NUTRITIONAL VALUE OF FISH IN REFERENCE TO ATHEROSCLEROSIS AND CURRENT DIETARY RESEARCH

By Charles Butler*

ABSTRACT

THERE IS MUCH IN TODAY'S NEWS ABOUT ATHEROSCLEROSIS, A DISORDER ARISING FROM THE DEPOSITION OF FATTY DEPOSITS, INCLUDING CHOLESTEROL, IN THE ARTERIES THAT SUPPLY BLOOD TO THE HEART. IN THE UNITED STATES ATHEROSCLEROSIS IS PRESENTLY THE CAUSE OF APPROXIMATELY ONE-THIRD OF THE TOTAL DEATHS OF MEN OVER 45 YEARS OF AGE. ALTHOUGH THERE IS NO AGREEMENT ON THE CAUSES FOR THIS DISEASE, IT DOES SEEM TO BE OF METABOLIC ORIGIN WITH A DEFICIENCY, EXCESS, OR IMBALANCE OF DIET POSSIBLY PLAYING AN OBSCURE ROLE IN RELATION TO DISTURBED LIPID METABOLISM.

FISH AND FISHERY PRODUCTS OFFER A NUMBER OF DEMONSTRATED NUTRITIVE MERITS IN THIS OR OTHER DISEASES THAT EVIDENCE NUTRITIONAL IMPLICATIONS. AMONG THESE FEATURES ARE: COMPLETE AND WELL-BALANCED PROTEIN; EASE OF DIGESTION; UNIQUE FORTIFICATION WITH UNSATURATED FATTY ACIDS; AND WIDE CHOICE IN FAT CONTENT, IN SPECIES (SPECIFIC FLAVORS AND TEXTURES), AND IN MARKET FORM SO THAT EYE AND APPETITE APPEAL NEED NOT BE SACRIFICED TO COMPLY WITH A STRICT DIETARY REGIMEN.

RESEARCH NOW UNDER WAY WILL ACCURATELY PINPOINT WHICH OF THE UNSATURATED FATTY ACIDS ARE PRESENT IN FISH OILS, INDICATE THE DEGREE OF ESSENTIALITY OF EACH OF THESE ACIDS IN FAT METABOLISM, AND THROW FURTHER LIGHT ON THE EFFECTS OF INCLUSION OF THESE FATTY ACIDS IN THE DIET ON THE DEPOSITION OF CHOLESTROL IN THE ARTERIES.

A SERIES OF TABLES ARE INCLUDED SHOWING THE CHOLESTEROL CONTENT OF SOME PROTEIN FOODS, THE DISTRIBUTION OF UNSATURATED FATTY ACIDS IN A FISH OIL, THE UNSATURATED FATTY ACID COMPOSITION OF OILS DERIVED FROM SOME MARINE-ANIMALS, LAND-ANIMALS, AND VEGETABLES, AS WELL AS THE PROXIMATE COMPOSITION FOR SOME SPECIES OF MARINE AND FRESH-WATER FISH, SHELLFISH, AND CRUSTACEA.

In relationship to diet, you hear much these days about arteriosclerosis, atherosclerosis, and coronary heart disease. As Samuel Johnson would say, these are "foot-and-a-half words." What do they mean?

Arteriosclerosis is a general term for any of the many forms of hardening of the arteries.

Atherosclerosis is hardening of the coronary arteries through waxy deposits. It therefore is one type of arteriosclerosis.

Coronary heart disease is a disorder in which fatty deposits form in the arteries that supply blood to the heart. The deposits result in constriction in the artery. If the process continues and the deposits harden, the artery then becomes constricted very considerably. In later stages of the disease, a blood clot may lodge in the artery and further impede the flow of blood. Coronary thrombosis then results.

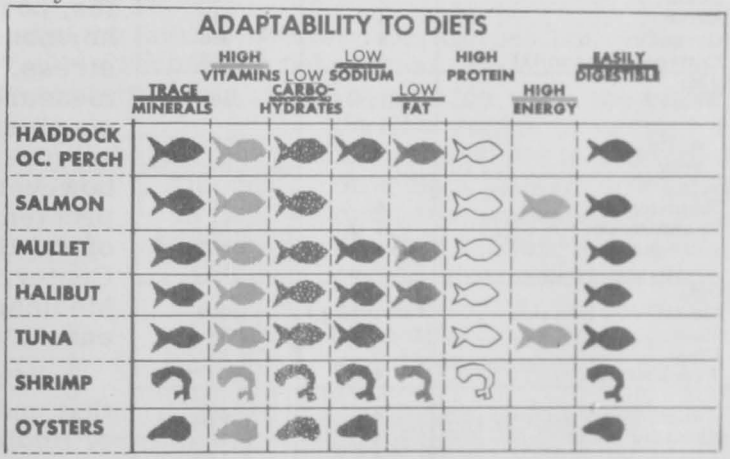

FIG. 1 - SHOWS THE ADAPTABILITY OF VARIOUS TYPES OF FISH AND SHELLFISH TO DIETS.

TWO VIEWPOINTS

Beyond this point, you can get an argument on almost any aspect of the problem of atherosclerosis. Let's look at two of the opposing views for further background.

