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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 like blue shark (Prionace glauca), shortfin mako (Isurus oxyrinchus), swordfish (Xiphias gladius) and bluefin tuna (Thunnus thynnus), are a rich source of essential nutrients like proteins (15–21%), lipids (0.5–3.3%), carbohydrates, vitamins A and D and minerals, like 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 or diabetes have caused the population to prefer with good nutritional foods but 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 of 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 provide beneficial effects on the health of the consumer, sometimes preventing or inhibiting the progression of various diseases or forming part of its treatment. Currently, numerous investigations focus on the advantages of consumption of different foods, including oily fish. Oily fish species, like 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 carcarrhiniformes, 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, squid and seabirds. It is found in the Atlantic, from Morocco to Norway, in the Mediterranean or in the Pacific Ocean, it 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 meters 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, 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 that can reach 3 meters in length and a high migratory capacity [3].

Regarding nutritional composition, oily fish contain around 60–80% of water, 20% of protein and between 10–18% of lipids. In addition, several studies have reported the presence of several bioactive compounds. For example, different bioactive peptides have been shown to exert antioxidant, antihypertensive, antimicrobial, and anti-obesity 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, 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 values 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).

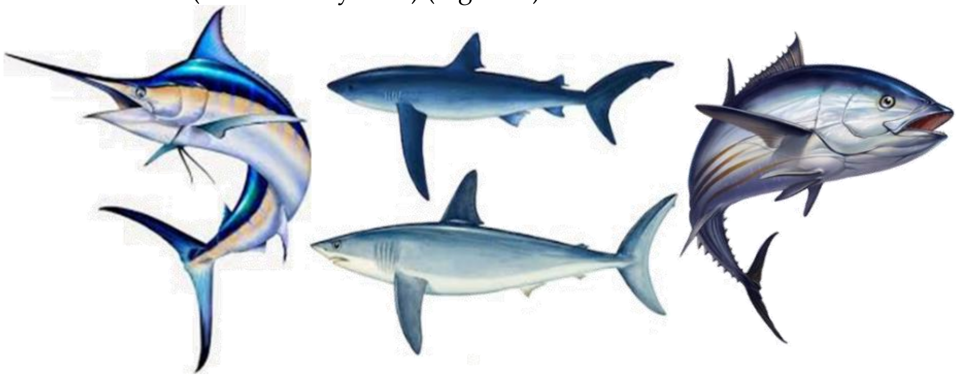

Figure 1. *Xiphias gladius* (**swordfish**), *Prionace glauca* (**blue shark**), *Isurus oxyrinchus* (**shortfin mako**) and *Thumus thynnus* (**bluefin tuna**).

2. Composition Nutritional and Bioactive Compounds in Selected Species

The numerous nutritional benefits of fish consumption have been associated to 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 (minly 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.

Table 1. Nutritional composition of selected species and nutrient recommendations.

	Xiphias gladius	*Prionace glauca*	*Isurus oxyrinchus*	*Thunnus thynnus*	**Men Daily recommendations**	**Women Daily recommendations**
			g/100 g			
Energy (Kcal)	107	82	87	200	3.000	2.300
Total protein	17	18.7	20.7	23	54	41
Total lipids	4.3	4.5	4.4	12	100- 117	77 -89
SFA	1.15	0.2	0.3	3.08	23 - 27	18 - 20
MFA	1.43	0.2	0.3	2.66	67	51
PFA	0.99	1.2	1	3.58	17	13
Carbohydrates	0	0	0.21	0	375- 413	288- 316
Fiber	0	0	-	0	>3 5	> 25
Water	78.7	78.5	76	65	2500	2000
			mg/g			
Calcium	19	34	12	38	1000	1000
Iron	0.9	0.8	0.957	1.3	10	18
Iodine	17.2	0	-	36.7	140	110
Magnesium	57	49	40	28	350	330
Zinc	0.4	0.4	0.358	1.1	15	15
Sodium	102	79	90	43	< 2000	< 2000
Potassium	342	160	167	40	3500	3500
Phosphorus	506	210	190	200	700	700
Selenium	48.1	28	28.5	82	70	55
Thiamine	0.05	0.04	0.03	0.05	1.2	0.9
Riboflavin	0.05	0.62	0.58	0.2	1.8	1.4
Niacin equivalents	9	2.9	2.1	17.8	20	15
Vitamin B6	0.51	0.50	-	0.46	1.8	1.6
Folates	15	0	-	15	400	400
Vitamin B12	5	1.49	1.35	5	2	2
Vitamin A	500	70	8.36	60	1000	1000
Vitamin D	7.2	8	8	25	15	15

Abbreviations: SFA, saturated fatty acids; MFA, monounsaturated fatty acids; PFA, polyunsaturated fatty acids. Data obtained from [9,10]..

