

THE NUTRITIONAL VALUE OF SHELLFISH

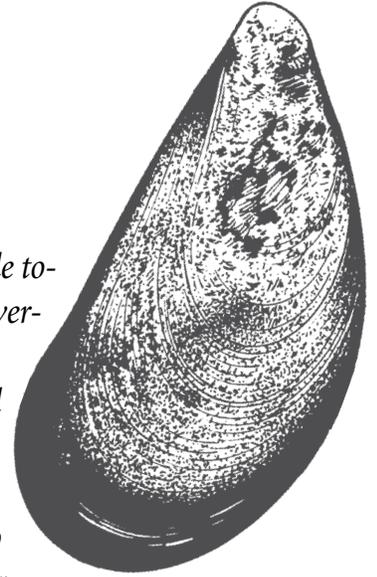
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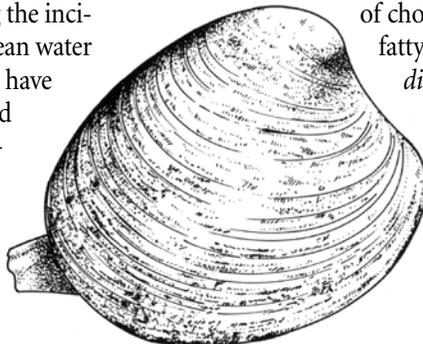
Maintaining good health and a sense of well-being are top priorities for many people today. Both health and well-being are strongly related to diet. The relationship of diet to overall health and the effect of diet on the incidence of certain chronic illnesses, such as heart disease, diabetes and cancer, continue to be active areas of nutrition research. Compared to the past, people today are generally more careful in managing their diets to reduce the chances of contracting life-threatening diseases. People are also paying more attention to better manage any diseases they may already have and to change their lifestyles to sustain longer and healthier lives. Based on current dietary recommendations, this paper examines whether shellfish should be included in a healthful diet.



CURRENT DIETARY RECOMMENDATIONS

Many years ago, the traditional definition of “good health” was merely the absence of disease and of any physical symptoms of nutritional deficiencies. This has been replaced by the current definition: a state of well-being and increased resistance to chronic diseases. Americans are experiencing a high incidence of several chronic diseases, many of which can have negative physical, emotional, financial, psychological and social impacts on their lives. These diseases, which include heart disease, hypertension, cancer, diabetes and obesity, are multifactorial in nature and are usually affected by lifestyle habits, genetic predispositions, environmental factors and diet. Dietary recommendations have been published most recently by the Department of Health and Human Services and the Department of Agriculture as the Dietary Guidelines for Americans, 2005 (www.health.gov/dietaryguidelines/). Given the information known about maintaining health and reducing the incidence of chronic diseases, shellfish grown in clean water and harvested using recommended procedures have a place in a healthy diet as part of the “Meat and Beans” group of the MyPyramid recommendations (mypyramid.gov/pyramid/meat.html).

Dietary Guidelines for Americans 2005 (scheduled to be revised in 2010) makes key recommendations to the general population related to: adequate nutrients within caloric needs; weight management; physical activity; food groups; fats; carbohydrates; sodium and potassium; alcoholic beverages; and food safety. The recommendations in the “fats” category encourage people to limit fat intake to between 20 and 35 percent of total calories from fat and to consume fats mainly from fish, nuts and vegetable oils that are good sources of monounsaturated fatty acids — such as those found in olive oil, peanut oil, walnuts and avocados — and polyunsaturated fatty acids, such as those found in vegetable oils and marine fish oils. The guidelines further recommend consuming less than 10 percent of calories from saturated fatty acids, such as those found in untrimmed red meat, and less than 300 milligrams per day of cholesterol. Consumers are cautioned to keep trans-fatty acid consumption as low as possible (health.gov/dietaryguidelines/dga2005/recommendations.htm).



SHELLFISH: A HEALTHFUL ADDITION TO A BALANCED, LOW-FAT DIET

Both the amount of fat and the proportions of saturated, monounsaturated and polyunsaturated fat in shellfish contribute to a healthful diet. More than 40 percent of the calories in beef and pork can come from fat. In shellfish — including shrimp, clams, scallops, lobsters, crabs and abalones — 15 percent or less of the calories come from fat (Figure 1). Even in oyster, mussel and geoduck meats, only about 20 to 28 percent of the calories come from fat. The types of fat in shellfish are also favorable. Although most foods contain some saturated, monounsaturated and polyunsaturated fat, the proportions of these fats may differ (Figure 2).