* CHIEF, BRANCH OF TECHNOLOGY, DIVISION OF INDUSTRIAL RESEARCH AND SERVICES, U. S. BUREAU OF COMMERCIAL FISHERIES, WASHINGTON, D. C.

MECHANICAL INJURY: One group contends that atherosclerosis occurs more often and more markedly in areas of stress induced within the artery injured by pressure of blood flow. Such injury may sensitize the tissues to biochemical action that weakens them and allows further mechanical injury.

A biochemical agent that weakens the tissues could be (1) a normal food ingredient not properly absorbed or excreted, (2) toxic products ingested or allowed to accumulate because of bodily imbalance, or (3) normally assimilable materials that for some reason build up in the blood above normal levels.

CHOLESTEROL DEPOSITS: Another group contends that atherosclerosis results from cholesterol becoming abnormally deposited in the arterial walls along with other lipids (fatty materials), protein, and ultimately, minerals.

Table 1 - Cholesterol Content of Some Protein Foods 1/

Food	Portion Size	Cholesterol Content
	Ounces	Grams 2/
Fish:		
Bluefish	4	.07
Cod	4	.06
Croaker	4	.07
Flounder	4	.072
Haddock	4	.077
Halibut	4	.072
Herring, smoked	4	.07
Lobster, canned	½ cup	.104
Mackerel, Atlantic	4	.096
Salmon, Pacific	4	.11
Salmon, canned	3	.11
Sardines (Atlantic), canned in oil, drained	3	.085
Shrimp, dry-pack, drained	3	.18
Swordfish	4	.07
Tuna, canned in oil, drained	3	.063
	3	.063
Cheese:		
Roquefort	1	.027
Cheddar	4	.032
Edam	4	.018
Swiss	4	.043
Cream	4	.036
Cottage (skim-milk)	4	.002
Eggs:		
Whole	Medium egg (54 g.)	.30
White	-	.00
Yolk	-	.30
Beef:		
Hamburger	4	.14
Round steak	4	.15
Rib roast	4	.352
Liver	4	.12
Pork:		
Bacon	1 strip (8 g.)	.008
Ham	4	.07
Chop	3	.11
Frankfurter	3.5	.07
Veal:		
Cutlet	4	.075
Shoulder roast	4	.11
Leg roast	4	.168
Chicken:		
Canned	4	.085
Fryers (breast)	4	.085
(leg)	4	.08
Milk:		
Whole	one cup	.033
Nonfat	one cup	.001

1/ DATA OBTAINED FROM U.S.D.A. HANDBOOK NO. 8, COMPOSITION OF FOODS, PP. 92-147.
2/ 28.3 GRAMS EQUALS ONE OUNCE.

Cholesterol is a part of the unsaponifiable fraction of fats and oils along with the fat-soluble vitamins A and D, squalene, and a number of the pigments or "color-bodies" of the fat. Fish oil may contain from from 1 to 2 percent of unsaponifiable matter of which 20 to 25 percent in turn may be cholesterol or about 0.2 to 0.5 percent of the total fish oil. Obviously, cholesterol is a very minor constituent of fish oils. Some foods, such as eggs, contain rather more of it. Table 1 shows the cholesterol content for a serving portion of several protein foods.

Among the factors studied by the many workers in this field, that were believed might affect the cholesterol level of blood, were sex, age, racial origin, economic status, body weight, build, obesity or leanness, hormonal balance, composition of diet, and stress. The effects of these factors as measured on test animals, indicate that no conclusive statements can yet be made on any one aspect of atherosclerosis. We are, however, gaining a better concept of the problem. In May 1957, Dr. Wendall Griffith of the University of California Medical Center, while reporting to the American Medical Association, summarized the present state of our knowledge as follows:

"Considerable evidence exists to show that under certain circumstances, sources of linoleic acid may lower elevated blood-serum cholesterol levels in man. The evidence favors the concept that essential unsaturated fatty acids are required for normal transport of cholesterol as lipoprotein and possibly phospholipid complexes in the circulatory system. Circumstances under which high cholesterol levels can be prevented remain to be spelled out. No valid experiments have yet shown the relative effects of surplus dietary calories, of an excess of the total dietary fat, of abnormal ratios of linoleic acid to other fatty acids in the diet, or of numerous other nutritive factors that may influence adversely the physical and chemical characteristics of fatty substances in the blood and in the walls of the vascular system.

Lacking a clearcut solution for prevention of atherosclerosis, a faulty diet may be one of the causative agents. The role of dietary fat remains to be established. Meanwhile, dietary control to attain and maintain optimum body weight and the choosing of a varied diet containing adequate amounts of those foods, including fats, that are shown to have special nutritive value is indicated."

ATHEROSCLEROSIS AND THE MARKETING OF FISH

What are the implications of our knowledge of atherosclerosis (although admittedly inconclusive) as it applies to the marketing of fish? If there is any agreement relating to atherosclerosis, at this stage, it is that this disorder is of metabolic origin--with a deficiency, excess, or imbalance of diet possibly playing an obscure role in relation to disturbed lipid metabolism.

