



Oily Fish as a Source of Bioactive Compounds in the Diet [†]

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Abstract: Current research has shown that oily fish, specifically pelagic species such as blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), swordfish (*Xiphias gladius*) and bluefin tuna (*Thunnus thynnus*), are a rich source of essential nutrients, such as proteins (15–21%), lipids (0.5–3.3%), carbohydrates, vitamins A and D, and minerals, such as calcium and selenium. In addition, they also contain bioactive compounds that have been reported to promote the health of the fish consumers. Bioactive compounds are components naturally present in food found in relatively small amounts, which, after enzymatic hydrolysis at the gastrointestinal level, influence cellular and physiological activities, obtaining a positive effect on consumer health. These benefits are achieved through multifactorial physiological mechanisms that include antioxidant, antihypertensive, antidiabetic, antimicrobial, antiviral or immunomodulatory activity, among others. The increase in diseases such as cancer, hypertension and diabetes has caused the population to prefer good nutritional foods that also exert beneficial effects on health. Some of the bioactive compounds reported in these species include bioactive peptides, omega-3 polyunsaturated fatty acids and minerals. Therefore, in this work, we have reviewed the scientific evidence for the benefits of consuming bioactive compounds from oily fish and their effect on physiological risk factors, molecular pathways and bioactive metabolites.

Keywords: pelagic species; nutritional profile; bioactive compounds; health benefits



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1. Introduction

It is known that food supplies energy and nutrients to our body but is also a source of compounds that have beneficial effects on the health of the consumer, sometimes preventing or inhibiting the progression of various diseases or forming part of their treatment. Currently, numerous investigations focus on the advantages of consumption of different foods, including oily fish. Oily fish species, such as *Prionace glauca*, *Isurus oxyrinchus*, *Xiphias gladius* and *Thunnus thynnus*, are economically important due to their high commercialization and nutritional characteristics. Blue shark is a species of elasmobranch of the Carcharhinidae family, common in pelagic oceanic waters, which has a stylized and elongated body. Like all carcharhiniformes, it has large eyes, has an average length of 2.5 m and can weigh up to 80 kg. It feeds mainly on fish such as mackerel, herring, grouper, horse mackerel, bonito, gadidae and squid and seabirds. It is found in the Atlantic, from Morocco to Norway, in the Mediterranean or in the Pacific Ocean, and is a highly migratory species [1]. As for the shortfin mako, it is a species of elasmobranch of the Lamnidae family. The specimens can measure between 3.5 and 4 m in length and weigh up to 500 kg. It has

a very wide distribution: it is found in the Pacific, Atlantic, Indian, Mediterranean and Red seas, and its diet is similar to that of the blue shark, but it can also attack large species such as swordfish, marlin and red tuna [2]. The swordfish is a species of perciform fish of the Xiphiidae family. They are stylized and can reach a maximum size of 4.3 m and a weight of 540 kg. They are large, highly migratory predatory fish, characterized by their long, flattened beak. Regarding its diet, it includes pelagic fish such as tuna, barracuda and flying fish [2]. On the other hand, bluefin tuna belongs to the family Scombridae, which is culturally known as “bluefin tuna” because of the scarlet color of its meat. Most of the bluefin tuna we consume comes from the pelagic ecosystem of the Atlantic Ocean and the Mediterranean Sea. It is known worldwide for its biological properties, such as a remarkable size, reaching 3 m in length, and a high migratory capacity [3].

