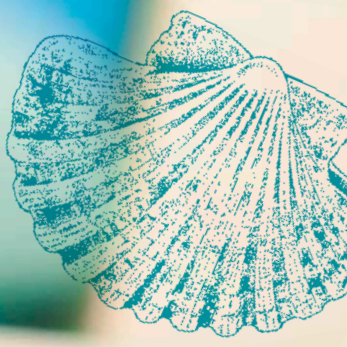
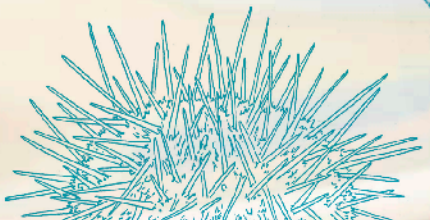
A SEA OF HEALTH

Nutritional content and health benefits of seafood





Content

Eat more fish!

Our diet influences our health throughout our entire life. Nutrition and diet have a major impact on growth and development in the foetal, infant, child and youth years. The diet in the early stages of life influences the risk of developing chronic illnesses as an adult.

Fish consumption in Norway has declined. Children, youth and young adults consume significantly less fish than adults, and young women in particular consume little fatty fish and fish as sandwich toppings. From a health perspective, it is favourable if the consumption of both lean and fatty fish increases.

The Norwegian Action Plan on Nutrition (2007-2011), "Recipe for a Healthier Diet", makes recommendations based on the combined scientific documentation on the relationship between diet and health. It advises that the consumption of fish and seafood should increase.

A unique food

Fish and seafood are important sources for vital nutrients such as proteins, vitamin D, vitamin B12, selenium and iodine. Seafood has a favourable fatty acid composition.

Fatty fish and cod liver oil are the most important sources of long-chain polyunsaturated omega-3 fatty acids and vitamin D, and is favourable with respect to both cardiovascular diseases and foetal development. Seafood has a low ratio of the saturated fats.

The main beneficial health effects of eating seafood are linked to the omega-3 fatty acids. Fatty fish is a good source of two important omega-3 fatty acids: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

These polyunsaturated and long-chain fatty acids are key building blocks in the cell membranes of fish, shellfish and marine mammals. Marine algae have an effective formation of EPA and DHA, while plants and land animals generally have poor production of these fatty acids, if any at all. As algae forms the basis in the marine food chain, EPA and DHA are enriched in seafood, making fish and other seafood good sources of these important omega-3 fatty acids.

Humans and most land animals have a limited ability to transform other fatty acids to EPA and DHA. It is, therefore, important to consume sufficient quantities of these fatty acids through ones diet.

The Norwegian Action Plan on Nutrition (2007-2011) recommends that approximately 30 % of the energy intake comes from fat. Of this fat, the proportion of saturated fat should be reduced from 14 % today to a maximum of 10 % of the energy intake. Consequently, some of the fat from today's diet should be replaced by healthy unsaturated fish fat.

Seafood and health

Cardiovascular diseases

It was not until the early 1970s that the link between seafood consumption and cardiovascular diseases was first explained. Studies were carried out to determine the extent of cardiovascular diseases among Greenland's Inuit and the Danish population. The findings showed that the Inuit people had a significantly lower death rate from cardiovascular diseases than their Danish counterparts, and that the cholesterol and fat content in the blood was different. These results were attributed to dietary differences. The Inuit diet consisted mostly of fish and marine mammals with a low content of saturated fat, a high content of omega-3 fatty acids and a smaller proportion of omega-6 fatty acids. These studies formed the start of comprehensive research on the association between seafood and health.

The majority of research on seafood and health has focused on the link between cardiovascular diseases and the consumption of fish or intake of omega-3 fatty acids. The studies have shown that the consumption of fish, particularly fatty fish, protects against the development of some cardiovascular diseases. Studies show that omega-3 fatty acids have a preventative effect against coronary heart disease and stroke. The Norwegian Scientific Committee for Food Safety has concluded that adults with high risk of developing cardiovascular diseases would have the greatest benefit of increased consumption of fish, particularly fatty fish.

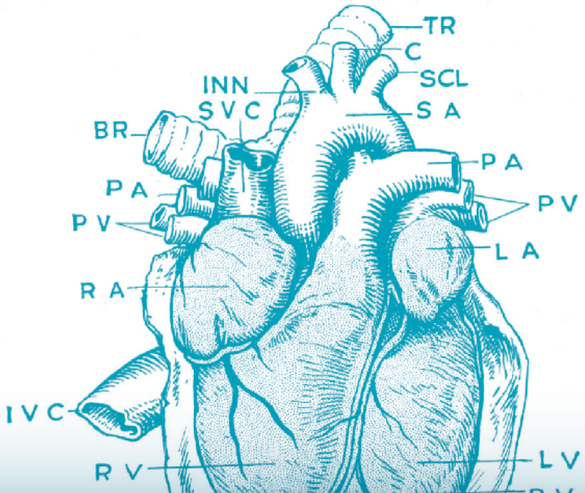
Fat and cholesterol

The fat and cholesterol content in blood indicates the risk of developing cardiovascular diseases. The consumption of seafood influences some of these risk factors. Most studies show that increased intake of the omega-3 fatty acids EPA and DHA leads to a lower level of triglycerides (fat) in the blood.

The cells in the human body require a certain amount of cholesterol, but too much cholesterol is linked to the development of atherosclerosis (hardening of the arteries). Cholesterol can be divided into bad cholesterol (LDL) and good cholesterol (HDL). Recent research has shown that it is the distribution between LDL cholesterol and HDL cholesterol that is important. Increased intake of EPA and DHA appears to increase the content of the good cholesterol, but has only small or no effect on altering total cholesterol and bad cholesterol.

Other cardiovascular diseases

Seafood may have a preventative impact against other cardiovascular diseases too, but these results are less clear. Some studies have shown that seafood or omega-3 can prevent arhythmia (irregular heartbeats), while other studies do not have the same findings. Consumption of seafood may also reduce blood pressure.



