Cholesterol and Total Fat Content in Farm-Raised Channel Catfish Cultured in North Carolina

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ABSTRACT: Six batches of channel catfish, obtained from six different farms in North Carolina, were analyzed for lipid and cholesterol content. A total of 70 catfish were studied by high-performance liquid chromatography for cholesterol estimation. The mean cholesterol value was 33.00 mg/100 g of edible fish portion. The mean fat content was 4.93 g/100 g of sample. Cholesterol content increased with fat, and fat increased with weight, whereas moisture decreased with increasing fat.
JAOCS 72, 1583–1585 (1995).

KEY WORDS: Catfish, cholesterol, fat, feed, HPLC.

Catfish (*Ictalurus punctatus*) is the most popular farmed species in the United States. The national production of catfish covers 139,000 acres with a market value of $285 million (U.S.) (1). North Carolina has nearly 1100 acres of ponds, which produced over 2.3 million pounds of catfish in 1991 (2).

The determination of sterol compounds, particularly cholesterol, is of growing importance to the food industry. The quantitative evaluation of sterols is of interest to the consumer because of an apparent relationship between increased incidence of coronary heart disease and elevated serum cholesterol level.

Although farm-raised channel catfish has gained widespread consumer acceptance, data on nutrient composition, especially fatty acid composition and cholesterol content, are lacking for channel catfish grown in different areas. It has been reported that fish fat and cholesterol content might vary with feed, fish habitat, and weight of the fish (3).

The purpose of this study was to determine the cholesterol and fat content of cultured catfish.

EXPERIMENTAL PROCEDURES

Channel catfish, 12–24 months old, were obtained from six different farms across North Carolina during March and May. Catfish were grouped into six batches according to the region from where they were obtained. Group I was from the northeast; Group II from the east; Groups III and IV were from the southwest; and Groups V and VI were from two different aquafarms in the southeast. The fish weighed 1–3 pounds, were kept in airtight plastic bags, and stored in the freezer.

The catfish feed diet varied in total crude protein content from 24 to 36%. Three manufacturers of catfish food, [Purina Mills, (Wilson, NC) Goldkist Mills (Atlanta, GA), and Southern States (Richmond, VA)] were used in the aquafarms. Catfish feed samples were divided into six feed groups corresponding to the six regional groups, and designated as catfish Feeds I–VI. Feeds I and II were minor variations of the catfish chow (dense culture) manufactured by Purina Mills. Feed III consisted of commercial 32% floating catfish food from Goldkist Inc. Feed IV had 36% floating catfish food (Goldkist Inc.). Feed V was a minor variation to the 36% Catfish Food. Finally, Feed VI was the catfish chow dense culture from Purina Mills.

Lipid extraction. Samples were prepared according to the method of Kovacs *et al.* (4). Two 10-g pieces of flesh from the center of each fish were taken, and each 10-g sample was mixed with 2:1 chloroform/methanol, ground three times and filtered, and the solvent was removed with a vacuum evaporator. About 50 mg of extracted fat was saponified and then extracted with 1.5 mL distilled water and 2.5 mL hexane four times.

High-performance liquid chromatography (HPLC). Waters Associates 820 HPLC (Millipore Corp., Milford, MA) was used for analysis of cholesterol at 210 nm with a resolve-C_{18} (8 × 100 mm) radial pak compression column, associated with a Waters Associates Bondpak C_{18} Guard-pak precolumn cartridge, and acetonitrile/isopropanol (1:1) as the mobile phase (5).

Moisture determination. Approximately 2 g of fish flesh was dried at 100°C in a drying oven to a constant weight for moisture determination. The loss of weight after the samples were dried indicated the moisture content. Means of data on 12 fish analyses for each batch were reported as moisture content.

Statistical analysis. Data were analyzed with the general linear model procedures from the SAS Institute (Cary, NC) (6). Standard errors and least squares means were presorted for batches. Batch means were separated with Duncan's Multiple Range test for mean separation. Pearson correlation coefficients and their probability of differing from zero were calculated to demonstrate relationships between characteristics measured on the fish (6).

RESULTS AND DISCUSSION

Catfish were grouped into six batches according to their origin. The feed samples also were grouped to correspond to each batch.

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Table 1 shows the cholesterol content in catfish and feed samples. Batch 4 had the lowest mean cholesterol, 24.88 ± 2.01 mg/100 g tissue. Although batch 6 had the highest mean cholesterol content, 43.27 ± 2.01 mg/100 g, it was not significantly greater than that of batch 5. The cholesterol content of batches 5 and 6 differ significantly from those of the first four batches. The mean cholesterol content of all the observations was 33.00 ± 1.12 mg/100 g.

Catfish moisture content ranged from 76–79%. Higher moisture content was obtained in fish samples in which fat content was low in the tissue. Feed samples differed little in moisture, which ranged from 8–9% (Table 1). The fat content of feed varied between 3.10 and 5.05 g/100 g. The cholesterol content was 14.27 ± 1.29 mg/100 g.