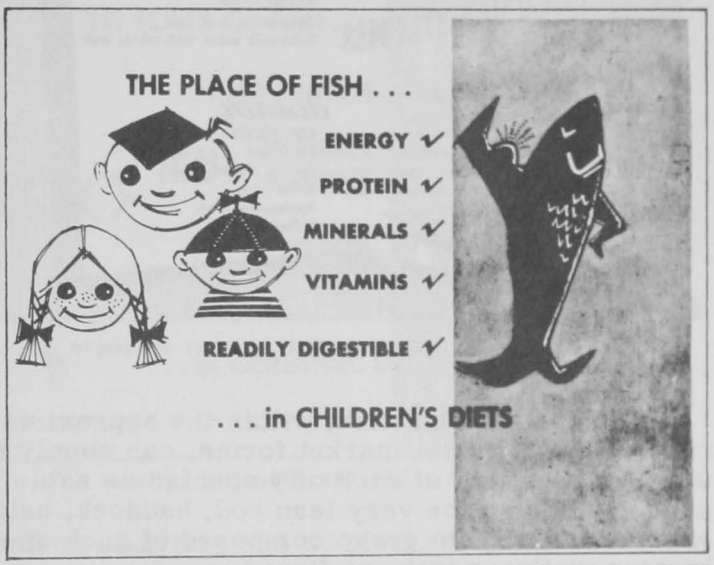

FIG. 2 - FISHERY PRODUCTS POSSESS THE IMPORTANT ELEMENTS NECESSARY FOR CHILDREN'S DIETS.

POSSIBLE BOOMERANG: As Dr. E. Geiger of Van Camp Seafoods Laboratory cogently put it, we can suggest what does not help. He says, in substance, that attempts to exploit preliminary reports may do more harm than good. Earlier, for example, we were told to avoid such cholesterol-containing foods as eggs and the land-animal fats. Next fat-free diets were pushed. Then saturated fats were suspect. Soon the thinking veered to "essential" fatty acids as being the more important of the fats in the diet. Dr. Geiger pointedly indicated that the heart authority who early recommended against canned fish for victims of coronary disease must have regretted this recommendation when the ideas on importance of essential fatty acids and unsaturated oils, both present in canned tuna, for example, came to the fore. Thus during this period of exploratory medical research, any seeking of temporary advantage may boomerang.

Table 2 - Unsaturated Fatty Acids in Pilchard Oils[1/]

Example of Fatty Acid	Carbon Atoms	Double Bonds	Amount in Oil
	No.	No.	Percent
Palmitoleic	16	1	12
Oleic	18	1	6
Linoleic	18	2	12
Arachidonic	20	4	18
Clupanodonic	22	5	14
Tetracosapolyenoic	24	?	15
			77

1/ FROM DATA COMPILED BY E. F. DREW AND COMPANY, INC., NEW YORK 10, NEW YORK.

GOOD STRATEGY: It would seem that a good, long-range strategy would be to push aggressively the more extensive use of fish and fishery products on demonstrated nutritive merits. Some of the well-established facts are pertinent here.

1. We know that fish are an excellent source of complete and well-balanced protein, essential to optimum nutrition.

2. We know that fish are easily digested and become readily available for assimilation, even for those in convalescence, for children, or for the aged.

3. We know that fish can be prepared with all these desirable qualities, but with very low sodium content, if that feature is essential, as it may be in cases of high blood pressure. Recently, Dr. Claude Thurston of the Bureau's Seattle Laboratory found that pink salmon can be made even more desirable for this purpose by the removal of the dark meat, which he found to contain a disproportionately high amount of sodium.

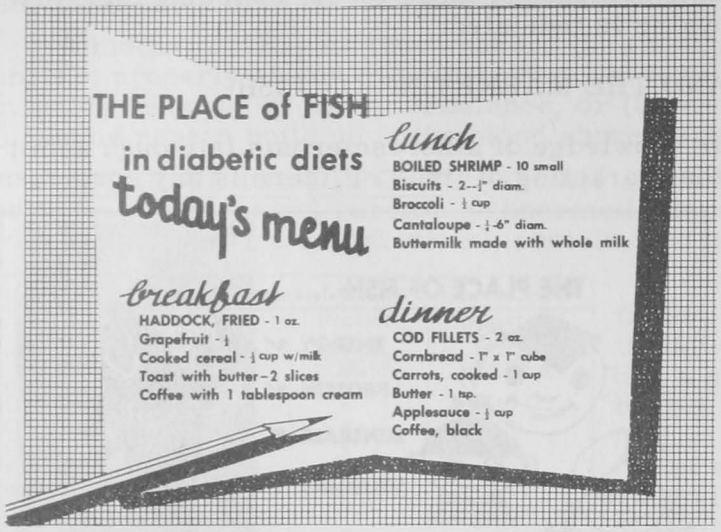

FIG. 3 - DIABETIC DIETS INCLUDE FISHERY PRODUCTS TO GOOD ADVANTAGE.

4. We know that fish oils are uniquely well fortified with more of the unsaturated fatty acids than are vegetable fats or land-animal fats. There is also some evidence that fish fat is easily digested and readily used by the body tissues. Table 2 shows the distribution of the principal unsaturated fatty acids in pilchard oil. At present, those fatty acids tentatively classed as being essential include linoleic, linolenic, and arachidonic.