The nervous system

The brain, nerves and eyes have a relatively high content of DHA and it is therefore important for the development of these organs. The significance of omega-3 fatty acids, particularly DHA, on foetal development and the development of the child in the first year of infancy has been studied. Increased intake of DHA leads to increased DHA concentration in the blood and breast milk and, consequently, to increased transfer of DHA to the child. Some research indicates that increased intake of DHA can lengthen the pregnancy and increase the birth weight. However, it is unclear whether this has any effect on the child's health. In a Norwegian study in which mothers took cod liver oil during pregnancy and the first three months after giving birth, the children had better neuropsychological development at age four than children from the control group.

Other studies have demonstrated a positive effect on the child's motoric and social skills, increased intelligence and better sight. This is an area of increased scientific interest, and evidence is mounting for the beneficial effect of DHA on infant and child health. Studies have also been carried out investigating whether omega-3 can prevent pre-eclampsia (pregnancy-induced hypertension) and antenatal/postnatal depression. Although some studies show beneficial effects, the results to date are unclear and further studies are required before any conclusions can be drawn.

Other diseases

Cancer
Epidemiological and animal studies show that consumption of fish and the intake of fish oils can prevent or restrain the development of some forms of cancer. However, most studies show no association between fish intake and cancer.

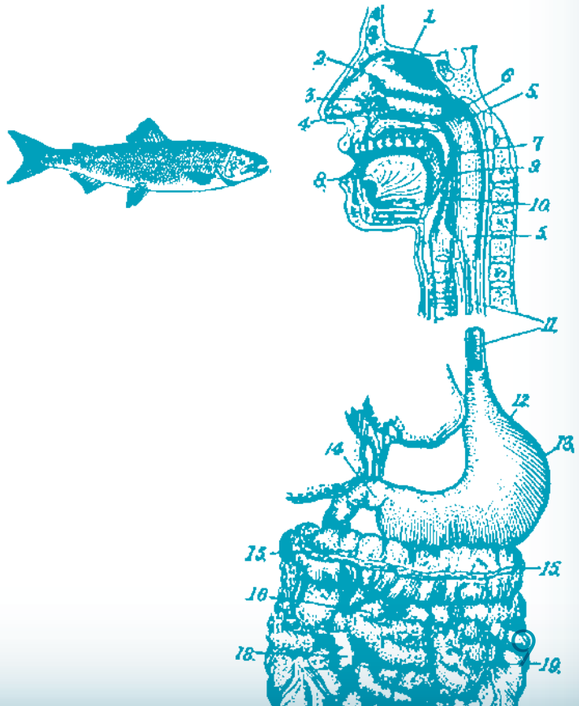
Inflammatory diseases
In addition to lower occurrences of cardiovascular diseases, far lower occurrences of some inflammatory diseases were also found among Inuit people than Danish people, including psoriasis, chronic inflammatory bowel diseases and arthritis. These diseases are characterised by the body's immune defence "running wild" and damaging the body's own tissue.

The effect of omega-3 fatty acids appears to be greatest against arthritis. Several studies have shown that supplements of omega-3 fatty acids can soothe pain and reduce morning stiffness.

Studies have also been carried out on whether omega-3 fatty acids can suppress symptoms resulting from chronic inflammatory bowel diseases. Despite favorable results have been found in individual studies, the efficacy of omega-3 against Crohn's disease and ulcerative colitis, is still disputed.

Mental and cognitive disorders
As DHA is an important component in the brain and nervous system, the intake of seafood and DHA has been studied in relation to Alzheimer's disease, Attention-Deficit Hyperactivity Disorder (ADHD) and some mental disorders.

For Alzheimer's disease and ADHD, some studies have shown favourable effects from increased seafood consumption, while other studies show no effect. Similar conclusions have been drawn for people suffering from schizophrenia and depression. Further and more comprehensive studies are required in order to confirm beneficial effects.



The healthy fat

The important balance

Fat is divided into three categories: saturated fat, monounsaturated fat and polyunsaturated fat. The polyunsaturated fat consists of the omega-3 and omega-6 fatty acids, which are important in our diet.

Linoleic acid (omega-6) and alpha-linolenic acid (omega-3) are essential for humans. We use these fatty acids to produce other fatty acids that are vital for our body. The alpha-linolenic acids are the basis for the omega-3 fatty acids EPA and DHA, while linoleic acid is the basis for other omega-6 fatty acids. It is vital that we have a proper balance of both omega-3 and omega-6 fatty acids in order to maintain good health.

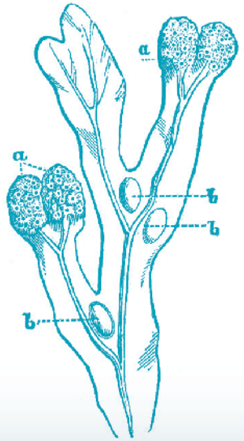
The primary sources of omega-6 fatty acids are vegetable oils, while seafood is a good source of omega-3 fatty acids. Human development was based on consuming a diet in which the content of omega-3 and omega-6 fatty acids was roughly the same. Over the last 100–150 years, the intake of omega-6 fatty acids has increased considerably. This can be attributed to the fact that we have started to use more vegetable oils and the consumption of fish has decreased.

The marine fatty acids

EPA and DHA are often referred to as the marine fatty acids. These fatty acids are different from other omega-3 fatty acids as they have a different structure and consequently have slightly different characteristics and functions.

Human beings have a poor ability to produce EPA and DHA from alpha-linolenic acid. Research has shown that it is more effective to intake EPA and DHA directly in the diet. This highlights the significance of getting sufficient amounts of these fatty acids in their natural form through our diet.

The only organisms that are able to easily produce EPA and DHA are marine algae. These organisms form the base of the marine food chain, and consequently the content of EPA and DHA becomes higher in fish and other marine animals. Seafood is a good source of these important omega-3 fatty acids, while land animals and vegetable oils have a low content of EPA and DHA.



