Dietary Effect on ω3 Fatty Acid Contents in Hybrid Striped Bass

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Hybrid striped bass, a cross of female striped bass and male white bass, were divided into two groups. One group was fed 38% protein trout feed (TF), and the other group was fed 30% protein catfish feed (CF). The dietary effect on polyunsaturated fatty acid contents in the bass was studied. The body weight of bass fed TF and CF averaged 727.46 and 379.92 g, respectively. The crude fat content in the TF group was 11.75 g, and it was 6.00 g in the CF group. Gas–liquid chromatographic analysis indicated that the bass fed TF contained higher amounts of eicosapentaenoic acid and docosahexaenoic acid than the bass fed CF. This study confirmed that fish diets greatly influence the fatty acid composition in fish tissue.

KEY WORDS: Catfish feed, DHA, EPA, fatty acid, hybrid striped bass, trout feed.

Increased interest in nutrition and diet in relation to health has led consumers to change their eating habits and to perceive fish to be a wise alternative food. There is currently an increasing demand for seafood in American diets. The per capita fish consumption in the United States shifted from 5.36 kg in 1970 to 6.58 kg in 1985, and could reach to 9.1 kg during the year 2000 (1). The increased consumption largely stems from the information that eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), found only in fish and other marine animals, play important roles in preventing coronary heart disease. These two ω3 fatty acids are also known to have a protective effect against rheumatoid arthritis and cancer at certain sites (2–5).

Aquaculture production is a way to meet the growing demand for seafood. Total United States aquaculture production is almost 400 million pounds, representing about 11% of the total edible production of fish and shellfish in 1988 (6).

In North Carolina, aquaculture is becoming an important contributor to the agricultural economy of the state. Hybrid bass were first developed in North and South Carolina and used as recreational species. Copeland (7) predicted that the potential for hybrid striped bass aquaculture development along the Eastern Seaboard in the United States could be as strong and as prosperous as the catfish culture in Mississippi or crawfish in Louisiana.

Deng *et. al.* (8) reported that the amount of ω3 fatty acids in fish varies with species, age, season and location of catch. Chanmugam and co-workers (9) studied differences in the ω3 fatty acid content in pond-reared and wild prawn, catfish and crawfish. They found that pond-reared animals have higher ω6 fatty acid levels and much lower levels of ω3 fatty acids than their wild counterparts. They also indicated that the ω3 content could be increased by dietary manipulation.

The objective of this study was to determine the amount of ω3 fatty acids in hybrid striped bass that were fed two different diets while cultured in North Carolina. The second objective was to find the effect of diets, trout grower feed (TF) and catfish feed (CF), on the amount of ω3 fatty acids in the bass.

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EXPERIMENTAL PROCEDURES

Bass samples. Hybrid bass samples (*Morone saxatilis*, female × *M. chrysops*, male) were obtained from Pamlico Aquaculture Field Laboratory (North Carolina State University, Raleigh, NC). Grow-out of hybrid striped bass samples was carried out by placing the advanced fingerlings in 1/4-acre ponds during the winter. Stocking densities were 4,000 fish/acre. The hybrids were fed diets at a rate of about 3% of body weight per day in two feedings. Flushing and aerators were used to maintain good water quality and to keep oxygen levels above 4 mg/L. The water temperature averaged about 28°C during the summer months (10). The bass samples were divided into two diet groups, TF (Zeigler Bros. Inc., Gardners, PA) and CF (Purina Mills, Inc., St. Louis, MO). According to the companies, the percentages of crude protein and fat were 38.0 and 8.0 in TF and were 30.0 and 2.5 in CF, respectively. After fish samples were caught, they were weighed individually and stored at a temperature below 18°C until analysis.

Lipid extraction and esterification. Lipids were extracted from fish tissues by the method of Folch *et al.* (11). A 10-g portion of fish tissue was homogenized in a Waring blender for 4 min with 168 mL chloroform/methanol (2:1, vol/vol). The crude fat was separated by means of filtration, and the solvent was removed in a rotary evaporator. Triplicate samples were taken from each fish. Fifty mL lipids were transesterified in a mixture of 3% H_2SO_4 in methanol by heating lipids at 80° for 1 h in a nitrogen atmosphere (12).

