MFR PAPER 1022

New study establishes values of chemical constituents of 32 types of fish.

Chemical and Nutritive Values of Several Fresh and Canned Finfish, Crustaceans, and Mollusks Part I: Proximate Composition, Calcium, and Phosphorus

VIRGINIA D. SIDWELL, JAMES C. BONNET, and ELIZABETH G. ZOOK

ABSTRACT

This paper presents the proximate composition, calcium, and phosphorus of the edible portion of 32 commonly eaten finfish, crustaceans and mollusks. Among these are the canned finfish, salmon and tuna in oil and tuna in brine. The mean, standard error of the mean, range, and number of analyses are given for each component.

INTRODUCTION

The data found in literature generally cover the results of a very limited number of chemical or nutritive components in several species of fish or fishery products. It is rare to find the results of as many analyses as we are reporting on the same species of fish or fishery product. Consequently these results are unique. The data are divided into three parts: (1) the proximate composition, calcium, and phosphorus; (2) crude fat and fatty acid composition; and (3) the amino acid composition. Part I on proximate composition is complete for the number of samples tested. The other two, which will appear later, are interim reports. The demand for these data has been so great that the partially complete listings will be valuable in giving a good approximation of the fatty acid content and amino acid content of raw edible fish or fishery products.

The objective of this paper (Part I) is to report the mean, standard error of the mean, range, and number of analyses for moisture, crude protein, ether fat,[1] ash, calcium, and phosphorus content of 32 commonly eaten fish or fishery products.

PROCEDURE

Samples

Samples were collected by personnel in the Technology Laboratories at Gloucester, Mass.; Pascagoula, Miss.; Seattle, Wash.; and College Park, Md. Each laboratory was assigned species of fish to be collected, as shown in Table 1.

Sampling Plan

The fish used in the study are the same as the ones used for the microconstituent study (Zook et al., Ms.) conducted by the College Park Laboratory.

[1] Ether fat or crude fat is that portion of a moisture-free fish sample that can be extracted by ethyl ether or petroleum ether.

Virginia D. Sidwell, James C. Bonnet, and Elizabeth G. Zook are members of the staff of the College Park Fishery Products Center, National Marine Fisheries Service, NOAA, College Park, MD 20740.

The collectors at each of the laboratories were requested to obtain eight samples of each of their assigned species large enough to be divided into two subsamples. Regrettably this was not adhered to in some cases, so the College Park technologists did not have sufficient samples for the following seven species: cultivated and wild catfish, *Icatalurus punctatus;* spiny lobster, *Panulirus argus;* calico scallops, *Argopecten gibbus;* Gulf white shrimp and South Atlantic white shrimp, *Penaeus setiferus;* and red snapper, *Lutjanus campechanus.* The remaining species contain data on nine individual lots with the 10th sample being a within-species duplication. The samples were caught during the spring, summer, and fall of 1971.

The information on the location of catch, date of catch, number of fish in each sample, and name of the boat and captain or the name of the com-

Table 1.—Species of fish to be obtained by each Technology Laboratory of the National Marine Fisheries Service.

Gloucester, Mass.	Pascagoula, Miss.	Seattle, Wash.	College Park, Md.
Cod inshore	Catfish cultured wild	Crab, king body meat leg meat	Clam hard shell soft shell surf
Flounder yellowtail	Lobster spiny	Halibut Pacific	Cod Icelandic
Haddock inshore	Scallop calico	Rockfish California	Crab blue
Oyster Long Island	Shrimp brown white, Gulf white, So. Atl.	Salmon sockeye canned	Hake Pacific
Perch ocean	Snapper red	Shrimp Alaskan Asian Mexican	Oyster Md. & Va.
Pollock Atlantic		Tuna yellowfin (canned)	
Scallop bay sea			
Shrimp Maine			
Whiting domestic			

Table 2.—Proximate composition, calcium, and phosphorus content of the edible portions of raw finfish.