Fat content in selected seafood products

	Fat	Saturated	Mono-unsaturated	Polyunsaturat	EPA	DHA
	g	g	g	g	g	g
Lean fish						
Cod	0.6	0.11	0.04	0.25	0.07	0.16
Saithe/coalfish	0.3	0.12	-	0.01	-	-
Tusk	0.3	0.03	0.04	0.05	-	-
Haddock	1.0	0.19	0.16	0.38	0.07	0.27
Redfish/ocean perch	0.9	0.16	0.31	0.16	0	0.10
European plaice	1.5	0.34	0.31	0.57	0.24	0.26
Moderately fatty fish						
Halibut	3.9	0.45	0.86	1.2	0.28	0.41
Spotted wolffish	4.8	0.77	1.17	1.47	0.70	0.40
Atlantic wolffish	2.7	0.43	0.64	0.81	0.40	0.20
Rainbow trout	6.7	1.49	2.43	2.02	0.32	1.16
Fatty fish						
Salmon	10.0	2.26	3.21	3.36	0.65	1.80
Greenland halibut	15.6	2.94	7.16	2.55	1.00	0.90
Mackerel	24.4	5.64	9.66	6.52	1.27	3.17
Herring (summer)	14.5	3.03	6.25	2.54	0.57	1.25
Herring (winter)	19.0	4.06	5.59	7.83	2.48	2.24
Eel	31.5	8.58	13.9	5.8	1.27	2.07
Shellfish						
Shrimps (boiled)	1.1	0.23	0.18	0.40	0.20	0.17
Lobster	1.3	0.17	0.28	0.43	0.22	0.10
Crayfish	0.5	0.11	-	0.02	-	-
Edible crab	1.8	0.21	0.34	0.52	0.27	0.13
Blue mussels	2.2	0.34	0.37	0.36	0.16	0.06
Oysters	1.5	0.30	0.15	0.38	0.15	0.17

Source:
** Møller, A., Saxholt, E., Christensen, A.T., Hartkopp, H.B., Hess Ygil, K.: Danish Food Composition Databank, revision 6.0, Food Informatics, Department of Nutrition, Danish Institute for Food and Veterinary Research, June 2005 - http://www.foodcomp.dk*

Nutritional content in seafood

High in proteins – low in carbohydrates

Proteins, fat and carbohydrates are the energy sources in the food we consume. Fish contains mainly proteins and fat and has a very low content of carbohydrates. Seafood in general contains little fibre, but products based on fish mince may have higher fibre content.

The Norwegian fisheries and aquaculture industry supplies delicacies to many dinner tables. Traditional Norwegian fisheries include the skrei fishery in Lofoten and fishing for herring and mackerel. Skrei are sexually mature cod which migrate from the Barents Sea to the Norwegian coast to spawn. The skrei season normally runs from the start of January until late March. Many Norwegians look forward to eating mølje, a traditional dish comprising fresh cod, liver and roe.

Norwegians normally eat a lot of herring during Christmas celebrations and many eat self-caught mackerel during their summer holiday. Farmed salmon and trout is also being used to an increasing extent in dinners and on sandwiches and is served fresh, cured or smoked. Fatty herring, mackerel and salmon are particularly good sources of the healthy omega-3 fatty acids and of the fat-soluble vitamins A and D.

Proteins
Fish contains 12 to 24 % protein, depending on the species. Fish protein contains all the essential amino acids, which means that fish may be used as the sole source of protein. The amino acid distribution in fish is relatively similar to other meats, including pork and chicken. Fish is seen as a particularly good protein source as it contains little saturated fat. Fish meat has a relatively low content of connective tissue and, when heated, the connective tissue becomes more soluble than is the case with connective tissue in land animals. This makes fish meat easy to chew and provides other culinary characteristics. The body's digestive enzymes can easily break down the connective tissue of fish, making it easy to digest.

Fat
Fish may be divided up into groups depending on the fat content: lean fish, moderately fatty fish and fatty fish. Lean fish has a fat content of less than 2 %, moderately fatty fish 2–8 % and fatty fish more than 8 %. Cod is an example of a lean fish, while salmon, herring and mackerel are examples of fatty fish species. The fat content of a fish species varies depending on the season, if it is sexually mature and spawning and what the fish eats. In farmed fish, the fat content is strongly dependent on what feed it receives.

The production and consumption of cod liver oil has long traditions in Norway. Cod liver oil gains distinction by being rich in omega-3 fatty acids, and in addition has a high content of vitamins A and D.

Shellfish
Shellfish – molluscs and crustaceans alike – belong to different animal groups than fish and have a slightly different nutritional composition. Shellfish are generally lean food. The content of carbohydrates is still low, but often slightly higher than in fish.

Nutrients and energy

Humans require energy to grow and to maintain their body. The daily energy consumption of an adult woman (inactive) is approx. 2150 kcal/d, while for an adult man (also in an inactive state) it is approx. 2600 kcal/d. Fat, carbohydrates and proteins are the nutrients that are the main energy sources. Protein is used first and foremost as a building material in the body.

The Norwegian Directorate of Health has issued recommendations about the intake of fat, carbohydrates and proteins as a proportion of the total energy intake. It recommends that the energy intake from fat should be reduced from the current level of approx. 34 % to approx. 30 %, and that the intake of saturated fat and trans fatty acids should be limited to 10 % and less than 1 %, respectively. The Norwegian Action Plan on Nutrition confirms that an increase in the consumption of fish and seafood will have a positive impact on the diet's fat intake.

