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NK Chandravanshi

Department of Fisheries
Chhattisgarh, Fish Processing
Technology, Faculty of Fishery
Sciences, West Bengal University
of Animal and Fishery Sciences,
Kolkata, West Bengal, India

Manisha

Department of Aquatic
Environment Management,
Faculty of Fishery Sciences,
West Bengal University of
Animal and Fishery Sciences,
Kolkata, West Bengal, India

P Dhruw

Department of Fish Processing
Technology, College of Fisheries
and Research Institute, Tamil
Nadu Dr. J. Jayalithaa
Fisheries University,
Thoothukudi, Tamil Nadu, India

RK Bharti

Department of Fisheries
Chhattisgarh, Fish Processing
Technology, Faculty of Fishery
Sciences, West Bengal University
of Animal and Fishery Sciences,
Kolkata, West Bengal, India

Correspondence**NK Chandravanshi**

Department of Fisheries
Chhattisgarh, Fish Processing
Technology, Faculty of Fishery
Sciences, West Bengal University
of Animal and Fishery Sciences,
Kolkata, West Bengal, India

Nutritional quality of fish food

NK Chandravanshi, Manisha, P Dhruw and RK Bharti

Abstract

The aims present article is to brief review of important nutrients from fish food and their impact on human health. Fish food gains excellent nutritional value by providing high-quality protein and wide variety of vitamins (both fat and water-soluble vitamins) and minerals like iodine, calcium, magnesium, phosphorus and selenium. Fish can have a significant positive impact in improving the quality of dietary protein by complementing the essential amino acids that are typically consumed in many developing countries. Fish oil is the richest source of long-chain polyunsaturated n-3 fatty acids that are vital to proper brain development in unborn babies and infants. These fatty acids are essential in human nutrition and have proven to be involved in many metabolic functions. Some fatty acids have anti-inflammatory effects, decrease platelet aggregation and are essential parts in the cell membranes, cardiovascular system, brain, and nervous tissue. Fish composition should be the most focused area in relation to nutritional combination and human health aspects. In this present article, the effects of fish consumption through fish food on human health are discussed.

Keywords: Fish food, Nutrients, Protein, n-3 fatty acids, Minerals

1. Introduction

Fish and seafood play an important role in hunger and malnutrition. An increased focus on nutrition for both developing as well as developed countries. The world fish production is 167.2 million tons, out of which 146.3 million tons play role in human consumption and remaining is used non-food purpose. More than 3.1 billion people consume 20% of their total animal protein intake from fish (FAO, 2016) [15]. In many developing countries, fish is the beneficial food source of animal protein and is an essential nutrient to vulnerable populations. Fish is a vital source of macronutrients like proteins, healthy fats including long-chain omega-3 fatty acids, mainly α -linolenic acid, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). Strong links between fish and seafood consumption and positive health effects is observable especially with the decreased risk of coronary heart and cardiovascular diseases (Bucher *et al.*, 2002) [9]. Triglyceride concentration in blood (Harris *et al.*, 1997; Vandongen *et al.*, 1993) [18; 43] decreased inflammatory disease as arthritis (Pilon *et al.*, 2011) [32] and prevention of cancer have been shown by many researchers (Calder, 2001; Rudkowska *et al.*; 2010; Lund, 2013) [10; 33; 22]. Fish food is essential for optimal brain development in human body (Pal *et al.*, 2018) [31].

Fish is considered as excellent source of protein for the human diet as fish protein has relatively high digestibility, biological and growth promoting values (Sujatha *et al.*, 2014) [38]. Nevertheless, macronutrients are not the only important nutrients in the fish and fishery products, but also a good source of essential micro-nutrients like iodine, calcium and other minerals (FAO, 2016) [15]. Furthermore, fish also provide significant proportions of iron, and zinc (Lund, 2013) [22]. They are also a vital source of fat-soluble vitamins (vitamin A, D, E and K) and B-group as water soluble vitamins (Erkan & Bilen, 2010) [11]. The major objective of this review is to focus on the important nutritional component in fish and their impacts on human health.