5. We know that fish, within the approximately 160 marketed varieties and the numerous additional market forms, can supply to the diet any degree of fat desired, whether it be that of such oily species as sablefish, pilchard, or mackerel; that of such species as the very lean cod, haddock, halibut, or shrimp; or that of the numerous intermediate group composed of such species as salmon, tuna, oysters, crab, lobster, yellow perch, or flounder.

Thus, proof already is at hand showing that fish is an excellent food, regardless of the outcome of the additional studies now being conducted on the problem of atherosclerosis.

It should be pointed out, in passing, that this demonstrated value of fish may be applied to the greater utilization of fish in other areas of disease or malnutrition not specifically touched on here. The well-deserved position gained for fish-liver oils as a source of vitamins A and D is not necessarily an isolated case.

OUR KNOWLEDGE MUST CONTINUE TO GROW: Whatever the outcome of continuing worldwide research, we should be alert to benefit from the findings. By corollary, however, it is essential that our presently-limited knowledge of the nutritive value of fish and, specifically, of those factors of greatest importance in current dietary research must continue to grow along with the knowledge being gained in the field of competing products if we are to keep pace. Additional efforts could actually put us ahead, since we are working with products of great merit.

Dr. Stare, of the Department of Nutrition, Harvard University, aptly sums up the situation for this phase of the atherosclerosis discussion, thusly:

"As a final word, we should like to leave the impression that nutritional researches in this important area of health are most promising, and we are enthusiastic about them. But, we think that such enthusiasm should be directed toward further research, to get the many answers we don't have, rather than toward suggesting changes in our accustomed diets, when we aren't too sure at this time, if, or how they should be changed."

FUNDAMENTAL RESEARCH AND THE SALE OF FISH

This summation logically leads us into the third phase of our problem--what, specifically, is being done in our research program that will be of effective help?

As was stated earlier, we know that fish oils contain a larger amount and a greater diversity of the unsaturated fatty acids than do many other food fats. This information is one of the findings of fundamental technological fishery research begun with funds provided by the Saltonstall-Kennedy Act. The elucidation of the detailed chemical structure of the fatty acids in menhaden oil is now far enough along to predict that fish oils generally possess these unique characteristics. The characterization of other principal fish oils soon will be possible, using the methods developed in this study. There is no reason to expect more than the usual minor variability among species that have a comparable oil content, such as menhaden, sardines, and mackerel. For purposes of comparison, table 3 is a compilation showing the unsaturated fatty acid composition of land-animal fats and marine-animal fats and of vegetable oils.

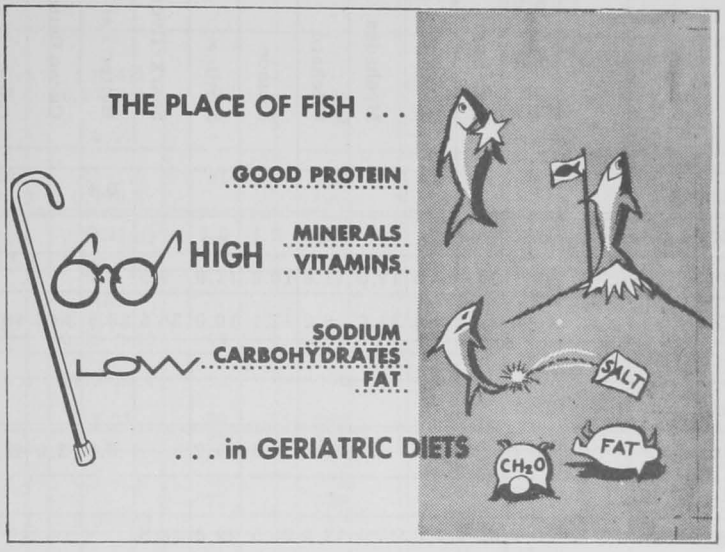

FIG. 4 - FISHERY PRODUCTS ARE IDEAL FOR GERIATRIC DIETS.

LIPOPROTEINS AND PHOSPHOLIPIDS: As a follow-up to a study of the physical-chemical characteristics of all commercially-produced fish oils, we now are setting up a study of the lipoproteins and phospholipids in fish oils. From statements made here, you will recall that these two phases of fat transport and metabolism in the body are believed to be a part of the atherosclerosis problem still unsolved.

DEPOSITION OF CHOLESTEROL: Again, you will recall that there is the unresolved problem of the deposition of cholesterol in the body. A new project now under way will include fish-oil fatty acids of known degrees of unsaturation in the diets of miniature pigs to follow the location and extent of deposition of cholesterol in the arteries. (The metabolism of pigs has been found to be similar to that of human beings. Use of miniature pigs reduces the cost of feeding and, therefore, of experimentation.) Ultimately, the pigs will be butchered, and their arteries examined to evaluate the effects of the several diets employed.

ESSENTIAL FATTY ACIDS: Another phase of this study is related again to the earlier remark about "essential" fatty acids. The diets of rats are set up (1) to throw further light on which of the several fatty acids are actually essential, (2) to determine whether their beneficial effects are available in fish oils, and (3) to point the way to the significance of these factors in human nutrition and in the related areas of human diseases.