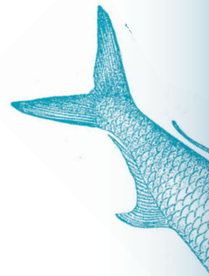
Nutrition and energy content in different fish species per 100 g (applies to the raw, edible part of the fish, unless otherwise stated)

Source: Norwegian Food Safety Authority, Norwegian Directorate of Health and the University of Oslo, Food composition table 2006 www.matportalen.no/matvaretabellen

	Water g	**Protein** g	**Fat** g	**Energy** kcal
Lean fish				
Monkfish	83	15.8	0.1	64
Tusk	82	16.1	0.2	66
Haddock	81	16.6	0.2	68
Common ling	80	17.5	0.2	72
Pollock	82	16.0	0.2	66
Lemon sole	81	16.0	0.3	67
Saithe/coalfish	80	16.5	0.3	69
Cod	80	18.1	0.3	75
Common sole	84	14.8	0.5	64
Whiting	80	18.3	0.6	79
Northern pike	80	18.4	0.7	80
Bluefish tuna	74	24.0	1.0	105
European perch	81	18.1	1.3	84
European plaice	82	13.4	1.4	66
Moderately fatty fish				
Wolffish	78	18.6	2.5	97
Turbot	79	15.9	2.4	85
Redfish/ocean perch	79	17.1	2.8	94
Common whitefish	74	21.5	3.0	113
Sea trout	74	20.0	3.3	110
Char	73	16.1	7.1	128
Fatty fish				
Farmed trout	70	17.2	10.2	161
Halibut	72	16.2	10.4	158
Greenland halibut	72	17.6	13.2	189
Wild salmon	66	19.7	11.5	182
Farmed salmon	67	19.9	13.4	200
European sprat	51	12.4	17.6	208
Mackerel	60	18.5	20.2	256
Fatty herring	56	17.0	25.0	293
Eel	46	17.3	32.5	362

Effect of cooking

Fish is a versatile ingredient, which may be cooked in many different ways. As with all other foods, the cooking method can influence the nutritional content. Heat treatment of food kills bacteria and parasites, but the culinary treatment can also reduce the content of individual nutrients. However, the fish will still contain the majority of the health promoting substances.



	Water g	**Protein** g	**Fat** g	***Carbohydrate** g	**Energy** kcal
European flying squid	80	15.4	1.7	-	77
Blue mussels	85	10.4	1.4	3.3	54
Lobster (boiled)	78	15.2	0.6	0.8	66
Scallops	78	17.9	1.1	-	82
Edible crab (boiled)	72	22.9	1.8	1.1	108
Crayfish (boiled)	85	10.7	1.3	-	54
Shrimps (boiled)	68	23.3	0.8	0.7	100
Oysters	80	9.3	2.4	4.2	59

Nutrition and energy content in different shellfish species per 100 g (applies to the raw, edible part of the fish, unless otherwise stated)

Source: Norwegian Food Safety Authority, Norwegian Directorate of Health and the University of Oslo, Food composition table 2006 www.matportalen.no/matvaretabellen

** Møller, A., Saxholt, E., Christensen, A.T., Hartkopp, H.B., Hess Ygil, K.: Danish Food Composition Databank, revision 6.0, Food Informatics, Department of Nutrition, Danish Institute for Food and Veterinary Research, June 2005 - http://www.foodcomp.dk*

Did you know that …?

… the whale is a mammal and has four stomachs, like cows do. The whale descends from a cloven-hoofed animal and, as such, is a distant relative of the cow.

… crabs also have a life up in the water. Before crabs settle down on the sea floor, they are larvae floating up in the water.

… shrimps change gender with size. Shrimps are born as boys, but when they grow and become big, they end up as women.

… all crustaceans must change shell when they become adults. The crustaceans creep out of their shell and are soft until the new shell hardens.

… there are fish without bones. Sharks and skates (which are also sharks) only have cartilage and not bones.

… fish hear with their bodies. Fish can "hear" as their lateral line is a sense organ that registers movements in the surrounding water.

… the octopus is very intelligent. It is among the cleverest invertebrates (animals without a backbone).

Nutritional content in seafood compared with other foods

	Energy kcal	Water g	Protein g	Fat g	Vit A RAE	Vit D µg	Vit E α-TE	Vit B_1 mg	Vit B_2 mg	Niacin NE
RDI					350 - 900	7.5 - 10	5 - 10	0.6 - 1.4	0.7 - 1.7	9 - 19
Seafood										
Cod	75	80	18.1	0.3	2	1.4	1.1	0.05	0.11	5.3
Saithe/coalfish	69	80	16.5	0.3	2	0.8	0.6	0.05	0.20	6.4
Haddock	68	81	16.6	0.2	2	0.7	0.5	0.05	0.11	7.0
Salmon	200	67	19.9	13.4	11	8.0	1.4	0.21	0.14	11.8
Mackerel	256	60	18.5	20.2	14	12.5	0.6	0.11	0.36	12.8
Herring	293	56	17.0	25.0	6	11.5	0.6	0.04	0.30	7.1
Shrimps (boiled)	100	68	23.3	0.8	2	3.5	5.3	0.01	0.07	6.6
Blue mussels	54	85	10.4	1.4	14	0	0.8	0.02	0.27	3.1
Meat and eggs										
Lamb (sirloin)	120	74	21.3	3.9	1	0	0.4	0.12	0.15	11.8
Beef (sirloin)	110	75	22.2	2.3	3	0	0.2	0.04	0.14	10.9
Pork (sirloin)	105	75	22.2	1.8	4	0	0.3	0.82	0.10	8.8
Chicken (breast fillet)	104	75	23.8	1.0	5	0	0.7	0.22	0.14	18.3
Eggs	142	75	2.4	10.1	215	3.8	5.3	0.15	0.53	3.2
Grain										
Whole grain bread	225	37	8.7	1.5	0	0	0.7	0.24	0.13	1.8
White bread	258	33	9.4	2.9	0	0	0.5	0.17	0.12	2.0
Pasta (dry)	347	9	11.9	1.3	0	0	0.1	0.22	0.06	2.8
Jasmine rice (dry)	354	13	7.5	0.7	0	0	0	0.04	0.05	1.5
Wheat flour	325	14	11.8	1.7	0	0	0.8	0.31	0.03	2.8
Fruit & vegetables										
Potato	72	78	1.7	0.1	0	0	0.2	0.08	0.02	1.6
Carrot	36	89	0.7	0.1	438	0	0.6	0.05	0.02	0.9
Orange	37	88	0.9	0.1	2	0	0.3	0.09	0.04	0.4
Apple	47	86	0.3	0.1	1	0	0.4	0.02	0.01	0.2
Beverages										
Orange juice	43	88	0.6	0	1	0	0.2	0.08	0.02	0.3
Semi-skimmed milk (1.5 %)	46	90	3.3	1.5	14	0	0	0.05	0.15	0.8
Coffee (filtered)	0	99	0.1	0	0	0	0	0	0	0
Tea (brewed)	1	100	0.3	0	0	0	0	0	0	0

