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IMPACT OF DIET ON THE FATTY ACIDS PROFILE OF EUROPEAN CATFISH (*SILURUS GLANIS* L.)

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ABSTRACT. The aim of this study was to determine the impact of diet on the fatty acids profile in European catfish meat. The study material was comprised of fish reared in earthen ponds and fed with natural food and fish fed intensively with artificial feed in a recirculating system. The quality of the fatty acids profile in the meat of the two groups differed. A total of twenty-eight acids were identified in the catfish reared on natural food. The fish fed artificial feed contained an additional two acids – 22:1n-9 and 16:4, which were also detected in the artificial feed. The combined total share of saturated acids, MUFA, and PUFA was similar. However, the share of most of the fatty acids from these groups, including total PUFA n-6 and n-3 and HUFA n-3 and n-6, differed significantly. The catfish fed on artificial feed contained more n-3 acids and fewer n-6 acids. Above all, this was caused by the greater share of 20:5n-3 (eicosapentaenoic, EPA), 22:6n-3 (docosahexaenoic, DHA), and 20:3n-3 and 20:4n-3 acids and the lesser share of 18:3n-3 (α-linolenic, ALA) acid. The meat of the fish from this group also contained fewer 20:4n-6 (arachidonic, AA), 20:3n-6, and 22:5n-6 acids. Additionally, the n-3/n-6 acid ratio was significantly different at 2.31 (pond culture) and 3.93 (intensive culture on artificial feed).

Key words: EUROPEAN CATFISH (*SILURUS GLANIS*), FATTY ACIDS, INTENSIVE CULTURE

INTRODUCTION

The economic significance of predatory fish, including the European catfish, *Silurus glanis* L., has increased in recent years. The culture of this species in earthen ponds (Wiśniewolski 1989, Mareš et al. 1995), ponds (Müller and Varadi 1980, Filipiak et al. 1997) and closed recirculating systems (Ulikowski et al. 1998, Linhart et al. 2002) is becoming increasingly common. Catfish cultivation in the latter system is the subject of intense study being conducted in many European countries. The aim is to develop a complex method of cultivating this species through artificial reproduction and larva and juvenile rearing. Effective artificial reproduction methods have already been developed,

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including out-of-season spawning (Kouril and Hamackova 1982, Epler and Bieniarz 1989, Babiak et al. 1996, Linhart et al. 1997, Brzuska and Adamek 1999, Brzuska 2001, Ulikowski 2003b). Methods for rearing larvae and juvenile stages exclusively on artificial feed (trout granulate) have also been developed (Ulikowski and Borkowska 1999).

Increased interest in breeding and rearing catfish stems from, among other factors, its rapid growth rate and highly effective utilization of feed (Heymann 1990, Ulikowski and Borkowska 1999). It is also worth noting that during intense fattening of catfish on artificial feed, individuals with a unit weight of over 1 kg can be obtained after just ten (Heymann 1990), and even, as Ulikowski (2003a) reports, seven months of cultivation. The catfish species is recommended as a component in polyculture with carp, *Cyprinus carpio* L., tench, *Tinca tinca* (L.), and herbivorous fish (Harsanyi 1987, Wiśniewolski 1989, Duda 1994). Recent research (Ulikowski et al. 2003) indicated that the values of zootechnical parameters such as growth rate and feed utilization effectiveness obtained by European catfish cultivated in polyculture were more advantageous than those in monoculture.

In comparison with other catfish species under intensive cultivation, the European catfish has better sensory properties (Manthey et al. 1988). They also exhibit a decidedly lower incidence of cannibalism, which has a significant impact on the economic results of its cultivation (Pruszyński and Pistelok 1999). The chemical composition of the meat of fish under intensive cultivation and fed only artificial feed can differ from that of the meat of fish from natural conditions. These differences are primarily in the fat contents and the fatty acids profile (Jobling 2001). It is know that fish, and especially the content of fatty acids, is a very significant component of the human diet. Therefore, determining the impact that artificial feed has on fish body composition is exceedingly important.

The aim of the present study was to determine the impact of feed (natural and artificial feed) on the fatty acids profile of the meat of the European catfish.