UNSAPONIFIABLE COMPONENTS: Still another phase will include the study of the values of another portion of fish oil--the unsaponifiable matter--for pharmaceutical and nutritive purposes. Certain of the unsaponifiable components of fish oil, for example, have been vaguely referred to in the scientific literature as being

effective in such diverse disorders as tuberculosis, excessive irritation of the skin, and wounds. These and other possibilities will be included in the study.

Table 3 - Unsaturated Fatty Acid Composition of Some Marine-Animal, Land-Animal, and Vegetable Oils 1/

Fatty Acids	No. Carbon Atoms	No. C=C Double Bonds	Percentage of Total Fatty Acid Composition																			
			Marine-animal Oils							Land-animal and Vegetable Oils												
			Cod-liver	Herring	Menhaden	Pilchard	Salmon	Sardine	Shark-liver	Butter Fat	Cacao Butter	Corn	Cottonseed	Lard	Olive	Peanut	Rapeseed	Safflower	Soyabean	Tallow-beef	Tallow Mutton
Lauroleic	12	1								0.4											
Myristoleic	14	1	0.2			0.1	0.1	0.1		1.6											
Palmitoleic	16	1	20.0	18.0	17.0	11.8	10.6	11.8	3.5	4.0											
Oleic	18	1	29.1	9.0	27.0	6.2	17.1	10.0	35.5	29.5	38.6	46.0	24.7	48.7	82.8	60.0	29.0	26.4	28.0	44.4	43.0
Gadoleic	20	1																			
Erucic	22	1															50.0				
Linoleic	18	2		13.0		11.5	11.5	15.0		3.6	2.0	42.3	49.7	12.2	7.2	21.0	15.0	67.3	52.6	2.2	5.0
Linolenic	18	3												0.7			1.0	0.2	8.0	0.4	
Arachidonic	20	4	25.4	20.0	20.0	17.9	23.5	22.0	16.5					0.4					0.05	0.1	
Clupanodonic	22	5	9.6	25.0	12.0	13.8	16.2	19.0	16.0												
Tetracosa-polyenoic	24	?				15.2			12.0												
Total			84.3	85.0	76.0	76.5	79.0	77.9	83.5	39.1	40.6	88.3	74.4	62.0	90.0	81.0	95.0	93.9	88.7	47.1	48.0

1/ DATA TAKEN FROM A CHART PREPARED BY THE E. F. DREW AND COMPANY, INC., NEW YORK 10, NEW YORK

PARALLEL STUDIES: To attain the maximum result from our research efforts, the fishing industry may wish to launch parallel studies, or to contribute to such studies. The Maine Sardine Industry now has such projects under way at the Massachusetts Institute of Technology and at the Harvard Medical School. Dr. Kinsell, at the Highland Alameda County Hospital, Oakland, Calif., is even now seeking the aid of private industry (not government) for a 10-year study of certain aspects of atherosclerosis on humans. He has some support, possibly from such groups as the meat industry, and is hopeful that other interested segments of the food industry will cooperate.

ADVANCING MORE WIDESPREAD USE: We come now to the last aspect of the problem under discussion--what can be done by the fishing industry to advance the more widespread use of its infinitely diverse and valuable food products in combating disorders resulting from poor nutrition.

Based on the information already available, the fishing industry can merchandise fish as a dietary staple just as the American Meat Institute, dairy associations, poultry associations, and many similar organizations now do for their protein products. A fishing firm, for example, could develop a sequence of advertisements or promotions around such features as already have been mentioned briefly (see also tables 4 to 7): (1) choice of fat level; (2) well-balanced and complete protein content; (3) essential vitamin and mineral content; (4) diversity of species each with characteristic palate and eye appeal; (5) ease of preparation for fresh, frozen, or canned fish; and (6) the heat-and-serve advantages of the newly-developed fishery products. All these approaches would stress adequate nutrition as a general means of combating nutritional disorders.