Regarding nutritional composition, oily fish contain around 60–80% of water, 20% of protein and between 10 and 18% of lipids. In addition, several studies have reported the presence of several bioactive compounds. For example, different bioactive peptides have been shown to have antioxidant, antihypertensive, antimicrobial and antiobesity capacity, among others. On the other hand, they contain significant amounts of omega-3 fatty acids, specifically eicosapentaenoic (EPA) and docosahexaenoic (DHA), to which important bioactive properties are also attributed, such as anti-inflammatory and cardioprotective effects [4]. Nowadays, there is considerable evidence that its regular consumption has positive effects on health [4]. These benefits are achieved through multifactorial physiological mechanisms, such as antioxidant activity, hormone mediation, improvement of the immune system and facilitation of the transit of substances through the digestive tract and the production of butyric acid in the colon, among others [4]. However, various studies have reported the presence of heavy metals in these species, especially mercury in its inorganic form (methylmercury). This has caused a decrease in its consumption. However, there is evidence that a moderate consumption of these species offers more benefits than risks for the health of the consumer, due to their good nutritional value and bioactive compounds that may counteract the negative effects of heavy metals. Therefore, the objective of this review is to discuss the bioactive compounds present in the pelagic species blue shark (*Prionace glauca*), shortfin mako shark (*Isurus oxyrinchus*), swordfish (*Xiphias gladius*) and bluefin tuna (*Thunnus thynnus*) (Figure 1).

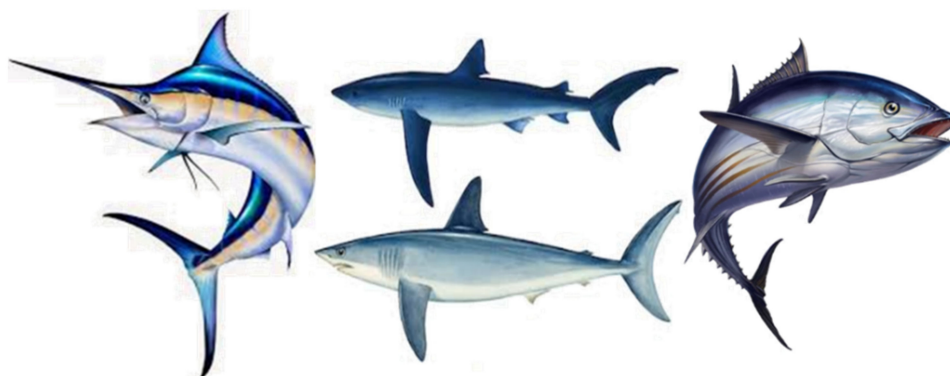


Figure 1. *Xiphias gladius* (swordfish), *Prionace glauca* (blue shark), *Isurus oxyrinchus* (shortfin mako) and *Thunnus thynnus* (bluefin tuna).

2. Composition of Nutritional and Bioactive Compounds in Selected Species

The numerous nutritional benefits of fish consumption have been associated with the high content of proteins of high biological value, an adequate contribution of polyunsaturated fatty acids (omega-3) and low cholesterol levels and its rich content of vitamins (mainly A and D) and minerals [5–8]. In this section we will highlight the nutritional composition and bioactive compounds of oily fish, paying special attention to the species *P. glauca*, *I. oxyrinchus*, *X. gladius* and *T. thynnus*.

species. According to Rodriguez et al. 2011 [20], they found bioactive shark peptides with important antioxidant properties. Another study reported high angiotensin-converting enzyme (ACE) inhibitory activity in shark hydrolysates, identifying four peptides, Cys-Phe, Glu-Tyr, Met-Phe and Phe-Glu, which achieved IC₅₀ values of 1.96, 2.68, 0.92 and 1.45 mM, respectively [21]. Additionally, it has been reported that these species contain immunoglobulins that act as a defense mechanism against viral and bacterial infections and prevent protein-calorie malnutrition [4].

2.2. Lipids and Fatty Acids

The lipid content in the studied species ranged between 4.3 and 12 g of lipids/100 g of fish for swordfish and bluefin tuna (Table 1). Regarding fatty acids, except in the case of swordfish, the polyunsaturated fraction showed higher values than SFA and MFA. Considering daily recommendations, 100 g of bluefin tuna would supply 20.6 and 27% of the recommended amount of PFA for men and women, respectively. Among PFA, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the most abundant. These compounds are well-known for having beneficial effects on health, including anti-inflammatory properties and neurological and cardiovascular protection [2,8,22,23]. Other important data include the proportion of omega-3 and omega-6 fatty acids. Omega-3 fatty acids, unlike omega-6, has different beneficial effects (Figure 2). In the case of swordfish, blue shark and mako shark, the contribution of omega-3 fatty acids ranges between 0.884 and 1 g/100 g [22], while bluefin tuna is the species with the highest contribution at 3.342 g/100 g [8].

