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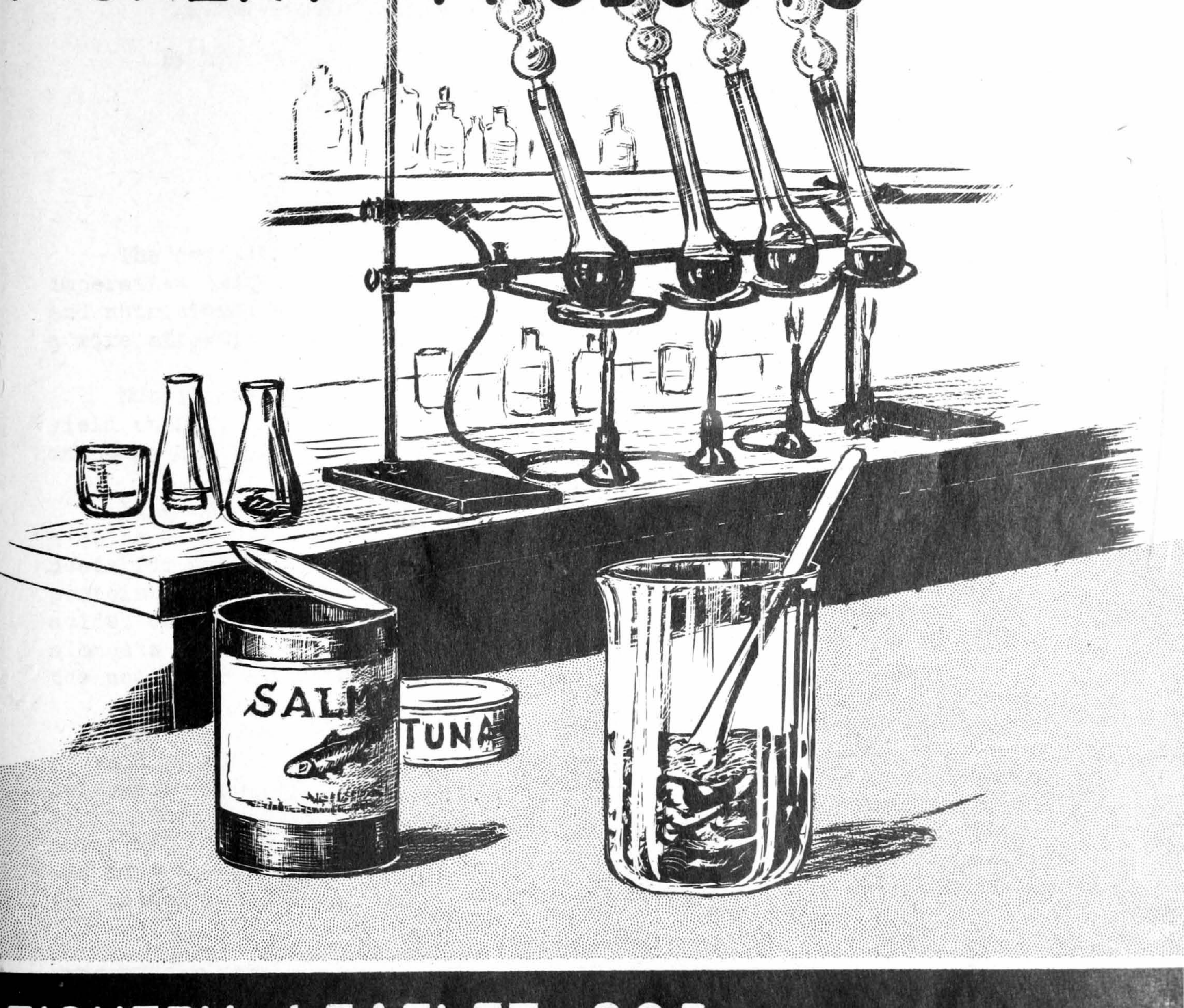

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INTRODUCTION

The critical food situation existing in the world today makes it imperative that we have available comprehensive data on the composition and nutritional value of all important foods. This information permits a more effective use of the variety of available foods.

