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The Nutritional Value of Seafoods

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Virginia Fisheries Laboratory of the College of
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CURTIS L. NEWCOMBE**

The yield of the fishery industry of the United States in 1938 was about four and one-quarter billion pounds, 45 percent of this amount being utilized by the nation for human food (Higgins, 1942). This represents an average annual consumption per person of about 14.5 pounds. As compared with the peoples of maritime countries in Europe and Asia, Americans are not large consumers of seafoods. In 1920, the consumption of oysters per person in the United States was 1.13 pounds, a little over double the amount eaten in 1938.

Growth of an understanding and appreciation of the nutritional values of seafood products has not kept pace with the growth in population. A time of national stress, when the nation's food supplies are diminishing rapidly, may be appropriate for replying to some of the questions that are frequently asked the student of nutrition.

WHAT IS A FOOD, AND UPON WHAT DOES FOOD VALUE DEPEND?

A food is a substance which may be used by a living organism to provide growth, repair and energy. In general, the value of a food depends upon its use for the development of good health. That which is a good food for one organism may be a poor food or even harmful for another organism.

Marine animals live in a medium which contains all the mineral elements in about the same proportions as they are needed in the human body. These animals extract the important mineral elements from the water, and supply them to us in a usable form. From seafoods we get iron which is needed to prevent anemia; iodine that prevents goiter; and phosphorus, copper and magnesium which are needed to regulate certain important body functions. Oysters, and crabs are rich in vitamins and have a much higher iron content than most kinds of fish. Oyster, shrimp and crab meats in addition to being rich sources of iron, copper, and iodine contain approximately one half as much calcium, three times as much magnesium and much more phosphorus than an equal quantity of milk.

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*Educational Series No. 2 representing a compilation of available information on the nutritional value of seafoods for the use of high school teachers. Principal sources of the nutritional data presented are given on the concluding page.

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Fin-fish constitute rich sources of protein, phosphorus, iron, and iodine. The many forms in which they may be obtained from the market such as smoked, pickled, salted, canned or fresh make them important. Fish provide a variety to the meat diet as well as an economical source of food materials.

The oyster, like milk, is more nearly balanced nutritionally and is a richer source of minerals, and vitamins than most foods. Fresh liver and oysters contain animal starch known as glycogen. The oyster can be compared with liver as a source of iron and copper in usable form. It is estimated that one pound of oysters provides about twelve percent of the energy needed by a man for a day, fifty percent of the protein, twenty-six percent of the calcium, forty percent of the phosphorus, over one hundred and eighty-four percent of the iron, and about one hundred and ten percent of the iodine (table IV). The oyster contributes to practically every dietary need, including vitamins A, B_1, B_2, and C.

WHAT ARE THE PRINCIPAL SEAFOODS?

The ten most important fish of Virginia in order of quantity produced are: menhaden, croaker, herring, gray trout, shad, spot, butterfish, porgy, flounder, and striped bass. The most important shellfish are oysters, blue crabs, hard-shelled clams and mussels.

WHY MUST SEAFOODS BE KEPT FRESH?

There is a great variation among different fresh seafoods, and pronounced variations in any one seafood before it reaches the consumer. This is due to enzyme action that immediately follows death, to bacterial growth and to various chemicals used for preservative purposes.

It is important that seafoods be kept fresh because in most cases the fresher the seafood, the more delicately it is flavored. Decomposition often produces a higher flavored food that one tires of in a short time. No special treatment is likely to improve the nutrient properties of fresh seafood. Rather, the nutrient value may be expected to decline with storage.

HOW MAY SEAFOODS BE KEPT FRESH?

There is a variety of ways in which seafoods may be kept fresh. One is by maintaining certain temperatures that lessen the direct chemical changes in the tissues and retard bacterial growth. Changes near the surface due to oxidation alter the taste and often the color of seafoods. Temperature changes often affect the water content of the tissues.

Many fish are preserved from bacterial growth by using salt. A smoking process is often combined with the salt. This is a specialized process involving the use of strong brine at a low temperature, followed by a strong current of air and later smoke of different kinds.