The fat in land animal meats, such as beef, lamb and pork, and also the fat in some tropical oils, including coconut oil, contain high levels of saturated fat. Other foods, such as salmon and shellfish, usually contain high levels of polyunsaturated fat. If the fats from chicken, beef, oyster and clam meats are compared, it is apparent that the proportions of polyunsaturated fat are higher and the proportions of saturated fat are lower in shellfish than in beef and chicken.

Shellfish also provide high quality protein with all the dietary-essential amino acids for maintenance and growth of the human body. For this reason, shellfish should be considered a low-fat, low-saturated-fat, high-protein food that can be included in a low-fat diet (Food and Nutrition Board, 2007).

Salmon and other fatty fish are rich sources of the “good” fats, called omega-3 fatty acids. Shellfish also contain significant amounts of these fats. The interest in omega 3-fatty acids grew in the early 1970’s, after the publication of studies of the Greenland Inuit people. The studies reported that compared to Danes, the Greenland Inuit had a healthier clinical profile: a much lower incidence of heart disease, lower total plasma cholesterol, lower low-density (bad) lipoprotein (LDL) in the blood, higher high-density (good) lipoprotein (HDL) in the blood, and lower plasma triglycerides (Nettleton 1995). Studies reported that the Greenland diet was very high in omega-3 fatty acids and, since then, research has reported that these fatty acids appear to have a wide range of functions (Table 1).

Although salmon is one of the richest sources of omega-3 fatty acids, even the lower levels in shellfish (Table 2) will contribute to the recommendation by the Food and Nutrition Board (2004) that women consume 1.1 grams and men 1.6 grams of omega-3 fatty acids (alpha-linolenic acid) per day (or 0.6 to 1.2 percent of caloric intake per day). The omega-3 fatty acid contribution of seafood stands in contrast to beef, chicken and pork, which have undetectable levels of omega-3 fatty acids. If the shellfish is cooked until done but not overcooked, then omega-3 fatty acids are usually preserved.

Table 1. Some functions of omega-3 fatty acids

- Essential for normal development and function of the retina
- Help to regulate nerve transmission
- Regulate blood pressure, blood clotting, body temperature, inflammation or hypersensitivity reactions, immune and allergic responses
- Maintain normal kidney function and fluid balance

(Byrd-Bredbenner et al., 2009)

Figure 1. Percent calories from fat

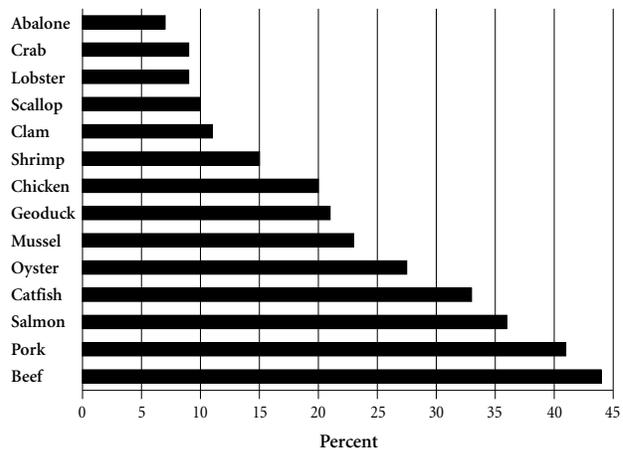
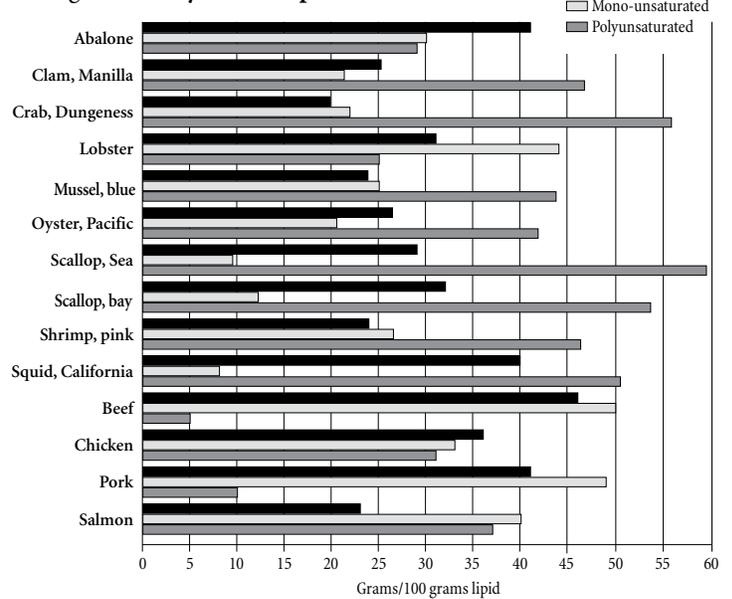


