Fatty Acids and Lipid Classes of Three Underutilized Species and Changes Due to Canning

MALCOLM B. HALE and THOMAS BROWN

Introduction

The coastal herrings are, in general, small, bony fishes of the family Clupeidae which regularly occur in large schools and have the highest potential yield of any fishery resource in the west-central Atlantic Ocean and Gulf of Mexico. Houde (1976) estimated that the resource in the eastern Gulf alone could probably support a 500,000 metric ton (t) annual yield. Several species have been utilized to some extent as bait fish and menhaden have been fully exploited for fish meal, but the untapped potential of small herrings and related species for food use is great.

The coastal herrings are not suitable for the traditional fresh or frozen markets because of their small size, bony structure, and readily oxidizable fat content. Several species have a good potential as canned products, however, since the bones are softened during heat processing and sealed cans prevent lipid oxidation during storage.

In recent years, there has been much interest in the effect of diet on the risk of coronary heart disease (CHD). Several studies have demonstrated that the consumption of fish or fish oils lowers serum lipid levels in both human subjects and experimental animals. Von Lossorny et al. (1978) showed that both serum cholesterol and triglycerides (triacylglycerols) were reduced in healthy human subjects by ingestion of a controlled diet based on mackerel. Truswell (1978) stated, "It is firmly established that plasma total cholesterol is positively related to the risk of subsequent CHD." In addition, eicosapentaenoic acid (EPA, 20:5ω3), a major fatty acid in marine fish, also protects against CHD by acting as a precursor for a prostaglandin which slows the rate of blood clotting (Rawls, 1981).

Coastal herrings and other underutilized species from southeastern U.S. coastal waters have relatively high contents of the highly unsaturated fatty acids (HUFA) containing five or six double bonds. Processing or storage conditions, however, could potentially result in undesirable changes to these labile compounds.

Although the effects of frozen storage on fatty acid composition of fish has been widely studied and reported, the effects of processing in general and canning in particular are not well known. Dudek et al. (1981) reported fatty acid data on six seasonal samples each of Atlantic mackerel and sockeye salmon. Their data indicated that neither canning, broiling, baking, nor microwave cooking had a significant effect on total polyunsaturated fatty acids (PUFA) or the five and six double-bonded HUFA. Giddings and Hill (1975) heat processed blue crab for 10 minutes at 121°C and found that PUFA losses were not excessive and changes in lipid fractions were slight.

In this paper we present fatty acid, lipid class, and proximate composition data on some abundant but generally unfamiliar species and indicate whether nutritionally desirable polyunsaturated fatty acids are affected by the canning process.

Materials and Methods

The fish samples used for the primary study were collected in May and June 1982, from the vicinity of Panama City, Fla. Spanish sardines, Sardinella aurita, and chub mackerel, Scomber japonicus, were harvested by beach seine; thread herring, Opisthopoena ogninum, was harvested by purse seine. Samples were frozen into ice blocks in polyethylene containers at the Southeast Fisheries Center's Panama City Laboratory and later transported to the SEFC Charleston Laboratory.

ABSTRACT—Canned products were prepared from three underutilized species that are abundant in the Gulf of Mexico: Spanish sardine, Sardinella aurita; thread herring, Opisthopoena ogninum; and chub mackerel, Scomber japonicus. Proximate chemical compositions, fatty acid profiles, and lipid class compositions are reported for both raw and canned products. Results indicate that heat processing in sealed cans has no significant effect on the fatty acid profile or lipid class composition. The use of vegetable oil as a packing medium, however, has major effects on the product fatty acid profile. Linoleic acid (18:2ω6) is greatly increased and the concentrations of long-chain polyunsaturated fatty acids decreases.
Laboratory in Styrofoam boxes. On arrival, the plastic containers were sealed in Cryovac bags and stored at −30°C until processed (within 2 weeks).