Fresh finfish	Proximates				Minerals	
	Moisture g%	Crude protein g%	Ash g%	Ether fat g%	Ca mg%	P mg%
Catfish (Cultured)	[1]77.4 ± 0.1	20.5 ± 0.7	1.53 ± 0.09	0.65 ± 0.32	64 ± 8	228 ± 14
Ictalurus punctatus	[2]74.5—80.7	17.0—23.9	1.10—1.94	0.09—2.31	20—90	130 – 240
	[3]10	10	10	8	9	9
Catfish (Wild)	79.4 ± 0.2	18.2 ± 0.3	1.19 ± 0.02	0.96 ± 0.11	27 ± 2	214 ± 8
Ictalurus punctatus	77.9—80.0	16.3—19.7	1.09—1.25	0.51—1.51	19—37	158—298
	10	10	10	9	9	15
Cod (Icelandic)	81.4 ± 0.2	18.1 ± 0.2	1.20 ± 0.02	0.10 ± 0.02	22 ± 1	192 ± 7
Gadus morhua	79.0—83.1	16.7—19.6	1.01—1.36	0.01—0.26	18—30	150—240
	22	20	20	20	16	15
Cod (Inshore-Domestic)	80.1 ± 0.3	19.6 ± 0.3	1.26 ± 0.04	0.12 ± 0.02	42 ± 5	222 ± 6
Gadus morhua	76.8—83.3	16.3—21.8	0.96—1.84	0.00—0.30	19—80	180—270
	23	24	20	20	16	18
Flounder, Yellowtail	76.5 ± 0.3	22.3 ± 0.4	1.21 ± 0.04	0.37 ± 0.06	27 ± 2	203 ± 12
Limanda ferruginea	74.1—78.7	18.8—25.5	1.05—1.76	0.05—1.16	20—40	170—300
	20	20	20	19	14	12
Haddock (Inshore)	79.0 ± 0.2	20.4 ± 0.3	1.50 ± 0.05	0.11 ± 0.01	62 ± 7	211 ± 13
Melanogrammus aeglefinus	78.0—80.7	16.7—22.6	1.12—1.87	0.03—0.23	20—90	150—350
	20	20	21	20	11	20
Hake, Pacific	80.1 ± 0.2	18.4 ± 0.4	1.25 ± 0.04	0.69 ± 0.10	28 ± 3	176 ± 5
Merluccius productus	78.7—81.1	16.2—22.4	1.00—1.59	0.20—1.50	20—50	150—200
	18	18	18	17	17	15
Halibut, Pacific	77.5 ± 0.4	20.1 ± 0.3	1.27 ± 0.02	1.22 ± 0.23	47 ± 6	221 ± 8
Hippoglossus stenolepsis	76.6—80.9	18.1—22.9	1.14—1.49	0.43—3.90	20—78	160—260
	23	21	21	19	13	16
Perch, Ocean	77.3 ± 0.3	21.7 ± 0.3	1.45 ± 0.03	0.81 ± 0.11	141 ± 7	223 ± 6
Sebastes marinus	75.8—80.2	19.6—24.8	1.18—1.71	0.10—1.44	80—190	160—270
	21	19	22	17	21	23
Pollock	77.7 ± 0.2	20.9 ± 0.2	1.47 ± 0.06	0.15 ± 0.03	87 ± 12	228 ± 10
Pollachius virens	75.8—80.6	19.2—22.5	1.12—2.01	0.0—0.51	30—150	160—300
	22	23	20	20	11	16
Rockfish, Pacific	79.7 ± 0.2	19.8 ± 0.3	1.26 ± 0.03	0.53 ± 0.10	39 ± 5	214 ± 7
Sebastes sp.	78.0—81.3	18.0—22.6	1.07—1.42	0.03—1.58	20—90	160—250
	22	22	20	19	9	12
Snapper, Red	76.0 ± 0.2	22.4 ± 0.1	1.31 ± 0.02	0.41 ± 0.08	28 ± 4	210 ± 8
Lutjanus blackfordii	73.8—77.7	20.9—23.6	1.16—1.55	0.09—1.36	20—50	160—240
	24	23	20	21	15	19
Whiting	78.7 ± 0.4	17.8 ± 0.2	1.26 ± 0.03	2.43 ± 0.22	72 ± 6	222 ± 11
Merluccius bilinearis	75.6—80.9	16.3—19.5	1.00—1.53	0.78—4.76	50—100	150—290
	22	25	21	20	11	13

[1] Mean and standard error of the mean.
[2] Range.
[3] Number of analyses.

mercial supplier may be obtained from the Appendix of Zook et al. (Ms.).