Mean fat value was 4.93 g/100 g tissue, which agreed with the United States Department of Agriculture (USDA) values (4.26 g/100 g) and the values observed by Mustafa and Medeiros (7) (4.5 g/100 g) (Table 2). Studies by Nettleton *et al.* (8) (6.9 g/100 g) and Hearn *et al.* (9) (9.8 g/100 g) indicated much higher fat values than our data and other reported data. In 1992, Nettleton and Exler (10) reported that fat content for farmed Mississippi catfish was 11.3 g/100 g, which was greater than previously reported values. Fat content may vary with the season. Mustafa and Medeiros (7) also reported that the fat content of catfish obtained in April was 3.5 g/100 g, based on hexane Soxlet extraction. They reported that the overall average of fat content of August, December, and April fillets was 4.5 g/100 g. In our study, body weight ranged from 297.1–1698.8 g. However, most samples averaged around 450–550 g (Table 2).

A positive correlation was observed between fish cholesterol and fish fat (Table 3). No relationship was observed between fish weight and cholesterol. An inverse relationship was found between cholesterol and moisture content. There was a positive relationship between fat and weight, but an inverse relationship between fat and moisture content.

The mean cholesterol content of 70 channel catfish, cultured in six different locations in North Carolina, was substantially below that reported in the literature. In this study, the cholesterol content was nearly half that reported by the USDA (33.0 mg/100 g vs. 58 mg/100 g) (11). The difference in the cholesterol content can be attributed to the extraction procedure, regional and seasonal variation, and species differences. Cholesterol measurements that were made by using direct saponification of the fish meat gave higher values than the Association of Analytical Chemists method (12). Nettleton and Exler (10) reported cholesterol values of 61 mg/100 g and 58 mg/100 g for cultured and wild catfish, respectively. They used the method of Adams *et al.* (12), which involved direct saponification of fish meat for the cholesterol determination. This value was much higher than the 33 mg/100 g published earlier (8). Our value coincides with the cholesterol content of their 1990 study. Nettleton *et al.* (10) also reported a seasonal variance in cholesterol content in the cultured channel catfish studied between April and November in the Mississippi delta region.

Fish feeds also were analyzed for the same parameters by the same procedures used for fish. The mean cholesterol content in the feed samples was found to be 14.3 mg/100 g and the mean fat content was 4.19 g/100 g. The mean moisture content was 8.51% (Table 2). Upon statistical analysis, no relationship was observed between feed and fish cholesterol. However, this analysis was based on only six pairs of cholesterol data from six batches of fish tissues and feeds. Data on other factors, such as caloric and other nutrient values and environmental conditions of the growing ponds, that were known to influence cholesterol levels in tissues, were not

TABLE 1
Average Values[a] of Cholesterol Content in Catfish and Feeds

Group number	Cholesterol		Moisture	
	In fish (mg/100 g)	In feed (mg/100 g)	In fish (%)	In feed (%)
1	$30.1 \pm 2.20^{*,b,c}$	$17.1 \pm 0.45^{*}$	$77.7 \pm 0.5^{*,a}$	8.5
2	$28.6 \pm 2.0^{b,c}$	13.8 ± 0.45	77.5 ± 0.4^{a}	8.1
3	31.5 ± 2.0^{b}	10.6 ± 0.45	76.1 ± 0.4^{b}	9.2
4	24.9 ± 2.0^{c}	11.7 ± 0.45	77.4 ± 0.5^{a}	8.4
5	39.7 ± 2.0^{a}	22.3 ± 0.45	77.6 ± 0.5^{a}	8.0
6	43.3 ± 2.0^{a}	10.1 ± 0.45	79.0 ± 0.4^{a}	8.9
Average	33.0 ± 1.1	14.3 ± 1.3	77.3 ± 0.2	8.5 ± 0.2

[a]Values reported as the means of 10–12 analyses for fish data and as the means of four analyses for feed data. Means with the same letter are not significantly different; *, standard error.

TABLE 2
Profile of Catfish Obtained from Six Locations in North Carolina[a]

Group number	Age of Fish (mon)	Body fat (g/100 g)	Body weighs (g)
1	14	$5.9 \pm 0.4^{*,a,b}$	$479 \pm 52^{*,b,c}$
2	14	$5.6 \pm 0.3^{a,b}$	613 ± 47^{b}
3	24	6.0 ± 0.3^{a}	934 ± 47^{a}
4	13	$4.6 \pm 0.3^{b,c}$	$540 \pm 47^{b,c}$
5	12	$3.9 \pm 0.3^{b,c}$	$522 \pm 47^{b,c}$
6	24	3.5 ± 0.3^{c}	424 ± 47^{c}
Average		4.9 ± 0.4	585 ± 27

[a]Values reported as the means of 10–12 fish analyses. Means with the same subscripted letter are not significantly different; *, standard error.

TABLE 3
Correlation Analysis[a] on Cholesterol, Fat, Body Weight, and Moisture Content in Fish

Variable	Cholesterol	Fat	Weight
Fat	0.146		
	0.015^{b}		
Weight	0.028	0.565	
	0.642	0.0001^{b}	
Moisture	−0.138	−0.402	−0.406
	0.021^{b}	0.0001^{b}	0.0001^{b}

[a]Pearson correlation coefficients and their probabilities of differing from zero are given in first and second rows, respectively, for each variable.
[b]Probability of r not equal to zero is $P > 0.05$.

available for the interpretation of this finding because this study was not designed to investigate the relationship between diet and tissue cholesterol levels.

ACKNOWLEDGMENTS

We thank Dr. Fields Gunsett (Department of Animal Science, North Carolina A&T State University) for his assistance in the statistical treatment of the data. This work was supported in part by research grants from USDA-CSRS (Grant No. NC.X-101-5-90-170-1).

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[Received August 29, 1994; accepted August 16, 1995]