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Fatty acid profile of Slovenian farmed rainbow trout

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Abstract

The present study was carried out to determine the fatty acid profile of rainbow trout (*Oncorynchus mykiss*) from three Slovenian fish farms; Zalog, Želimlje and Povodje. Fatty acids composition was determined on a gas chromatograph with a flame ionization detector (GC-FID). The results showed that farming conditions have a significant influence on the fatty acid composition of rainbow trout. The predominant saturated fatty acid (SFA) was palmitic acid, oleic acid was the main monounsaturated fatty acid (MUFA), while the eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were the main long chain n-3 polyunsaturated fatty acids (n-3 PUFA). The percentage of DHA exceeded that of EPA in all rainbow trout samples studied. The n-6/n-3 ratio ranged from 0.89 to 1.54 and the PUFA/SFA ratio was between 1.81 and 2.36. In dorsal and ventral fillet parts, the content of most fatty acids was similar, exceptions were observed for some PUFAs; arachidonic acid, EPA and DHA.

Keywords: farmed fish, rainbow trout, fatty acid profile, long chain n-3 polyunsaturated fatty acids

Introduction

Fish meat is not only an important source of protein, but also contains nutritionally valuable lipids and fatty acids (FA). It is known as a rich source of long-chain n-3 polyunsaturated fatty acids (n-3 PUFA), especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are essential for normal growth, development and reproduction in all vertebrates, including fish and humans (Lauritzen et al., 2001; Howe et al., 2005). Interest in the health benefits of long-chain n-3 PUFA is increasing as numerous studies report that a diet rich in fish protects against chronic diseases such as coronary heart disease. Consumption of fish meat is increasing today as consumers become aware of the positive health effects and numerous micronutrients such as vitamin A, vitamin B_{12}, zinc, selenium and iodine (Guler et al., 2008).

Fats have a high energy density and are therefore an important source of energy in the diet of fish. They build cell membranes and are important for maintaining their functions. Fish,

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like all other animals, cannot synthesize n-3 and n-6 PUFAs themselves, so they must be supplied through the diet (Gonzalez et al., 2006). At least 1 % of the daily energy requirement must be provided by n-3 fatty acids. It is known that excessive levels of n-6 fatty acids can negatively affect fish growth, as it can inhibit the conversion of linolenic acid to polyunsaturated fatty acids (Ruxton et al., 2004). Vegetable oils such as soybean and canola oils are rich in linolenic acid and are used in trout nutrition. Fish oils have an even better effect on fish growth as they contain long chain PUFAs, namely EPA and DHA, in concentrations of over 30 %, while n-6 concentrations are much lower compared to vegetable oils. The trout diet should contain between 6 % and 14 % of the daily energy requirement from pure fat (Ruxton et al., 2004).

In fish, n-3 fatty acids are present in high concentrations in the phosphoglycerides of cell membranes. In farmed fish, diet has a major influence (McKenzie et al., 2000; Luzar, 2018). The lipid composition of farm fish is more constant than that in wild fish. Farmed fish have a higher fat content than wild fish and are therefore a better source of n-3 fatty acids (Ibrahim Haliloglu et al., 2004). Lipid distribution in fish muscle varies greatly, depending on species, type of muscle and sampling site; in rainbow trout, variations in lipid content were found both in dorsal and ventral part (Testi et al., 2006). Research and development in aquaculture has focused on feed ingredients, as the amount of lipids and fatty acids in the diet is of fundamental importance. However, in wild trout meat, the fatty acid profile varies greatly. It depends on the amount of food consumed, the season, the geographical area and the age of the fish. In farmed trout, there are approximately the same data between fish, which generates a positive response in the market. Farmed fish generally have higher total lipid levels than wild fish, 100 g of farmed fish can provide a higher amount of n-3 PUFAs (especially EPA and DHA) than 100 g of wild fish (Cahu et al., 2004). As farmed fish become an important part of the world's fish supply, it is important to maintain the high lipid nutrient quality of the product and continue to provide customers with large quantities of the n-3 PUFAs.

