Proximate Chemical Composition and Fatty Acids of Three Small Coastal Pelagic Species

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ABSTRACT—The coastal herrings complex comprises the largest underutilized fisheries resource in the Gulf of Mexico. Several species have good potential for food use as canned products, but the lack of chemical composition data inhibits their development. In this paper, proximate chemical compositions and fatty acid profiles are reported for seasonal samples of Spanish sardine, Sardinella aurita*; thread herring,* Opisthonema oglinum*; and round scad,* Decapterus punctatus*, from both the Atlantic Ocean and the Gulf of Mexico. Mean protein contents ranged from 20.6 percent for thread herring to 22.6 percent for round scad from the Gulf. Mean fat contents ranged from 1.8 percent for Spanish sardines from the Atlantic to 3.2 percent for thread herring from the Gulf. Fat contents of sardines and scad decreased over the period of spring to late summer. Spanish sardines have a particularly high level of 22:6ω3, but in general the fatty acid profiles of the three species were similar and did not change seasonally.*

Introduction

Information on the proximate chemical composition and fatty acid profiles of a number of pelagic species has been developed at the Charleston Laboratory of the NMFS Southeast Fisheries Center. The data reported here are for Spanish sardine, *Sardinella aurita*; Atlantic thread herring, *Opisthonema oglinum*; and round scad, *Decapterus punctatus*. These species are placed in a common grouping referred to as "coastal herrings," for utilization purposes, although the round scad is actually a member of the jack family, Carangidae.

Small pelagic species, primarily the herrings, the smaller jacks, and anchovies, make up the greatest underutilized finfish resource in the Gulf of Mexico (Reintjes, 1979). Based on egg and larval survey data reported by Houde (1976) and Leak (1977), the combined potential yield for thread herring, Spanish sardine, and round scad was estimated at 190,000-325,000 metric tons in the eastern Gulf of Mexico. Although menhaden are fully exploited for meal and oil production, and there are bait fisheries for other coastal herrings, there has been no significant direct food use of coastal herrings in the Gulf of Mexico.

Coastal herrings are generally small, dark fleshed, and bony. They contain moderate to high levels of oil, which is subject to oxidation during frozen storage. They are not suitable for traditional fresh or frozen products in developed countries but they have potential for use as canned products. Considerable interest has developed in recent years in the canning of coastal herrings, but very little information on the chemical composition of these species has been published to encourage such a development.

Thompson (1966) reported seasonal compositions of various species of Gulf of Mexico industrial fish. The fish, caught by commercial trawlers for a petfood canning plant, did not include the Spanish sardine or round scad. Seasonal proximate compositions were reported for whole thread herring, but fatty acids were not determined. Sidwell (1981) listed proximate analyses for several flesh and whole fish samples of thread herring and for several samples of sardine from the eastern Atlantic (*S. aurita*, but referred to as golden sardine). Round scad was not reported. Proximate and fatty acid compositions of raw and canned thread herring and Spanish sardine were included in a study of the effects of canning on fatty acids (Hale and Brown, 1983), which demonstrated that heat processing did not significantly alter the fatty acid profiles.

This paper includes some of those data along with other analyses for a range of seasonal samples. We also present information, not previously available, on the chemical composition of edible forms of the three small pelagic species with potential for much greater use.

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Materials and Methods

Round scad and Spanish sardine were obtained from both the South Atlantic Bight and the Gulf of Mexico. The Atlantic samples were collected during resource survey cruises, sealed in heavy polyethylene bags, and frozen onboard the vessel. Thread herring, as well as scad and Spanish sardine, were obtained from the Gulf of Mexico. Samples were obtained from baitfish harvesters, primarily in Port St. Joe, Fla. (Raffields Fisheries), or in the Panama City, Fla., area. The samples