In order to insure the freshest conditions the temperature should be lowered quickly to about zero degree F. as soon after death as possible. This low temperature should be maintained until shortly before the seafood is to be used. The surface should be protected from air action.

WHY IS IT DIFFICULT TO KEEP FISH FRESH?

It is necessary that the fishermen take their catch where, when, and in such quantities as they are available. Often the capture involves the death of the animal. Sometimes there is mechanical injury to the body tissue which speeds up the process of decomposition.

WHAT ENERGY PRODUCING SUBSTANCES MAKE UP FOODS?

The fuel value of foods is expressed by a simple energy unit called the calorie. By definition a calorie is the amount of heat that is necessary to raise the temperature of one pound of water four degrees F. One pound of starch (carbohydrate), if completely burned to produce heat and energy either outside or inside the human body, will develop enough heat to raise 1900 pounds of water four degrees F. in temperature. While fish are very low in carbohydrates (starches and sugars), they contain larger amounts of protein and fat types of food material. Proteins and carbohydrates have about the same fuel value whereas fats have over double as much fuel value.

While proteins, carbohydrates, and fats comprise by far the greater proportion of our foods, there is another essential food substance, namely, the inorganic matter or ash. The ash-constituents of bone tissues are exceptionally high. Deficiencies in inorganic substances or mineral elements such as calcium and iodine give rise to serious ailments. Fish and shellfish, as compared with many other foods, are very rich in essential minerals including calcium, magnesium, phosphorus, iron, copper and especially iodine.

WHAT ARE THE PROTEIN, FAT AND CARBOHYDRATE CONTENTS OF SEAFOODS?

Generally speaking, the percentages of moisture and of fat vary more than the percentage of protein or inorganic matter (ash) in different species of fish. There has also been found to be seasonal variation in composition and in food value of any one kind of fish. The tendency is toward an increase in fat content from spring to fall. The degree of ripeness of some fish, e. g. shad or bluefish, also affects inversely the fat content of the flesh.

In general, the fuel value of the edible parts of molluscs and crustaceans is not as high as that of fish flesh. The reason is that fish flesh usually contains more fat. However, it contains very little—less than one half of one percent—of carbohydrate. Molluscs and crustaceans on the other hand contain some carbohydrate in the form of glycogen, sometimes called animal starch, which is a form of sugar storage in the muscles and also in the liver.

Table I indicates the proximate composition of some of our most important seafoods. These may be compared with milk, beef, and liver in respect to their edible portions or the parts most commonly eaten. The water content varies considerably. Fish may be contrasted with other seafoods listed in that they possess very little carbohydrate. Although it is frequently present, it is generally less than 0.5 percent. Total carbohydrate includes starch, dextrin and sugars.

Shellfish range up to nearly 6 percent in carbohydrate content, while crustacea are relatively low. Milk and liver are as high or higher than shellfish (table I).

In general, fish are considered to fall into three classes—(1), those fairly low in fat and having about 19 percent protein, e. g. sea bass, rockfish, croaker, sea trout, bluefish and herring; (2), those very low in fat and somewhat lower in protein than those referred to above, such as cod and flounder; and (3), those higher in fat content and comprising a variable group subject to distinct seasonal variations, e. g. shad, Spanish mackerel and butterfish. Most of the commercial fish of the Chesapeake Bay fall into one of these categories. The protein content of fish is comparable to that of beef and liver and significantly higher than that of milk (table I). Although the shad, butterfish, and Spanish mackerel, illustrating class 3, average about 11 percent in content of fat, most of our local commercial fishes are below 4 percent. The fat content of oysters is around 2 percent and that of the lobster and crab still less. Fish are comparable to milk and beef liver in the percentage of fat and beef meat ranges as high as 19 per cent.