Sample Preparations

Fish were filleted and skinned if possible. The fillets were very finely ground in either a stainless steel Hobart[2] Silent Cutter or Waring Blendor. With the canned fish the entire contents of each can were ground. The flesh of mollusks and crustaceans was removed from the shell and treated like the finfish. All equipment was rinsed with double distilled water just prior to use. The finely ground fish was packed into 4-ounce plastic ice cream containers, packed in dry ice, and shipped via air freight to College Park.

[2] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

ANALYTICAL PROCEDURES

The analyses for crude protein and ether fat were done according to the methods described in the Official Methods of Analysis (Horwitz, 1970: protein 2-051; ether fat, 7.048).

The moisture analyses were done by placing a weighed sample in moisture tins, dried for 16 hours in a forced air oven at 100°C.

The ash was determined by placing the sample in a crucible and burning it at 550°C for 16 hours.

The calcium and phosphorus were determined by an automated method outlined in the paper by Smith, Kurtzman, and Ambrose (1966).

Table 3.—Proximate composition, calcium, and phosphorus content of the edible portions of canned finfish.

	Proximates				Minerals	
Canned finfish	Moisture g%	Crude protein g%	Ash g%	Ether fat g%	Ca mg%	P mg%
Salmon, Sockeye	[1]71.3 ± 0.2	21.0 ± 0.2	2.35 ± 0.11	6.04 ± 0.13	22 ± 1	273 ± 10
Oncorhynchus nerka	[2]69.3—72.5	19.3—22.1	1.55—3.03	5.20—7.08	19—28	180—340
	[3]16	20	17	16	9	17
Tuna, Yellowfin (canned	59.9 ± 0.4	22.9 ± 0.5	1.91 ± 0.05	15.2 ± 0.4	37 ± 7	224 ± 5
in oil)	57.9—62.2	19.3—24.3	1.51—2.11	13.0—17.7	20—67	190—260
Thunnus albacares	14	12	12	11	7	15
Tuna, Yellowfin (canned	74.8 ± 0.4	24.0 ± 0.2	1.48 ± 0.12	0.81 ± 0.08	33 ± 9	195 ± 12
in brine)	73.1—76.5	23.3—24.8	1.14—1.92	0.43—1.04	20—50	180—230
Thunnus albacares	8	8	8	8	3	4

[1] Mean and standard error of the mean.
[2] Range.
[3] Number of analyses.

Table 4.—Proximate composition, calcium, and phosphorus content of the edible portion of raw crustaceans.