2. Proximate Composition

Proximate composition illustrates the nutritional quality of fish (Azam *et al.*, 2004) [3]. Protein and fat are the major nutrients in fish and their percentage help to describe the nutritional status of the particular organism. The proximate composition of fish varies greatly from one individual to another depending on age, sex, food availability environment and season (Oduor-Odote & Kazungu, 2008) [30]. Proximate constituents together contribute about 95-98% of the total tissue weight i.e. including major constituent moisture, protein and fat (Table 1).

A variety of many other small quantity nutrients also present called minor constituents (carbohydrate, vitamins, free amino acids and non-protein nitrogenous compound).

Table 1: Proximate composition of fish muscle

| Constituent | Percentage (%) |
|----------------|----------------|
| Moisture | 66 – 84 % |
| Protein | 15 – 24 % |
| Lipid | 0.1 – 22 % |
| Ash (Minerals) | 0.8 – 2 % |

(Source: Ninawe and Rathnakumar, 2008) [28]

Evaluation of the proximate composition of fish food is the most significant aspect to determine nutritional value in fish. Many researchers experimented that the protein content may change according to the change in quality (Smith *et al.*, 2015) [36]. The fat content fluctuates over a wide range depending upon the season. The chemical composition of fish varies greatly from one species and one individual to another depending on the starvation and intensive food intake periods (Huss, 1995) [19] and external factors such as temperature and salinity (Zlatanov & Laskaridis, 2007) [44]. Thammapat *et al.* (2010) [40] analyzed the proximate and fatty acids composition of the muscles and viscera of *Pangasius bocourti*, and found that the contents of protein, moisture and ash were inversely proportional to lipid content. Viscera had the highest lipid content followed by ventral and dorsal. Azam *et al.* (2004) [3] worked on the proximate composition of various species, and reported that, protein and ash content tend to remain constant through the year.

The species, environmental condition and location of fish harvesting reflect the variations in proximate and biochemical composition of fish. The changes in the composition of biochemical constituents of the biota vary not only with environmental changes but also with seasons (Sowmya *et al.*, 2013; Shejwal *et al.*, 2014; Ullah *et al.*, 2016) [37; 35; 42]. Such changes have also been attributed to various physiological and other factors like feeding, maturation and spawning etc. (Adewumi, 2015) [1]. Fagbenro *et al.* (2005) [12] reported that the proximate composition of fish is dependent on age, sex, environmental condition and seasons.

3. Major constituents of fish muscle

3.1. Moisture

The water is a principle component of fish flesh, which usually accounts for about 70 to 80 percent of the total weight of fresh fish meat. The highest moisture contents found in Bombay duck (*Harpodon nehereus*) with 90%. The decrease in moisture and lipid content of the tissue is probably associated with spawning. Nisa and Asadullah (2011) [29] High values of tissue moisture content were observed in the spring and summer months, however low values were noted in the winter months.

Boran & Karacam (2011) [8] observed both the lowest water and the highest fat were in shad with the values of 61.52% and 19.70%, respectively. Moisture content also varied significantly in some species, as lipid and moisture contents were inversely correlated ($r^2 = 0.84$). A similar observation is reflected in various studies that the higher moisture content during the dry period and lower moisture content during the rainy period is reflected on its lipid counterpart having the higher and lower values in reciprocal order.