TABLE I

PROXIMATE COMPOSITION OF EDIBLE PORTIONS OF FISH, SHELLFISH, AND CRUSTACEA IN COMPARISON WITH MILK, BEEF, AND LIVER, EXPRESSED IN PER CENT AND IN GRAMS AND CALORIES PER POUND

(Modified after Chatfield and Adams*, 1940)

FOOD	PROTEIN		FAT		ASH		CARBOHYDRATES		FUEL VALUE
	Per Cent	Grams†	Per Cent	Grams	Per Cent	Grams	Per Cent	Grams	Calories
FISH:									
Alewife or Branch Herring	19.4	88.0	4.9	22.2	1.5	6.8	0.		550
Bluefish or Tailor	20.5	93.0	4.0	18.1	1.2	5.4	0.		535
Butterfish or Dollarfish	18.1	82.1	10.2	46.3	1.4	6.4	0.		745
Carp or German Carp	18.2	82.6	2.2	10.0	1.2	5.4	0.		420
Croaker or Hardhead	17.8	80.8	2.2	10.0	1.3	5.9	0.		415
Drum, Red or Channel Bass	18.0	81.6	0.4	1.8	1.3	5.9	0.		345
Eel, American	18.6	84.4	9.1	41.3	1.0	4.5	0.		710
Flounder, Summer and Winter	14.9	67.6	0.5	2.3	1.3	5.9	0.		290
Mackerel, Atlantic	18.7	84.8	12.0	54.4	1.2	5.4	0.		830
Mackerel, Spanish	19.8	89.8	13.3	60.3	1.3	5.9	0.		900
Mullet, Jumping or Fatback	19.3	87.5	4.4	20.0	1.2	5.4	0.		530
Mullet, Sea or King Whiting	18.3	83.0	3.0	13.6	1.3	5.9	0.		455
Perch, White	19.3	87.5	4.0	18.1	1.2	5.4	0.		515
Porgy or Scup	18.6	84.4	4.5	20.4	1.4	6.4	0.		520
Rockfish or Striped Bass	18.9	85.7	2.7	12.2	1.2	5.4	0.		455
Sea Bass or Black Will	19.2	87.0	1.2	5.4	1.2	5.4	0.		395
Shad	18.7	84.8	9.8	44.4	1.4	6.4	0.		740
Sturgeon	18.1	82.1	1.9	8.6	1.4	6.4	0.		405
Trout, Gray or Weakfish	17.8	80.8	1.7	7.7	1.2	5.4	0.		390
Average	18.5	84.1	4.8	22.0	1.3	5.8	0.		534

TABLE I—CONTINUED

FOOD	PROTEIN		FAT		ASH		CARBO-HYDRATES		FUEL VALUE
	Per Cent	Grams†	Per Cent	Grams	Per Cent	Grams	Per Cent	Grams	Calories
SHELLFISH‡:									
Clam or Maninose	13.6	61.6	1.7	7.7	2.0	9.0	2.1	9.5	355
Clam, Hard-shelled	11.1	50.3	0.9	4.1	2.3	10.4	5.9	26.8	345
Mussel, Sea or Edible	14.4	65.3	2.3	10.4	1.6	7.3	4.5	20.4	435
Oyster	9.8	44.4	2.0	9.0	2.0	9.0	5.9	26.8	365
Average	12.2	55.4	1.7	7.8	2.0	8.9	4.6	20.9	375
CRUSTACEA:									
Crab, Blue and Pacific	16.1	73.0	1.6	7.2	1.7	7.7	0.6	2.7	370
Lobster	16.2	73.5	1.9	8.6	2.2	10.0	0.5	2.3	380
Average	16.1	73.2	1.7	7.9	1.9	8.8	0.5	2.5	375
MILK, cow (fresh)	3.5	15.8	3.9	17.7	0.7	3.2	4.9	22.2	310
BEEF, medium (fresh)	18.2	82.6	19.0	86.2	0.8	3.6	0.	0.	1110
LIVER, beef (fresh)	19.7	89.4	3.2	14.6	1.4	6.4	6.0	27.2	600

*USDA Circular No. 549.
†One pound = 453.6 grams.
‡Meat only, not including oyster liquor.