In Slovenia, rainbow trout or California trout (*Oncorynchus mykiss*) is widely distributed and represents an important freshwater fish from a nutritional and economic point of view. In present study we focused on the fatty acid composition of rainbow trout from selected fish farms and attempted to assess whether individual rainbow trout samples meet the required nutritional parameters, especially in terms of long chain n-3 PUFAs.

Material and Methods

Sampling and sample preparation

Rainbow trout or California trout (*Oncorynchus mykiss*) samples (n=12) were taken from three Slovenian fish farms (Povodje, Zalog and Želimlje), located in the Osrednjeslovenska statistical region, randomly from the pond where they were reared under specific farming conditions. The sampling was carried out between March and April, 2019. Trout samples were slaughtered in water and ice, packed in polystyrene cool boxes and transported to the laboratory where they were processed. The head and tail were removed, and the abdominal cavity was opened along a ventral midline incision. All visceral mass, skin and bones were removed and discarded. To separate both fillets from each carcass, an incision was made along the dorsal fin to the caudal fin and another incision was made behind the opercula, leaving out the lateral and ventral fins. Each fillet was cut along the insertion line of the ribs to obtain one dorsal and one ventral fillet. Two dorsal fillets from each fish were joined together. The same was done with the two ventral fillets. Sampling was done at 6 different locations; 3 on the dorsal and 3 on the ventral parts of the carcass. The samples were homogenized with a Grindomix homogeniser GM 200 (Retsch, Haan, Germany), vacuum packed and stored at a temperature of -20 °C until further analysis.

Fatty acid profile determination

Fatty acid composition of rainbow trout samples was determined according to the method of Park and Goins (1994), modified by Polak et al. (2008) The *in situ* transesterification (ISTE) was used to determine the individual fatty acid in the sample.

The proportion of each fatty acid was determined by gas chromatography on a gas chromatograph (GC) Agilent Technologies 6890, with a flame ionization detector (FID) (Agilent, Califor-

nia, USA). A HP-88 capillary column (100 m x 0.25 mm x 0.2 μm) was used. Separation and detection were carried out under the following conditions: temperature program: 150 ºC (10 min); 2 ºC /min to 180 ºC, 3 ºC /min to 240 ºC (20 min), injector temperature: 250 ºC, detector temperature: 280 ºC, injector: split-splitless: 1:30, injected volume: 1 μL, carrier gas: He 2.3 mL/min, make-up gas: N2 45 mL/min, gas detector: H2 40 mL/min; synthetic air (21 % 0_2) 450 mL/min.

The FAMEs were determined through their retention times in comparison to the relevant standard mixtures using: 37 Components FAME mix (Supelco, Bellefonte, USA); PUFA No. 1-animal source (Supelco, Bellefonte, USA); linoleic acid methyl ester cis/trans isomer Mix (Supelco, Bellefonte, USA); cis-7-octadecenoic methyl ester (Supelco, Bellefonte, USA) and cis-11-octadecenoic methyl ester (Supelco, Bellefonte, USA); methyl stearidonate (Sigma-Aldrich, Schnelldorf, Germany); Nu-Chek standards GLC68D, GLC-85, GLC-411g (Nu-Chek, Minnesota, USA). The GLC-68D and GLC-85 standard mixtures were used to determine the response factor for each FA. The weight of each FA in the feed and fillets was determined using the response factor and the transformation factor of the FA content from the FAME content. The samples of feed and fillets were analyzed in duplicate. The FAMEs were expressed as percentages of the total FA content.

Statistical analysis

In the statistical analysis, the data were analyzed for normal distributions using the UNIVARIATE procedure (SAS/STAT, USA). The differences according to the fish farm or fish fillet part (dorsal, ventral) were analyzed through ANOVA procedure and Duncan test (SAS/STAT), with a 0.05 level of significance. The experiment was performed in three production replications.