2.1. Protein and Amino Acid Profile

As could be observed in Table 1, the protein content in the selected species ranges between 17 and 23 g of protein per 100 g of fish for swordfish and bluefin tuna, respectively. Considering the daily recommendations, 100 g of those species would supply 31.5 and 42.6% of daily protein content for men, and 41.5 and 56.1% for women, respectively. Fish proteins are considered to be of better quality than red meat proteins, due to their lower collagen content and better proteolytic digestion [11]. In addition, various studies affirm that fish proteins contain a large amount of essential amino acids (EAA) (lysine, methionine, threonine, tryptophan, isoleucine, phenylalanine and valine) [4,11]. Regarding amino acid profile, no data has been found for blue and mako sharks. On the other hand, bluefin and swordfish are rich in the essential amino acids histidine (0.583–0.648 g/100g), isoleucine (0.912–1.014 g/100), leucine (1.61–1.788 g/100), lysine (1.82–2.20), methionine (0.586–0.651 g/100) and tryptophan (0.222–0.246 g/100), being bluefin tuna the species with the highest contribution of essential amino acids [9,10].

Fish proteins have been recognized as a source of bioactive peptides that have gained considerable attention, due to their multiple beneficial effects on health. In particular, these peptides exhibit antioxidant, antihypertensive, antiproliferative, anticoagulant, calcium-binding, antiobesity, and antidiabetic activities [12–15]. The antioxidant properties of bioactive peptides are related to their composition, structure, and hydrophobicity. Methionine, lysine, isoleucine, phenylalanine, and valine are examples of amino acids responsible for antioxidant capacity and are present in high amounts in oily fish [16]. Considering the species selected, many studies have demonstrated the presence of bioactive peptides. For instance, various studies report the antioxidant [3,17], antiproliferative [18], antihypertensive [19] and angiogenic effects [1] of bioactive peptides present in bluefin tuna species. According to Rodrigez et al 2011 [20], they found bioactive shark peptides with important antioxidant properties. Other study reported high angiotensin converting enzyme (ACE) inhibitory activity in shark hydrolysates, identifying 4 peptides Cys-Phe, Glu-Tyr, Met-Phe and Phe-Glu, which achieved IC50 values of 1.96, 2.68 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, respectively (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 a 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 providing beneficial effects on health, including anti-inflammatory properties, and neurological and cardiovascular protection [2,8,22,23]. Other important data is the proportion of omega 3 and omega 6 fatty acids. Omega 3 fatty acids, unlike omega 6, had 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, 3.342 g/100 g [8].

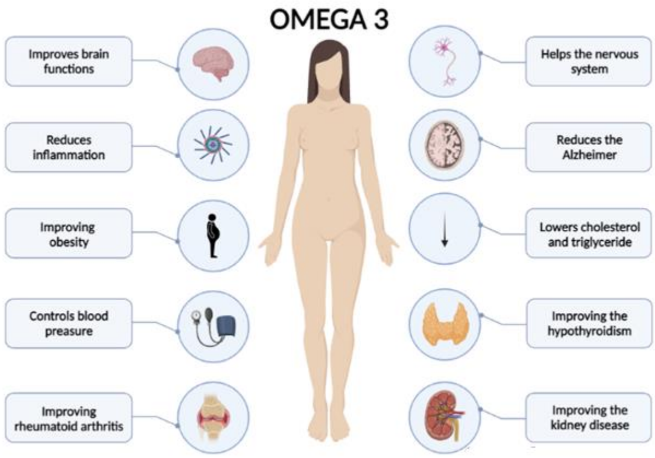

Figure 2. Benefits of consuming omega 3 fatty acids.

2.3. Vitamins

Regarding the major vitamins present in the composition of selected species, the content of vitamin A stands out (Table 1), ranging between 8.36 and 500 mg/g for mako shark and swordfish, respectively. For the latest 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 correct functioning of the nervous system, the maintenance of mucous membranes and skin, and helps reduce tiredness and fatigue. Content of vitamin B12 is also remarkable, which varies between 1.35 mg/g for mako shark and 5 mg/g for swordfish and bluefin tuna, respectively. 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 could be observed in Table 1, these species are a rich source of potassium, phosphorous, 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 other study of Carbañero and co-workers, who analyzed the nutritional composition of 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]. Other important mineral is manganese, highlighting its content in the swordfish, reaching 57 mg/g, equivalent to a 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 values [27]. However, various studies suggest that some nutrients, specially selenium, but also omega 3 fatty acids, can form complexes with Hg, reducing its bioavailability and the risk of exposure and thereof 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 like 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.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "conceptualization, F.C. and M.C.; methodology, A.P.; software, J.E.; validation, M.F., P.G. and F.C.; formal analysis, F.C.; investigation, J.E.; resources, M.P.; data curation, F.C.; writing—original draft preparation, F.C.; writing—review and editing, M.P.; visualization, M.P.; supervision, M.P and J.S Authorship must be limited to those who have contributed substantially to the work reported.

