Antioxidant and Processing Treatments to Prevent Rancidity in Mullet

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ABSTRACT

The fatty acid composition of the neutral lipids of mullet were determined. Based on their degree of polyunsaturation, mullet lipids should not be less stable than those of other commercially valuable fish species.

A sodium ascorbate dip was found to be an effective antioxidant preventing rancidity during storage of mullet fillets at 1° C. Processing the fillet for the white flesh also yielded a storage stable fillet. Long term storage studies using these treatments are presently under way.

INTRODUCTION

Approximately 40 million pounds of mullet (*Mugil cephalus*) are harvested annually from the Gulf of Mexico. Compared to other Gulf species, the market value of mullet is low because of inadequate stability of the flesh while in storage. Mullet is storage stable in the round, the traditional method of marketing mullet. Mullet in the round, however, meets limited consumer acceptability. Methods leading to long-term storage stability of mullet fillets are required for effective marketing.

The instability of mullet flesh during storage has been attributed to the particular susceptibility of the flesh lipids to oxidative rancidity (Watts, 1961). This susceptibility is believed to be due to the heme pigments present in the large lateral band of the fillet (Zipser and Watts, 1961).

Previous studies have been concerned with controlling oxidative rancidity in mullet flesh while in storage using various antioxidants (Angalet, 1971; Saenz and Dubrow, 1959 and Thompson, 1962). Generally, conventional lipid antioxidants have been found to be ineffective on whole fillets at maximum legal limits. Rancidity during storage can be controlled in cooked flesh using an antioxidant mixture of sodium tripolyphosphate and ascorbate (Zipser and Watts, 1961). These antioxidants were not used on fresh, whole fillets.

The purpose of this study was to analyze the lipids of mullet to determine their possible relationships to rancidity in the flesh and to investigate further the effect of antioxidant treatments and processing modifications on extending the storage stability of mullet flesh.

MATERIALS AND METHODS

Mullet for this study were harvested from the West Coast of Florida during August and September, 1973. Iced fish were obtained from commercial fishermen and transported to the laboratories in Gainesville where they were immediately filleted and skinned. For each treatment, approximately ten fillets were selected. The fillets were treated by dipping into appropriate strength solutions. Concentrations of reagents applied were obtained by difference. The treated fillets were loosely wrapped in aluminum foil and stored at 1° C. This storage temperature was selected to rapidly assess the effect of the particular treatment (Mendenhall, 1972).

The thiobarbituric acid number (Sinnhuber and Yu, 1959) was used to determine the effect of the antioxidant on the development of rancidity during storage of the mullet fillets. The lipids were extracted according to the procedure of Folch et al., (1957). An aliquot of the extract was used to determine the total lipid content. The remainder was used for preparation of the fatty acid methyl esters.

The triglycerides were purified from the total lipid extract using silica gel TLC (Mangold, 1961), and the methyl esters prepared using BF_3-methanol (Metcalf et al., 1966). The methyl esters were analyzed on an Aerograph 1520B gas chromatograph equipped with dual flame ionization detectors. The columns were 6' x 1/8" glass with 10% diethylene glycol succinate supported on 80-100 mesh Chromosorb W. The operating conditions were: injector 225°, column 190°, detector 230°, and helium flow rate 40 ml/min. The gas chromatographic peaks were identified by comparison with pure methyl esters, equivalent chain length values, and silver nitrate-silicic acid thin layer chromatography. The area of each peak was obtained by multiplication of the peak height by the width at half-height. The percent was determined as the percent of the total area. Correction factors were used where necessary (Ackman and Sipos, 1964).

RESULTS AND DISCUSSION

Mullet triglycerides were previously reported to be unique among fish oils because of the high content of odd-chain length fatty acids present (Gruger et al., 1964). The fatty acid composition of mullet harvested in August 1973 (Table 1) showed a similar high odd-chain length fatty acid content. The total polyunsaturated fatty acid content, the least stable fatty acids, was not found to be significantly greater than that reported for several other commercially valuable species (Stansby, 1967). This indicates that the fats in themselves are probably not responsible for the tendency of mullet flesh to the development of oxidative rancidity during storage.