Figure 2. Fatty acid composition



From King et al. (1990) and USDA Web site (see references)

Table 2. Concentrations of EPA and DHA¹

	grams per 100 grams raw edible portion
Sockeye salmon, wild	1.17
Oyster, Pacific	0.69
Squid, mixed species	0.49
Shrimp, mixed species	0.48
Mussel, blue	0.44
Lobster, spiny, mixed species	0.37
Crab, blue	0.32
Snapper, mixed species	0.31
Crab, Dungeness	0.31
Catfish, channel, farmed	0.27
Scallop, mixed species	0.20
Clam, mixed species	0.14

USDA National Nutrient Database for Standard Reference, <http://www.nal.usda.gov/fnic/food-comp/search/>

¹ EPA = eicosapentaenoic acid; DHA = docosahexaenoic acid

WHAT ABOUT THE CHOLESTEROL IN SHELLFISH?

Cholesterol is essential in the body because it is used to make important compounds such as bile acids (which help to digest fat in the intestine), sex hormones and vitamin D. Cells in the body make about two-thirds of the cholesterol in the body, while the other third comes from foods eaten (Byrd-Bredbenner et al., 2009). Although most animal products high in saturated fats are also sources of dietary cholesterol, there are some foods like squid and egg yolk that are low in saturated fat but have a fair amount of cholesterol. When examining the cholesterol content of shellfish, it is important also to measure the other sterols that may be present. Shellfish in general are low in fat, and some, notably squid, contain a high concentration

of cholesterol. However, non-cholesterol sterols (also known as plant sterols or plant stanols) are found in herbivorous mollusks, such as clams and scallops (Table 3). These non-cholesterol compounds are absorbed from the intestine and can actually decrease the absorption of cholesterol (Byrd-Bredbenner et al., 2009) and therefore have a positive effect on health. Aside from shrimp and squid, the shellfish in Table 3 have cholesterol concentrations of less than 80 milligrams per 100 grams (edible portion) and therefore can be consumed by people trying to limit their dietary cholesterol intake. It should be repeated that shellfish are low in fat, including saturated fat, and can contribute significantly to a low-fat diet.

Table 3. Types of sterols in shellfish

milligrams/100 grams shellfish

Item	Cholesterol	C-26 sterol	Brassicasterol	7-dehydrocholesterol	Campesterol	Stigmasterol	β -sitosterol	TOTAL
Clam, Manila	36	25	47	33	8	3	3	155
Crab, Dungeness	72	—	6	—	—	—	—	78
Mussel, blue	37	21	18	16	8	3	4	107
Oyster, Pacific	48	12	19	—	31	6	8	124
Scallop, sea	27	12	21	25	4	—	8	97
Scallop, bay	37	13	20	19	4	4	10	107
Shrimp, pink	147	—	10	—	—	—	—	157
Squid, California	231	—	—	—	—	—	—	231

From King et al. (1990)

DO SHELLFISH CONTRIBUTE MINERALS AND VITAMINS TO THE DIET?

Shellfish are rich in several nutrients that are needed in the body. Iron is an essential mineral in the heme molecule of hemoglobin, the component of the red blood cell that carries oxygen in the bloodstream. People who do not eat enough iron can suffer from iron-deficiency anemia. Worldwide, about 1 billion people have iron-deficiency anemia, and about 2 billion people are deficient in zinc (Muller et al., 2005). In the U.S., around 3.3 million women of childbearing age have iron-deficiency anemia (Byrd-Bredbenner et al., 2009). Several kinds of shellfish are rich sources of iron (Table 4). Clams in particular have enough iron in 100 grams to meet about 78% of the Dietary Reference Intake for 19-50-year-old, non-pregnant females and exceed that for adult men starting at age 19 and for women who are 51 years old and older (Food and Nutrition Board, 2004). Oysters, mussels, abalone and shrimp also contribute significant amounts. Although beef and other red meats are often touted as rich iron sources because of the presence of heme iron, it is reasonable to assume that the iron in shellfish should also be easily absorbed.

Zinc is also necessary for a healthy diet. This mineral helps with immune function and is essential for healing of wounds, development of sexual organs and bones, immune function, storage/release/function of insulin, and cell membrane structure and function (Wardlaw and Smith, 2009). An examination of the zinc content in shellfish reveals that oyster meat is a very rich source. A 100-gram serving will provide more than the Dietary Reference Intake of zinc

for both men and women (Table 5) (Food and Nutrition Board, 2004).

