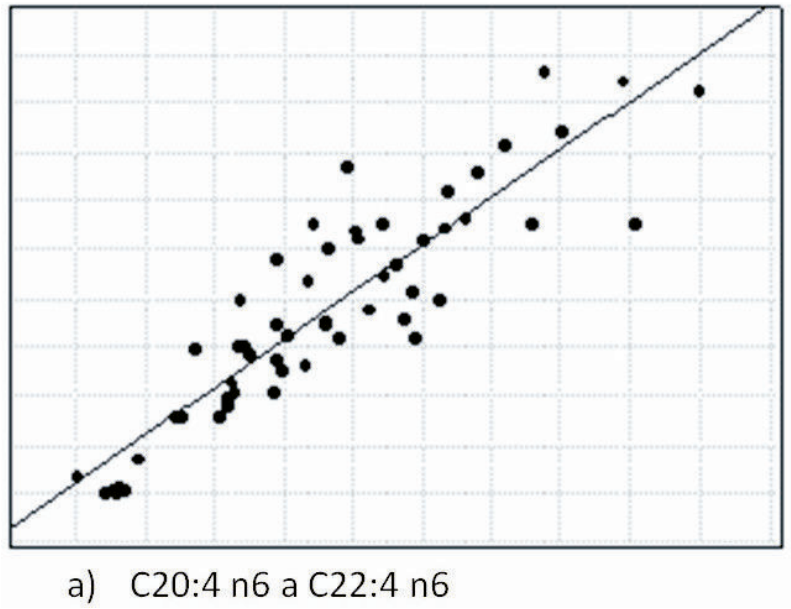
In general, fish are relatively low in SFA (<30%) (GULER *et al*. 2008). In the meat of roach originating from the Masurian Great Lakes region, C16:0 was the dominant SFA (25.38%) and the total amount of SFA for this species accounted for 35.38% (ŁUCZYŃSKA *et al*. 2008). KOŁAKOWSKA *et al*. (2000) noted that roach caught in the Odra and Regalica River contained higher amounts of SFA (34.98%) and MUFA (46.83%) than total PUFA (18.19%). The total fatty acids of roach caught from the Vistula Lagoon were comprised of 25.10% of SFA, 32.49% of MUFA and 42.41% of PUFA (POLAK-JUSZCZAK & KOMAR-SZYMCZAK 2009). In the meat of fish called kutum (*Rutilus frisii*) caught in Seyhan Dam Lake in Adana (Turkey) the highest percentage of SFA was reported for C16:0 and C18:0, and total SFA was 34.59% (ÖZOGUL *et al*. 2007). C16:0 was the primary saturated fatty acid (14.6%-16.6%) in the meat of carp caught in all four seasons (GULER *et al*. 2008). As reported by LUZZANA *et al*. (1996) the content of SFA in muscle of the coregonid bondella (*Coregonus macrophthalmus*) from Lake Maggiore increased during the growth season in both sexes and decreased by the end of the feeding season. In females, the decrease in muscle SFA during the non-feeding period was particularly sharp. Muscle tissue of males showed a non-significant decrease in relative MUFA content. This indicated that males use SFA and MUFA as an energy source, on the contrary, females use SFA. Starved fish show an evident depletion of TG and the SFA are predominant fatty acids in these molecules. As reported by AKPINAR *et al*. (2009), smaller differences were found between SFA in male and female muscles of *Salmo trutta macrostigma*.

Oleic acid was identified as a primary MUFA in the roach for females and males in spring (32.27% and 34.70%) and in autumn (34.99% and 29.87%) (tab. 2). Besides C18:1 n-9, C16:1 n-7 was the second most abundant MUFA (7.48%-11.02%). The same results were observed for carp (*Cyprinus carpio* L.) from Beysehir Lake (Turkey) by GULER *et al*. (2008). They determined C18:1 n-9 as the dominant MUFA (15.1%-20.3%) in the muscle of fish caught in spring, summer, autumn and winter. The same results were obtained by KALYONCU *et al*. (2009). They analysed that C18:1 n-9 was a primary MUFA (22.4%-28.4%) in the meat of vimba (*Vimba vimba tenella*) from Eđirdir Lake (Turkey). The highest amounts of this acid were observed in winter. In the meat of *Salmo trutta macrostigma* from the Tohma River in Turkey, C18:1 n-9 was the predominant MUFA in muscle of female (22.1%) and male (22.4%), and was at similar levels (AKPINAR *et al*. 2009).

PUFA contents in the meat of analysed roach ranged from 19.96% to 27.97% and there were no significant differences between females and males caught within both seasons. There was a statistically significant difference ($p<0.05$) in PUFA content between males caught in different seasons (Table 2). The dominant PUFA in roach from the Brda River was C 18:2 n-6 (7.41%-10.11%). In the meat of roach, the PUFA occurring in highest proportions included C20:5 n-3, ranging from 7% to 12% (AHLGREN *et al*. 1994), 10% (GRAHL-NIELSEN *et al*. 2011) and 9% (UYSAL *et al*. 2008). DHA and EPA were in the range of 3.27%-5.16% and 1.22%-2.15%, respectively. The highest amounts of DHA and EPA were determined in males in autumn, but differences were not significant when compared to the percentage content of this fatty acid in females (caught in spring and autumn) and males from spring. GULER *et al*. (2008) showed that the low PUFA content (29.3%) in carp (*Cyprinus carpio* L.) in winter may be attributed to this reason. The percentages of PUFA, such EPA and DHA in fish muscles, are dependent on diet. Variation in fatty acid composition may be related to the changes in nutritional habits of fish. LUZZIA *et al*. (2003) reported the lowest EPA + DHA content in curimbatás (*Prochilodus* spp.) during winter, in tilápias (*Oreochromis* spp.) in summer. The highest content of the sum of EPA and DHA was in sardines during winter.