MATERIALS AND METHODS

The study material was comprised of European catfish cultivated in earthen ponds on natural feed and fish from intensive culture in a recirculating system and fed on artificial feed. The pond specimens came from the Fisheries Facility in Samoklęski in southeastern Poland. The fish were 2.5 years old and had been cultivated in a polyculture with carp and tench. During the first year of rearing, the catfish larvae, which had been obtained through artificial spawning, were stocked in ponds

with carp fry. Next, the juveniles were fished out in the fall and relocated to growing-out ponds, where they were kept for the following two growth seasons.

The fish fattened on artificial feed were obtained from the Dgał Experimental Hatchery of the Inland Fisheries Institute in Olsztyn. The 1.5 year-old specimens were the product of artificial spawning and intensive culture on artificial feed exclusively (Ulikowski 2003a). The larvae and juvenile stages were reared in tanks with a volume of 1 m^3 that were part of a recirculating system. The fish were fed Nutra Classic trout granulate by Trouvit, France. In the last two months of fattening Nutra Classic T-3P with a 5 mm granulate size was applied (chemical composition: 43% protein; 18% fat; 21.3% carbohydrates; 8% ash). The feed was delivered by an automatic feeder 24 hours per day. The stock density during the last two months was 30-60 kg m^{-3}.

Water samples were taken from the system every two to three days during rearing to determine the contents of total ammonia nitrogen N-NH_4 and nitrite nitrogen N-NO_2. The concentration of ammonia was 0.1-0.8 mg dm^{-3}, and of nitrite 0.02-0.35 mg dm^{-3}. The temperature and oxygen concentration at the tank outlet were measured daily with an OxyGuard electronic device. Water oxygen saturation at the outflow remained above 40%, and the water temperature was 25 ± 2°C.

Ten catfish each from the pond culture and the recirculating system were caught in mid November. The total length (Lt ± 1mm) and weight (BW ± 0.1g) were measured. The fish were filleted and the filets were weighed. The right fillet was passed through a sieve with 3-mm mesh, then the fat contents and lipid profile were determined.

DETERMINING THE FAT CONTENTS AND FATTY ACIDS PROFILE

The Soxhlet method was used to determine the fat contents with petroleum benzine as the solvent (AOAC 1975). The quantitative and qualitative analyses of the fatty acids was conducted after the tissue lipids had been cold extracted according to Folch et al. (1957). The fatty acids were methylated with a mixture of chloroform : metanol : sulfuic acid (100:100:1) (Peisker 1964). Chromatographic separation was done with an Agilent Technologies 6890 N gas chromatograph, with a flame-ionizing detector (FID) and a 30 m capillary column with an internal diameter of 0.32 mm. Liquid phase Supelcowax 10, film thickness 0.25 µm. Separation conditions: carrier gas – helium; flow rate 1 ml min^{-1}. Temperatures – detector 250°C, injector 225°C, columns 180°C. The detector signal was registered with a Philips device on a scale of 1mV at a tape speed of 10 mm min^{-1}. The various acids were identified by comparing the retention times with standards from Supelco (Bellefonte, PA, USA).

STATISTICAL ANALYSES

The results are presented at the mean ± S.E.M. (standard error mean). Significant differences ($P < 0.01$) were calculated using one factor analysis of variance (ANOVA), with the SNK (Student-Newman-Keuls) test. The calculations were done with Statistica 6.0 PL.

RESULTS AND DISCUSSION

The catfish fed natural feed in pond culture and those from intensive fattening on artificial feed did not differ with respect to total length, which was 59.9 and 58.2 cm, respectively, or weight, which ranged from 1341.1 to 1189.4 g, respectively. The weight of the fillets obtained from both groups was also similar (Table 1).

TABLE 1

Characteristics of European catfish fed natural feed (reared in ponds) or artificial feed (fattened in a recirculating system) (mean ± S.E.M.)

Parameter	Catfish – natural feed	Catfish – artificial feed
Total length (cm)	59.9 ± 0.43 [a]	58.2 ± 0.56 [a]
Body weight (g)	1341.1 ± 45.86 [a]	1189.4 ± 36.58 [a]
Fillet weight (g)	573.9 ± 21.75 [a]	536.6 ± 16.65 [a]

Values in the same row with different letters differ significantly statistically at $P < 0.01$

The fat content of the fillets obtained from the catfish reared in the ponds compared to that of the catfish from intensive cultivation differed (Table 2). Feeding the catfish with commercial feed that contained 18% fat caused a significant increase of 1.09% in the meat content of this component as compared to that of the fish raised on natural feed.