Table 4 - Composition of Some Marine Fishes1/

Common Name	Scientific Name	Range of Protein	Range of Oil	Sodium	Potassium	Thiamine	Riboflavin	Niacin
		(Percent)		(Mg./100 g.2/)				
Anglerfish	Lophius piscatorius	8.8-12.4	0.5-4.5	-	-	-	-	-
Bluefish	Pomatomus saltatrix	-	-	-	-	0.12	0.09	1.9
Butterfish	Poronotus triacanthus	16.2-18.2	7.6-22.2	-	-	-	-	-
Cod	Gadus morhua	16.9-19.2	0.23-1.1	76	372	0.06-90	0.09-50	2.2
Croaker	Micropogon undulatus	-	-	-	-	-	-	-
Cusk	Brosme brosme	20.0	1.8	-	-	0.032	0.94	-
Drum: Red	Sciaenops ocellata	-	-	-	-	-	-	-
Flounder:								
Blackback	Pseudopleuronectes americanus	15.5-17.8	1.8-4.2	-	-	-	-	-
Starry	Platichthys stellatus	14.9-19.0	0.87-3.4	85	285	-	-	-
Yellowtail	Limanda ferruginea	-	-	56	366	-	-	-
Fluke	Paralichthys dentatus	20.6	0.07	-	-	-	-	-
Haddock	Melanogrammus aeglefinus	15.5-20.5	.05-1.3	61	304	0.05	0.08-1.1	2.4
Hake	Urophycis tenuis	15.5-16.3	0.2-0.6	-	-	-	-	-
Halibut:								
Pacific	Hippoglossus stenolepis	15.1-20.6	0.21-7.02	53	379	0.07	0.06	9.2
Arrowtooth	Atheresthes stomias	15.0-18.8	0.86-4.38	-	-	-	-	-
Herring,								
Alaska	Clupea pallasii	16.0	12.5	-	-	-	-	-
King whiting	Menticirrhus species	-	-	-	-	-	-	-
Lingcod	Ophiodon elongatus	15.32-18.1	0.35-0.70	62	352	-	-	-
Mackerel:								
Atlantic	Scomber scombrus	16.4-18.4	19.3-28.7	48	236	0.15	0.35	8.4
Pacific (Spanish)	Scomberomorus maculatus	21.6	1.01	89	292	-	-	-
Mullet	Mugil cephalus	-	-	81	292	-	-	-
Ocean perch:								
Atlantic	Sebastes marinus	16.0-19.9	0.2-4.1	79	269	-	-	-
Pacific	Sebastodes alutus	-	-	79	324	-	-	-
Pilchard	Sardinops caerulea	17.9-27.3	2.0-25.1	-	-	-	5.4	-
Pollock:								
Atlantic	Pollachius virens	18.5-19.6	0.2	48	350	0.05	0.08	-
Alaska	Theragra chalcogramma	17.2-18.8	0.8-1.3	-	-	-	-	-
Red Snapper	Lutianus blackfordii	-	-	70	323	-	-	-
Rockfish:								
Black	Sebastodes melanops	17.0-17.9	.06-1.4	66	432	-	-	-
Orange	Sebastodes penniger	16.4-18.0	0.2-0.5	71	347	-	-	-
Red	Sebastodes ruberrimus	17.8-18.0	0.1-0.23	66	413	-	-	-
Sablefish	Anoplopoma fimbria	10.6-16.6	2.6-22.9	-	-	-	-	-
Salmon:								
Chum	Oncorhynchus keta	20.2-23.2	2.2-7.3	-	-	-	-	-
King	Oncorhynchus tshawytscha	20.1-21.2	5.1-7.2	-	-	0.10	0.23	7.2
Pink	Oncorhynchus gorbuscha	17.4-23.2	1.7-9.7	76	290	-	5.2	-
Red	Oncorhynchus nerka	20.3-21.9	7.8-13.7	-	-	-	-	-
Silver	Oncorhynchus kisutch	20.4-22.3	3.3-11.2	-	-	-	-	-
Scup	Stenotomus versicolor	-	-	63	287	-	-	-
Sea trout	Cynoscion arenarius	-	-	59	317	-	-	-
Shad	Alosa sapidissima	-	-	54	330	0.15	0.24	8.4
Smelt	Thaleichthys pacificus	13.2-15.3	4.6-8.8	-	-	-	-	-
Sole:								
Dover	Microstomus pacificus	12.8-17.6	0.5-2.0	-	-	-	-	-
English	Parophrys vetulus	16.0-16.8	0.58-1.8	91	330	-	-	-
Flathead	Hippoglossoides ellasodon	19.0-19.7	1.00-1.2	-	-	-	-	-
Lemon	Pleuronectes quadrituberculatus	16.1	1.0	-	-	-	-	-
Petrale	Eopsetta jordani	14.4-16.4	0.3-3.0	96	268	-	-	-
Rex	Glyptocephalus zachirus	17.0	0.7	-	-	-	-	-
Rock	Lepidopsetta bilineata	19.2	1.3	-	-	-	-	-
Yellowfin	Limanda aspera	17.0	1.3	-	-	-	-	-
Spot	Leiostomus xanthurus	-	-	-	-	-	-	-
Striped bass	Roccus saxatilis	-	-	-	-	-	-	-
Tilefish	Lopholatilus chameleonticeps	19.8	1.8	-	-	-	-	-
Tuna:								
Albacore	Germo alalunga	22.3-25.2	6.5-12.8	34	293	-	-	-
Yellowfin	Neothunnus macroptera	23.3-29.0	6.3-12.9	-	-	-	-	-
Whiting	Merluccius bilinearis	15.4	0.2	65	274	-	-	-

1/ DATA IN THIS TABLE ARE FROM THE BUREAU'S FISHERY TECHNOLOGICAL LABORATORIES. EDIBLE PORTION OF THE FISH WAS USED FOR ANALYSES. IN SOME INSTANCES, ONLY A LIMITED NUMBER OF SAMPLES HAVE BEEN ANALYZED. OTHER DATA ARE BASED ON REASONABLY COMPLETE SAMPLING FOR SEASON, LOCALITY OF CATCH, AND THE HARVEST OF SEVERAL DIFFERENT YEARS.

2/ MILLIGRAMS PER 100 GRAMS OF MEAT. TO CONVERT MG./100 G. TO MG./4 OZ. MULTIPLY THESE FIGURES BY 1.13.