Results and Discussion

The fatty acid profile (as a percentage of total fatty acid) of the rainbow trout species is presented in Table 1. The analysis showed that there were significant differences in the fatty acid profile between the rainbow trout samples from all tested fish farms.

The highest total level of SFAs was found in trout fillets from Želimlje fish farm (21.70 %), compared to trout fillets from Zalog (17.49 %) and trout fillets from Povodje (15.39 %). Among SFAs, myristic acid (C14:0), palmitic acid (C16:0) and stearic acid (C18:0) were found most frequently. Palmitic acid was the predominant fatty acid in trout fillets, with significant differences among farms (15.42 % of the total FA for Želimlje, 11.81 % of the total fatty acid for Zalog and 10.06 % of the total fatty acid for Povodje). When we compare the data obtained for total SFA with data from the study of Blanchet et al. (2005), who analyzed the fatty acid composition of farmed rainbow trout, the total SFA content was higher (26.9 %) compared to our results. In the present study, MUFA content in rainbow fillets was higher than SFA content in all three fish farms, which is in agreement with the results of Celik et al. (2008).

The major MUFA was oleic acid (C18:1) and differed significantly between fish farms. Rainbow trout from Povodje showed the highest percentage (40.33 %), followed by Zalog (35.37 %) and the lowest for Želimlje (28.83 %). Various vegetable oils are added to fish feed as a source of energy. The most common is rapeseed oil, which contains erucic acid. The presence of erucic acid (C22:1) in the trout samples studied confirmed its origin from the feed for the farmed specimens (Barbara et al., 2003).

In general, the total content of PUFAs ranged from 36.25 % (Povodje), 38.48 % (Zalog) to 39.21 % of the total FA (Želimlje). Compared to the data of Blanchet et al. (2005), PUFAs content in farmed rainbow trout samples was 40.60 % and in wild trout samples 58.60 %, where the total lipid content was three times higher in farmed trout samples. In contrast, in the study by Renko (2012), the total PUFAs content in farmed European bass fish (*Dicentrarchus labrax*) was 35.00 %, which was higher than wild European bass (26.95 % of total fatty acids). Significant differences in the content of long-chain n-3 and n-6 fatty acids, referred to as PUFAs, were found in our study. The percentage of total n-3 PUFAs tended to be higher in trout samples from Želimlje (20.17 %) than in rainbow trout samples from Povodje (15.29 %) and samples from Zalog (14.80 %), while the content of n-6 PUFAs were highest in trout samples from Zalog (22.84 %) and lowest in trout samples from Želimlje (18.01 %).

Table 1 The fatty acid profile (% of total FA) of rainbow trout according to the fish farm

