VARIATION IN PHYSICAL AND CHEMICAL CHARACTERISTICS OF HERRING, MENHADEN, SALMON, AND TUNA OILS

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ABSTRACT

Refractive index, iodine number, free fatty acid, saponification number, nonsaponifiable matter, stearine fraction, and Gardner color index were determined for herring, menhaden, salmon, and tuna oils. The data for menhaden oil are given for the various geographical areas along the East and Gulf coasts ranging from Long Island to the Mexican border.

INTRODUCTION

Processing industrial products from fish is an extensive industry. During 1956, in the menhaden industry alone, for example, over 2 billion menhaden were reduced to fish meal, solubles, and oil.

An adequate domestic market exists for the fish meal and solubles as components of commercial mixed feeds for poultry and swine, but the domestic demand for fish oils has declined during the last several years. One of the reasons for this decline was the preconceived concept that commercially-available fish-body oils varied considerably in physical and chemical characteristics.

The purpose of this research project was to determine the normal variation in physical and chemical characteristics of fish oils produced in the United States and Alaska. This study is a part of the over-all research program on fish oils initiated by the U. S. Bureau of Commercial Fisheries. The anticipated practical result is to extend the market for fish oils through a better knowledge of their physical and chemical properties.

EXPERIMENTAL

During the 1955 and 1956 season, samples of fish-body oils were analyzed for refractive index, iodine number, content of free fatty acid, saponification number, content of nonsaponifiable matter, and Gardner color number. During the 1956 and 1957 season these same analyses were made. In addition, the oils were separated into a stearine-oil fraction and a winterized-oil fraction, and the relative amounts were determined of these fractions. Also, the refractive index and iodine numbers were determined for these fractions.

A Bausch and Lomb Precision Refractometer was used to determine refractive index, and the Gardner color number of the oils was determined with the 1953 series Gardner color standards for liquids. All iodine values were determined by the Wijs method using a reaction time of 1 hour. Commonly-accepted procedures as outlined in the Official and Tentative Methods of the American Oil Chemists' Society were used for the other determinations. Stearine was determined by a defined winterizing process that consisted of stepwise lowering the temperature of the oil to 5° C. and separating the solid phase and the liquid phase by centrifugation.

A total of 126 menhaden and 14 herring body oils and 12 tuna and 12 salmon cannery byproduct oils were analyzed. The menhaden samples were received from plants located on the Atlantic and Gulf of Mexico Coasts, extending from Port Monmouth, N. J., to Port Arthur, Tex.; the tuna samples came from California, and the herring and the salmon samples came from Alaska.

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Table 1 - Some Physical and Chemical Properties of Various Fractions of Fish Oils Collected from Different Geographical Areas

Area	Type of Oil	Refractive Index				Iodine Number				Free Fatty Acid				Saponification Number				Nonsaponifiable Matter				Stearine Fraction				Gardner Color Index			
		No. of Samples	High	Low	Median	No. of Samples	High	Low	Median	No. of Samples	High	Low	Median	No. of Samples	High	Low	Median	No. of Samples	High	Low	Median	No. of Samples	High	Low	Median	No. Samples	High	Low	Median
	Menhaden:										(Percent)				(Percent)				(Percent)				(Percent)						
Northern New Jersey and Long Island	Whole	18	1.4724	1.4698	1.4706	18	181.5	172.1	176.6	18	2.57	0.47	0.76	18	198.3	162.6	192.1	14	1.69	0.64	0.77	16	46.1	18.0	36.2	19	12	10	11
	Winterized1/	10	1.4722	1.4711	1.4712	10	194.3	179.2	187.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	10	1.4700	1.4678	1.4684	10	171.3	156.4	161.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Jersey and Delaware	Whole	20	1.4810	1.4689	1.4711	20	190.8	166.6	182.6	20	2.89	0.56	1.40	20	198.3	190.4	192.8	18	1.06	0.68	0.82	20	41.0	9.0	31.7	20	12	10	11
	Winterized	14	1.4735	1.4690	1.4722	14	197.1	166.8	189.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	14	1.4714	1.4651	1.4688	14	173.7	134.4	163.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chesapeake Bay	Whole	5	1.4712	1.4683	1.4695	5	175.3	159.8	169.2	5	2.73	1.22	2.11	5	194.8	191.8	193.7	3	1.30	0.91	0.97	6	91.7	36.2	39.9	5	12	11	12
	Winterized	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North and South Carolina	Whole	14	1.4699	1.4664	1.4687	14	174.0	150.5	162.8	12	3.57	0.67	1.70	12	198.2	190.4	192.6	12	2.89	0.53	1.17	14	94.2	28.2	54.2	12	13	9	12
	Winterized	7	1.4695	1.4701	1.4709	7	179.1	161.0	175.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	7	1.4689	1.4662	1.4681	7	162.9	141.4	157.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Coast of Florida	Whole	3	1.4680	1.4669	1.4679	3	158.6	150.0	157.5	3	2.94	1.07	2.30	3	196.5	193.3	193.8	3	1.29	0.75	1.24	3	62.8	48.7	61.5	3	14	10	11
	Winterized	3	1.4694	1.4684	1.4693	3	168.2	161.7	167.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	3	1.4674	1.4654	1.4672	3	150.9	136.4	149.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East of Mississippi Delta	Whole	49	1.4705	1.4662	1.4673	51	182.2	140.1	152.5	51	74.20	0.77	1.70	51	201.4	180.0	195.9	40	1.35	0.13	0.92	49	76.9	19.2	46.2	51	black	10	12
	Winterized	31	1.4722	1.4673	1.4688	31	191.5	148.5	164.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	31	1.4707	1.4638	1.4663	31	168.8	123.9	139.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West of delta to Mexican border	Whole	15	1.4706	1.4666	1.4674	15	165.2	150.7	152.7	15	3.31	1.00	1.78	15	197.5	195.1	196.4	13	1.32	0.59	0.93	15	66.0	22.4	42.8	14	12	11	11
	Winterized	12	1.4699	1.4681	1.4690	12	175.2	140.0	158.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	12	1.4664	1.4567	1.4659	12	145.8	123.2	132.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined data	Whole	114	1.4810	1.4662	1.4687	126	190.8	140.1	162.8	124	74.20	0.47	1.70	124	201.4	162.6	193.7	103	2.89	0.13	0.93	123	94.2	9.0	42.8	124	black	9	11
	Winterized	77	1.4735	1.4673	1.4701	77	197.1	140.0	171.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	77	1.4714	1.4567	1.4677	77	173.7	123.2	153.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
California	Tuna:																												
	Whole	12	1.4758	1.4732	1.4749	12	193.8	163.7	186.8	8	4.96	0.68	3.47	4	198.1	186.2	194.5	1	1.33	1.33	1.33	11	71.8	12.8	42.3	8	black	brown-ish red	dark brown-ish red
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alaska	Herring:																												
	Whole	14	1.4672	1.4646	1.4657	14	172.8	123.1	133.5	14	3.31	0.57	2.05	14	195.2	186.2	188.3	13	1.74	0.77	1.01	14	72.4	26.3	42.0	12	12	7	12
	Winterized	12	1.4678	1.4648	1.4665	12	155.2	120.6	135.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	12	1.4666	1.4638	1.4649	12	146.4	109.4	126.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alaska	Salmon:																												
	Whole	12	1.4707	1.4681	1.4685	12	175.1	150.8	168.6	12	3.48	1.14	2.06	12	187.5	184.9	185.7	10	1.18	0.77	1.00	12	38.5	2.6	3.0	12	13	11	13
	Winterized	8	1.4709	1.4680	1.4691	8	167.4	141.9	152.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stearine	8	1.4693	1.4668	1.4675	6	162.8	94.1	110.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