Nutritional chemistry today teaches that the functions of food are to yield energy, build up or replace the body tissues and to regulate and maintain the body processes.

In general, human nutritional requirements may be summarized as consisting of sufficient digestible organic foodstuffs to satisfy the body needs for energy, expressed in energy units termed "calories;" enough protein of a quality suitable to meet body needs for essential amino acids; an adequate amount and proper proportions of the essential mineral elements generally designated as ash constituents, and enough of each of the necessary vitamins.

The ability of a food to satisfy nutritional requirements of energy, protein, fat, and minerals is related to its composition, which is determined chemically and usually expressed as "proximate composition." Proximate composition includes moisture, protein, carbohydrate, fat, and total ash. A fundamental contribution in the field of food composition was made by W. O. Atwater in the 19th century. His tables of composition for common human foods have formed a base for nearly all nutritional tables.

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Subsequent to Atwater's initial contribution on food composition, investigations have been confined largely to agricultural and related products; until very recently, little attention has been given to fishery products. Much of the available data are based on analysis of the raw products. Such information is of doubtful validity when used in computing the value of cooked or canned fish and fishery products because of changes taking place during preparation for cooking and in the cooking or canning process. This lack of information on processed fish and fishery products emphasizes the need for presenting reliable data.

The collection of a large number of canned fishery products in the course of a technological study on canning made available a wide range of material for determination of the proximate composition of an important source of food in a field where data were lacking. It was necessary in this canning study to make a determination of the dissolved iron content. Since this chemical determination was required it was decided to make additional analyses for proximate composition as well; resulting data are herewith presented.

SOURCE OF SAMPLES

The samples analyzed in this study were obtained from packs prepared during a study of tin-substitute containers conducted during the Second World War by the Fish and Wildlife Service. This contribution was part of a cooperative study conducted by the canning and can making industries to develop substitutes for the "standard" tin can to make the most effective use of the available supply of tin. The Fish and Wildlife Service made experimental packs using cans made from types of experimental plates found to have commercial possibilities in the packing of fruits, vegetables, meat and milk in the research studies of the National Canners Association.

The substitute plates selected were tested with all commercially canned fishery products packed in the United States. All packs were prepared in commercial canneries and standard procedures in handling, packing, processing, cooling, storing and shipping, were followed. The packs made were thus essentially commercial packs. Therefore it was decided to make proximate analyses of the packs canned under this program, to overcome the previously mentioned lack of data on this subject and to check the validity of existing data. Packs were prepared at important fish canning centers on both the Atlantic and Pacific Coasts. A total of 226 packs of 33 different species was made under this program.

Three special product packs of mixed composition were included in the series. The clam chowder, Manhattan style, was a regular commercial pack of private formula. Each No. 1 picnic can contained assorted vegetables and two ounces of clam meats. The clam chowder, New England style, to fill a No. 1 picnic can, consisted of $3\frac{1}{2}$ ounces of clam meats, $3\frac{1}{2}$ ounces of diced potatoes, and $3\frac{1}{2}$ ounces of a mixture made of wheat flour, onions, hydrogenated vegetable oil, water and spices. The fish chowder, New England style, to fill a No. 1 picnic can, consisted of $3\frac{1}{2}$ ounces of cooked haddock flesh, $3\frac{1}{2}$ ounces of diced potatoes, and $3\frac{1}{2}$ ounces of a mixture made of wheat flour, onions, hydrogenated vegetable oil, water and spices.

PREPARATION OF SAMPLES FOR ANALYSIS

The whole contents of a can were used for analysis except for the sardines in oil. These were drained free of excess oil. The can contents were disintegrated in a Waring Blendor and kept thereafter in a glass topped jar until analyzed. In most cases, a measured proportion of distilled water was added to the material in the blendor to facilitate the disintegration of the sample, and the values obtained were corrected to the original dry matter content of the material.