Fatty acid	Povodje	Zalog	Želimlje	SEM	*P*
			% of total FA		
C8:0	0.09	0.06	0.13	0.09	Ns
C12:0	0.01^{b}	0.04^{a}	Nd	0.02	***
C14:0	1.09^{c}	1.403^{b}	1.54^{a}	0.10	***
C14:1c-5	Nd	0.01^{a}	Nd	0.01	*
C15:0	0.11^{c}	0.14^{b}	0.15^{a}	0.01	***
C15:1c-5	0.10^{b}	0.10^{b}	0.24^{a}	0.05	***
C16:0	10.06^{c}	11.81^{b}	15.42^{a}	0.70	***
C16:1t-9	0.18	0.19	0.19	0.14	Ns
C16:1c-9	1.91^{c}	2.29^{b}	2.53^{a}	0.16	***
C17:0	0.19^{b}	0.22^{a}	0.20^{a}	0.01	**
C17:1t-10	0.09^{b}	0.17^{a}	0.10^{b}	0.05	***
C17:1c-10	0.09^{a}	0.05^{b}	0.09^{a}	0.04	*
C18:0	3.36^{b}	3.36^{b}	3.81^{a}	0.20	***
C18:1t-9	0.01^{b}	0.10^{a}	0.01^{b}	0.02	***
C18:1c-7	0.32^{a}	0.15^{b}	0.30^{a}	0.09	***
C18:1c-9	40.33^{a}	35.37^{b}	28.83^{c}	2.80	***
C18:1c-11	1.32^{b}	2.34^{a}	2.71^{a}	1.08	*
C18:2t-9,12	0.02	0.05	0.07	0.05	Ns
C18:2c-9,12	17.07^{b}	20.11^{a}	15.35^{c}	0.92	***
C18:3c-6,9,12	0.40^{b}	0.63^{a}	0.31^{c}	0.05	***
C18:3c-9,12,15	2.82^{c}	3.78^{a}	3.27^{b}	0.11	***
C20:0	0.28^{a}	0.23^{a}	0.17^{b}	0.07	**
C20:1c-5	0.79^{a}	0.06^{b}	0.07^{b}	0.67	*
C20:1c-8	0.18^{b}	0.67^{a}	0.54^{a}	0.38	*
C20:1c-11	2.05	1.75	2.28	0.59	Ns
C21:0	0.10	0.08	0.09	0.08	Ns
C20:2c-8,11	0.95^{b}	0.83^{c}	1.08^{a}	0.04	***
C20:3c-11,14,17	0.88^{a}	0.77^{b}	0.93^{a}	0.06	***
C20:4c-5,8,11,14	1.29^{a}	1.00^{b}	0.93^{b}	0.21	***
C22:0	0.10	0.12	0.18	0.11	Ns
C20:3c-8,11,14	0.03	0.09	0.08	0.00	Ns
C22:1c-13	0.75^{a}	0.55^{b}	0.88^{a}	0.21	*
C20:5c-5,8,11,14,17	1.92^{b}	2.11^{b}	2.40^{a}	0.39	*
C22:2c-13,16	0.02	0.03	0.04	0.04	Ns
C24:1c-15	0.24^{b}	0.24^{b}	0.32^{a}	0.04	***
C22:5c-7,10,13,16,19	0.95^{a}	$0,54^{b}$	0.83^{a}	0.26	**
C22:6c-4,7,10,13,16,19	9.54^{b}	8.23^{b}	13.52^{a}	2.60	***
SFA	15.39^{c}	17.49^{b}	21.70^{a}	2.55	***
MUFA	48.36^{a}	44.03^{b}	39.10^{c}	2.17	***
PUFA	$36,25^{b}$	38.48^{ab}	39.21^{a}	2.31	**
P/S	2.36^{a}	2.20^{a}	1.81^{b}	0.81	*
n-3	15.29^{b}	14.80^{c}	20.17^{a}	1.77	***
n-6	20.06^{b}	22.84^{a}	18.01^{c}	1.56	***
n-6/n-3	1.31^{a}	1.54^{a}	0.89^{b}	0.22	*
trans	0.03^{b}	0.15^{a}	0.08^{ab}	0.06	**

P value, statistical probability of sample effect; ***P<0.001, statistically very highly significant; **P≤0.01 statistically highly significant; *P≤0.05, statistically significant; Ns, P≥0.05, statistically not significant; Nd, not detected; SEM, standard error of mean; Means with a different superscript within (^{a}, ^{b}, ^{c}) raw differ significantly.

SFAs, saturated fatty acids: C8:0; C12:0; C14:0; C15:0; C16:0; C17:0; C18:0; C20:0; C21:0; C22:0

MUFAs, monounsaturated fatty acids: C14:1c-5; C15:1c-5; C16:1t-9; C16:1c-9; C17:1t-10; C17:1c-10; C18:1t-9; C18:1c-7; C18:1c-9; C18:1c-11; C20:1c-5; C20:1c-8; C20:1c-11; C22:1c-13; C24:1c-15