3.2. Protein

Protein is made up of about 20 amino acids. It is the most important constituent of fish from the nutritional point of view. Fish are regarded as a cheapest and vital source of high-quality protein, particularly the essential amino acids (EAA) lysine and methionine (Pal *et al.*, 2018) [31]. The percent of protein in fish is usually between 16 and 21%, but values lower than 16% or as high as 28% are occasionally found in some species. In the diet, protein serves as the source of amino acids which are used for the synthesis of human body protein (Ninawe & Rathnakumar, 2008) [28]. Fish proteins are having high biological value as they contain all essential amino acids (lysine, methionine, threonine, tryptophan, leucine, isoleucine, valine, phenylalanine, arginine and histidine) in the right proportional and specially, lysine as well as sulphur containing amino acid such as methionine and cysteine which are absent in plant protein and the amino acids are united by a peptide linkage $-\text{CO}-\text{NH}-$ (Ninawe & Rathnakumar, 2008; Tacon & Metian, 2013; Pal *et al.*, 2018) [28; 39; 31]. If one or more of these essential amino acid (EAA) are absent or insufficient in the intake food, may lead to improper or no utilization of protein. As a result, it will cause stunted growth in children or loss of muscle mass in adults and leads to two extreme forms of malnutrition described as marasmus and kwashiorkor which are characterized by edema and general deficiency (Ninawe & Rathnakumar, 2008) [28]. Protein is a necessary dietary intake for animal since important for growth and development of the body, maintenance and repairing of worn out tissues. The protein content of fish muscle depends on species, nutritional condition and type of muscle.

Moreover, some other amino acids and particularly taurine, found especially in fatty fishes including sardines, plays beneficial role in limiting the complications of type 2 diabetes and decreasing glucose, insulin and insulin resistance (Madani *et al.*, 2012) [24]. On the other hand, Balfego *et al.* (2016) [7] showed that inclusion of 100g of sardines 5 days a week into the standard diet for type 2 diabetes patients for 6 months cannot control glycemic but lower cardiovascular risk.

3.3. Lipids

Lipids are the fat-soluble compounds found in the tissues of plants and animals. Fats are the fatty acid esters of glycerol and are the primary energy depots. These helps in long-term energy requirements during extensive exercise or in the periods of inadequate food and energy intake. The lipid content of fish influenced by many factors including its nutrition which are species, size of fish, amount of diet intake, composition of feed taken, geographic origin of harvesting, season change, maturity and reproduction period (Lunn & Theobald, 2006, Bagtha Singh *et al.*, 2016) [4; 23].

The lipid content ranges usually from 0.2 to 25% as the fat content rises, so the water content falls and vice versa (Pal *et al.*, 2018) [31]. Fish lipid contains high amount of polyunsaturated fatty acids (PUFAs) in two different groups which are namely 'omega-3-fatty acids ($\omega 3$ fatty acids) and 'omega-6-fatty acids' ($\omega 6$ fatty acids). Some of the fatty acids are synthesized in our body and known as non-essential fatty acid but some of the unsaturated fatty acids cannot be synthesized in human body which are considered as essential fatty acids and both the above mentioned fatty acids are considered as essential fatty acids as the cannot be synthesized by humans therefore, must be obtained from diet

or supplementation (Kris-Etherton *et al.* 2002) [20]. Fish lipids are known to provide high amount of important components, such as nutritional lipid-soluble vitamins (A and D) for the human diet. Omega-3 polyunsaturated fatty acids have a positive role in preventing certain human diseases, including cardiovascular ones (Gerling *et al.*, 2019) [16]. It was reported that a fish consumption of 1 to 2 servings per week could be protective against coronary heart diseases and ischemic stroke (FAO & WHO, 2011; Tilami & Sampels, 2017) [13; 41].

4. Fish Lipids and Human Nutrition

To achieve a balanced diet the food should contain low fat and right proportion of quality and desirable fatty acid composition.

4.1. Food with low fat: Fish is usually considered as good food for its low-fat content containing very low or no saturated fat. It is low in calories. The nutritional value of fish will vary with the composition of fatty acids which depend on the location it is harvested, cut of fish and age of the fish.

4.2. Reduce cholesterol level in the blood: Cholesterol is the type of fat which is naturally produced by our bodies and also found in the diet. Unsaturated fats can help to reduce the cholesterol level in the blood, thus lowering the risk of heart disease. Oil-rich fish such as mackerel, sardines, herring and sprats are excellent sources of Omega-3 fatty acids which are valuable for health.