	Proximates				Minerals	
Crustaceans	Moisture g%	Crude protein g%	Ash g%	Ether fat g%	Ca mg%	P mg%
Crab, Blue	[1]77.4 ± 0.3	19.8 ± 0.1	2.06 ± 0.04	1.02 ± 0.07	102 ± 12	272 ± 10
Callinectes sapidus	[2]75.2—80.6	18.4—21.0	1.81—2.46	0.55—1.58	22—180	200—370
	[3]22	22	22	20	13	16
Crab, King (body)	79.2 ± 0.3	18.3 ± 0.2	1.60 ± 0.05	0.38 ± 0.02	42 ± 3	212 ± 10
Paralithodes camschatica	76.7—81.4	17.0—19.5	1.19—1.83	0.24—0.54	21—69	180—273
	16	16	16	16	24	25
Crab, King (leg)	76.8 ± 0.07	20.1 ± 0.5	1.81 ± 0.06	0.40 ± 0.03	55 ± 4	228 ± 10
Paralithodes camschatica	69.2—79.3	17.2—24.9	1.28—2.52	0.22 – 0.67	40—80	160—320
	17	18	18	18	12	18
Lobster, Spiny	75.6 ± 0.3	23.1 ± 0.2	1.71 ± 0.02	0.33 ± 0.03	47 ± 4	237 ± 11
Panulirus argus	74.2—79.0	22.0—25.6	1.51—1.96	0.17—0.55	20—80	150—320
	23	20	20	15	18	19
Shrimp, Alaskan	77.4 ± 0.3	20.1 ± 0.4	2.26 ± 0.14	0.64 ± 0.02	49 ± 4	187 ± 4
Mixed spp.	75.5—79.7	16.7—26.2	1.41—3.77	0.44—0.85	40—80	170—210
	20	22	19	20	14	12
Shrimp, Asian	84.0 ± 0.4	15.2 ± 0.4	0.77 ± 0.03	0.42 ± 0.17	68 ± 5	181 ± 10
Mixed spp.	81.0—87.3	13.1—18.8	0.53—0.96	0.12– 3.00	30—90	130—230
	20	20	21	16	14	10
Shrimp, Brown	76.2 ± 0.1	21.4 ± 0.2	1.63 ± 0.01	0.14 ± 0.01	59 ± 2	248 ± 5
Penaeus aztecus	75.2—76.5	17.2—23.3	1.54—1.72	0.05—0.28	40—80	220—290
	20	23	20	20	19	18
Shrimp, Maine	81.5 ± 0.5	17.1 ± 0.4	1.30 ± 0.06	0.39 ± 0.05	54 ± 4	177 ± 9
Pandalus borealis	77.9—86.0	13.5—20.2	0.93—1.86	0.12—0.82	40—80	150—270
	19	23	20	19	11	14
Shrimp, Mexican	80.4 ± 0.3	18.1 ± 0.3	1.40 ± 0.04	0.18 ± 0.03	95 ± 2	176 ± 4
Mixed spp.	78.5—82.5	16.5—20.6	1.14—1.68	0.06—0.55	70—120	150—210
	22	23	20	18	14	18
Shrimp, White (Gulf)	77.4 ± 0.2	20.6 ± 0.1	1.41 ± 0.02	0.20 ± 0.02	50 ± 1	233 ± 9
Penaeus setiferus	76.4—78.7	19.5—21.6	1.26—1.57	0.05—0.40	40—60	150—290
	20	21	20	20	20	17
Shrimp, White	76.2 ± 0.2	22.0 ± 0.2	1.90 ± 0.05	0.17 ± 0.02	64 ± 3	281 ± 11
(South Atlantic)	75.3—79.5	20.9—23.5	1.86—2.03	0.06—0.26	50—90	160—350
Penaeus setiferus	22	20	20	15	17	17

[1] Mean and standard error of the mean.
[2] Range.
[3] Number of analyses.

RESULTS AND DISCUSSIONS

The proximate composition of the raw edible portion of finfish is listed in Table 2. The standard error of the mean for each mean value is quite small. The ranges for each species are quite large. This variability may be due to the fact that these fish may have been in different physiological status since they were caught from spring to fall. These finfish may be considered as low-fat fish since the range of fat in the fish flesh was from 0.00 to 4.76 percent.

Table 5.—Proximate composition, calcium, and phosphorus content of the edible portion of raw Mollusca.