PUFAs, polyunsaturated fatty acids: C18:2t-9,12; C18:2c-9,12; C18:2c-9,12; C18:3c-6,9,12 (n-6); C18:3c-9,12,15 (n-3); C20:2c-8,11; C20:3c-11,14,17; C20:4c-5,8,11,14 (n-6); C20:3c-8,11,14; C20:5c-5,8,11,14,17 (n-3) (EPA); C22:2c-13,16 (n-6); C22:5c-7,10,13,16,19 (n-3); C22:6c-4,7,10,13,16,19 (n-3) (DHA)

P/S – PUFAs/SFAs ratio

Level the n-3 PUFAs, alpha-linolenic acid (C18:3) should be mentioned, the levels of which differed significantly in trout samples from different fish farms. The highest value was observed in Zalog fish farm (3.78 %), followed by Želimlje (3.27 %) and the lowest value was determined in trout samples from Povodje (2.82 %).

Among the long chain n-3 PUFAs, it is worth mentioning EPA and DHA, which are essential nutrients as they are main components of cell membranes and have an important role in nutrition for human health. EPA and DHA possess extremely beneficial properties for the prevention of human coronary artery disease and are precursors for prostaglandins, leukotrienes, and tromboxanes of n-3 family. Therefore, fish diet is recommended as an important component for human health (Simopoulos, 2002). The percentage of DHA exceeds the percentage of EPA in all studied trout samples, the highest value was observed in Želimlje fish farm (13.52 %), followed by Povodje (9.54 %) and Zalog (8.23 %). Dietary recommendations for EPA and DHA based on cardiovascular risk considerations are between 250 and 500 mg/day for European adults (EFSA, 2012). On average, with consumption of 100 g rainbow trout from our study daily recommendations for EPA and DHA are reached or even exceeded.

About 90 % of total n-6 PUFAs belonged to linoleic acid (C18:2), which is an essential fatty acid and precursor of arachidonic acid with elongation and saturation. This fatty acid is found in vegetable oil, which is present in the diet of farmed fish (Grigorakis et al., 2002). In the present study, trout samples from all three fish farms contained arachidonic acid, which is a precursor for prostaglandins, leukotrienes, and tromboxanes of n-6 family (Gurr, 2000). Arachidonic acid also plays a role in brain, retinal and infant growth. In the study of Blanchet et al. (2005), linoleic acid, alpfa-linolenic acid, and arachidonic acid were higher in farmed trout than in wild trout samples. This could be explained by the use of vegetable oils in fish feed. The n-6/n-3 ratio ranged from 0.89 (Želimlje) to 1.54 (Zalog). Data were comparable with study of Luzar (2018), where the average n-6/n-3 ratio of rainbow trout from Slovenian fish farms was 0.98. All rainbow trout samples tested had the n-6/n-3 within the recommended ratio. Suggested ratio n-6/n-3 (5:1) constitute a healthy human diet (Simopoulos, 2002). Moreover, the P/S ratio was much lower in the trout samples from Želimlje (1.81) due to the abundance of SFAs, especially palmitic acid. The n-6/n-3 is important because n-6 fatty acid derived eicosanoids are more inflammatory than n-3 fatty acid derived eicosanoids (Connor, 2000). As a result, n-3 fatty acids are considered anti-inflammatory because replacing the more inflammatory n-6 fatty acid derived eicosanoids with n-3 fatty acid derived eicosanoids will decrease inflammation.