The fatty acids profile of the fillets of both groups studied are presented in Table 2. Twenty-eight fatty acids were identified in the meat of catfish reared traditionally, while two additional acids were found in the meat of the catfish fed granulated feed. The combined value of saturated fatty acids, which was similar for the traditionally and intensively raised catfish, was 25.41 and 26.36%, respectively. The amount of the dominating 16:0 (palmitic) acid in this group was similar at 15.89 and 16.32%, respectively. The amount of 20:0 acid (arachic) was also similar. However, the catfish from traditional cultivation contained less 14:0 acid (mirystic), which was compensated for by higher values of 18:0 (stearic) and 15:0 acids.

TABLE 2

Fatty acids profile of the meat of European catfish fed natural feed (reared in ponds) or artificial feed (fattened in a recirculating system) (% of the total fatty acids) (mean ± S.E.M.)

Fatty acids	Catfish – natural feed	Catfish – artificial feed
14:0	2.44 ± 0.31 [a]	5.75 ± 0.03 [b]
15:0	0.96 ± 0.13 [a]	0.51 ± 0.10 [b]
16:0	15.89 ± 0.49 [a]	16.32 ± 0.13 [a]
18:0	5.85 ± 0.21 [a]	3.56 ± 0.05 [b]
20:0	0.25 ± 0.01 [a]	0.20 ± 0.02 [a]
Σ saturated acids	25.41 ± 0.33 [a]	26.36 ± 0.16 [a]
14:1	0.65 ± 0.11 [a]	0.26 ± 0.10 [b]
16:1	10.38 ± 0.70 [a]	6.94 ± 0.04 [b]
17:1	1.22 ± 0.15 [a]	0.84 ± 0.01 [b]
18:1cis9	19.69 ± 2.40 [a]	13.11 ± 0.24 [b]
18:1cis11	5.62 ± 0.36 [a]	3.32 ± 0.04 [b]
20:1n-9	1.91 ± 0.16 [a]	7.23 ± 0.16 [b]
20:1n-7	0.27 ± 0.03 [a]	0.33 ± 0.03 [a]
22:1n-11	0.12 ± 0.01 [a]	5.04 ± 0.18 [b]
22:1n-9	-	0.75 ± 0.02
Σ monounsaturated acids	39.86 ± 1.37 [a]	37.82 ± 0.29 [a]
16:4	-	0.49 ± 0.01
18:2n-6	5.31 ± 1.12 [a]	5.37 ± 0.06 [a]
18:3n-4	0.54 ± 0.08 [a]	0.33 ± 0.01 [b]
18:3n-3	4.07 ± 0.52 [a]	1.14 ± 0.01 [b]
18:4	0.65 ± 0.10 [a]	1.78 ± 0.04 [b]
20:2	0.51 ± 0.09 [a]	0.43 ± 0.02 [a]
20:3n-6	0.64 ± 0.08 [a]	0.20 ± 0.07 [b]
20:4n-6	3.14 ± 0.11 [a]	0.67 ± 0.02 [b]
20:3n-3	0.59 ± 0.07 [a]	0.15 ± 0.05 [b]
20:4n-3	1.17 ± 0.18 [a]	1.03 ± 0.02 [b]
20:5n-3	4.46 ± 0.62 [a]	7.67 ± 0.10 [b]
21:5	0.24 ± 0.02 [a]	0.46 ± 0.01 [a]
22:5n-6	0.82 ± 0.05 [a]	0.32 ± 0.01 [b]
22:5n-3	2.65 ± 0.27 [a]	2.23 ± 0.04 [a]
22:6n-3	9.94 ± 0.92 [a]	13.53 ± 0.17 [b]
Σ polyunsaturated acids	34.73 ± 1.59 [a]	35.82 ± 0.26 [a]
Σ unsaturated acids	74.59 ± 0.33 [a]	73.64 ± 0.16 [a]
Fats	2.33 ± 0.24 [a]	3.42 ± 0.14 [b]

Values in the same row with different superscripts differ significantly statistically at $P < 0.01$

The unsaturated acids were the largest group in both number and percentage. The total amount of these acids was similar in the catfish from traditional (74.59%) and intensive (73.64%) cultivation. The total content of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) acids in the meat of the fish from the two groups did not differ significantly at 39.86 and 34.73% (traditional cultivation) and 37.82 and 35.82% (intensive cultivation).