Gas-chromatographic analysis. Analysis of fatty acid methyl esters was performed by gas chromatography on a Hewlett-Packard 5890A (Hewlett-Packard, Palo Alto, CA). A 1.84 m column (3.2 mm i.d.) packed with GP/3% SP-2310/2% SP-2300 on Chromosorb. WAW was used for this study. The chromatographic conditions were as follows: injection port temperature, 220°C; flame-ionization detector temperature, 230°C; initial oven temperature,

TABLE 1

Body Weight[a], Moisture[b] and Fat Content[c] in Hybrid Striped Bass Fed Trout Feed and Catfish Feed[d]

	Bass fed trout feed [g/100/g; mean ± standard error (S.E.)]	Bass fed catfish feed (g/100/g; mean ± S.E.)
Body weight	727.46[e] ± 47.01	379.92[f] ± 37.12
Moisture	73.65[e] ± 0.59	77.22[f] ± 0.59
Crude fat	11.75[e] ± 0.79	6.00[f] ± 0.79

[a]Values and analysis of data based on average of eight samples in each group.
[b]Values and analysis of data based on duplicate analysis on each of 16 hybrid striped bass.
[c]Values and analysis of data based on nine sample analyses on each of 16 hybrid striped bass.
[d]Values within each row that bear the same letter are not significantly different ($P < 0.05$),

180°C; final oven temperature, 220°C; programming rate, 2°C/min; the carrier gas was nitrogen, and the flow rate was 30 mL/min.

Moisture determination. The samples were dried in a drying oven at 100°C for 6 h, and the moisture content was calculated.

RESULTS AND DISCUSSION

The average body weight for the bass fed the TF diet was 722.46 g, which was almost twice as heavy as that of the bass fed the CF diet, which weighed 379.92 g. The crude fat contents of the fish showed a similar pattern, i.e., 11.75 g fat for the TF group and 6 g for the CF group (Table 1). This corresponded well to the crude fat contents in the feeds, 9.5 g for TF and 5.85 g for CF (Table 2). So, an increased amount of fat in the diet led to higher body weight and also to a larger deposit of body fat.

The moisture contents exhibited a pattern opposite that seen for either body weight or body fat content. This was consistent with the report of Wang *et al.* (13), who showed that moisture content was inversely proportional to the lipid content.

For the eight fatty acids analyzed, the bass fed TF contained significantly higher amounts of palmitic, stearic, oleic, EPA and DHA than the bass fed CF.

The amounts of linoleic, linolenic and arachidonic acid were not different between the two groups of bass (Table 3). According to the manufacturers' labels on the feeds, the TF contains fish oils and fish meals, which are major sources of EPA and DHA, as opposed to the CF, which contains animal and plant proteins and are poor sources of the long-chain ω3 fatty acids. The fatty acid composition data on feeds show that TF contains much higher levels of both EPA and DHA than CF (Table 2). It has been well documented that dietary lipids significantly influence the tissue fatty acid composition in fish (14,15). Palmitic, oleic and linoleic acids were the major fatty acids in both bass fed TF and bass fed CF. However, a significant amount of DHA was found only in the bass fed TF.

CF contained much higher levels of linoleic and linolenic acids than TF but contained much lower amounts of the six other fatty acids. Table 3 shows that the pattern of the major fatty acid contents in the feeds is similar to the fatty acid composition of the bass tissues in both groups, with the exception of the EPA level in the TF group.

Correlation analysis was conducted on the variables, such as the bass weight, crude fat content, and individual fatty acid content for both bass groups. Correlation analysis showed that the crude fat was significantly correlated with all the fatty acids except with EPA in the bass fed TF. In the bass fed CF, the crude fat correlated with palmitic, oleic and DHA (Table 4). Further studies have been recommended to explain the factors that affected the relationship between the crude fat content and the fatty acid content.