TABLE II

MINERAL CONTENT OF THE EDIBLE PORTION OF FISH FILLETS, SHELLFISH, CRUSTACEA, MILK AND BEEF

(Modified after Nilson and Coulson, 1939*)

FOOD	MILLIGRAMS PER POUND†					
	Calcium	Magnesium	Phosphorus	Iron	Copper	Iodine
FISH:						
Cod (*Gadus morrhus*)	49.9	127.1	845.0	2.35	0.19	0.47
Haddock (*Melanogrammus aeglefinus*)	74.9	107.1	787.0	2.34	0.19	2.33
Mackerel (*Scomber scombrus*)	21.8	127.6	986.0	5.56	0.52	0.24
Mullet (*Mugil cephalus*)	118.5	144.4	999.0	8.08	0.37	2.20
Flounder (*Pleuronectidae*)	53.1	138.5	933.0	.....	.....	0.13
SHELLFISH:						
Oyster, Eastern (*O. virginica*)	262.9	145.3	509.5	27.69	16.93	0.22
Oysters, Pa. Natives (*O. lurida*)	286.9	109.9	699.9	22.43	5.63	0.14
CRUSTACEA:						
Blue crab, white meat (*C. sapidus*)	466.7	152.5	932.5	10.27	7.18	0.19
Blue crab, claw meat	320.5	156.6	816.1	3.39	1.67	0.68
Shrimp, raw (*P. brasiliensis*)	246.1	191.1	1038.0	9.93	1.50	0.10
MILK	544.8	54.5	422.0	0.91	0.09	0.03
BEEF	54.5	109.0	981.0	13.62	0.45	0.004

*U. S. D. A., Invest. Rept. No. 41.

†CONVERSION NOTE.—1 milligram per pound is equivalent to 2.2 parts per million (p.p.m.). 1 pound = 453.6 grams. Thus 49.94 mgms. per pound = 110 p.p.m. of calcium. (Conversion from p.p.m. to mgms. per pound made by the writer.)

While molluscs and crustaceans as a group do not have as high fuel value on the average as fresh fish flesh, they play an important part in the diet because they contain considerable quantities of protein essential for muscle building and are particularly noted for their delicate and unusual flavors, being widely used as appetizers.

WHAT ARE THE QUANTITIES AND FUNCTIONS OF THE MINERALS IN THE HUMAN BODY?

There are six minerals that are important in determining the nutritional value of food. They are: calcium, magnesium, phosphorus, iron, copper, and iodine. The quantity of these elements present in seafood provides a useful index to their relative food values since

TABLE III

APPROXIMATE DAILY REQUIREMENTS* FOR AVERAGE ADULT

	Range	Average
Total Calories	2000–4000	3000
Protein	60–130 gms.	90.0 gms.
Fat	20–50 gms.	35.0 gms.
Calcium	0.6–1.4 gms.	1.0 gms.
Phosphorus	0.8–1.4 gms.	1.3 gms.
Iron	12–15 mgs.	15.0 mgs.
Copper	2.0–3.5 mgs.	3.0 mgs.
Iodine	0.05–0.5 mg.	0.2 mg.
VITAMINS:		
A	1.5–3.3 mgs.	3.0 mgs.
B_1 thiamin	1.0–2.0 mgs.	1.8 mgs.
B_2 riboflavin	2.0–3.0 mgs.	2.5 mgs.
C ascorbic acid	70–100 mgs.	80.0 mgs.
D	0.01–0.02 mg.	0.02 mg.

*Sources—USDA Yearbook, 1939, and other standard works.

the human body has a fairly definite requirement for these substances (table III).

Of the six elements, calcium is the one that is most likely to be present in insufficient quantity in our diet. It is greatly needed. Nearly 99% of the calcium in the body is in the bones and the teeth. For their growth and development, calcium and phosphorus are essential.

Approximately 70% of phosphorus in the body is in the teeth and bones. Certain essential elements are required for the metabolism of the body cells. The bones contain about 70% of the magnesium in the body. Muscle tissue contains more magnesium than calcium, while blood contains relatively more calcium. It is likely that the average diet contains sufficient amounts of magnesium to meet the needs of the body.