Mollusca	Proximates				Minerals	
	Moisture g%	Crude protein g%	Ash g%	Ether fat g%	Ca mg%	P mg%
Clams (Hard Shell)	[1]91.8 ± 0.1	4.41 ± 0.17	1.97 ± 0.02	0.21 ± 0.02	65 ± 3	69 ± 3
Marcenaria mercenaria	[2]90.8—92.5	3.20—6.24	1.79—2.16	0.10—0.42	20—91	50—130
	[3]20	19	20	20	31	26
Clams (Soft Shell)	83.3 ± 0.9	9.51 ± 0.43	1.19 ± 0.09	1.27 ± 0.16	53 ± 3	152 ± 6
Mya arenaria	76.6—90.8	5.48—11.68	0.62—1.99	0.42—2.64	17—73	110—206
	20	20	17	20	27	24
Clams (Surf)	79.4 ± 0.2	15.6 ± 0.1	2.29 ± 0.10	0.34 ± 0.06	41 ± 3	194 ± 5
Spisula solidissima	78.2—80.9	14.6—16.7	1.10—3.05	0.10 – 0.87	17—80	110—265
	20	20	20	20	31	36
Oysters (Long Island)	85.4 ± 0.2	7.86 ± 0.23	1.11 ± 0.02	1.13 ± 0.07	52 ± 3	145 ± 6
Crassostrea virginica	82.5—86.6	6.65—10.28	0.93—1.28	0.75—1.89	30—70	110—240
	20	20	20	20	20	20
Oysters (Maryland & Virginia)	88.3 ± 0.2	5.77 ± 0.24	0.65 ± 0.02	1.06 ± 0.08	36 ± 4	121 ± 5
	87.0—90.0	4.48—7.86	0.55—0.83	0.56—1.97	20—70	100—140
Crassostrea virginica	21	20	20	19	17	7
Scallops (Bay)	78.8 ± 0.7	14.1 ± 0.1	1.42 ± 0.02	0.20 ± 0.03	32 ± 5	207 ± 5
Pecten sp.	76.4—87.8	12.9—14.8	1.25—1.59	0.09—0.43	20—80	180—250
	20	19	20	20	16	17
Scallops (Calico)	77.8 ± 0.4	16.9 ± 0.1	1.79 ± 0.01	0.21 ± 0.02	32 ± 2	215 ± 5
Argopecten gibbus	76.8—83.6	15.9—18.5	1.71—1.89	0.11—0.31	20—60	160—270
	20	20	20	19	19	20
Scallops (Sea)	78.2 ± 0.2	18.2 ± 0.1	1.50 ± 0.02	0.17 ± 0.02	22 ± 1	234 ± 16
Placopecten magellanicus	77.2—79.7	17.1—19.0	1.38—1.84	0.02—0.32	20—30	150—320
	21	20	20	20	15	16

[1] Mean and standard error of the mean.
[2] Range.
[3] Number of analyses.

There was a great variability in the amounts of calcium and phosphorus found in the raw flesh. Probably this is due to the method of filleting the fish. It is rather difficult to remove all the bony tissue during the fillet process, and smaller fish would retain more bones.

In Table 3 are the results of the most commonly utilized canned finfish. The fat content of the canned in oil tuna is 5 percent lower than the value listed in Agriculture Handbook 8 (Watt and Merrill, 1963: 15.2 and 20.5, respectively). The same is true for the protein value. The fat content of the tuna canned in brine is the same, 0.8 percent, but the protein value is lower in our results—24.0 percent and 28.0 percent, respectively. The canned salmon is approximately like the ones found in Handbook 8.

In Table 4 it may be observed that the king crab, *Paralithodes camschatica*, tends to have a higher protein value in the leg portion than in the body meat. The tail meat of the spiny Florida lobster, *Panulirus argus*, has the highest protein value. The fat content of the crustaceans is very low except for the blue crab, *Callinectes sapidus*.

As it may be noted in Table 5, some oysters contain much less protein and more moisture than the scallops. The scallops approximate the values observed in finfish or crustaceans.

In summary, this report presents values for crude protein, moisture, ether fat, ash, calcium, and phosphorus of 32 fish or fishery products that are commonly eaten in the United States.

LITERATURE CITED

Horwitz, W. (editor). 1970. Official methods of analysis. Association of Official Agricultural Chemists. Assoc. Off. Agric. Chem., Washington, D.C.
Smith, P., C. H. Kurtzman, and M. E. Ambrose. 1966. Automatic method for the determination of calcium in the presence of magnesium and phosphate ions. Clin. Chem. 12:418-427.
Watt, B. K., and A. L. Merrill. 1963. Composition of Foods. Raw, processed, prepared. Agriculture Handbook No. 8, U.S. Dep. Agric., Wash., D. C. 190 p.
Zook, E., J. Powell, B. Hackley, J. Emerson, J. Brooker, and G. Knobl, Jr. Ms. Survey for selected heavy metal content of consumer available fish. (In preparation).

MFR Paper 1022. From Marine Fisheries Review, *Vol. 35, No. 12, December 1973. Reprints of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*