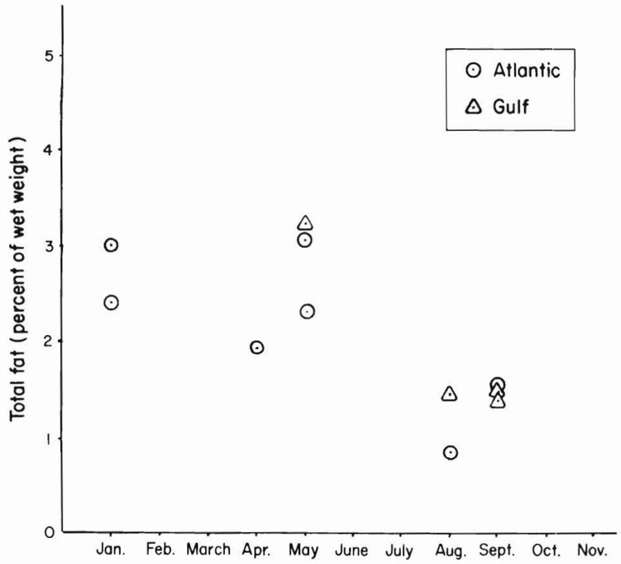

Figure 1.—Fat content of headed and gutted Spanish sardine, *Sardinella aurita*, versus month of harvest.

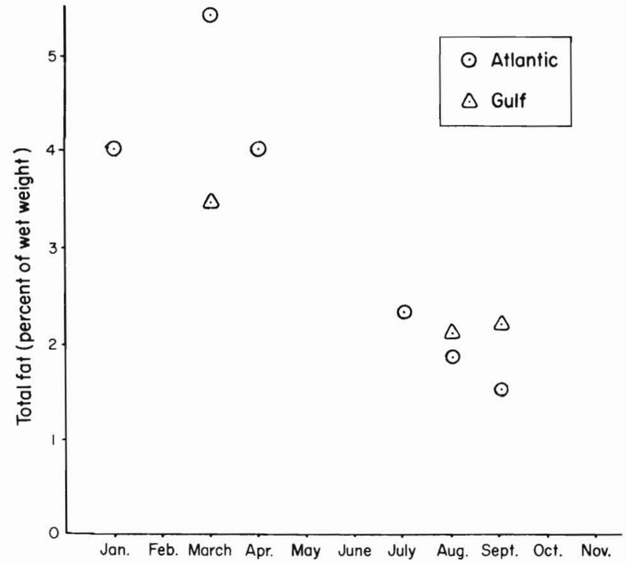

Figure 2.—Fat content of headed and gutted round scad, *Decapturus punctatus*, versus month of harvest.

were frozen before being transported to Charleston, S.C., for processing. Analyses were generally made after less than 2 months of frozen storage.

All samples were homogenized in a food processor, placed in polypropylene sample cups, frozen, and stored until analyzed. Samples were analyzed for crude protein by the Kjeldahl method (AOAC, 1965). Samples were dried to constant weight overnight at 100°C for moisture determination, and were heated overnight at 600°C for ash determination. Total fat was determined by a chloroform-methanol extraction (Smith et al., 1964). Duplicate analyses were performed on all samples.

Fatty acids were determined by gas-liquid chromatography of methyl esters. The esters were prepared from extracted oils by a boron trifluoride-methanol procedure (Metcalfe and Schmitz, 1961). A column packed with diethylene glycol succinate polyester (DEGS) was employed in a Hewlett-Packard[1] Model 5831A chromatograph with electronic integrator. Identification of fatty acid esters was as described by Ackman and Burgher (1965).

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 1.—Proximate chemical analyses of the raw, headed, and gutted form of round scad, Spanish sardine, and thread herring.

Species	Source	Number of samples	Average weight (g)	Percent Protein	Fat	Moisture	Ash
Round scad	Atlantic	11	35.1	21.64	2.52	74.06	3.12
	Gulf	3	36.8	22.60	2.60	73.95	2.60
Spanish sardine	Atlantic	6	33.4	20.83	1.79	76.05	2.68
	Gulf	6	60.9	20.90	2.42	74.73	2.69
Thread herring	Gulf	4	78.9	20.65	3.22	73.23	3.68

Results and Discussion

The coastal herring species described have high protein contents and moderate fat contents. Overall average values of the proximate chemical compositions determined for the raw, headed and gutted (H&G) forms of round scad, Spanish sardine, and thread herring are listed in Table 1. The samples referred to in Table 1 are composites of 8-20 fish each, depending on fish size. The H&G form is that most likely to be utilized in canned food products. The chemical compositions of samples from the Atlantic did not differ significantly from those of Gulf samples. Although Spanish sardines from the Gulf were larger, and had a slightly higher mean fat content, correlations between fish size and fat content were generally low. The fat content did vary with the season, however, apparently as a function of the reproductive cycle.