RDI= Recommended daily intake

Nutrition and energy content in different fish species per 100 g (applies to the raw, edible part of the fish, unless otherwise stated)

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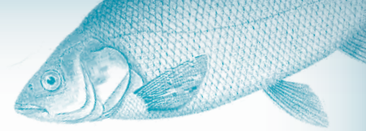

	Vit B6 mg	Folic acid µg	Vit B_{12} µg	Vit C mg	Calcium mg	Iron mg	Magnesium mg	Zinc mg	Selenium µg	Iodine* µg
RDI	0.7 - 1.6	80 - 400	0.8 - 2.0	30 - 75	600 - 800	8 - 15	120 - 350	6 - 11	25 - 50	90 - 150
Seafood										
Cod	0.2	12	1.0	0	8	0.1	29	1	30	253
Saithe/coalfish	0.5	12	4.0	0	8	0.1	22	1	30	85
Haddock	0.5	9	2.0	0	19	0.1	27	0	30	-
Salmon	0.5	13	6.9	1	12	0.4	28	0	30	30
Mackerel	0.8	1	12.0	0	12	0.9	27	1	30	84
Herring	0.5	9	12.0	0	38	1.0	38	1	50	24
Shrimps (boiled)	0.1	4	4.6	0	61	0.1	43	1	30	17
Blue mussels	0.1	37	25.0	0	38	5.8	23	3	51	140
Meat and eggs										
Lamb (sirloin)	0.26	1	1.1	0	8	2.6	24	2	4	-
Beef (sirloin)	0.25	4	1.1	0	3	2.1	24	4	7	1.1
Pork (sirloin)	0.32	2	0.4	0	10	0.7	17	2	14	-
Chicken (breast fillet)	0.82	11	0.5	0	4	0.2	31	1	8	0.4
Eggs	0.12	69	2.3	0	57	2.2	12	1	19	21
Grain										
Whole grain bread	0.09	31	0	0	26	1.6	46	1	2	2.0
White bread	0.06	25	0	0	29	1.1	26	1	3	2.6
Pasta (dry)	0.11	16	0	0	25	1.0	52	1	6	0.6
Jasmine rice (dry)	0.75	11	0	0	0	0	10	2	0	2.2
Wheat flour	0.08	18	0	0	18	1.4	39	1	6	1.9
Fruit & vegetables										
Potato	0.12	15	0	13	6	0.7	23	0	0	1.2
Carrot	0.05	15	0	4	28	0.3	12	0	0	3.0
Orange	0.06	28	0	51	42	0.1	13	0	0	0.3
Apple	0.05	1	0	10	5	0.1	5	0	0	0.2
Beverages										
Orange juice	0.07	23	0	30	11	0.1	12	0	1	-
Semi-skimmed milk (1.5 %)	0.04	5	0.4	0	100	0	13	0	1	17.9
Coffee (filtered)	-	0	0	0	2	0	5	0	0	0
Tea (brewed)	0	0	0	0	-	0	3	0	0	0.2

Source: Norwegian Food Safety Authority, Norwegian Directorate of Health and the University of Oslo, Food composition table 2006 www.matportalen.no/matvaretabellen

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Vitamins and minerals

Vitamins

Seafood is a source of several vitamins. Fatty fish species are generally rich in fat soluble vitamins such as vitamins D and A. Among water soluble vitamins, the content of vitamin B12 is particularly high.

Vitamin D
Vitamin D improves the uptake of calcium and phosphates in the bowel, and contributes to regulating the calcium level in the blood. Vitamin D is also involved in the formation and structure of the skeleton. It is also suggested that vitamin D plays a role in the prevention of some forms of cancer.

Humans can form sufficient vitamin D with the aid of sunlight. As Norway is located so far north, the amount of sunlight is limited in winter, which can result in the body producing insufficient vitamin D. Older people, who mainly stay indoors, should receive a dietary supplement of 10 µg of vitamin D per day. Norwegian authorities recommend that infants receive a supplement of 10 µg vitamin D per day from four weeks of age. Fatty fish is a good source of vitamin D, and 100 g of fatty fish covers 50–200 % of the recommended daily intake (RDI). Cod liver oil is rich in vitamin D.

Vitamin A
Vitamin A is a fat-soluble vitamin that has a host of functions in the body, including an important task in the eyes relating to transferring light signals to the brain, and is also important for night vision. Vitamin A deficiency can amongst other things lead to reduced immune defence. Liver and fish are good sources of vitamin A, and some types of fruits and vegetables contain large amounts of carotenoids (provitamin A). Cod liver oil also contains a lot of vitamin A.

Vitamin E
Some types of seafood also contain large amounts of vitamin E. Vitamin E is an antioxidant that protects fat against oxidation in living cells. Vitamin E is also an essential component in the functioning of the nervous system.

Water-soluble vitamins
Fish is particularly rich in vitamin B12, and 100 g of fish normally covers more than 100 % of the recommended daily intake. Vitamin B12 plays a role in the formation of red blood cells, and insufficient B12 levels can lead to a form of anaemia. Most fish species also contain smaller amounts of the other forms of vitamin B. Seafood contains little vitamin C.