4.3. Omega-3 fatty acids for healthy living: Two most important omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic (DHA) rich in fishes such as salmon, trout, mackerel, herring and sardines have a very good health benefit. Schizophrenia symptoms can be eliminated or diminished by oral supplementation with EPA. DHA is the building block of human brain tissue and is particularly abundant in the grey matter of the brain and the retina. Low levels of DHA have been associated with depression, memory loss, dementia and visual problems. DHA is particularly important for fetuses and infants; the DHA contents of the infant's brain triples during the first three months of life. DHA levels should be optimum for pregnant and lactating mothers. The special Omega-3 oils from fish have been shown to have a lowering effect on blood fats, cholesterol and reduce the risk of heart attack.

4.4. Prevent cancer: Fish oils can help to prevent cancer cells from progressing to the tumor stage. They may also reduce inflammation and provide relief people suffering from rheumatoid arthritis and even some skin disorders such as psoriasis.

4.5. Needed for the development of Brain: Omega-3 oils can play an important part in aiding the development of the brain. Expectant mothers are advised to eat a lot of oil-rich fish in the last three months of pregnancy to assist the baby's brain growth. A good supply of Omega-3 oils assists in the development of nerves and eyesight.

5. Minor constituents of fish muscle

5.1. Vitamins

Vitamins are low molecular weight substances performing important roles in regulating the body functions. These are

substance, which the body cannot synthesize and hence must be supplied through food for normal growth and development (Balachandan, 2002) [6]. Fish is a great source of particular vitamins which hold very important functions within the body. Fatty fish is a rich source of vitamins A and D, which play important role in the growth and development of children. Lean fish is a good source of the vitamins B group. Vitamin A is necessary for normal growth, bones and teeth formation and cell building. It prevents poor eyesight and helps in the treatment of many eye diseases. Vitamin D helps to use of calcium and phosphorus in correct way, which are necessary for strengthen bone and teeth. With the combination of vitamin A and C, vitamin D helps to prevent cold (Pal *et al.*, 2018) [31]. Vitamin B is important for enzyme functioning which accelerates chemical processes in the body. Vitamin K present in fish is responsible for the anti-hemorrhage factor. It also helps to prevent internal bleeding and stimulates correct coagulation of blood. Fatty seafood such as mackerel, herring, salmon and trout are rich in vitamin A and D. Fish oil is taken with vitamin E reduces levels of inflammation, joint swelling, pain and tenderness characteristic of rheumatoid arthritis (Anon, 2017) [2].

5.2. Minerals

Fish is a good source of almost all minerals which are found in seawater and the value ranges from 0.4 to 1.5% (Pal *et al.*, 2018) [31]. The minerals present in fish include iron, calcium, zinc, phosphorus, selenium fluorine, iodine with high 'bioavailability' (Balachandan, 2002) [6]. Availability of selenium and iodine in marine fish have special significance from a nutritional point of view. Selenium is an essential antioxidant trace element. Iodine is important for hormones thyroxin that regulate body metabolism and in children, it is required for growth and mental development. Iron is important in the synthesis of hemoglobin in red blood cells for transporting oxygen to all parts of the body.

Calcium is another important mineral in human nutrition being responsible for bone density (FAO, 2002) [14]. The recommended daily intake of calcium by WHO/FAO is 400 to 500 mg/day for adults. Compared with other minerals, calcium absorbance to the body is relatively inefficient. Fish and seafood products are a rich source of calcium (Martinez-Valverde *et al.*, 2000) [26]. In addition, salmon and codfish bones were evaluated as a good source for well absorbable calcium (Malde *et al.*, 2010) [25]. The authors suggested these fish bones as a valuable by-product to be used as a natural calcium source in functional foods or food supplements.