Only about three or four grams of iron are present in the human body and of this amount 2.5 gm. are in circulation. It has been estimated that about 15 milligrams of iron per day are sufficient to meet the daily requirements of the human body. Apparently copper is needed for the conversion of absorbed iron into hemoglobin for the blood.

A most important constituent in the diet is iodine. Its absence or presence in insufficient quantity causes endemic goiter. Iodine is likely to be deficient in all inland areas. A daily intake of 0.2 milligram of iodine has been recommended by nutritional experts. In this respect, seafoods are most important.

WHAT IS THE MINERAL CONTENT OF SEAFOODS?

In general, the amounts of mineral substance in marine organisms are highly variable in the same species depending on the season and place of collection. Table II includes some values of different classes of food given by Nilson and Coulson (1939). These records afford a fairly good basis for a general comparison of the mineral content of fish, shellfish, crustacea, milk, and beef.

In regard to calcium content, fish compare with beef and are much lower than shellfish and crustacea. White meat of the blue crab is highest in calcium content, being almost as rich as milk in this important bone-building mineral. As compared with fish, oysters are high in calcium (table IV).

TABLE IV

THE PERCENTAGE OF DAILY REQUIREMENTS PROVIDED BY 0.5 POUND OF VARIOUS SEAFOODS AND BY MILK AND BEEFSTEAK

(Data from Tables I, II and III)

FOOD	Per Cent Calories	Per Cent Protein	Per Cent Fat	Per Cent Calcium	Per Cent Iron	Per Cent Copper	Per Cent Iodine
Mullet	8.8	48.6	28.4	5.9	26.9	6.0	550.0
Flounder	4.8	37.5	3.2	2.6	.....	.....	30.0
Oyster	6.1	24.6	12.8	13.1	92.3	282.0	55.0
Crab*	6.2	40.5	10.2	23.3	34.2	119.5	50.0
MILK	5.1	8.7	25.2	27.2	3.0	1.5	7.5
BEEF	18.5	49.6	123.1	2.7	45.0	7.5	1.0

*White meat.

Phosphorus is usually considered along with calcium because they are believed to be absorbed in a fairly constant ratio of about 1 part of calcium to 2 parts of phosphorus. A deficiency of one tends to limit the amount of absorption of the other. Phosphorus is present in relatively large quantities in most seafoods. Fish are particularly high comparing favorably with meat.

The magnesium content of fish, oysters, crabs, and shrimp exceeds that of milk and beef. Seafoods also far exceed milk in respect to their phosphorus content. Eastern oysters are known to contain nearly three times as much iron as the white meat of blue crabs and they also far exceed many species of fish. Milk is relatively low in iron.

Oysters contain over twice as much copper as white meat of the blue crab, nearly forty times as much as beef and thirty or more times as much as such fish as cod, haddock, mackerel, and mullet.

Iodine, so important for human well-being, is present in relatively large amounts in seafood. The oyster and crab contain about six or seven times as much as milk and forty or fifty times as much as beef.

As more is learned about nutritional disorders, increasing importance is attached to the mineral content of food as a means of prevention. Table II clearly shows how seafood products may meet these mineral needs and contribute greatly to the building up of our bodies.

WHAT IS THE VITAMIN CONTENT OF SEAFOODS?

Vitamin A is an important component of food because it promotes growth and helps to maintain healthy and hence more germ-resistant tissue. Absence of vitamin A results in a diseased condition known as "dry eye" which is accompanied by a loss of visual power. Cells of the body surfaces need vitamin A to retain normal vitality.

There is marked variation in the amount of any particular vitamin possessed by different kinds of fish, shellfish, and crustacea. Considering vitamin A, it is clear that fish oils may be expected to yield high values. Halibut liver oil contains about 100,000 International Units per 100 grams (272 milligrams per pound); cod liver oil, 85,000 I. U. (230 mgms.); blue fin tuna oil, 78,000 I. U. (212 mgms.); mackerel liver oil, as high as 120,000 I. U. (326 mgms. per pound); and shark liver oil, from 5,500 to 120,000 I. U. (15 to 326 mgms. per pound).

