1. NUTRITIONAL IMPORTANCE OF FISH

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Introduction

The fisheries and aquaculture sector is crucial for improving food security and human nutrition. The quantity of fish consumed and demand is increasing continuously. Aquaculture is considered as the world's fastest growing food production industry. Aquaculture has provided more fish for human consumption than capture fisheries, and by 2030 it is estimated that 60 % of the fish consumed by human will be from aquaculture. Increasingly intensive aquaculture production methods, with greater use of crop-based feedstuffs and lower fishmeal and fish oil inclusion rates, are likely to influence the nutrient content of farmed aquatic products. A focus on the nutrient content of farmed aquatic foods is especially important where they have a key role in food-based approaches to food security and nutrition. The awareness about the fish as a part of healthy diet is well accepted by the majority of the population. In addition to providing essential nutrients at affordable price, fish also contributes to the food and nutritional security of poor households in developing countries. Fish can be considered as a treasure store of nutrients. It provides more than 20 % of the average per capita animal protein intake for 3 billion people, and more than 50 % in some less developed countries. Fish and fish products are excellent sources of high-quality protein; bioavailability of protein from fish is approximately 5-15 % higher than that from plant sources. Fish contains all the amino acids essential for human health.

Many fish (especially fatty fish) are a source of long-chain omega-3 fatty acids, which contribute to visual and cognitive human development, especially during the first 1 000 days of a child's life. The fat content and fatty acid profiles of farm raised fishes affected by the feed used in culture practice. Though the fish consumption has increased, people are obtaining smaller amounts of omega-3 fatty acids from aquatic foods, because these fats are more prevalent in marine fishes than in freshwater fish. Fish also provides essential minerals such as calcium, phosphorus, zinc, iron, selenium and iodine as well as vitamins A, D and B, thus helping to reduce the risks of both malnutrition and noncommunicable diseases which may co-occur when high energy intake is combined with a lack of balanced nutrition. Nutritional content is especially high in small fish species consumed whole and in fish parts that are not usually consumed (such as heads, bones and skin) which are having lower economic value. It is desirable to increase the production and consumption of small fish and to find ways of transforming the non-consumed parts into nutritionally rich products.

There remains considerable scope to increase the amount of fish – or nutrients derived from fish – for human consumption by reducing post-harvest losses, especially from capture fisheries; by more efficient use of fishmeal and fish oil and in animal (especially aquaculture) feeds; and by improved feed formulations for farmed fish and crustaceans. The fish industry often only extracts fillets for human consumption consigning nutritious co-products to be used for animal feeds instead of exploring their use in tackling micronutrient deficiencies. Fish processing co-products, such as fish carcasses, which are increasingly used to produce fishmeal and fish oil, represent an underutilized source of nutrients and micronutrients for human consumption. The fishmeal and fish oil content of aquaculture feeds can be reduced without compromising the nutrient content of farmed aquatic products. Improvements in feed formulations and in feed manufacture, combined with better on-farm feed management, can hugely reduce the quantities of feed (and thus fishmeal and fish oil) used per kilogram of farmed aquatic food produced.

The FAO/INFOODS Global Food Composition Database for Fish and Shellfish (uFiSH) includes a complete nutrient profile (minerals, vitamins, amino acids and fatty acids) for 78 species in raw, cooked and processed forms. The data were extracted from 2 630 food records from 250 data sources and compiled following international FAO/INFOODS (International Network of Food Data Systems) standards. Such information is much usefull to have better understanding the nutritional value of fish.

Nutritional Value of Fish and Shellfish

Fish Proteins

Fish and shellfish are excellent sources of protein. A 100 g cooked serving of most types of fish and shellfish provides approximately 18–20 g of protein, or about a third of the average daily recommended protein intake. The recommended dietary allowance (RDA) of protein for human male and female adults is in the range of 45–65 g day. In accordance with this, an intake of 100 g of fish would contribute 15–25% of the total daily protein require-ment of healthy adults and 70% of that of children. The fish protein is of high quality, containing an abundance of essential amino acids, and is very digestible by people of all ages. Both finfish and shellfish are highly valuable sources of pro-teins in human nutrition, supplying approximately 7.9% of the world's protein requirements and 15.3% of the total ani-mal protein.

The protein content of fish flesh, in contrast to the fat content, is highly constant, independent of seasonal variations caused by the feeding and reproductive cycles, and shows only small differences among species. The approximate protein contents of the various finfish and shellfish groups are given in the following table.