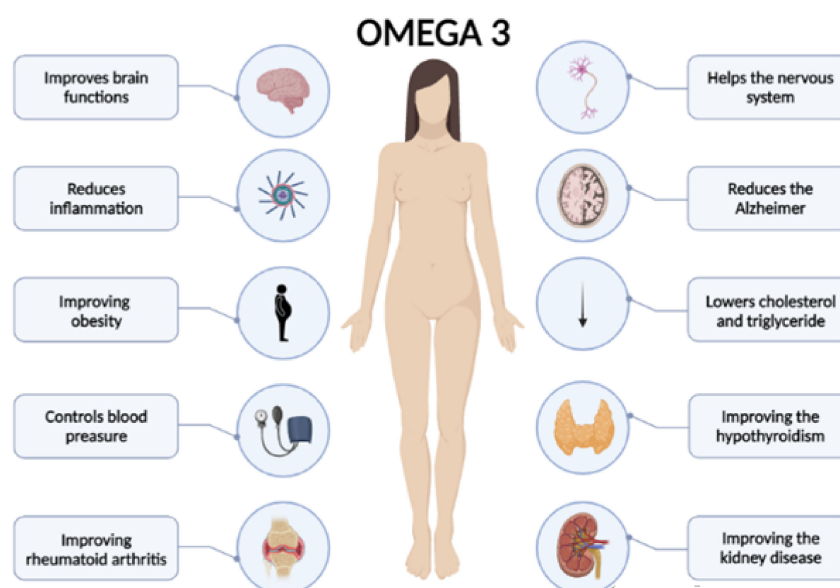


Figure 2. Benefits of consuming omega-3 fatty acids.

2.3. Vitamins

Regarding the major vitamins present in the composition of the selected species, the content of vitamin A stands out (Table 1), ranging between 8.36 and 500 mg/g for mako shark and swordfish. For the latter species, 100 g can provide 50% of the daily requirement for men and women [23–25]. In addition, a high contribution of B-complex vitamins, mainly niacin (B3), is described. It is important to note that vitamin B3 is important for the correct functioning of the nervous system and the maintenance of mucous membranes and skin and helps reduce tiredness and fatigue. The content of vitamin B12 is also remarkable, varying between 1.35 mg/g for mako shark and 5 mg/g for swordfish and bluefin tuna. This vitamin has a fundamental role in the formation of red blood cells, cell metabolism, nerve function and DNA production. It is reported that bluefin tuna and swordfish can provide 250% of the daily requirement of this vitamin (Table 1).

2.4. Minerals

As can be observed in Table 1, these species are a rich source of potassium, phosphorus, sodium and also selenium. For the last mineral, the content was lower in both shark species, while higher levels were reported for bluefin and swordfish. In fact, 100 g of bluefin tuna can provide 113% of selenium for men and 149% in the case of women. These data are in agreement with another study by Carbañero and co-workers, who analyzed the nutritional composition of the most consumed fish in Spain and Portugal, finding the highest selenium levels were found in tuna (0.92 mg/kg) and swordfish (0.47 mg/kg) [26]. Another important mineral is manganese, and its content is particularly high in the swordfish, reaching 57 mg/g, equivalent to 17% of the daily recommendation for this mineral.

It is known that the species under study have a higher content of Hg compared to smaller species, which has caused the control agencies to advise limitations on the consumption of these species, despite their good nutritional value [27]. However, various studies suggest that some nutrients, especially selenium, but also omega-3 fatty acids, can form complexes with Hg, reducing its bioavailability and the risk of exposure and therefore its negative effects on consumers' health [28–30].

3. Conclusions

Nowadays, several reports have demonstrated that the selected oily species present good nutritional values, being a rich source of nutrients such as proteins, lipids, vitamins and minerals. In addition, these species contain diverse bioactive compounds, mainly bioactive peptides, EPA and DHA, with many biological activities (antioxidant, anti-inflammatory, cardioprotective, etc.) that are associated with the beneficial effects of the consumption of these species.

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