Fat content decreased in both Spanish sardine and round scad during the summer (Fig. 1 and 2). Samples were not available to describe the fat increase that must occur during the fall. The data available for thread herring indicate an increase in fat content during the early fall. A September H&G sample approached 4 percent fat and an October skinless fillet sample exceeded 5 percent fat. Thompson (1966) reported for whole thread herring an increase from 4.3 percent fat in late September to 15.6 percent fat about 1 month later. The lowest and highest oil contents measured for thread herring by Thompson were similar to those measured for menhaden, but the median of all seasonal samples was much lower in thread herring (5.1 vs. 13.3 percent).

Proximate analyses of three product forms (skinless fillets, headed and gutted, and whole fish) are listed in Table 2. These are average values of the Atlantic samples of scad and sardine and of the Gulf samples of thread herring. Samples of whole thread herring were not analyzed.

The major fatty acids determined for the three species are listed in Table 3. The species exhibit a similar pattern, with high concentrations of 16:0 and 22:6ω3. Spanish sardines are particularly rich in the 22:6 fatty acid. The totals of the highly unsaturated fatty acids, containing 5 and 6 double bonds, range from 28.3 percent in the thread herring to 36.2 percent in the Spanish sardine. Recent research indicates that these fatty acids may help to prevent coronary attacks by reducing blood clotting rates as well as reducing cholesterol levels in the blood (Rawls, 1981). Erucic acid (22:1ω9), which has adverse effects on certain laboratory animals (e.g., heart lesions in male weanling rats) when fed at high levels, is quite low in these species. The total of all 22:1 isomers is only about 0.3 percent of total fatty acids.

The results of this study indicate that Spanish sardine, thread herring, and round scad have high protein and moderate fat contents during the normal period of availability. Fatty acid patterns are similar, with high concentrations of long-chained polyunsaturates. Additional data are needed to better describe fat content in the fall and winter, but the reported data should be of value for greater utilization of the abundant coastal herring resources.

Table 2.—Proximate chemical composition of three product forms of round scad, Spanish sardine, and thread herring.

Species and source	Product form	Percent Protein	Fat	Moisture	Ash
Round scad (Atl.)	Fillet	22.22	1.90	75.71	1.42
	H&G	21.64	2.52	74.06	3.12
	Whole	20.03	2.96	74.18	3.89
Spanish sardines (Atl.)	Fillet	22.40	1.31	75.86	1.77
	H&G	20.83	1.79	76.05	2.68
	Whole	18.59	1.84	76.99	4.08
Thread herring (Gulf)	Fillet	20.63	2.58	75.68	1.36
	H&G	20.65	3.22	73.23	3.68

Table 3.—Major fatty acids of Spanish sardine, thread herring, and round scad.

Fatty acid[1]	Percent of total fatty acids: Spanish sardine	Thread herring	Round scad
14:0	2.8	4.7	3.9
16:0	23.2	23.8	20.5
18:0	7.7	7.8	9.3
16:1	4.8	5.6	6.0
18:1	8.6	10.6	11.7
20:1	0.9	1.3	1.1
22:1	0.3	0.3	0.3
18:2ω6	1.4	1.5	2.0
18:3ω3	0.5	0.9	0.9
18:4ω3	0.6	1.0	1.0
20:4ω6	2.6	3.3	2.7
20:5ω3	6.3	6.4	6.6
22:5ω6	1.7	1.5	1.6
22:5ω3	1.2	1.6	1.8
22:6ω3	27.0	18.8	20.0
Total saturates	37.7	42.1	36.2
Total monoenes	16.7	20.1	20.5
Total PUFA[2]	45.6	37.8	43.3

[1]For polyunsaturated fatty acids, the first number to the right of the colon indicates the number of double bonds and the last number is the number of carbon atoms separating the first double bond from the methyl end of the molecule.
[2]PUFA = Polyunsaturated fatty acids.

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