Fish group	Percentage
White finfish	16–19
Fatty finfish	18–21
Crustaceans	18–22
Bivalves	10–12
Cephalopods	16–18

Fatty finfish and crustaceans have slightly higher than average protein concentrations. Bivalves have the lowest values if the whole body mass is considered (most of them are usually eaten whole), whereas values are roughly average if specific muscular parts alone are consumed; this is the case with the scallop, in which only the adductor muscle is usually eaten. Fish proteins, with only slight differences among groups, possess a high nutritive value, similar to that of meat proteins and slightly lower than that of egg. It is worth pointing out the elevated supply, relative to meat, of essential amino acids such as lysine, methionine, and threonine. In addition, owing in part to the low collagen content, fish proteins are easily digestible, giving rise to a digestibility co-efficient of nearly 100.

Essential amino acids in fish and shellfish (g/100g)

Fish group	Isoleucine	Leucine	Lysine	Methionine	Phenylalanine	Threonine	Tryptophan	Valine
Finfish	5.3	8.5	9.8	2.9	4.2	4.8	1.1	5.8
Crustaceans	4.6	8.6	7.8	2.9	4.0	4.6	1.1	4.8
Molluscs	4.8	7.7	8.0	2.7	4.2	4.6	1.3	6.2

Fish lipids

In fish, depot fat is liquid at room temperature (oil) and is seldom visible to the consumer; an exception is the belly flaps of certain fishes mainly farm arose. Many species of finfish and almost all shellfish contain less than 2.5% total fat, and less than 20% of the total calories come from fat. Almost all fish has less than 10% total fat, and even the fattiest fish, such as herring, mackerel, and salmon, contains no more than 20% fat. In order to obtain a good general idea of the fat contents of most finfish species, flesh color might be considered. The leanest species, such as cod and flounder, have a white or lighter color, whereas fattier fishes, such as salmon, herring, and mackerel, have a much darker color.

The triacylglycerol depot fat in edible fish muscle is subject to seasonal variation in all marine and freshwater fishes from all over the world. Fat levels tend to be higher during times of the year when fishes are feeding heavily (usually during the warmer months) and in older and healthier individual fishes. Fat levels tend to be lower during spawning or reproduction. When comparing fat contents between farmed and wild-caught food fish, it should be remembered that farmed species have a tendency to show a higher proportion of muscle fat than their wild counterparts. Also, the fattyacid composition of farmed fish depends on the type of dietary fat used in raising the fish.

Cholesterol in Fish

Cholesterol is independent of fat content and is similar in wild and cultivated fishes. The fish and shellfish contain well under 100 mg of cholesterol per 100 g, and many of the leaner types of fish typically have 40–60 mg of cholesterol in each 100 g of edible muscle. It is known that most shellfish also contain less than 100 mg of cholesterol per 100 g. Shrimp contain somewhat higher amounts of cholesterol, over 150 mg per 100 g, and squid is the only fish product with a significantly elevated cholesterol content, which averages 300 mg per 100 g portion. Fish roe, caviar, internal organs of fishes (such as livers), the tomalley of lobsters, and the hepatopancreas of crabs can contain high amounts of cholesterol.

A note on Omega-3 PUFA in Fish and Shellfish

The PUFA of many fish lipids are dominated by two members of the omega-3 (n-3) family, C20:5 n-3 (EPA), and C22:6 n-3 (DHA). They are so named because the first of several double bonds occurs three carbon atoms away from the terminal end of the carbon chain.

All fish and shellfish contain some omega-3, but the amount can vary, as their relative concentrations are species specific. Generally, the fattier fishes contain more omega-3 fatty acids than the leaner fishes. The amount of omega-3 fatty acids in farm-raised products can also vary greatly, depending on the diet of the fishes or shellfish. Many companies now recognize this fact and provide a source of omega-3 fatty acids in their fish diets. Omega-3 fatty acids can be destroyed by heat, air, and light, so the less processing, heat, air exposure, and storage time the better for preserving omega-3 in fish. Freezing and normal cooking cause minimal omega-3 losses, whereas deep frying and conditions leading to oxidation (rancidity) can destroy some omega-3 fatty acids.

Vitamins in Fish

The vitamin content of fish and shellfish is rich and varied in composition, although somewhat variable in concentration. In fact, significant differences are neatly evident among groups, especially regarding fat-soluble vitamins. Furthermore, vitamin content shows large differences among species as a function of feeding regimes. Of the fat-soluble vitamins, vitamin E (tocopherol) is distributed most equally, showing relatively high concentrations in all fish groups, higher than those of meat. However, only a part of the vitamin E content is available as active tocopherol on consumption of fish, because it is oxidized in protecting fatty acids from oxidation. The presence of vitamins A (retinol) and D is closely related to the fat content, and so they are almost absent in most low-fat groups. Appreciable but low concentrations of vitamin A are found in fatty finfish and bivalve molluscs, whereas vitamin D is very abundant in fatty fish.