Although there was no difference in the total content of the acid groups, the level of the majority of fatty acids differed significantly in the catfish meat. Higher amounts of the following MUFA acids were determined in the meat of catfish from traditional culture than those in the meat of fish from intensive culture: 14:1 (mirystic); 16:1 (palmitic); 17:1 (margaroleic); 18:1cis9 (oleic); 18:1cis11. The amounts of the following acids were lower: 20:1n-9 (gadoleic); 22:1n-11 (cetoleic). Only the share of 20:1n-7 acid did not differ significantly. Of the acids in this group, 18:1cis9 occurred in the largest amounts; 19.69% in the meat of catfish from traditional culture and 13.11% in intensive culture. The 16:1 acid comprised 10.38% (traditional culture) and 6.94% (intensive culture), while the 18:1cis11 acid comprised 5.62 and 3.32%, respectively. Large differences were also determined in the contents of the 20:1n-9 and 22:1n-11 acids, which occurred in relatively small amounts in the catfish cultivated on natural food.

The 22:1n-11 and 20:1n-9 acids occur in the fish used to manufacture the fish meals and oils used in feeds (Gruger 1967). The percentage of these acids in the feed fed to the catfish was high at 8.20% (22:1n-11) and 7.36% (20:1n-9). This caused a very significant increase in their values in the meat, which was compensated for by the amounts of 16:1 and 18:1cis9 acids (Table 3).

TABLE 3

Fatty acids profile of artificial feed (trout granulate) (% of the total fatty acids) (mean ± S.E.M.)

Fatty acid	Percentage	Fatty acid	Percentage
14:0	6.71	16:4	0.95
15:0	0.53	18:2n-6	5.43
16:0	16.39	18:3n-4	-
18:0	2.88	18:3n-3	1.29
20:0	0.24	18:4	2.96
Σ saturated acids	26.75	20:2	0.23
14:1	0.29	20:3n-6	0.11
16:1	6.96	20:4n-6	0.52
17:1	0.91	20:3n-3	-
18:1cis9	10.61	20:4n-3	0.61
18:1cis11	2.59	20:5n-3	9.99
20:1n-9	7.36	21:5	-
20:1n-7	0.38	22:5n-6	0.25
22:1n-11	8.20	22:5n-3	1.15
22:1n-9	0.93	22:6n-3	11.53
Σ monounsaturated acids	38.23	Σ polyunsaturated acids	35.02
		Σ unsaturated acids	73.25
		Fats	18.00

Additionally, two MUFAs – 22:1n-9 (erucic) and 16:4, occurred in very small amounts of less than 1% only in the catfish fed artificial feed. This indicates that the source of them was the feed that contained 0.93% 22:1 n-9 acid and 0.95% 16:4 acid, *i.e.*, amounts that were equal to those detected in the meat of catfish (Tables 2 and 3). The 22:1n-9 acid is an ingredient of rapeseed oil used often in commercial feeds manufactured for fish and is also determined in their meat (Lovell 1991).

The comparison of the various polyunsaturated acids from the n-3 family revealed a significant difference between the two groups of fish with regard to the following acids: 18:3n-3 (α-linolenic, ALA); 20:3n-3, 20:4n-3 (eicosatetraenoic); 20:5n-3 (eicosapentaenoic, EPA); 22:6n-3 (docosahexaenoic, DHA). Only the level of the 22:5n-3 acid (docosapentaenoic, DPA) was similar in the two groups.

The percentage of DHA, which occurred in the highest amounts, was lower in the meat of catfish from traditional culture at 9.94%, than from intensive culture at 13.53%. Similarly, the amount of EPA in catfish from traditional culture was lower (4.46% versus 7.67%), but the ALA was higher (4.07% versus 1.14%). The meat of catfish from pond culture was also characterized by a higher share of 20:3n-3 and 20:4n-3 acids.

A significant difference was also determined in three of the four n-6 acids identified. Higher levels of the 20:4n-6 (arachidonic, AA), 20:3n-6, and 22:5n-6 (docosapentaenoic) acids were determined in the meat of catfish from pond culture. The content of the acid 20:4n-6 was the most highly differentiated at 3.14% in catfish from pond culture and 0.67% from intensive culture. The level of 18:2n-6 (linoleic, LA) acid in the meat of catfish cultivated under various conditions was very similar.