METHODS OF ANALYSIS

The methods of analysis used were in general those of the American Association of Agricultural Chemists (AOAC) (1945). Moisture was determined as the loss on heating in a vacuum oven. The ether extract was obtained on a weighed sample dried in the extraction cups in a vacuum oven (Modified Bailey-Walker Method). The dried material was extracted for 48 hours, the ether evaporated and the fat residue in the flask dried and weighed directly.

The total nitrogen was determined by the Gunning-Arnold modification of the Kjeldahl method. The ammonia was distilled, absorbed in a solution of boric acid, and titrated directly with standard hydrochloric acid using a mixed indicator.

Ash content was determined as the residue on ignition in a muffle furnace with temperature controlled at 525° C. The mineral constituents were determined in a hydrochloric acid solution of the ash residue.

Calcium was determined by the microtitration procedure of the A.O.A.C. Phosphorus was determined by the colorimetric method of Stoloff (1942), which utilizes the blue color developed by the reduction of phosphomolybdic acid. Iron was determined by the A.O.A.C. method for plants using potassium persulfate instead of nitric acid to oxidize the iron. The red color developed with thiocyanate in aqueous solution was read directly, without extraction. A photoelectric colorimeter was used to compare the colors developed in both the iron and phosphorus determinations.

Carbohydrates were present only in the chowder packs, from the vegetables, and in the clams and oysters as glycogen. The carbohydrate content was estimated as the difference between the dry matter content, and the sum of the protein, ether extract, and ash. The energy value in calories per hundred grams has been calculated on the basis of four calories per gram of protein and carbohydrate, and nine calories per gram of fat.

The pH of the contents from all cans was taken as the cans were opened. These data have not been included, as they have no bearing on the nutritive value of the food. Virtually all packs were very slightly acid, the range of pH varied from 5.56 to 7.10 with the majority of packs having a pH of less than 6.5.

DISCUSSION

The analytical results are listed in tables 1 and 2 with data calculated to a dry matter basis in table 2 as well as on an "as canned" basis in table 1. The dry matter content of the different types of fish varied considerably, from the minced razor clams which contained only 13.9 percent, to the oil packed bluefin tuna which was almost half dry matter or 47.2 percent. Generally speaking, the fatty fish - salmon, herring, mackerel, sardines and menhaden - are high in dry matter and in energy value. This is true because the protein content of all species is fairly constant, at 17 to 20 percent, higher only when fish have had a precook and partial dehydration. The fat content, which may range up to 20 percent, is in addition to rather than a replacement of any part of the protein.

The scientific names of the fish tested are listed in table 3 along with the more common names for positive identification, since local names vary considerably.

The second column of table 1 shows the number of analyses represented by the average values in the table. Except for the sample of Pacific hard clams and one of the two samples of Gulf oysters which were composites of three cans, all data were for a single can.

Six individual cans of menhaden were analyzed and eight cans each of the packs of pollock flakes and deep-sea fish roe. The data for these packs (table 4) demonstrate the order of variation which may normally be encountered between single cans of the same packs. The existence of this wide range in the truly normal composition of so many of the species of fish should be kept in mind when such data are used in dietetic calculations.