Copper is also an essential mineral in the diet, because it helps to form hemoglobin and collagen (a ubiquitous protein in the body). It is also a part of several enzyme systems, including those that prevent oxidative damage to cell membranes. Lastly, copper helps to regulate neurotransmitters (Byrd-Bredbenner et al., 2009). The copper concentrations in shellfish (Table 6) indicate that the meats of squid, lobster, oyster and several other shellfish are excellent dietary sources of copper.

Vitamin B-12 helps the body maintain sheaths around nerve fibers, to activate another B-vitamin called folic acid, and participates in many cellular processes (Wardlaw and Smith, 2009). It is found exclusively in animal products and vitamin B-12-fortified plant products, such as meat replacements. Generally, it is not difficult to get enough vitamin B-12 in the diet. Typically, vitamin B-12 deficiencies are observed among vegetarians who avoid all animal products and don't take vitamin B-12 supplements. Vitamin B-12 deficiencies are also observed among the elderly, who may not have enough acid in their stomachs to release vitamin B-12 from food and allow it to bind to the carrier that aids in absorption of the vitamin (Wardlaw and Smith, 2009). A 100-gram serving of clam, oyster, mussel, crab and several other shellfish meats will provide more than the Dietary Reference Intake (NAS 2004) of this vitamin (Table 7) (Food and Nutrition Board, 2004).

Table 4.
Iron concentrations
milligrams per 100 grams raw edible portion

Clam, mixed species	13.98
Oyster, Pacific	5.11
Mussel, blue	3.95
Shrimp, mixed species	2.41
Lobster, spiny, mixed species	1.22
Crab, blue	0.74
Squid, mixed species	0.68
Catfish, channel, farmed	0.50
Sockeye salmon, wild	0.47
Crab, Dungeness	0.37
Scallop, mixed species	0.29
Snapper, mixed species	0.18

USDA National Nutrient Database for Standard Reference, <http://www.nal.usda.gov/fnic/foodcomp/search/>

Dietary Reference Intakes (NAS 2004):
Females, 19 to 50 years old (non-pregnant):
18 milligrams per day
Females, 51 to >70 years old: 8 milligrams
per day
Males, 19 to >70 years old: 8 milligrams per
day

Table 5.
Zinc concentrations
milligrams per 100 grams raw edible portion

Oyster, Pacific	16.62
Lobster, spiny, mixed species	5.67
Crab, Dungeness	4.27
Crab, blue	3.54
Mussel, blue	1.60
Squid, mixed species	1.53
Clam, mixed species	1.37
Shrimp, mixed species	1.11
Scallop, mixed species	0.95
Catfish, channel, farmed	0.74
Sockeye salmon, wild	0.54
Snapper, mixed species	0.36

USDA National Nutrient Database for Standard Reference, <http://www.nal.usda.gov/fnic/foodcomp/search/>

Dietary Reference Intakes (NAS 2004):
Females, 19 to >70 years old: 8 milligrams
per day
Males, 19 to >70 years old: 11 milligrams
per day

Table 6.
Copper concentrations
milligrams per 100 grams raw edible portion

Sockeye salmon, wild	0.05
Mussel, blue	0.09
Clam, mixed species	0.34
Oyster, Pacific	1.58
Squid, mixed species	1.89
Crab, blue	0.67
Crab, Dungeness	0.67
Shrimp, mixed species	0.26
Snapper, mixed species	0.03
Catfish, channel, farmed	0.10
Scallop, mixed species	0.05
Lobster, spiny, mixed species	0.38

USDA National Nutrient Database for Standard Reference, <http://www.nal.usda.gov/fnic/foodcomp/search/>

Dietary Reference Intakes (NAS 2004):
Females and males, 19 to >70 years old: 0.9
milligrams per day

Table 7.
Vitamin B₁₂ concentrations
micrograms per 100 grams raw edible portion

Clam, mixed species	49
Oyster, Pacific	16
Mussel, blue	12
Crab, blue	9
Crab, Dungeness	9
Sockeye salmon, wild	5
Lobster, spiny, mixed species	3
Snapper, mixed species	3
Catfish, channel, farmed	2
Scallop, mixed species	1.5
Squid, mixed species	1.3
Shrimp, mixed species	1.2

USDA National Nutrient Database for Standard Reference, <http://www.nal.usda.gov/fnic/foodcomp/search/>

Dietary Reference Intakes (NAS 2004):
Females and males, 19 to >70 years old: 0.9
micrograms per day

SUMMARY

Increased intake of a variety of shellfish should be encouraged to provide a healthy diet. Shellfish are low in fat, especially low in saturated fat, contain the omega-3 fatty acids, are excellent protein sources, and are especially good sources of iron, zinc, copper and vitamin B-12.

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