In this study, correlations between fatty acids from the n-3 and n-6 group were calculated. A positive and statistically significant relationship was found between C20:4 n-6 and C22:4 n-6 ($p= 0.000$, $R=0.9065$) and C20:5 n-3 and C22:6 n-3 ($p=0.000$, $r=0.8555$) (Fig.1). C22:4 n-6 and C22:6 n-3 acids are converted from C20:4 n-6 and C20:5 n-3, respectively. The n-3 series is derived from α -linolenic acid (C18:3 n-3), and the n-6 series from linoleic acid (C18:2 n-6) (STEFFENS & WIRTH 2005).

The ratio of n-3/n-6 was highest in the meat of females of analysed roach caught in spring (Table 2). The n-3 fatty acids ranged from 8.19% to 11.03%, and fatty acids from n-6 series ranged from 11.81% to 17.47%. Many analyses reported that n-3 fatty acids are lower than the n-6 acids in fishes from cold and deep seawater. The amount of longer-chain n-3 PUFAs differs among species and can be influenced by a number of factors (for example: diet, size, age, phase of reproductive cycle, temperature and season). In the meat of vimba (*Vimba vimba tenella*) from Eđirdir Lake (Turkey) the n-3/n-6 ratio was 1.4 in spring, 1.5 in summer, 1.2 in autumn and 1.4 in winter (KALYONCU *et al*. 2009). The n-3/n-6 ratio in the meat of roach ranged from 1.9 (UYSAL *et al*. 2008) to 2.0 and 3.0 (AHLGREN *et al*. 1994). These results show that this freshwater fish species has a high nutritional value for human consumption due to its high



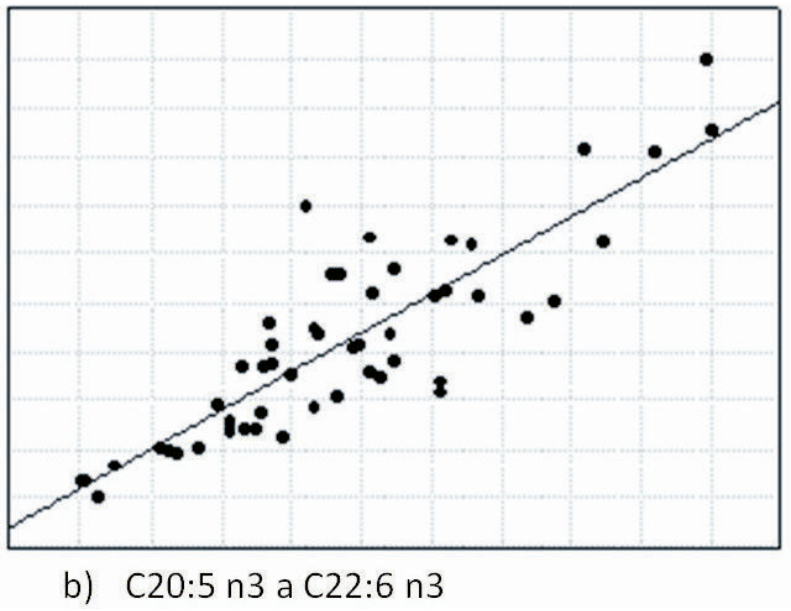


Fig. 1. Correlation between C20:4 n-6 and C22:4 n-6 (p= 0.000, R=0.9065) (a) and C20:5 n-3 and C22:6 n-3 (p=0.000, r=0.8555) (b).

n-3/n-6 ratio. Muscles of common carp reared in warm water showed a higher n-3/n-6 PUFA ratio with 1.52 in comparison to carp of the same age (15-month-old) reared in water from a natural temperature range with a ratio of 0.47 (GERI *et al*. 1995). GULER *et al*. (2007) analysed meat of zander (*Sander lucioperca*) from Beysehir Lake in Turkey and determined a higher n-3/n-6 ratio in spring (1.49). The ratio of n-3/n-6 PUFAs in total lipids of freshwater fish changes mostly between 0.5 and 3.8 whereas for marine fish it was 4.7-14.4 (GULER *et al*. 2008). It was shown to be a useful indicator for comparing relative nutritional values of fish oil.

The AI index ranged from 0.35 to 0.46 and the mean values of TI ranged from 0.41 to 0.54 (Table 2). Such values were lower than those which were observed for other food products, for example: lamb, beef, pork, rabbit and chicken. As indicated by JANKOWSKA *et al*. (2010) the mean value of AI in the meat of wild perch was 0.38 and TI was 0.24. These indexes indicate the global dietetic quality of lipids and their potential effect on the prevention of coronary disease.

In conclusions:

1. Fishing season has a very important influence on the fat and cholesterol content in fish meat.

2. There were no differences between meat of females and males collected within each season, both in percentage of fat and total cholesterol content.

3. The total amounts of SFA, MUFA and PUFA ranged from 30.05% to 33.57%, from 39.53% to 47.64% And From 19.96% To 27.42%, Respectively.

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