The fatty acid profile of the dorsal and

Table 2 The fatty acid profile (% of total FA) of dorsal and ventral fillet part of rainbow trout

Fatty acid	dorsal	ventral	SEM	*P*
	% of total FA			
C8:0	0.07	0.12	0.09	Ns
C12:0	0.02	0.02	0.03	Ns
C14:0	1.33	1.35	0.22	Ns
C14:1c-5	Nd	Nd	-	-
C15:0	0.13	0.13	0.02	Ns
C15:1c-5	0.18	0,11	0.08	Ns
C16:0	12.69	11.98	2.39	Ns
C16:1t-9	0.23	0.14	0.13	Ns
C16:1c-9	2.18	2.26	0.29	Ns
C17:0	0.21	0.20	0.02	Ns
C17:1t-10	0.12	0.11	0.06	Ns
C17:1c-10	0.09	0.07	0.04	Ns
C18:0	3.57	3.40	0.29	Ns
C18:1t-9	0.03	0.04	0.05	Ns
C18:1c-7	0.23	0.29	0.12	Ns
C18:1c-9	33.53	35.60	5.50	Ns
C18:1c-11	2.19	2.00	1.22	Ns
C18:2t-9,12	0.04	0.05	0.05	Ns

Table 2 The fatty acid profile (% of total FA) of dorsal and ventral fillet part of rainbow trout

Fatty acid	dorsal	ventral	SEM	*P*
	% of total FA			
C18:3c-6,9,12	0.42	0,45	0.14	Ns
C18:3c-9,12,15	3.21	3.29	0.40	Ns
C20:0	0.22	0.23	0.08	Ns
C20:1c-8	0.36	0.55	0.42	Ns
C20:1c-11	2.05	1.99	0.62	Ns
C20:1c-5	0.16	0.47	0.73	Ns
C21:0	0.06[b]	0.11[a]	0.07	*
C20:2c-8,11	0.93	0.97	0.11	Ns
C20:3c-11,14,17	0.87	0.84	0.09	Ns
C20:4c-5,8,11,14	1.17[a]	0.95[b]	0.23	**
C22:0	0.09[b]	0.18[a]	0.10	*
C20:3c-8,11,14	0.05	0.08	0.06	Ns
C22:1c-13	0.73	0,73	0.25	Ns
C20:5c-5,8,11,14,17	2.32[a]	1.91[b]	0.38	**
C22:2c-13,16	0.02	0.04	0.04	Ns
C24:1c-15	0.27	0.26	0.06	Ns
C22:5c-7,10,13,16,19	0.82	0.73	0.31	Ns
C22:6c-4,7,10,13,16,19	11.54[a]	9.22[b]	3.29	*
SFA	18.39	17.71	2.11	Ns
MUFA	42.35	44.63	1.98	Ns
PUFA	39.26[a]	37.66[b]	1.87	*
P/S	2.13	2.13	0.74	Ns
n-3	17.98[a]	15.30[b]	1.44	*
n-6	19.78	20.35	1.24	Ns
n-6/n-3	1.10[b]	1.33[a]	0.12	*
trans	0.08	0.09	0.05	Ns

P value, statistical probability of sample effect; ***P<0.001, statistically very highly significant; **P≤0.01 statistically highly significant; *P≤0.05, statistically significant; Ns, P≥0.05, statistically not significant; Nd, not detected; SEM, standard error of mean; Means with a different superscript within (a, b, c) raw differ significantly.
SFAs, saturated fatty acids: C8:0; C12:0; C14:0; C15:0; C16:0; C17:0; C18:0; C20:0; C21:0; C22:0
MUFAs, monounsaturated fatty acids: C14:1c-5; C15:1c-5; C16:1t-9; C16:1c-9; C17:1t-10; C17:1c-10; C18:1t-9; C18:1c-7; C18:1c-9; C18:1c-11; C20:1c-5; C20:1c-8; C20:1c-11; C22:1c-13; C24:1c-15
PUFAs, polyunsaturated fatty acids: C18:2t-9,12; C18:2c-9,12; C18:2c-9,12; C18:3c-6,9,12 (n-6); C18:3c-9,12,15 (n-3); C20:2c-8,11; C20:3c-11,14,17; C20:4c-5,8,11,14 (n-6); C20:3c-8,11,14; C20:5c-5,8,11,14,17 (n-3) (EPA); C22:2c-13,16 (n-6); C22:5c-7,10,13,16,19 (n-3); C22:6c-4,7,10,13,16,19 (n-3) (DHA)
P/S – PUFAs/SFAs ratio