Vitamin content in fish and shellfish

	Vit A RE	Vit D µg	Vit E α-TE	Vit B_1 mg Thiamine	Vit B_2 mg Riboflavin	Vit B_3 NE Niacin	Vit B_6 mg Pyridoxine	Vit B_9 µg Folic acid	Vit B_{12} µg Cobalamin
RDI	350 - 900	7.5 - 10	5 - 10	0.6- 1.4	0.7 - 1.7	9 - 19	0.7 - 1.6	80 - 400	0.8 - 2.0
Lean fish									
Monkfish	80	1.0	0.5	0.03	0.06	5.0	0.2	12	1
Tusk	2	0	0.3	0.05	0.15	5.8	0.3	2	1
Haddock	2	0.7	0.5	0.05	0.11	7.0	0.5	9	2
Common ling	2	3.4	0.3	0.05	0.08	5.5	0.3	7	1
Pollock	2	2.2	0.7	0.05	0.10	4.8	0.2	3	1
Lemon sole	0	0	0.5	0.09	0.08	6.4	0.3	11	1
Saithe/coalfish	2	0.8	0.6	0.05	0.20	6.4	0.5	12	4
Cod	2	1.4	1.1	0.05	0.11	5.3	0.2	12	1
Common sole	0	8.0	0.6	0.06	0.10	5.7	0.3	11	1
Whiting	3	0.7	0.2	0.05	0.05	5.4	0.2	12	1
Northern pike	9	0.9	0.7	0.07	0.07	7.4	0.1	9	24
Bluefish tuna	372	1.6	1.2	0.16	0.16	13.5	0.4	15	5
European perch	9	0.8	1.2	0.07	0.07	7.3	0.1	9	5
European plaice	4	6.6	0.4	0.15	0.09	6.0	0.3	11	10
Moderately fatty fish									
Wolffish	27	1.8	1.1	0.07	0.08	5.6	0.3	5	2
Turbot	4	1.7	0.6	0.05	0.11	5.0	0.3	11	2
Redfish/ocean perch	3	0	1.4	0.10	0.11	5.1	0.2	9	1
Common whitefish	8	3.0	2.6	0.07	0.07	7.9	0.1	9	4
Sea trout	12	9.0	0.6	0.10	0.21	8.9	0.5	9	5
Char	30	6.9	1.3	0.09	0.02	9.1	0.6	26	10

RDI= Recommended daily intake

Vitamin content in different fish species per 100 g (applies to the raw, edible part of the fish, unless otherwise stated)

The table continues on the following page.

	Vit A RE	Vit D µg	Vit E α-TE	Vit B1 mg Thiamine	Vit B2 mg Riboflavin	Vit B3 NE Niacin	Vit B6 mg Pyridoxine	Vit B9 µg Folic acid	Vit B12 µg Cobalamin
RDI	350 - 900	7.5 - 10	5 - 10	0.6- 1.4	0.7 - 1.7	9 - 19	0.7 - 1.6	80 - 400	0.8 - 2.0
Fatty fish									
Farmed trout	10	10.0	2.7	0.10	0.21	8.4	0.6	9	5
Halibut	0	18.0	1.0	0.04	0.06	7.4	0.5	9	1
Greenland halibut	5	11.4	2.2	0.06	0.08	4.7	0.5	12	1
Wild salmon	0	8.0	1.3	0.20	0.15	10.6	0.6	1	3 7
Farmed salmon	11	8.0	1.4	0.21	0.14	11.8	0.5	13	7
European sprat	60	18.7	1.2	0.08	0.15	7.0	0.2	9	7
Mackerel	14	12.5	0.6	0.11	0.36	12.8	0.8	1	12
Fatty herring	6	11.5	0.6	0.04	0.30	7.1	0.5	9	12
Eel	600	30.0	8.0	0.20	0.04	6.7	0.3	12	3
Shellfish									
European flying squid	15	0	1.2	0.10	0.12	6.2	0.7	13	3
Blue mussels	14	0	0.8	0.02	0.27	3.1	0.1	37	25
Lobster (boiled)	26	0	4.3	0.10	0.06	4.6	0.1	17	1
Scallops	4	4.2	1.3	0.01	0.09	5.2	0.2	18	4
Edible crab (boiled)	4	0	1.2	0.05	0.40	5.9	0.2	20	14
Crayfish (boiled)	0	0	3.2	0.14	0.06	4.4	0.2	8	3
Shrimps (boiled)	2	3.5	5.3	0.01	0.07	6.6	0.1	4	5
Oysters	38	3.1	1.1	0.20	0.20	3.7	0.2	10	14

RE – Retinol equivalents: 1 RE = 1 µg retinol = 12 µg ß-carotene
α-TE – Tocopherol equivalents
NE – Niacin equivalents:
mg – milligram
µg – microgram

Source: Norwegian Food Safety Authority, Norwegian Directorate of Health and the University of Oslo, Food composition table 2006 www.matportalen.no/matvaretabellen

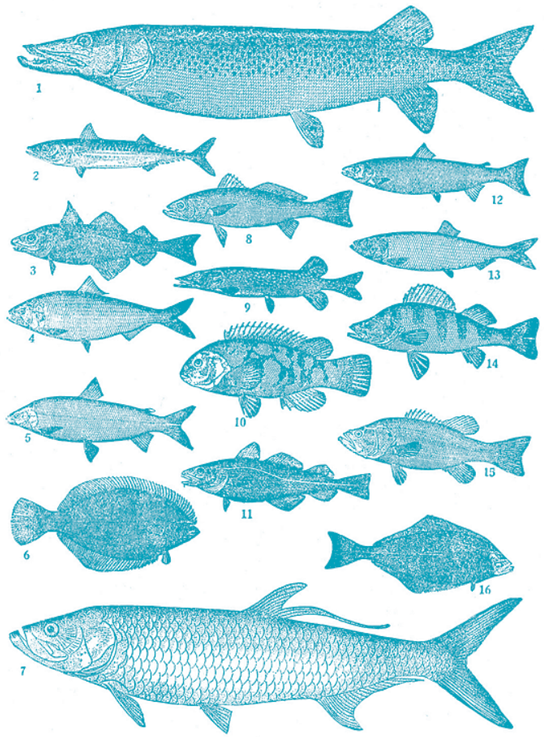
Minerals

Seafood is a good source of minerals, and the content of iodine and selenium is higher than in meat from land animals. Seafood can also contribute to covering the requirement for other minerals, e.g. iron, zinc, magnesium and calcium.

Iodine
Fish contains more iodine than all other food in a normal diet. Iodine has a central role in regulating the body metabolism. Iodine deficiency can lead to changes in metabolism and in turn reduced growth and cognitive decline. On a global basis, iodine deficiency is one of the most widespread deficiencies. Therefore, iodine is added to normal table salt. In Norway, fish and other seafood, as well as dairy products, are the most important dietary sources of iodine.

