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A REVIEW: NUTRITION, FOOD SAFETY, PROCESS AND WASTE OF FISH

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ABSTRACT
Balanced and sufficient nutrition must be essential in the human health; Evaluation of fish products contain processed fish products apart from fresh or natural consumption of fish and its waste and by-products. Food safety is the great issue of the food consumption that means providing food production without becoming any risk and hazard to human health from field or source of food until reaching consumer fork. Biochemical composition of fish especially polyunsaturated fatty acids (PUFAs); eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA)have beneficial effects for cardiovascular systems and preventing atherosclerosis and thrombosis, good effect to mental health, effect lower blood pressure (systolic and diastolic) with hypertension, rheumatoid arthritis (RA). Food safety also comprises environment factors. It is well known that fish has a rich biochemical composition or high nutritive value. Balanced nutrition to be able to get all of nutrients, particularly essential nutrients such as essential amino acids, essential fatty acids, minerals, vitamins that cannot be synthesized food compounds in the human body. Sufficient nutrition is providing intake of daily energy requirement. On the other hand, evaluation of waste or by products processed fish is the important from point of both health and economy that including environment. Water pollution is the great threatened to food safety. In this review, mentioned topics will be explained in detail.

Key Words: Fish, nutrition, process, food safety, environment

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1. INTRODUCTION

Fish and its products are the rich in biochemical composition and have important functional properties for health. Especially, fish oil were investigated many scientists over the World. (Elvevoll, 2004; Özoğul et al., 2007, Özoğul and Özoğul, 2007; Arts et al., 2011; Çağlarırmak, 2012). Fish an essential source of food supply for people. It is man's most important single source of high-quality protein, providing 16% of the animal protein consumed by the world's population, according to the Food and Agriculture Organization (FAO) of the United Nations. It is a particularly important protein source in regions where livestock is relatively scarce—fish supplies <10% of animal protein consumed in North America and Europe, but 17% in Africa, 26% in Asia and 22% in China. The FAO estimates that about one billion people world-wide rely on fish as their primary source of animal protein (FAO, 1999, 2000).

Today, fish is provided primarily from the wild rather than farmed with marine capture historically accounting for >80% of the world's fish supply. Total landings from marine fisheries increased 5fold in the 40 year period from 1950 to 1990 (Tidwell and Alan, 2001, EMBO REPORTS).

There are kinds of reviews, researches and reports about biochemistry that focused polyunsaturated fish oil (Elvevoll, 2004; Arts et al., 2011; Çağlarırmak, 2012) Animal originated protein consumption is very important because of essential amino acids intake and high biologic value (Çağlarırmak,1998), Thus fish provides high biologic value protein intake for organism.

In this review these topics were summarized by reading literatures. Fatty acids (FA) are inextricably linked with key physiological and biochemical processes and are thus integral to proper ecosystem functioning. FA not biosynthesized effectively by animals are termed essential fatty acids (EFA) (Arts, et al., 2011).

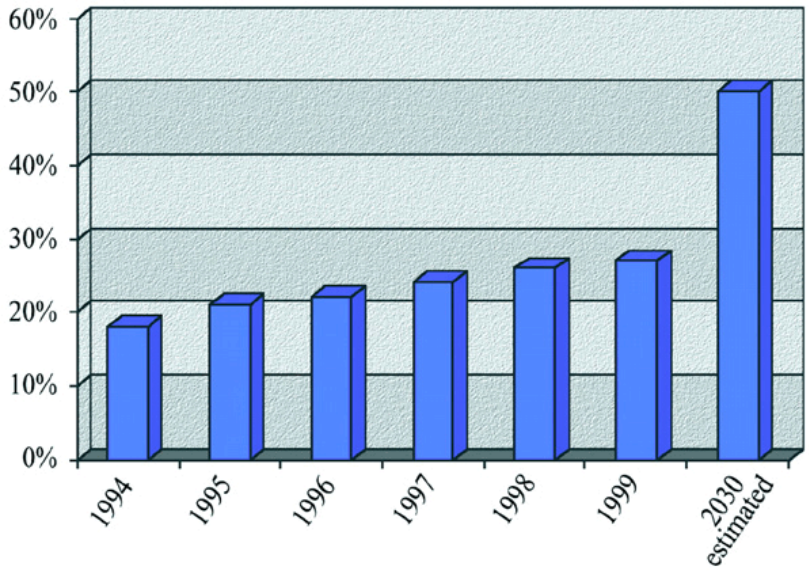
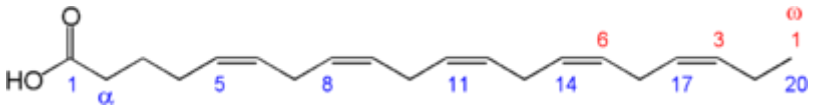
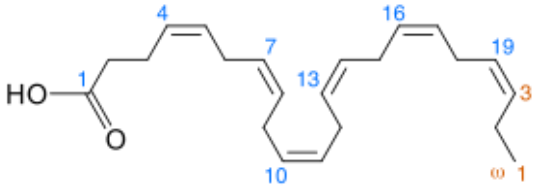


Fig 1. The percentage of total food fish supplied by aquaculture (Tidwell and Alan, 2001).