The differences in the levels of various polyunsaturated fatty acids belonging to the n-3 and n-6 families meant that the combined total level of the acids from these two groups differed. The meat of catfish from intensive culture had higher levels of n-3 acids and lowered n-6 acid levels in comparison with the catfish from pond culture. The meat of the fish fed artificial feed had higher levels of highly unsaturated fatty acids (HUFA) and lower levels of HUFA n-6. As a consequence, the ratio of n-3/n-6 acids was significantly different at 2.31 (traditional culture) and 3.93 (intensive culture) (Table 4).

TABLE 4

Content of n-3 and n-6 fatty acids in the meat of European catfish fed natural (reared in ponds) or artificial feed (fattened in a recirculating system) (% of the total fatty acids) (mean ± S.E.M.)

Parameter	Catfish – natural feed	Catfish – artificial feed
Σ n-3 acids	22.88 ± 2.52 [a]	25.75 ± 0.27 [b]
Σ kw n-6 acids	9.91 ± 1.16 [a]	6.56 ± 0.06 [b]
n-3/n-6	2.31 ± 0.38 [a]	3.93 ± 0.06 [b]
Σ HUFA n-3	18.22 ± 0.74 [a]	24.46 ± 0.21 [b]
Σ HUFA n-6	3.96 ± 0.08 [a]	0.99 ± 0.02 [b]

Values in the same row with different superscripts differ significantly statistically at $P < 0.01$

Differences in the composition of fatty acids in fish cultivated under various conditions are largely the result of the different feeds applied. In the case of catfish, it occurred that the feed type had no impact on the combined share of saturated, unsaturated, MUFA or PUFA acids. The proportion between these groups of acids in the fish fed natural and artificial feed was similar, although the share of the majority of the fatty acids within each group differed. Significant differences were identified in the combined levels of PUFAn-3 and n-6; the higher share of n-3 acids in the catfish fed artificial feed was compensated for by the lower share of n-6 acids.

The catfish is a predatory fish, and the share of fish in the food composition of adult specimens reaches 80% (Bryliński and Chybowski 2000). Just as in other predatory fish, this food produces high levels of n-3 polyunsaturated fatty acids in the meat (Steffens 1997, Hunter and Roberts 2000, Kołakowska et al. 2000). According to Bieniarz et al. (2000), the meat of catfish from the inland waters of Poland cultivated in a polyculture with carp has 21.85% PUFA n-3, and the n-3/n-6 ratio is 2.39. The results from fish cultivated on natural food obtained in the current study are similar to those of the Bieniarz et al. (2000) study.

Replacing natural feed with granulated feed caused a significant shift in the contents of the fatty acids from the n-3 family. Feeding the fish trout granulate (24.56% n-3 acids) caused an overall increase in n-3 and HUFAn-3 acids, including EPA and DHA, in comparison with the fish from traditional culture (Table 3). Similarly to Fullner and Wirth (1996), the comparison of three-year-old European catfish fed trout granulate or zooplankton for one year, and then only fish for the next two years, the former had higher values of n-3 fatty acids. Shirai et al. (2002) also reported that the contents of DHA in the dorsal meat fillets from Japanese catfish, *Silurus asotus* L., depended on the feed content and confirmed the possibility of increasing the amount

of DHA in the meat by applying feed enriched with this acid. However, according to Bogut et al. (2002), supplementing granulated feed that European catfish were fed with the 18:3n-3 acid caused an increase in the value of the n-3/n-6 coefficient in the meat, which resulted from an increase in the levels of n-3 acids such as EPA and DHA.

The results of the current study also indicated that the contents of ALA in the feed and the catfish meat was similar, while the amount of EPA acid in the meat was lower, and the DPA and DHA acids were higher than in the feed. The n-3 polyunsaturated fatty acids cannot be synthesized *de novo*, but its primary form with a shorter chain, which is delivered with the fish food, might undergo bioconversion into a more unsaturated long chained derivative (Henderson 1996). This process has been demonstrated in fish such as the white seabream, *Diplodus sargus* (L.), Atlantic salmon, *Salmo salar* L., rainbow trout, *Oncorhynchus mykiss* (Wal.), and Northern pike, *Esox lucius* L., (Cejas et al. 2004, Rollin et al. 2003, Buzzi et al. 1996, 1997). The comparison of feed with catfish meat indicates that the shorter-chained acid (C18n-3) did not undergo transformation; however, EPA acid transformed into a longer-chained acid with more unsaturated bonds, i.e., DPA and DHA (although, within a fairly narrow range).