ventral fillet parts of rainbow trout was focused on, with particular attention to some differences in nutritional quality. From the results in Table 2, it could be seen that the content of most fatty acids were similar for both dorsal and ventral part of fish fillet. Statistical differences were observed in PUFAs, especially for arachidonic acid (1.17 % in dorsal vs 0.95 % in ventral part), EPA (2.32 % in dorsal vs 1.91 % in ventral part) and DHA (11.54 % in dorsal vs 9.22 % in ventral part). Similar results were obtained in the study of Testi et al. (2006), who determined statistical differences between dorsal and ventral fillet part of rainbow trout for total PUFAs and MUFAs content.

Conclusion

Despite significant differences in the fatty acid profile of rainbow trout samples between farms, the results showed that consumption of all rainbow trout tested provided high levels of beneficial long-chain n-3 PUFAs, especially in terms of cardiovascular disease prevention. Considering the data from our recent research (Luzar, 2018), where the total fat content of farmed rainbow trout was determined (2.52 g/100g), the recommended daily intake of EPA + DHA is achieved with the consumption of 100 g of rainbow trout meat. The data obtained are important for our country, where farmed fish raised in appropriate conditions represent a large part of nutritionally desirable fatty acids.

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Profil masnih kiselina kalifornijske pastrve iz uzgajališta u Sloveniji

Sažetak

Navedeno istraživanje je provedeno s ciljem utvrđivanja profila masnih kiselina kalifornijske pastrve (*Oncorhynchus mykiss*) iz tri slovenska riblja uzgajališta: Zalog, Želimlje i Povodje. Sastav masnih kiselina je utvrđen na plinskom kromatografu s plameno-ionizacijskim detektorom (GC-FID). Rezultati su pokazali da uvjeti uzgoja imaju značajan utjecaj na sastav masnih kiselina kalifornijske pastrve. Dominantna zasićena masna kiselina (SFA) bila je palmitinska kiselina, oleinska kiselina je bila glavna mononezasićena masna kiselina (MUFA), dok su eikosapentaenoična kiselina (EPA) i dokosaheksaenoična kiselina (DHA) bile glavne dugolančane n-3 polinezasićene masne kiseline (n-3 PUFA). Postotak DHA je premašio postotak EPA u svim proučavanim uzorcima kalifornijske pastrve. Omjer n-6/n-3 se kretao u rasponu od 0.89 do 1.54, a PUFA/SFA omjer je bio između 1.81 i 2.36. U dorzalnim i ventralnim dijelovima fileta sastav većine masnih kiselina bio je sličan, iznimke su zamijećene za određene polinezasićene masne kiseline, i to arahidonsku kiselinu, EPA i DHA.

Ključne riječi: uzgojena riba, kalifornijska pastrva, profil masnih kiselina, dugolančane n-3 polinezasićene masne kiseline

Fettsäureprofil der Regenbogenforellen aus Fischfarmen in Slowenien

Zusammenfassung

Die vorliegende Studie wurde durchgeführt, um das Fettsäureprofil von Regenbogenforellen (*Oncorynchus mykiss*) aus drei slowenischen Fischfarmen zu bestimmen: Zalog, Želimlje und Povodje. Die Fettsäurezusammensetzung wurde anhand eines Gaschromatographs mit Flammenionisationsdetektor (GC FID) bestimmt. Die Ergebnisse zeigten, dass die Zuchtbedingungen einen signifikanten Einfluss auf die Fettsäurezusammensetzung der Regenbogenforelle haben. Die vorherrschende gesättigte Fettsäure (SFA) war die Palmitinsäure; die Ölsäure war die wichtigste einfach ungesättigte Fettsäure (MUFA), während die Eicosapentaensäure (EPA) und die Docosahexaensäure (DHA) die wichtigsten langkettigen n-3 mehrfach ungesättigten Fettsäuren (n-3 PUFA) waren. Der prozentuale Anteil von DHA überstieg den von EPA in allen untersuchten Regenbogenforellenproben. Das n-6/n-3-Verhältnis reichte von 0,89 bis 1,54 und das PUFA/SFA-Verhältnis lag zwischen 1,81 und 2,36. In dorsalen und ventralen Filetteilen war der Gehalt der meisten Fettsäuren ähnlich, Ausnahmen wurden für einige mehrfach ungesättigte Fettsäuren beobachtet: Arachidonsäure, EPA und DHA.