Available information indicates that fish muscle, like many meats, does not contain much vitamin A. Salmon, mackerel, and shad are perhaps among the best fish sources, comparing favorably with milk, while fish roe is relatively rich in this vitamin and may be classed as a superior source along with such standard sources as spinach, hens' eggs and cheese. As indicated in Tables V and VI, one pound of shad roe furnishes almost 7.0 milligrams of vitamin A, which is over two times the daily adult requirement, while a like amount of hens' eggs furnishes 4 milligrams or one and one-half times the daily requirement. Milk (two glasses) and chicken meat furnish only 0.5 milligrams or one-sixth of the daily requirement.

Oysters are a good source of vitamin A, exceeding clams and comparing favorably with crustacea, for which values are known (table V). The vitamin A content of aquatic animals probably originates in the microscopic plant food in the water.

Vitamin B_1 or thiamin is the vitamin which, if deficient in the diet, leads to such early symptoms as loss of appetite, loss of weight, constipation, slowing of the heart beat and neuritis. It is also necessary for the proper utilization of carbohydrates by the body. Lobsters, crabs, oysters and shad roe are relatively high in vitamin B_1 content, one pound of each containing over half the daily requirement of an average adult. Salmon, sardines and shrimp are also fairly good sources comparing favorably with beef, chicken, eggs, potatoes, and orange juice (tables V and VI).

TABLE V

VITAMINS IN VARIOUS FOODS

Showing the amounts of vitamins A, B_1, B_2, and C in one-half pound portions of various foods expressed in milligrams and in per cent of average daily requirements. (Modified after Taylor*, 1942, and others.)

FOOD	A		B_1		B_2		C	
	Milligrams Per Half Pound	Per Cent of Daily Need	Milligrams Per Half Pound	Per Cent of Daily Need	Milligrams Per Half Pound	Per Cent of Daily Need	Milligrams Per Half Pound	Per Cent of Daily Need
FISH:								
Codfish steak	0.012	0.40	0.169	9.37	0.108	4.33	—	—
Halibut steak			0.166	9.20	0.420	16.78	—	—
Herring, smoked	Fair	Fair	Fair	Fair	0.794	31.75	—	—
Mackerel, broiled	0.239	7.97	0.199	11.07	1.456	58.23		
Shad roe	3.402	113.38	0.567	31.50	1.361	54.43	11.63	14.54
Shad, broiled	0.204	6.80	0.170	9.45	0.454	18.14		
Salmon, canned	0.426	14.21	0.082	4.53	0.511	20.44		
Salmon, fresh	0.368	12.28	0.270	15.02	0.545	21.81		
Sardines, canned	0.019	0.63	0.208	11.52	0.794	31.75	—	—
SHELLFISH:								
Clams	0.026	0.88	0.046	2.56	0.033	1.31	68.04	85.05
Oyster stew	0.529	17.65	0.238	13.23	0.006	0.26	4.41	5.51
Oysters, fresh	0.304	10.14	0.568	31.55	1.042	41.67	6.80	8.50
Oysters, fried	0.596	19.86	0.366	20.33	0.915	36.60	0.03	0.04
CRUSTACEA:								
Crab meat	Good	Good	0.521	28.95	0.340	13.61	28.35	35.44
Shrimp	Fair	Fair	0.203	11.30	0.361	14.43	10.47	13.09
Lobster, meat			0.342	18.99	0.297	11.86	11.34	14.17

TABLE V—CONTINUED

FOOD	A		B_1		B_2		C	
	Milligrams Per Half Pound	Per Cent of Daily Need	Milligrams Per Half Pound	Per Cent of Daily Need	Milligrams Per Half Pound	Per Cent of Daily Need	Milligrams Per Half Pound	Per Cent of Daily Need
OTHER FOODS:								
Milk, whole, fresh	0.262	8.74	0.120	6.66	0.494	19.75	4.65	5.81
Beef, round	0.040	1.33	0.334	18.52	0.578	23.11	—	—
Eggs	2.084	69.47	0.347	19.30	0.811	32.42		
Pork chop, broiled	—	—	1.361	75.60	0.454	18.14		
Potatoes, baked	0.051	1.70	0.247	13.75	0.136	5.44	13.23	16.54
Oats, rolled, cooked	Trace	Trace	0.233	12.97	0.063	2.53	—	—
Orange juice, fresh	0.305	10.18	0.248	13.78	0.034	1.37	122.19	152.74
Spinach, steamed	27.216	907.11	0.183	10.17	0.791	31.65	38.25	47.81
Cheese, American	4.082	136.06	0.113	6.30	1.191	47.63	—	—
Chicken, lean meat	Fair	Fair	0.266	14.77	0.341	13.66	—	—