This study confirmed that fish diets influence the fatty acid composition of fatty acid in fish tissues. The TF is a more suitable feed for culturing hybrid striped bass based on the growth rate and fatty acid composition of the fish.

TABLE 2

Moisture, Fat Content and Fatty Acid Composition in Feeds[a,b]

	Trout feed (g/100 g)	Catfish feed (g/100 g)
Moisture	$9.17^d \pm 0.14$	$9.76^d \pm 0.17$
Crude fat	$9.50^d \pm 0.12$	$5.85^e \pm 0.12$
16:0[c]	$0.013^d \pm 0.013$	$0.572^e \pm 0.013$
18:0	$0.175^d \pm 0.003$	$0.146^e \pm 0.003$
18:1	$0.649^d \pm 0.010$	$0.557^e \pm 0.010$
18:2n-6	$0.661^d \pm 0.009$	$1.250^e \pm 0.009$
18:3n-3	$0.075^d \pm 0.001$	$0.153^e \pm 0.001$
20:4n-6	$0.026^d \pm 0.0006$	$0.008^e \pm 0.0006$
20:5n-3	$0.281^d \pm 0.005$	$0.055^e \pm 0.005$
22:6n-3	$0.254^c \pm 0.005$	$0.039^e \pm 0.005$

[a]Values and analysis of data based on four sample analyses on each of two feeds.
[b]Values within each row that bear the same letter are not significantly different ($P < 0.05$).
[c]Shorthand notation denotes number of carbon atoms; number of double bonds; n-3 and n-6 indicate ω3 and ω6, respectively.
*Standard error (S.E.).

TABLE 3

Selected Fatty Acid Compositions in Hybrid Striped Bass Fed Trout Feed and Catfish Feed[a]

Fatty acid	Bass fed trout feed	Bass fed catfish feed
16:0[b]	$0.405^b \pm 0.015$*	$0.276^c \pm 0.015$
18:0	$0.097^b \pm 0.003$	$0.071^c \pm 0.003$
18:1	$0.339^b \pm 0.017$	$0.238^c \pm 0.017$
18:2n-6	$0.187^b \pm 0.009$	$0.195^b \pm 0.009$
18:3n-3	$0.021^b \pm 0.001$	$0.020^b \pm 0.001$
20:4n-6	$0.012^b \pm 0.0015$	$0.015^b \pm 0.0015$
20:5n-3	$0.039^b \pm 0.001$	$0.021^c \pm 0.001$
22:6n-3	$0.157^b \pm 0.004$	$0.049^c \pm 0.004$

[a]See footnote b in Table 2.
[b]Shorthand notation denotes number of carbon atoms; number of double bonds; n-3 and n-6 indicate ω3 and ω6, respectively.
*Standard error (S.E.).

TABLE 4

Correlation Analysis of Variables Between Crude Fat and Fatty Acids in Hybrid Striped Bass

Fatty acid	TF[a]	CF[a]
16:0[b]	0.9066	0.8308
	0.0019[c]	0.0106[c]
18:0	0.9694	0.2201
	0.0001[c]	0.6004
18:1	0.8689	0.9642
	0.0051[c]	0.0001[c]
18:2	0.9390	0.6834
	0.0005[c]	0.0617
18:3n	0.8985	0.6239
	0.0024[c]	0.0983
20:4	0.8322	−0.1048
	0.0104[c]	0.8049
20:5	0.4926	−0.0249
	0.2150	0.9534
22:6	0.9213	−0.7470
	0.0011[c]	0.0332[c]

[a]TF, Trout feed group; CF, catfish feed group.
[b]16:0, Palmitic; 18:0, stearic; 18:1, oleic; 18:2, linoleic; 18:3, linolenic; 20:4, arachidonic; 20:5, eicosapentaenoic; 22:6, docosahexaenoic.
[c]Significant $P < 0.05$.

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