Schlüsselwörter: Zuchtfisch, Regenbogenforelle, Fettsäureprofil, langkettige n-3 mehrfach ungesättigte Fettsäuren

El perfil de ácidos grasos de trucha arco iris cultivada en Eslovenia

Resumen

Este estudio fue realizado para determinar el perfil de ácidos grasos de la trucha arco iris (*Oncorhynchus mykiss*) de tres piscifactorías eslovenas: Zalog, Želimlje y Povodje. La composición de ácidos grasos fue determinada en en un cromatógrafo de gases con detector de ionización de llama (GC-FID). Los resultados mostraron que las piscifactorías tienen un impacto significativo en la composición de ácidos grasos de la trucha arco iris. El ácido graso saturado dominante (SFA) fue el ácido palmítico, el ácido oleico fue el principal ácido graso monoinsaturado (MUFA), mientras que el ácido eicosapentaenoico (EPA) y el ácido docosahexaenoico (DHA) fueron los principales ácidos grasos poliinsaturados n-3 de cadena larga (n-3 PUFA). El porcentaje de DHA excedió el porcentaje de EPA en todas las muestras de truchas arco iris estudiadas. La relación n-6 / n-3 osciló entre 0,89 y 1,54, y la relación PUFA / SFA estuvo entre 1,81 y 2,36. En las partes dorsal y ventral del filete la composición de la mayoría de los ácidos grasos fue similar, se observaron excepciones para ciertos PUFA: el ácido araquidónico, el EPA y el DHA.

Palabras claves: pescado de piscifactoría, trucha arco iris, perfil de ácidos grasos, ácidos grasos poliinsaturados n-3 de cadena larga

Il profilo degli acidi grassi della trota iridea allevata nei vivai ittici sloveni

Riassunto

La citata ricerca è stata condotta con lo scopo di accertare il profilo degli acidi grassi della trota iridea (*Oncorhynchus mykiss*) allevata in tre vivai ittici sloveni: Zalog, Želimlje e Povodje. La composizione degli acidi grassi è stata accertata mediante gascromatografia con rivelatore a ionizzazione di fiamma (GC-FID). I risultati hanno dimostrato che le condizioni d'allevamento esercitano un forte impatto sulla composizione degli acidi grassi trota iridea (detta anche trota arcobaleno o salmonata). L'acido palmitico è risultato l'acido grasso saturo dominante (SFA), l'acido oleico il principale acido monoinsaturo (MUFA), mentre l'acido eicosapentaenoico (EPA) e l'acido docosaesaenoico (DHA) sono risultati i principali acidi grassi polinsaturi omega-3 a catena lunga (n-3 PUFA). La percentuale di DHA ha superato quella dell'EPA in tutti i campioni di trota iridea esaminati. Per quanto riguarda il rapporto n-6/n-3, sono stati registrati valori oscillanti tra 0.89 e 1.54, mentre il rapporto PUFA/SFA ha fatto registrare valori compresi tra 1.81 e 2.36. Nelle parti dorsali e ventrali dei filetti, la composizione della maggior parte degli acidi grassi è risultata simile, con alcune eccezioni riguardo a determinati acidi grassi polinsaturi, quali l'acido arachidonico, l'EPA e il DHA.

Parole chiave: pesce d'allevamento, trota iridea, profilo degli acidi grassi, acidi grassi polinsaturi omega-3 a catena lunga