Selenium
Seafood is also a very good source of selenium. Selenium requirements are normally covered by grains, but the soil in some areas has a low content of selenium. Fish can contribute to covering the daily requirement.

Selenium exists in many enzymes and has several important tasks in the human body. Some of the selenium-enzymes participate in the detoxification of heavy metals, as well as protecting the body against oxidation. Selenium also plays a role in the regulation of metabolism.

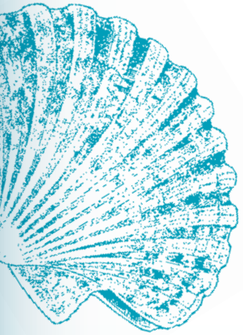


Mineral content in fish and shellfish

	Calcium mg	Iron mg	Magnesium mg	Zinc mg	Selenium µg	Iodine* µg
RDI	600-800	8-15	120-350	6-11	25-50	90-150
Lean fish						
Monkfish	49	0.3	189	3.3	290	-
Tusk	37	0.1	23	0.4	30	-
Haddock	19	0.1	27	0.3	30	-
Common ling	28	0.2	24	0.4	30	-
Pollock	8	0.1	23	0.3	30	-
Lemon sole	26	0.1	22	0.3	40	-
Saithe/coalfish	8	0.1	22	0.7	30	85
Cod	8	0.1	29	0.5	30	253
Common sole	29	0.1	25	0.5	30	25
Whiting	50	0.3	24	0.5	25	-
Northern pike	44	0.6	28	1.0	22	-
Bluefish tuna	11	2.3	39	0.6	200	7
European perch	110	0.6	26	0.8	28	-
European plaice	34	0.1	19	0.6	30	34
Moderately fatty fish						
Wolffish	13	0.2	20	0.9	50	60
Turbot	16	0.2	19	0.6	30	35
Redfish/ocean perch	21	0.2	26	0.3	50	-
Common whitefish	24	0.5	32	0.3	37	-
Sea trout	20	1.2	30	0.4	26	-
Char	16	0.2	25	0.4	30	-

Mineral content in different fish species per 100 g (applies to the raw, edible part of the fish, unless otherwise stated)

The table continues on the following page.

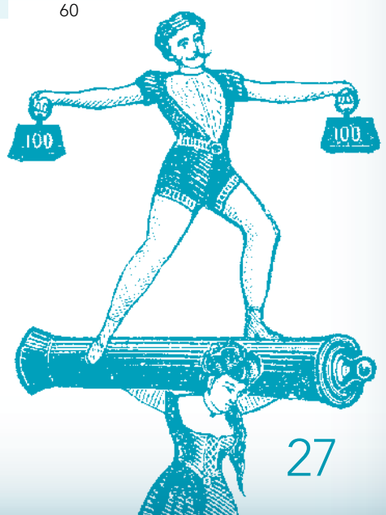


	Calcium mg	Iron mg	Magnesium mg	Zinc mg	Selenium µg	Iodine* µg
RDI	600-800	8-15	120-350	6-11	25-50	90-150
Fatty fish						
Farmed trout	20	0.2	28	0.4	30	5.3
Halibut	6	0.2	16	0.3	40	0.1
Greenland halibut	8	0.1	19	0.4	20	20
Wild salmon	8	0.4	30	0.4	50	30
Farmed salmon	12	0.4	28	0.4	0	30
European sprat	47	0.8	16	0.9	10	-
Mackerel	12	0.9	27	0.6	30	84
Fatty herring	38	1.0	38	0.5	50	24
Eel	35	0.4	15	2.0	25	25
Shellfish						
European flying squid	13	0.5	28	1.1	66	-
Blue mussels	38	5.8	23	2.5	51	140
Lobster (boiled)	138	0.7	45	4.1	80	700
Scallops	7	0.6	19	1.8	20	-
Edible crab (boiled)	55	1.8	63	6.5	200	60
Crayfish (boiled)	222	2.4	33	2.4	30	-
Shrimps (boiled)	61	0.1	43	1.0	30	17
Oysters	22	3.1	19	42	60	60

RDI = Recommended daily intake

Sources: Norwegian Food Safety Authority, Norwegian Directorate of Health and the University of Oslo, Food composition table 2006 www.matportalen.no/matvaretabellen

** Møller, A., Saxholt, E., Christensen, A.T., Hartkopp, H.B., Hess Ygil,K.: Danish Food Composition Databank, revision 6.0, Food Informatics, Department of Nutrition, Danish Institute for Food and Veterinary Research, June 2005 - http://www.foodcomp.dk/*



Other components in seafood

Most research on the health effects of seafood has been linked to the omega-3 fatty acids. Recently, there has been an increasing interest in other health promoting components from seafood. These include coenzyme Q10 (ubiquinone), a component that is central in the energy metabolism, and taurine, which is involved in many physiological processes.

Ubiquinone, Q10
Ubiquinone is a fat-soluble component, of which approx. 50 % comes via dietary intake and approx. 50 % is produced in the body. Seafood is a rich source of ubiquinone, but no recommended daily intake (RDI) exists. Ubiquinone is an antioxidant and a few studies have shown that dietary Q10 can be beneficial for cardiovascular health.

Taurine
Taurine, a substance found in most tissue and organs, is believed to serve many functions in our body. It is important for the development of eyes and the nervous system in newborns, and is therefore used as an additive in infant formula. Some studies have linked increased intake of taurine to a lower risk of developing cardiovascular diseases. Seafood, in particular shellfish, has a high taurine content.

Cholesterol
Some shellfish species contain relatively high amounts of cholesterol. Recent research has shown that it is not the cholesterol in the food that is decisive for the cholesterol level in the blood. The most important factor for the cholesterol level is the fat intake, in particular the intake of saturated fatty acids.