If continuing research further establishes the essentiality of some of the unsaturated fatty acids peculiar to fish, the advantages of eating fish can then be more

Table 5 - Composition of Some Fresh-Water Fish of Great Lakes-Mississippi Valley Area[1/]

Common Name	Scientific Name	Range of Protein	Range of Oil	Sodium	Potassium
		. . . (Percent) . . .		. . (Mg./100 g.) . .	
Carp	Cyprinus carpio	15.6-19.3	1-12	51	285
Blue pike	Stizostedion vitreum glaucum	18.3-19.4	0.7-1.19	-	-
Buffalofish	Ictiobus species	16.3-19.0	1.6-6.9	50	292
Lake chub	Leucichthys species	13.8-16.4	4-13	-	-
Lake herring (Huron)	Leucichthys artedi			38	280
Lake herring (Superior)	Leucichthys artedi			56	358
Lake smelt	Osmerus mordax	17.5-20.0	1.5-3.3	-	-
Lake whitefish	Coregonus clupeaformis	16.3-19.8	4.7-18.8	53	317
Lake trout	Cristisomer namaycush namaycush	15.8-19.6	1.9-16.2	-	-
Mullet (suckers)	Catostomidae species			52	344
Sheepshead (Lake)	Aplodinotus grunniens	14.9-19.6	0.7-10.0	84	278
Sheepshead (River)	Aplodinotus grunniens			59	301
Yellow perch	Perca flavescens	18.2-20.3	0.8-1.2	67	238
Yellow pike	Stizostedion vitreum vitreum	18.7-19.7	0.8-3.0	52	324

1/ DATA IN THIS TABLE ARE FROM THE BUREAU'S FISHERY TECHNOLOGICAL LABORATORIES. EDIBLE PORTION OF THE FISH WAS USED FOR ANALYSES. IN SOME INSTANCES ONLY A LIMITED NUMBER OF SAMPLES HAVE BEEN ANALYZED. OTHER DATA ARE BASED ON REASONABLY COMPLETE SAMPLING FOR SEASON, LOCALITY OF CATCH, AND THE HARVEST OF SEVERAL DIFFERENT YEARS.

specifically stressed for nutrition in which such fatty acids are important. If fish oils are practically the only natural source of the more highly unsaturates (table 3), our studies on the characteristics of the fatty acids will have been well founded and profitable indeed.

Table 6 - Composition of Some Shellfish and Crustaceans[1/]

Common Name	Scientific Name	Range of Protein	Range of Oil	Thiamine	Riboflavin	Niacin
		. . . (Percent). . . .		. . . . . (Mg./100 g.).		
Lobster	Homarus vulgarus	19.7-20.7	0.3-2.5	-	-	-
Lobster	Homarus americanus	16.2	1.9	-	-	-
Scallop, Pacific	Pecten maximus	17.5	0.5-1.0	-	-	-
Shrimp	(unknown)	25.0	1.0	-	-	-
Crab: Dungeness	Cancer magister	22.6-24.2	1.4-1.5	-	-	-
King	Paralithodes camtschatica	18.3-19.6	1.3-1.5	0.18-0.3	0.13	5
Eastern, hardshell	Unknown--probably blue crab, Callinectes sapidus	15.8	1.5	0.14	0.06	2.7
Oyster: Eastern	Ostrea virginicus	4-9	0.7-2.8	0.18-0.3	0.23-0.46	1.2
Pacific (Jap.)	Ostrea gigas	10.7	0.8	-	-	-
Pacific (Native)	Ostrea lurida	-	-	-	-	-
Shrimp, Alaska	Pandalus borealis	21.1	0.8	-	-	-
Mussel	Mya edulus	8.7-13.0	1.1-1.3	-	-	-
Clam: Soft	Mya arenaria	11.4-13.6	1.0-1.7	-	-	-
Little neck	Paphia staminea	13.5	1.0	-	-	-
Cockle	Cardium corbis	10.1-13.5	0.9-1.4	-	-	-
Butter	Saxidomus giganteus	12.8-15.1	1.6-2.8	0.1	0.18	0.16
Abalone, Alaska	Haliotea kamtschatkama	17.1	0.7	-	-	-

1/ DATA IN THIS TABLE ARE FROM THE BUREAU'S FISHERY TECHNOLOGICAL LABORATORIES. EDIBLE PORTION OF THE FISH WAS USED FOR ANALYSIS. IN SOME INSTANCES ONLY A LIMITED NUMBER OF SAMPLES HAVE BEEN ANALYZED. OTHER DATA ARE BASED ON REASONABLY COMPLETE SAMPLING FOR SEASON, LOCALITY OF CATCH, AND THE HARVEST OF SEVERAL DIFFERENT YEARS.