TABLE 1

PROXIMATE COMPOSITION OF FISHERY PRODUCTS AS CANNED

Fish	No. of anal.	Moisture	Total solids	Total nitrogen	Protein (Nx6.25)	Ether extract	Ash	Carbohydrates by diff.	Calcium	Phosphorus	Iron	Calories per 100 grams
		Grams per one hundred grams							mgs per 100 grams			
rring, Maine sea	4	62.2	37.8	2.81	17.5	17.5	3.1	-	147	297	1.8	227
rring, river		73.0	27.0	2.59	16.2	8.0	3.4	-				137
ckerel, Boston	1	62.9	37.1	2.71	17.0	18.1	3.2	-	186	260	3.2	230
ckerel, California	1	63.1	36.9	3.09	19.3	15.9	2.9	-	343	384	3.6	220
nhaden	6	67.9	32.1	2.99	18.7	10.2	3.8	-	N.D.	N.D.	1.3	167
lchard, Cal. "natural" pack	1	65.2	34.8	2.83	17.7	13.5	2.9	-				192
lchard, Cal. tomato pack	1	65.1	34.9	2.86	17.9	13.8	2.7	-				196
llock, flakes	8	72.9	27.1	3.89	24.3	1.54	1.9	-	49	232	0.8	111
lmon, chinook	1	60.8	39.2	3.08	19.3	17.7	2.0	-	200	326	0.5	236
rdines, in mustard	1	68.6	31.4	3.15	19.7	7.9	3.7	-	279	403	5.2	150
rdines, in oil (drained)	1	61.6	38.4	3.76	23.5	12.7	3.1	-	363	488	1.4	208
ad, Columbia River	2	71.1	28.9	2.70	16.9	8.8	2.8	-	N.D.	N.D.	0.7	147
elt	2	54.7	45.3	3.38	21.1	13.5	5.4	-	358	370	1.7	206
na, bluefin	1	52.8	47.2	3.46	21.6	22.6	3.1	-	N.D.	N.D.	1.2	290
Shellfish												
am, Atlantic, hard	1	82.6	17.4	1.54	9.6	0.88	2.6	4.3	87	125	6.3	64
am, Pacific, hard	2	81.9	18.1	1.80	11.2	1.42	1.5	4.0	63	147	2.2	74
am, razor, minced	1	86.1	13.9	1.43	8.9	0.70	1.6	2.7	14	140	1.6	53
ab, Dungeness (Pacific)	4	76.6	23.4	3.28	20.5	1.22	2.1	-	52	213	0.9	93
sters, Atlantic	2	81.7	18.3	1.49	9.3	2.56	4.5	1.9	45	130	8.4	68
sters, Gulf Coast	2	81.7	18.3	1.17	7.3	2.42	1.4	7.2	10	117	3.6	80
rimp, dry pack	1	64.6	35.4	4.53	28.2	1.96	6.5	-	126	286	2.7	131
rimp, wet pack	1	77.3	22.7	2.52	15.8	1.02	5.8	-	63	155	1.5	72
Special Products												
am chowder (1943 pack), anhattan style (tomato)	1	82.5	17.5	0.45	2.8	2.85	2.7	9.2	40	52	1.1	74
am chowder (1945 pack), anhattan style	1	82.9	17.1	0.42	2.6	2.26	2.7	9.5	N.D.	N.D.	1.1	69
am chowder (1943 pack), ew England style	1	78.1	21.9	1.05	6.5	1.17	7.5	6.7	29	86	5.7	63
am chowder (1945 pack), ew England style	1	80.8	19.2	0.79	4.9	0.86	2.4	11.0	15	63	5.8	72
sh chowder, New England tyle	1	84.1	15.9	1.16	7.3	1.39	2.2	5.1	23	68	1.5	62
sh roe, deep sea cod and haddock)	8	75.5	24.5	3.13	19.6	3.34	1.5	-	15	346	1.2	108
e, herring, river	2	73.0	27.0	2.56	16.0	7.94	3.4	-	N.D.	N.D.	1.2	135