Changes in the share of the n-6 family of acids and HUFAn-6, elicited by replacing natural catfish food with artificial feed, resulted primarily from the lower levels of the 20:4n-6 acid. In addition to its content in the food, the share of fatty acids in meat can be influenced by the transformation process of n-6 acids with short chains into long chained derivatives. It was determined, however, that the amount of 18:2n-6 as well as 20:4n-6 acids in the artificial feed and meat was similar. This indicates that the bioconversion of the acids from this family did not occur. This might be due to the fact that the elongation and desaturation of n-6 acids is effective only when the fish diet is poor in PUFAn-3 or when there is competition between n-3 and n-6 acids over the desaturation enzyme (Henderson 1996). Presumably, as a result of this, the meat of catfish cultivated on artificial feed, with a low content of AA acid, differed from the catfish fed natural food with respect to this acid. A similar dependence was also determined for pikeperch, *Sander lucioperca* (L.); it indicated that the meat of wild pikeperch (originating from a lake) contained more AA acid that that of cultivated fish (fed artificial feed). This was due to the higher levels of this acid in natural food and the fact that 18n-6 acid was not transformed into its long chained derivative (Jankowska et al. 2003). Based on the example of European perch, *Perca fluviatilis* L., Xu et al. (2001) demonstrated that the relatively low conversion of n-6 acids with

shorter chains in comparison with the effective conversion of n-3 acids might indicate the effect of competition on the metabolic process of the n-3 and n-6 acids.

CONCLUSIONS

1. Substituting natural feed with artificial feed had an impact on the quality of the fatty acids content of the meat of European catfish.
2. Feeding the catfish artificial feed did not change the combined share of saturated, unsaturated, and mono- and polyunsaturated acids that is characteristic for the meat of this species when cultivated on natural feed.
3. The feed caused differences in the percentage of most of the fatty acids as well as on the total amount of n-3 and n-6 w acids in catfish meat.
4. The higher amounts of n-3 acids, characteristic for the meat of catfish cultivated on artificial feed, was caused by the long chain highly unsaturated EPA and DHA acids.

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STRESZCZENIE

WPŁYW POKARMU NA PROFILE KWASÓW TŁUSZCZOWYCH SUMA EUROPEJSKIEGO (*SILURUS GLANIS* L.)

Celem badań było porównanie profilu kwasów tłuszczowych mięsa suma europejskiego chowanego na pokarmie naturalnym i paszy sztucznej. Ustalono, że mięso obu grup sumów różniło się jakościowym składem kwasów tłuszczowych i udziałem większości z nich. W mięsie suma z chowu tradycyjnego stwierdzono obecność dodatkowych dwóch kwasów, występujących w ilości poniżej 1%, pochodzących z paszy (tab. 2 i 3). Badane ryby cechowała zbliżona łączna zawartość kwasów nasyconych, nienasyconych w tym mono- i polienowych oraz zróżnicowany poziom kwasów n-3 oraz n-6 (tab. 2). Porównując łączną zawartość kwasów polienowych rodziny n-3 stwierdzono, że mięso suma chowanego na paszy sztucznej posiadało ich więcej, natomiast zawierało ono mniej kwasów rodziny n-6. Istotne różnice pomiędzy obiema grupami ryb stwierdzono w przypadku kwasów; 18:3n-3 (α-linolenowy, ALA), 20:3n-3, 20:4n-3 (eikozatetraenowy), 20:5n-3 (eikozapentaenowy, EPA), 22:6n-3 (dokozaheksaenowy, DHA) oraz 20:4n-6 (arachidonowy, AA), 20:3n-6, i 22:5n-6 (dokozapentaenowy). Charakterystyczny dla ryb żywionych paszą sztuczną był też wyższy poziom wysokonienasyconych kwasów tłuszczowych (HUFA) n-3 i niższa zawartość HUFA n-6 (tab. 4).