Water-soluble vitamins are well represented in all kinds of fish, with the sole exception of vitamin C (ascorbic acid), which is almost absent in all of them. The concentrations of the rest are highly variable; however, with few exceptions, they constitute a medium-to-good source of such vitamins, com-parable with, or even better than, meat. The contents of vita-mins B_2 (riboflavin), B_6 (pyridoxine), niacin, biotin, and B_{12} (cobalamin) are relatively high. Indeed, 100 g of fish can contribute up to 38, 60, 50, 33, and 100%, respectively, of the total daily requirements of those vitamins. Fatty fish also provides a higher supply of many of the water-soluble vitamins (namely pyridoxine, niacin, pantothenic acid, and cobalamin) than does white fish or shellfish. Crustaceans also possess a relatively higher content of pantothenic acid, whereas bivalve molluscs have much higher concentrations of folate and cobalamine.

Fish Minerals

Seafood is also loaded with minerals such as phosphorus, magnesium, iron, zinc, and iodine in marine fish. The first point to note is that all kinds of finfish and shellfish present a well-balanced content of most minerals, either macrominerals or trace elements, with only a few exceptions. Sodium content is low, as in other muscle and animal origin foods. However, it must be remembered that sodium is usually added to fish in most cooking practices in the form of common salt; also, surimi-based and other manufactured foods contain high amounts of added sodium.

Calorific value

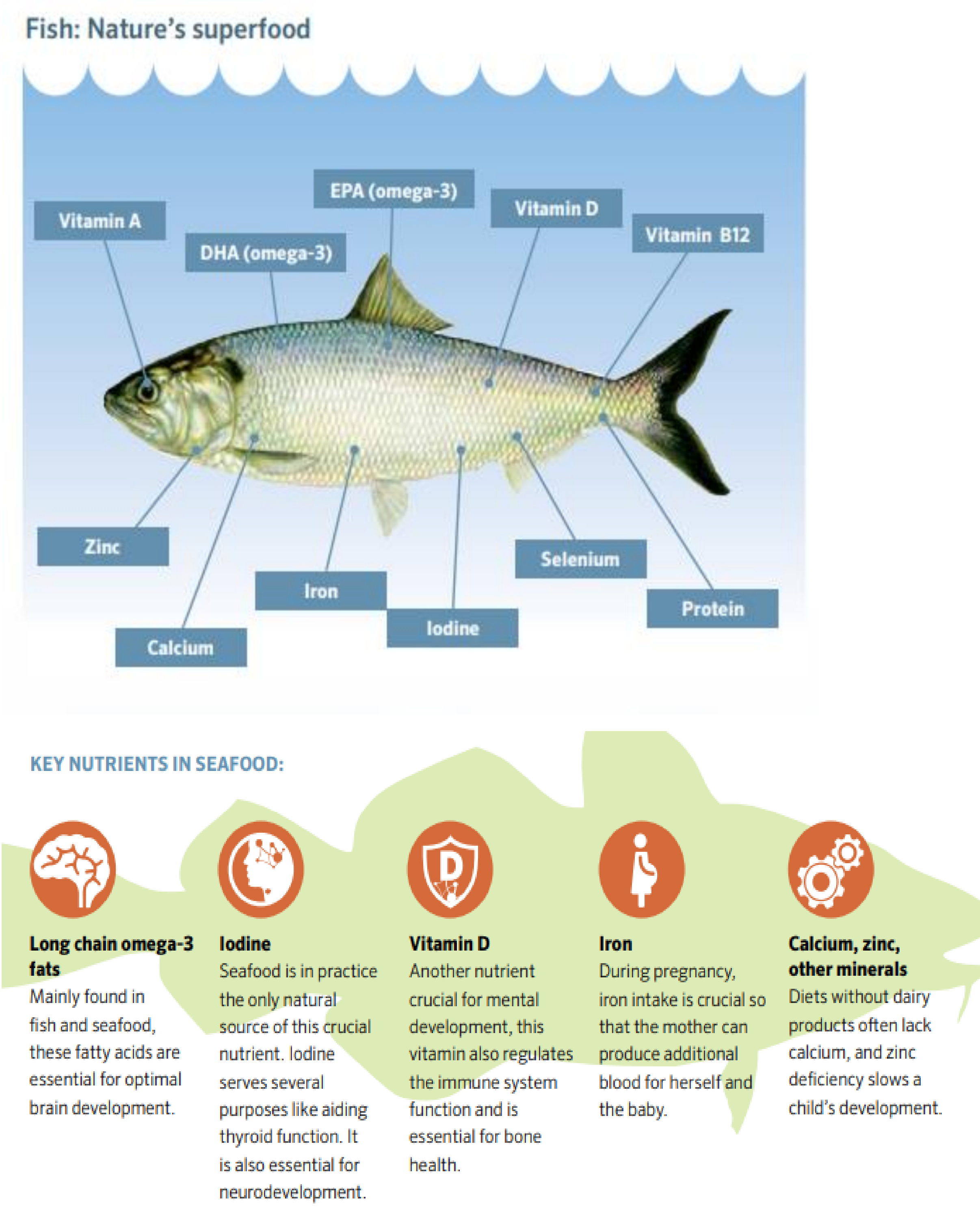
The caloric value of fish is related to the fat and protein content. The fat varies with species, size, diet, and season. Seafood is generally lower in fat and calories than beef, poultry, or pork. Most lean or low-fat species of fish, such as cod, hake, flounder, and sole, contain less than 100 kcal (418 kJ) per 100 g portion, and even fatty fish, like mackerel contain approximately 250 kcal (1045 kJ) or less in a 100 g serving.