Seafood and persistent organic pollutants (POPs)

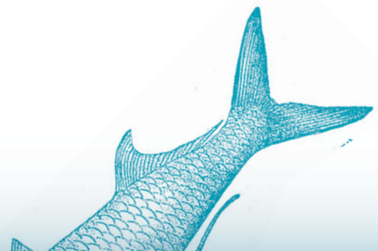
As with virtually all other foods, seafood can contain small amounts of persistent organic pollutants (POPs). The greatest attention has been associated with the content of mercury, polychlorinated biphenyls (PCBs) and dioxins. The Norwegian Scientific Committee for Food Safety carried out a comprehensive impact assessment of consuming seafood against the possible negative effects resulting from POPs. The committee concluded that from an overall perspective it is beneficial for one's health to consume both lean and fatty fish.

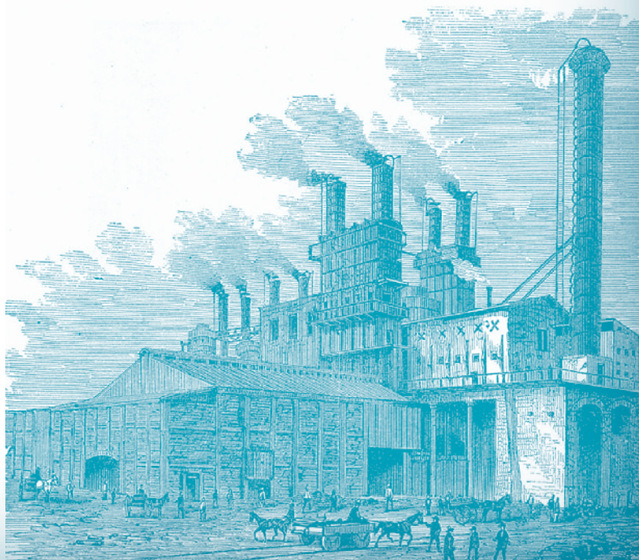
The level of mercury is generally so low that it does not pose a risk, even from large consumption of seafood. The exception may be fish from some contaminated watercourses. It is gratifying to note that the level of PCBs and dioxins has become significantly lower both in the environment and in fish as a result of reduced industrial discharge.

The Norwegian Scientific Committee for Food Safety also assessed whether the content of dioxins and PCBs could pose a risk. However, it had no doubts about consuming fish and other seafood equivalent to four meals or more per week for adults, when consumption is varied and fatty fish accounts for two or more meals per week.

All cod liver oil sold in Norwegian grocery stores is purified for remains from POPs. The Norwegian Food Safety Authority issues dietary advice about limited consumption as a result of POPs. The prevailing advice is that consumption of all Northern pike, perch over 25 cm and wild char and trout over 1 kg should be limited to once per month. The intake of fish liver and spreads made from fish lever should also be limited. In general, no commercial species in Norwegian waters pose a risk for consumption based on levels of contaminant.

The Norwegian Food Safety Authority advises women against eating the specified amounts of the above-mentioned species, brown meat from crabs or exotic species such as sharks, swordfish, skates and fresh tuna during pregnancy or while breastfeeding.





Sources

This brochure was inspired by a similar brochure published by the Irish Sea Fisheries Board (www.bim.ie).

Comprehensive reports on the topic have mainly been used as the basic documentation of the health effects. The following organisations are responsible for the various reports: the Norwegian Scientific Committee for Food Safety (www.vkm.no); the Institute of Medicine, USA (www.iom.edu); the Scientific Advisory Committee of Toxicity, United Kingdom; the Ministry of Food, Agriculture and Fisheries, Denmark (www.fdir.dk); and the Nordic Network of Marine Functional Food (www.marifunc.org).

The values for the nutritional content in seafood are mainly obtained from the Food comparison table 2006 (www.matportalen.no) prepared by the Norwegian Food Safety Authority, Norwegian Directorate of Health and the University of Oslo. The values for some foods are obtained from the Food Composition Databank, Food Informatics, Department of Nutrition, Danish Institute for Food and Veterinary Research (www.foodcomp.dk). Values for recommended daily intake of foods are obtained from the "Nordic Nutrition Recommendations 2004", a report providing joint Nordic recommendations for the intake of foods, published by the Nordic Council of Ministers (www.norden.org).

For more information about the link between seafood and health, please refer to:

A comprehensive assessment of fish and fish products, 2003, Danish Institute for Food and Veterinary Research, www.foedevarestyrelsen.dk/FDir/Publications/2003017/Rapport.htm

Seafood and health – what is the full story? MARIFUNC position paper, 2008, Ingrid Undeland, Helen Lindqvist, Yun Chen-Yun, Eva Falch, Alfonso Ramel, Marie Cooper, Asbjørn Gildberg, Edel Elvevoll, Even Stenberg, Henrik Hauch Nielsen and Joop Luten (www.marifunc.org)

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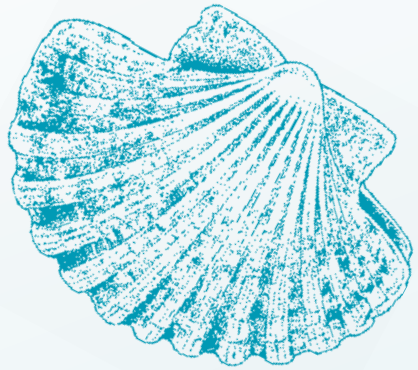

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The Fishery and Aquaculture Industry Research Fund (FHF) engages in R & D on behalf of the fisheries and aquaculture industry. The Norwegian Seafood Export Council (NSEC) markets Norwegian fish and seafood worldwide on behalf of the fisheries and aquaculture industry. The Norwegian Seafood Association (NSL) is a nationwide association for the fisheries and aquaculture industry. Nofima (The Norwegian Institute of Food, Fisheries and Aquaculture Research) engages in R & D for the fisheries, aquaculture and food industry. This brochure is developed for the general public on behalf of the fisheries and aquaculture industry. The first edition of the brochure was created in 2008 by Scientist Rune Larsen, Journalist Martin Steinholt, Graphic designer Oddvar Dahl and Project manager Joop Luten at Nofima Marin in collaboration with Kristin Lauritzsen, who is R & D Coordinator at NSL and R & D contact for FHF. The second edition in Norwegian language was designed by Treehouse in 2009. This third edition in English language is also designed by Treehouse. FHF has financed the development of the brochure, while the distribution is supported by FHF and NSEC.

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