Whole mullet fillets showed a rapid increase in TBA values during storage at 1° C (Fig. 1) with a rapid darkening of the red flesh. Sodium ascorbate treated whole fillets showed a limited increase in TBA values during storage. The flesh color was similar to that of fresh fillets. Sodium nitrite and nitrate previously reported to prevent oxidative rancidity in mullet (Mendenhall et al., 1973)

Table 1. Fatty Acid Composition of the Neutral Lipids of Mullet

Fatty Acid	Percent	Fatty Acid	Percent
14:0	6.22	17:2w5	2.89
15:0	10.82	18:2w6	3.35
16:0	15.59	18:3w3	0.64
17:0	2.77	18:4w	1.16
18:0	1.66	18:4w3	1.20
20:0	0.46	20:3w6	1.88
Total Saturates	37.52	20:3w3	0.19
		20:4w6	2.62
		20:4w3	0.50
15:1w6	1.24	20:5w3	7.78
16:1w7	15.04	22:4w3	0.21
17:1w8	7.76	22:5w6	0.65
18:1w9	7.38	22:5w3	2.91
19:1w7	1.56		
		Total	
Total Monoenes	32.98	Polyunsaturates	28.48
Total Odd-Numbered		27.04	

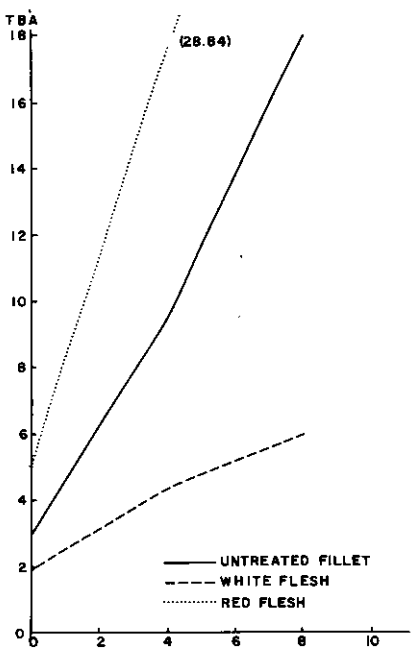

Fig. 1. Effect of antioxidants on the TBA value of mullet fillets during storage at 1° C.

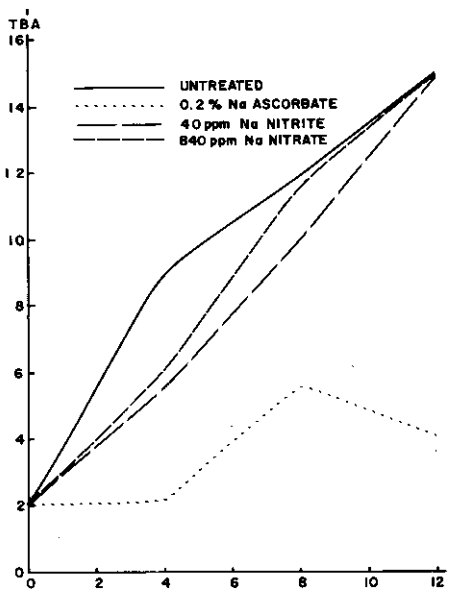

Fig. 2. TBA values of dark and white flesh portions of mullet fillets during storage at 1° C.

showed almost no antioxidant effect in these studies. The nitrite produced an objectionable pink flesh color in the fried fish.

Since it was reported that the heme pigments present in the dark lateral band of the fillet were responsible for catalyzing oxidative rancidity in mullet, the flesh was divided on the basis of flesh color. Analysis of the total lipids showed the dark flesh, representing 1/3 of the fillet, contained approximately 2.5 times the lipid content of the white flesh (Table 2). The dark flesh exhibited a very rapid increase in TBA values during storage whereas the white flesh remained stable (Fig. 2) indicating that rancidity in the whole fillet most likely occurs in the dark lateral line.

Preliminary results of longer term frozen storage studies (Table 3) indicate that both the ascorbate treatment and division of the fillet for the white flesh are effective treatments to prolong the storage stability of mullet fillets. Completion of these studies is required, however. Both taste acceptability and optimum processing procedures must also be established.

Table 2. The Yield and Total Fat Content of the Dark and White Flesh Portions of Mullet Fillets. (Total fat analysis)

Sample	Yield	Percent
Whole fillet	—	7.73
White flesh	66.5	3.72
Dark flesh	33.5	10.08

Table 3. TBA Values of Ascorbate Treated and Divided Flesh Portions of Mullet Fillets during Frozen Storage

Sample	Time (Months) 3	6
Untreated fillet	3.7	4.2
0.2% sodium ascorbate	1.1	2.3
White flesh	2.3	1.8
Dark flesh	5.9	5.0

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