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Conflicts of Interest: The authors declare no conflict of interest.

References

1. Zheng, L.; Ling, P.; Wang, Z.; Niu, R.; Hu, C.; Zhang, T.; Lin, X. A novel polypeptide from shark cartilage with potent anti-angiogenic activity. *Cancer Biol. Ther.* **2007**, *6*, 775–780, doi:10.4161/cbt.6.5.4002.
2. Vlieg, P.; Murray, T.; Body, D. Nutritional Data on Six Oceanic Pelagic Fih Species from Nez Zeland Waters 1993, 45–54.
3. Bougatef, A.; Balti, R.; Haddar, A.; Jellouli, K.; Souissi, N.; Nasri, M. Protein hydrolysates from bluefin tuna (Thunnus thynnus) heads as influenced by the extent of enzymatic hydrolysis. *Biotechnol. Bioprocess Eng.* **2012**, *17*, 841–852, doi:10.1007/s12257-012-0053-y.
4. Balami, S.; Sharma, A.; Karn, R. Significance Of Nutritional Value Of Fish For Human Health. *Malaysian J. Halal Res.* **2019**, *2*, 32–34, doi:10.2478/mjhr-2019-0012.
5. Mohanty, B.P.; Mahanty, A.; Ganguly, S.; Mitra, T.; Karunakaran, D.; Anandan, R. Nutritional composition of food fishes and their importance in providing food and nutritional security. *Food Chem.* **2019**, *293*, 561–570, doi:10.1016/j.foodchem.2017.11.039.
6. Olmedo, P.; Hernández, A.F.; Pla, A.; Femia, P.; Navas-Acien, A.; Gil, F. Determination of essential elements (copper, manganese, selenium and zinc) in fish and shellfish samples. Risk and nutritional assessment and mercury–selenium balance. *Food Chem. Toxicol.* **2013**, *62*, 299–307, doi:10.1016/j.fct.2013.08.076.
7. Erkan, N.; Can Tunçelli, İ.; Özden, Ö.; Üren, S. Nutritional Composition and heavy Metal Concentrations in Sardinella maderensis (Lowe, 1838) obtained from the Mauritanian fisheries. *J. Appl. Ichthyol.* **2020**, *36*, 906–911, doi:10.1111/jai.14143.
8. Mesa, M.D.; Gil, F.; Olmedo, P. Nutritional Importance of Selected Fresh Fishes , Shrimps and. **2021**.
9. Olga, M.; Carbajal, A.; Cabrera, L.; Carmen Cuadrado *Tablas de composicion de alimentos*; Piramide, Ed.; 19th ed.; Spain, 2018; ISBN 9788436839470.
10. Food and Agriculture Organization of the United Nations (FAO); Organisation des Nations Unies pour l'alimentation et l'Agriculture (FAO); International Network of Food Data Systems (INFOODS); Réseau international de systèmes de données sur les aliments (INFOODS) *FAO/INFOODS Food Composition Table for Western Africa (2019) – Table de composition des aliments FAO/INFOODS pour l'Afrique de l'Ouest (2019)*; 2020; ISBN 9789251322239.
11. Weichselbaum, E.; Coe, S.; Buttriss, J.; Stanner, S. Fish in the diet: A review. *Nutr. Bull.* **2013**, *38*, 128–177, doi:10.1111/nbu.12021.
12. Ryan, J.T.; Ross, R.P.; Bolton, D.; Fitzgerald, G.F.; Stanton, C. Bioactive peptides from muscle sources: Meat and fish. *Nutrients* **2011**, *3*, 765–791, doi:10.3390/nu3090765.
13. Kim, S.K.; Ngo, D.H.; Vo, T.S. *Marine Fish-Derived Bioactive Peptides as Potential Antihypertensive Agents*; 1st ed.; Elsevier Inc., 2012; Vol. 65; ISBN 9780124160033.
14. Chiesa, G.; Busnelli, M.; Manzini, S.; Parolini, C. Nutraceuticals and bioactive components from fish for dyslipidemia and cardiovascular risk reduction. *Mar. Drugs* **2016**, *14*, 1–15, doi:10.3390/md14060113.
15. Wang, X.; Yu, H.; Xing, R.; Li, P. Characterization, Preparation, and Purification of Marine Bioactive Peptides. *Biomed Res. Int.* **2017**, *2017*, doi:10.1155/2017/9746720.
16. Görgüç, A.; Gençdağ, E.; Yılmaz, F.M. Bioactive peptides derived from plant origin by-products: Biological activities and techno-functional utilizations in food developments – A review. *Food Res. Int.* **2020**, *136*, 109504, doi:10.1016/j.foodres.2020.109504.
17. Je, J.Y.; Qian, Z.J.; Byun, H.G.; Kim, S.K. Purification and characterization of an antioxidant peptide obtained from tuna backbone protein by enzymatic hydrolysis. *Process Biochem.* **2007**, *42*, 840–846, doi:10.1016/j.procbio.2007.02.006.
18. Hsu, K.C.; Li-Chan, E.C.Y.; Jao, C.L. Antiproliferative activity of peptides prepared from enzymatic hydrolysates of tuna dark muscle on human breast cancer cell line MCF-7. *Food Chem.* **2011**, *126*, 617–622, doi:10.1016/j.foodchem.2010.11.066.
19. Lee, S.H.; Qian, Z.J.; Kim, S.K. A novel angiotensin I converting enzyme inhibitory peptide from tuna frame protein hydrolysate and its antihypertensive effect in spontaneously hypertensive rats. *Food Chem.* **2010**, *118*, 96–102, doi:10.1016/j.foodchem.2009.04.086.
20. Rodríguez-Díaz, J.C.; Kurozawa, L.E.; Netto, F.M.; Hubinger, M.D. Optimization of the Enzymatic Hydrolysis of Blue Shark Skin. *J. Food Sci.* **2011**, *76*, 938–949, doi:10.1111/j.1750-3841.2011.02318.x.
21. Wu, H.; He, H.L.; Chen, X.L.; Sun, C.Y.; Zhang, Y.Z.; Zhou, B.C. Purification and identification of novel angiotensin-I-converting enzyme inhibitory peptides from shark meat hydrolysate. *Process Biochem.* **2008**, *43*, 457–461, doi:10.1016/j.procbio.2008.01.018.
22. Smida, M.A.B.; Marzouk, B.; Cafsi, M. El The composition of fatty acids in the tissues of Tunisian swordfish (Xiphias gladius). *Food Chem.* **2009**, *115*, 522–528, doi:10.1016/j.foodchem.2008.12.084.
23. Cobas, N.; Piñeiro-Lago, L.; Gómez-Limia, L.; Franco, I.; Martínez, S. Vitamin retention during the canning of swordfish (Xiphias gladius) with different filling media. *J. Food Sci.* **2021**, *86*, 1704–1713, doi:10.1111/1750-3841.15691.
24. G, D.M.; V, S.M.; H, B.; L, O. VITAMIN CONTENT OF FISH AND FISH PRODUCTS CONSUMED IN PORTUGAL. *Electron. Journa Environ. Agric. Food Chem.* **2003**, *2*, 510–513.