The individual fish were separated from ice blocks in cold tap water after partial thawing in a chilled room overnight. Length and weight measurements were made on a representative sample of each lot. A sub-sample of approximately 500 g was sent from the individual cans for which the specified F₀ values were determined.

Spanish sardines, harvested in September 1981, from the vicinity of Port St. Joe, Fla., were canned in an earlier processing study. The dressed fish were heat processed to the normal level (F₀ = 12) in two groups: 1) With a 2 percent brine packing medium and 2) with soybean oil as a packing medium. Raw dressed samples and drained solids from each canned product were comminuted and analyzed for proximate chemical compositions and fatty acid profiles.

Table 1.-Size data for whole fish and proximate chemical compositions for dressed, H&G fish, both raw and canned.

<table>
<thead>
<tr>
<th>Item</th>
<th>Spanish sardine</th>
<th>Thread herring</th>
<th>Chub mackerel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean weight (g ± SD)</td>
<td>71.5 ± 23.8</td>
<td>108.4 ± 12.6</td>
<td>78.8 ± 13.5</td>
</tr>
<tr>
<td>Mean length (cm ± SD)</td>
<td>16.9 ± 1.7</td>
<td>18.2 ± 0.56</td>
<td>18.8 ± 0.77</td>
</tr>
</tbody>
</table>

Proximate composition (dressed, H&G)

<table>
<thead>
<tr>
<th></th>
<th>Raw</th>
<th>Canned</th>
<th>Raw</th>
<th>Canned</th>
<th>Raw</th>
<th>Canned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>75.41</td>
<td>69.63</td>
<td>75.22</td>
<td>70.81</td>
<td>73.73</td>
<td>69.77</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>20.09</td>
<td>24.52</td>
<td>20.05</td>
<td>23.21</td>
<td>21.08</td>
<td>24.79</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>3.22</td>
<td>4.21</td>
<td>2.71</td>
<td>3.41</td>
<td>3.07</td>
<td>3.30</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>1.75</td>
<td>1.90</td>
<td>3.04</td>
<td>3.21</td>
<td>2.66</td>
<td>3.03</td>
</tr>
</tbody>
</table>

Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.
with five or six double bonds (HUFA). However, neither docosahexaenoic acid (22:6ω3) nor other HUFA showed any consistent pattern of change due to heat processing in this study.

Shown in Table 5 is the effect that packing media can have on the fatty acid profiles of canned fish. Lipid content and selected fatty acids are listed for the Spanish sardines harvested in September 1981. Headed and gutted (H&G) fish were analyzed both raw and as the drained solids after canning in either 2 percent brine or in soybean oil. Fat content of these Spanish sardines was low, and a significant amount of the soybean oil was absorbed. Consequently, the fatty acid profile showed a much higher level of 18:2ω6 and much lower 22:6ω3, since soybean oil contains about 65 percent 18:2 and no 22:6ω3, since soybean oil contains.

The lipid class compositions as determined by the automated TLC system, for Spanish sardine, thread herring, and chub mackerel appear in Tables 6, 7, and 8, respectively. All the raw samples have a similar pattern. Triglycerides predominate with polar lipids a strong second. An apparent shift from triglycerides to polar lipids was indicated by analyses of two of the canned samples. This shift did not show up in the corresponding samples canned at higher temperature, for Spanish sardine, thread herring, and chub mackerel, respectively.

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Conclusions

Lipid characteristics of these samples of Spanish sardines, thread herring, and chub mackerel are fairly similar, with relatively high levels of highly unsaturated fatty acids and a predominance of triglycerides as a lipid class. No significant changes in PUFA concentrations or lipid class distributions due to heat processing in sealed cans were demonstrated. The use of oil as a packing medium can have great effects on the lipid content and fatty acid profile of the final product. The positive medical benefits of the highly unsaturated fatty acids contained in marine lipids could be more fully realized with a fish oil packing medium rather than vegetable oils. The present food regulations would probably limit usage to oil recovered from precooking of the same species, however.

Acknowledgments

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Literature Cited