N.D. = No Data

TABLE 2

PROXIMATE COMPOSITION OF CANNED FISHERY PRODUCTS
ON A DRY MATTER BASIS

Fish	Total protein	Ether extract	Ash	Calcium	Phos-phorus	Carbo-hydrates by diff.	Calories per 100 gms
	Grams per 100 grams			Mgs per 100 gms			
Herring, Maine sea	46.4	46.2	8.2	389	785	-	601
Herring, river	60.0	29.6	12.6			-	507
Mackerel, Boston	45.7	48.7	8.6	501	701	-	620
Mackerel, California	52.4	43.1	7.9	930	1041	-	596
Menhaden	58.3	31.8	11.8	N.D.	N.D.	-	520
Pilchard, Cal. "natural" pack	50.9	38.8	8.3			-	552
Pilchard, Cal. tomato pack	51.3	39.5	7.7			-	562
Pollock, flakes	89.8	5.7	7.2	181	856	-	410
Salmon, chinook	49.2	45.1	5.2	511	832	-	602
Sardines, in mustard	62.7	25.1	11.7	887	1282	-	478
Sardines, in oil (drained)	61.2	33.0	8.0	946	1272	-	542
Shad, Columbia River	58.5	30.4	9.7	N.D.	N.D.	-	509
Smelt	46.6	30.0	11.9	79	817	-	455
Tuna, bluefin	45.8	47.9	6.6	N.D.	N.D.	-	615
Shellfish							
Clam, Atlantic, hard	55.4	5.1	14.9	503	722	24.7	368
Clam, Pacific, hard	61.8	7.8	8.3	345	810	22.1	409
Clam, razor, minced	64.0	5.0	11.7	97	1005	19.4	381
Crab, Dungeness (Pacific)	87.4	5.2	8.9	222	910	-	397
Oysters, Atlantic	50.9	14.0	24.6	246	715	10.4	372
Oysters, Gulf Coast	39.9	13.2	7.5	550	636	39.3	437
Shrimp, dry pack	80.0	5.5	18.3	356	809	-	370
Shrimp, wet pack	69.5	4.5	25.6	276	684	-	317
Special Products							
Clam chowder (1943 pack), Manhattan style (tomato)	16.0	16.3	15.2	229	296	52.6	423
Clam chowder (1945 pack), Manhattan style	15.2	13.2	15.8	N.D.	N.D.	55.6	404
Clam chowder (1943 pack), New England style	29.8	5.3	34.4	131	392	30.6	288
Clam chowder (1945 pack), New England style	25.7	4.5	12.5	80	330	57.2	375
Fish chowder, New England style	45.6	8.7	13.6	144	427	32.1	390
Fish roe, deep sea (cod and haddock)	79.7	13.6	6.0	62	1410	-	441
Roe, herring, river	59.3	29.4	12.6	N.D.	N.D.	-	500

N.D. = No Data

TABLE 3

COMMON AND SCIENTIFIC NAMES OF CANNED FISH TESTED

Clam, Atlantic, hard	*Venus mercenaria*
Clam, Pacific, hard	*Tirela stultorum*
Clam, razor	*Siliqua patula*
Crab, Dungeness	*Cancer magister*
Herring, Maine, sea	*Clupea harengus*
Herring, river (alewife)	*Pomolobus pseudoharengus*
Mackerel, Boston	*Scomber scombrus*
Mackerel, California	*Pneumatophorus diego*
Menhaden	*Brevoortia tyrannus*
Oyster (Gulf and Atlantic)	*Ostrea virginica*
Pilchard, California	*Sardinia caerulea*
Pollock	*Pollachius virens*
Salmon, Chinook	*Oncorhynchus tschawytscha*
Sardines, Maine	*Clupea harengus*
Shad, Columbia River	*Alosa sapidissima*
Shrimp (Atlantic and Gulf)	*Penaeus setiferus*
Smelt	*Osmerus mordax*
Tuna, bluefin	*Thunnus thynnus*

TABLE 4

VARIATION IN PROXIMATE ANALYSIS OF DIFFERENT CANS FROM THE SAME PACK OF FISH

Pack	Variation	Total N	Ether Extract	Ash	Calcium	Phosphorus
llock lakes	Range	3.73 - 4.04	1.31 - 1.72	1.72 - 2.14	24.7 - 72.3	21.7 - 24.6
	Percent of mean	8.0	26.6	21.6	96.6	12.5
ep sea e	Range	2.84 - 3.52	3.11 - 3.71	1.39 - 1.61	12.0 - 18.0	31 - 39
	Percent of mean	21.8	18.0	14.9	40.0	23.1
nhaden	Range	2.71 - 3.61	7.51 - 15.0	3.46 - 3.88		
	Percent of mean	30.1	73.6	11.2		