25. Bernstein, A.S.; Oken, E.; De Ferranti, S.; Lowry, J.A.; Ahdoot, S.; Baum, C.R.; Bernstein, A.S.; Bole, A.; Byron, L.G.; Landrigan, P.J.; et al. Fish, shellfish, and children's health: An assessment of benefits, risks, and sustainability. *Pediatrics* **2019**, *143*, doi:10.1542/peds.2019-0999.
26. Cabañero, A.I.; Carvalho, C.; Madrid, Y.; Batoréu, C.; Cámara, C. Quantification and speciation of mercury and selenium in fish samples of high consumption in Spain and Portugal. *Biol. Trace Elem. Res.* **2005**, *103*, 17–35, doi:10.1385/bter:103:1:017.
27. Committee, E.S. Statement on the benefits of fish/seafood consumption compared to the risks of methylmercury in fish/seafood. *EFSA J.* **2015**, *13*, 1–36, doi:10.2903/j.efsa.2015.3982.
28. Ralston, N.V.C.; Raymond, L.J. Selenium status and intake influences mercury exposure risk assessments. *Selenium Environ. Hum. Heal. - Proc. 3rd Int. Conf. Selenium Environ. Hum. Heal.* **2014**, 203–205, doi:10.1201/b15960-90.
29. Mahaffey, K.R. Fish and shellfish as dietary sources of methylmercury and the ω-3 fatty acids, eicosahexaenoic acid and docosahexaenoic acid: Risks and benefits. *Environ. Res.* **2004**, *95*, 414–428, doi:10.1016/j.envres.2004.02.006.
30. Park, K.; Mozaffarian, D. Omega-3 fatty acids, mercury, and selenium in fish and the risk of cardiovascular diseases. *Curr. Atheroscler. Rep.* **2010**, *12*, 414–422, doi:10.1007/s11883-010-0138-z.