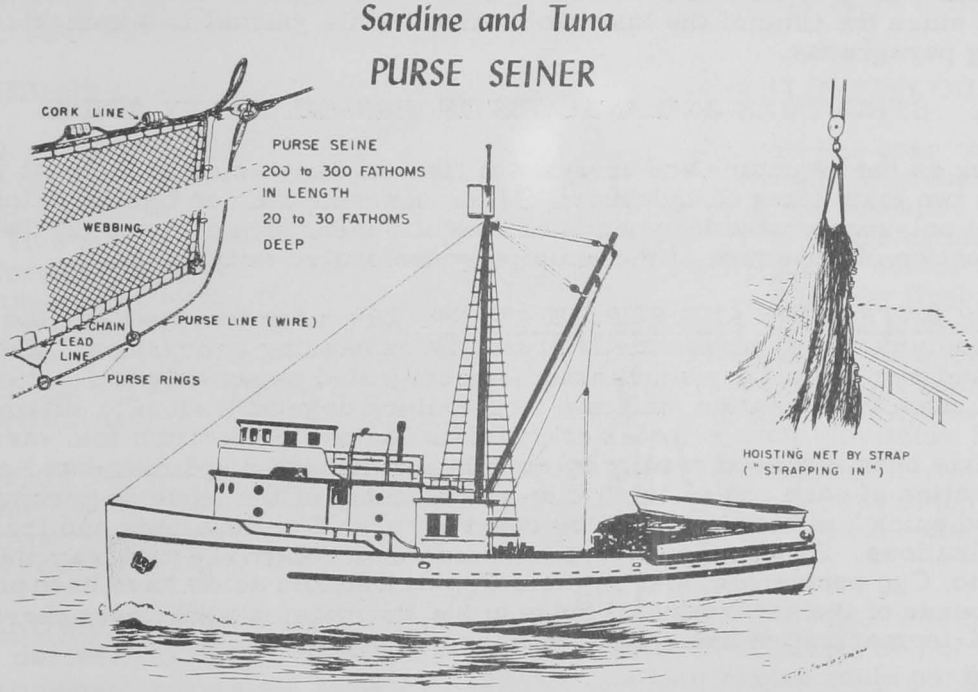
1/Winterized-oil fraction; stearine-oil fraction.

RESULTS

In Table 1 are presented the data obtained in the present work. In addition to the data reported here, data on analysis of oils from individual menhaden reduction plants and data on time of catch of fish from which these oils were produced have been analyzed statistically by a variance technique at the Department of Experimental Statistics of North Carolina State College at Raleigh. At present, these analyses of the physical and chemical characteristics of the fish body oils are being correlated with the many processing variables associated with the different lots of oil and will be reported later.

WEST COAST SARDINE AND TUNA PURSE SEINER

In the Pacific Coast tuna fisheries, the purse seiners or netters are next to tuna clippers in importance. Purse seiners are not as large as the clippers and have a smaller cruising radius and smaller cargo capacity. They were originally designed for sardine and mackerel fishing and usually pursue these species during the fall. Larger purse seiners may fish tuna the year-around and generally catch the same species as the clippers.



The purse seiners use a large net to encircle the schools of fish. The nets generally are about 1,800 feet long and 180 feet deep and generally cost about $30,000 each.