Phosphorus also plays an important role in bones formation as well as in the cellular membranes as a component of the phospholipids, the membrane lipid bilayer. The total phosphorus content in human body is about 700 g among which 80% is in bones, 10.9% in viscera and 9% in skeletal muscle tissue (Martinez-Valverde *et al.*, 2000; Ghosh & Joshi, 2008) [26; 17].

Table 2: Important mineral constituent of fish muscle

| Element | Average value (mg/100g) |
|----------------|-------------------------|
| Sodium (Na) | 72 |
| Potassium(K) | 278 |
| Calcium (Ca) | 79 |
| magnesium (Mg) | 38 |
| Phosphorus (P) | 190 |

(Source: Pal *et al.*, 2018) [31]

6. Factors influencing nutritional value in fish

A number of factors affect the composition of fish meat. Every step in the history of the fish, for example, the way of production and processing influences the quality of the final product. Under intensive culture conditions feed composition and feeding, regimens have a major influence (Lie, 2001) [21]. In contrary, as long as fish are fed adequate diets containing all needed nutrients in sufficient amounts, the protein content and composition seem to be predetermined for each species of fish regardless of the content in the diet or the feeding regimen. Especially the lipid compositions are easily influenced by feed composition also in addition to feeding regimen and rearing system (Morris, 2001; Shearer, 2001) [27; 34]. Micronutrients can be influenced and can have some effect on flesh quality (Baker, 2001) [5]. Last but not least the way of

culinary preparation has a significant influence on the FA composition of the finally consumed product.

7. Conclusion

Fish and fish products play a beneficial role in the nutritional quality because they are rich source of nutrients providing good proteins balance amino acids and peptides. Fish have not only high nutritional value but also impact on human health issues. Fish a good source of several minerals, vitamins and micronutrients. In addition, fish beneficial sources of Polyunsaturated fatty acids which have positive effects in reducing the risk of cardiovascular diseases and are linked with positive benefits in many other health problems particularly, certain types of cancer and arthritis.

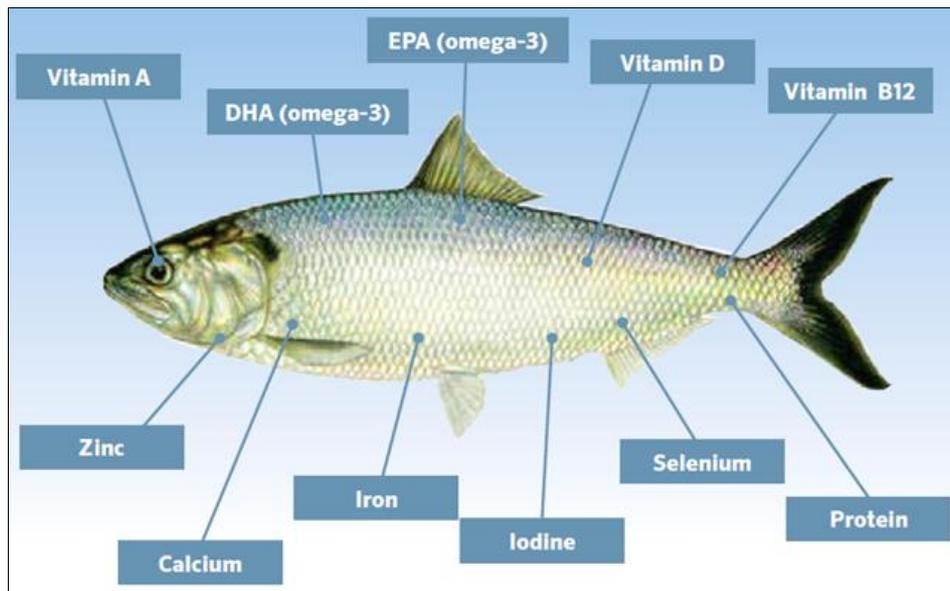


Fig 1: Nutritional value of fish

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