Vitamin content of the different groups of fish and shellfish (mg or mg per 100 g), and relation to DRIs

	A (mg)	D (mg)	E (mg)	B1 (mg)	B2 (mg)	B6 (mg)	Niacin (mg)	Biotin (mg)	Pantothenic acid (mg)	Folate (mg)	B12 (mg)	C (mg)
White finfish	Trace	Trace	0.3–1.0	0.02–0.2	0.05–0.5	0.15–0.5	1.0–5.0	1.0–10	0.1–0.5	5.0–15	1.0–5.0	Trace
Fatty finfish	20–60	5–20	0.2–3.0	0.01–0.1	0.1–0.5	0.2–0.8	3.0–8.0	1.0–10	0.4–1.0	5.0–15	5.0–20	Trace
Crustaceans	Trace	Trace	0.5–2.0	0.01–0.1	0.02–0.3	0.1–0.3	0.5–3.0	1.0–10	0.5–1.0	1.0–10	1.0–10	Trace
Molluscs	10–100	Trace	0.5–1.0	0.03–0.1	0.05–0.3	0.05–0.2	0.2–2.0	1.0–10	0.1–0.5	20–50	2.0–30	Trace
Cephalopods	Trace	Trace	0.2–1.0	0.02–0.1	0.05–0.5	0.3–0.1	1.0–5.0	1.0–10	0.5–1.0	10–20	1.0–5.0	Trace
RDA	700/900	5	15	1.1/1.2	1.1/1.3	1.3	14/16	30	5.0	400	2.4	75/90
% RDA per 100 g	0–11	0–100	2–20	1–20	2–38	5–60	1–50	3–33	2–20	0.3–12	40–100	0
% RDAMd	2	50	7	5	15	25	18	5	8	2	100	0

Selected mineral content of the different groups of fish and shellfish (mg per 100 g), and relation to DRIs

	Na	K	Ca	Mg	P	Fe	Zn	Mn	Cu	Se	Cr	Mo	I
White finfish	50–150	200–500	10–50	15–30	100–300	0.2–0.6	0.2–1.0	0.01–0.05	0.01–0.05	0.02–0.1	0.005–0.02	0.005–0.02	0.01–0.5
Fatty finfish	50–200	200–500	10–200	20–50	200–500	1.0–5.0	0.2–1.0	0.01–0.05	0.01–0.05	0.02–0.1	0.005–0.02	0.005–0.02	0.01–0.5
Crustaceans	100–500	100–500	20–200	20–200	100–700	0.2–2.0	1.0–5.0	0.02–0.2	0.1–2.0	0.05–0.1	0.005–0.02	0.01–0.05	0.01–0.2
Molluscs	50–300	100–500	50–200	20–200	100–300	0.5–10	2.0–10	0.02–0.2	0.02–10	0.05–0.1	0.005–0.02	0.01–0.2	0.05—0.5
Cephalopods	100–200	200–300	10–100	20–100	100–300	0.2–1.0	1.0—5.0	0.01–0.1	0.02–0.1	0.02–0.1	0.005–0.02	0.01–0.2	0.01–0.1
RDA	1500	4700	1000	320/420	700	18/8	8/11	1.8/2.3	0.9	0.025/0.055	0.035	0.045	0.15
% RDA per 100 g	3–33	2–10	1–20	4–50	15–100	2–50	1–90	0–10	1–100	25–100	15–60	10–100	8-100
% RDA/Md			6	5	30	18	2		2	100			100



Source: FAO - Fish and human nutrition

Further reading

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