Table 7 - Composition of Some Protein Foods[1/]

Food	State	Portion	Food Energy	Protein	Oil
		Ounces	Calories	. . . . (Grams)	
Bacon, Canadian	Raw	4	262	25	17
Beef: Hamburger	Raw	3	316	19	26
Porterhouse	Boneless	3	293	20	23
Round	Boneless	3	197	23	11
Rib roast	Boneless	3	266	20	20
Roast	Canned	3	189	21	11
Bluefish	Baked	4	193	34	5
Bluefish	Fried	5.3	307	34	15
Cheese: Cheddar	-	1	113	7	9
Cottage	-	1	27	6	.1
Cream	-	1	106	2.6	10.5
Chicken: Broiler	Raw, boneless	8	332	44	16
Roaster	Raw, boneless	4	227	23	14
Fryer, breast	Raw, boneless	8	210	47	1
Fryer, leg	Raw, boneless	5	159	29	4
Clams	Raw, canned	4	92	14.5	1.6
	Canned	3	44	6.7	0.9
Cod	Raw	4	84	18.7	0.5
	Dried	1	104	23.2	0.8
Eggs	Raw or cooked	1 medium	77	6	5.5
Flounder	Raw	4	78	17	0.6
Haddock	Fried	4	166	22.5	6.3
Halibut	Broiled	4	207	29.8	9
Pork	Raw	3	100	14.4	4.1
Herring: Atlantic	Raw	4	217	20.8	14.2
Pacific	Raw	4	106	18.8	2.9
Lamb: Chop	Cooked, boneless	3	356	20	30
Leg	Roasted, boneless	3	230	20	16
Mackerel: Atlantic	Canned	3	155	16.4	9.4
Pacific	Canned	3	153	17.9	8.5
Milk, whole	Raw	3	231	11.9	13.3
Oysters, meats	Raw	3	71.7	6.6	1.7
Peanuts	Roasted	1 cup	805	38.7	63.6
Peas	Green	1 cup	111	7.8	0.6
Pork: Ham	Cooked, boneless	3	339	20	28
Loin	Raw, boneless	3	284	20	22
Salmon:	Broiled	1 steak	204	33.6	6.7
King	Canned	3	173	16.8	11.2
Chum	Canned	3	118	18.3	4.4
Silver	Canned	3	140	17.9	7.1
Pink	Canned	3	122	17.4	5.3
Red	Canned	3	147	17.2	8.2
Sardines, Atlantic	Canned in oil	3	288	17.9	23
Pilchards, Pacific	Canned, natural	3	171	15.1	11.5
	Canned tom. sauce	3	184	15.1	12.6
Sausage, bologna	-	4	252	16.8	18.0
Frankfurter	Cooked	4	283	16.0	23.0
Scallops	Raw	4	89	16.8	0.1
Shad	Raw	4	191	21.2	11.1
Shrimp	Canned, drained	3	108	22.8	1.2
Swordfish	Broiled	1 steak	223	34.2	8.5
Tuna	Canned, oil, drained	3	169	24.7	7.0
	Canned, not drained	3	247	20.2	17.8
Veal: Cutlet	Cooked, boneless	3	184	24	9
Roast	Cooked, boneless	3	193	24	10

1/ DATA OBTAINED FROM U.S.D.A. HANDBOOK NO. 8, COMPOSITION OF FOODS, PP. 92-147.

Since the study of the efficiency of these unsaturated fatty acids in lowering blood-serum cholesterol will move hand in hand with the study on the nutritional essentiality of them, our work will allow us to keep abreast of the best present thinking by medical science. We therefore also can build on what may be found by other research workers with other fats.

In summary, then, an appealing, high-quality, nutritionally adequate, well-balanced food, available in suitable form for any home or institutional use, gives a strong foundation on which to build a program for aiding buoyant national health and for combating the inroad of not just one but of numerous types of nutritional diseases. On such a program is a sound and prosperous fishing industry based.

CANNED TUNA

Canned tuna is a familiar item in almost every American home and on every groceryman's shelf. It is economical, excellent nutritionally, easy to prepare, and universal in taste appeal.

Several species of fish are marketed as tuna, all of which are equally desirable to the homemaker. On the Pacific coast, the catch includes albacore, bluefin, skipjack, and yellowfin. Bluefin and little tuna are taken on the Atlantic coast. Albacore has lighter meat than the other species and is the only tuna permitted to be labeled as "white meat." The other species are labeled as "light meat" tuna.

Canned tuna is available in three different styles of pack. The pack does not indicate a quality difference, but refers to the size of the pieces in the can.

"Fancy or Solid Pack" is marketed in $3\frac{1}{2}$-, 7-, and 12-ounce cans. This style is mechanically cut to convenient pieces and packed in oil. This pack is especially adaptable to salads and other dishes where chunks of tuna are desirable. It is the moderately-priced pack.

"Chunk Style" is marketed in $3\frac{1}{4}$-, 6-, $6\frac{1}{2}$-, and 12-ounce cans. This style is mechanically cut to convenient pieces and packed in oil. This pack is especially adaptable to salads and other dishes where chunks of tuna are desirable. It is the moderately-priced pack.

"Flake and Grated Style" is marketed in 6- or 11-ounce cans. This style is mechanically cut to smaller pieces than the "chunk style" and is also packed in oil. It is excellent for canapes or sandwiches where the tuna is blended into a paste. It is generally lower-priced than the preceding packs.

A number of specialty packs are also available, such as "tonno," consisting of solid-meat tuna packed in olive oil and about double the amount of salt; a "dietetic," packed in distilled water for people who must avoid salt and fat in their diets; a baby food; a tuna paste; and others.

The inexpensiveness and versatility of canned tuna account for this fish being the most frequently served canned fish in the United States. One or two cans of tuna, used as an extender in casseroles or salads, or on sandwiches, will provide an adequate serving for six people.