— = absence of; blank space = no satisfactory information.
*"Food values in Shares and Weights," by C. M. Taylor.

TABLE VI

Sources of Vitamins

Selected Seafoods Compared with Certain Other Foods as Sources of Vitamins Arranged in Approximate Order of Value*. (See Table V.)

	A	B_1	B_2	C
Superior	Spinach Cheese, American Shad roe Eggs	Pork chops Oysters, fresh Shad roe Crab meat	Mackerel, broiled Shad roe Cheese, American Oysters, fresh Oysters, fried Eggs Herring, smoked Sardines, canned Spinach, steamed	Orange juice, fresh Clams Spinach, steamed Crab meat
Good	Oysters, fried Oyster stew Crab meat	Oysters, fried Eggs Lobster meat Beef, round	Beef, round Salmon, fresh Salmon, canned Milk, raw, whole Shad, broiled Pork chops, broiled Halibut steak	Potatoes, baked
Fair	Salmon, canned Salmon, fresh Orange juice Oysters, fresh Milk, whole, raw Mackerel, broiled Shad, broiled Herring, smoked Shrimp Chicken meat	Salmon, fresh Chicken, lean meat Orange juice, fresh Potatoes, baked Oyster stew Oats, rolled, cooked Sardines, canned Shrimp Mackerel, broiled Spinach, steamed Shad, broiled Codfish steak Halibut steak Milk Cheese, American Herring, smoked	Shrimp Chicken, lean meat Crab meat Lobster meat	Shad roe Lobster meat Shrimp Oysters, fresh
Poor	Potatoes Beef, round Clams Sardines, canned Codfish steak	Salmon, canned Clams	Potatoes, baked Codfish, steak Oats, rolled, cooked Clams Orange juice, fresh Oyster stew	Milk, whole, raw Oyster stew Oysters, fried

*In this table, Superior = 26% or over of daily adult requirements; good = 16 to 26%; fair = 6 to 16%; poor = below 6%.

Vitamin B_2 or riboflavin is made synthetically and is available commercially. Various bodily disorders result from deficiency of this vitamin, including loss of hair, weakness, cataract, and nervous trouble. Oysters, herring, mackerel, shad roe, and sardines are probably among the best sources of supply. They compare favorably with eggs, spinach and cheese (table VI).

Vitamin C, called the antiscorbutic vitamin, favors teeth development, growth and possibly tissue respiration. It improves the appetite and protects the blood system. Certain kinds of cells of the body require vitamin C in order to function normally. Available information indicates that most fish contain very little if any, vitamin C. Clams and crabs are seemingly among the best seafood sources while fresh oysters, scallops, shrimp, and lobsters are fairly good, far exceeding milk (tables V and VI).

Vitamin D, known as the anti-rachitic vitamin, regulates metabolism of calcium and phosphorus in the body and is essential to normal bone growth and development of the teeth. A deficiency of this vitamin may produce rickets, a softening of the bones and slowing up of growth. Ribbed mussels, common in Virginia, have recently been found to contain a large amount of vitamin D, which is used in the manufacture of poultry food. Fish oils and certain fish such as herring, sardines, salmon, tuna, and halibut are good sources of vitamin D. In most instances they far exceed eggs, lean meat, butter, peanuts and most common foods. Fair amounts of it are present in crustacea and some shellfish.

In general, seafoods as a group provide a superior source of essential food substance. By selecting them carefully, almost any dietary demand may be met, whether it be a mineral requirement, a vitamin or protein, or fat or carbohydrate essential.

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