NUTRITION OF FISH



5*Z*,8*Z*,11*Z*,14*Z*,17*Z*)-5,8,11,14,17-icosapentaenoic acid



4*Z*,7*Z*,10*Z*,13*Z*,16*Z*,19*Z*)-docosa-4,7,10,13,16,19-hexaenoic acid; Doconexent (Arts et al., 2011).

In other study, it was investigated Beverley et al, (1985) that examined the effects of fish oil in 20 hypertriglyceridemic patients: 10 with Type IIb hyperlipidemia and 10 with Type V. These patients were put on three diets differing primarily in fatty acid composition and fat content. The control diet contained a fatty acid mixture typical of a low-fat therapeutic diet (ratio of polyunsaturated to saturated fat, 1.4), the fish-oil diet contained omega-3 fatty acids, and the vegetable-oil diet was rich in the omega-6 fatty acid, linoleic acid. Scientists concluded that fish oils and fish may be useful components of diets for the treatment of hypertriglyceridemia.

In the literature, proved to functional properties and health benefits of unsaturated fatty acids. 1 g of fish oil has shown to reduce overall and cardiovascular mortality, myocardial infarction, and sudden cardiac death. Higher doses may be used for its potent triglyceride-lowering effects and for patients with rheumatoid arthritis to reduce nonsteroidal anti-inflammatory use. Ω-3 fatty acid supplementation of infant formula has shown benefit in infant neural growth and development. With the potential health benefits of fish, women of childbearing age should be encouraged to eat fish that was obtained according to food safety conditions (Oh, 2005). Rivellese et al., (1996) evaluated the long-term (6-month) effects of moderate fish oil supplementation on insulin sensitivity and plasma lipoproteins in NIDDM patients with hypertriglyceridemia. This amount of ω-3 fatty acids was unable to improve insulin sensitivity in this group of patients.

Ten species of freshwater invertebrates that are natural food organisms available to Atlantic salmon were collected and their lipid composition determined: Neutral lipids represented 40–70% and polar lipids 26–55% of total lipids (Bell et al., 2011).

PUFAs (polyunsaturated fatty acids have vital health importance) so high priorities in the future development of aquaculture are considered to be genetic improvement of farmed fish stocks with enhanced abilities to convert C_{18} to C_{20} and C_{22} *n*-3 polyunsaturated fatty acids, enhanced development of primary production of 20:5*n*-3 and 22:6*n*-3 by single-cell marine organisms, and continuing development of new species (Sargent and Tacon, 1999).

Özoğul et al, (2007); Ozoğul and Ozoğul, (2007) were investigated quantity of fatty acids among the species that were grown in Turkey. The fatty acid compositions of seawater fish species were found to be 25.5–39.4% saturated (SFA), 13.2–29.0% monounsaturated (MUFAs) and 25.2–48.2% polyunsaturated acids (PUFAs), The results showed that fatty acid profiles of most freshwater fish are basically comparable to those of seawater fish as sources of PUFAs.

The similar fatty acid contents study was made by Kinsella, (1987) Recent research findings are reviewed concerning the possible beneficial effects of consuming fish oils containing n-3 polyunsaturated fatty acids (PUFA's) with particular reference to reducing ischemic heart disease and thromboembolic risk. Wz (Bell et al., 2003).

Beneficial health effects of n-3 PUFAs are reviewed by (Hossein, 2011). These are cardiovascular heart, disease, inflammation, hypotriglyceridemic effect, allergies, hypertension, arthritis, autoimmune disorders, and cancer, and preventing atherosclerosis and thrombosis.

FISH TECHNOLOGY and PROCESS

In the food industry, there are known food technologies such as canning, drying, smoking fish, fish flour etc. Nevertheless, in last year's, developed the new technologies and processes in fish industries. Some of examples were given in this review as below: A new method for the production of fish mince from a small fatty fish is presented. The method involves (a) cutting the fish into short pieces, (b) washing out the depot fat, dark pigments and viscera under acid (pH 4) or neutral conditions, and (c) bone separation. The resulting mince has a white appearance and a low fat content (approximately 7% of dry wt) (Eide et al., 2006).

Although TAGs are the predominant molecular form of edible fats and oils, it might be necessary to subject them to separation according to their chemical composition or to modify them in different ways (Wanasundara et al., 2005).

Principles of separating fatty acids are based on specific properties of each acid or acid group. Two major properties (vapor pressure and melting point difference) were used in developing separation techniques.

Some of new food Technologies high hydrostatic pressure has recently been applied in food processing, and several commercial fruit and vegetable products have already been put on sale. Recent intensive research on the effects of high hydrostatic pressure on fish tissues has gradually revealed the benefits and defects of this novel processing technology (Ohshima, et al., 2001).

Modified atmosphere packaging (MAP) protects and extends shelf life of most fishery products by inhibiting microbial activity and growth of microorganisms and oxidative reactions. Packaging of fishery products under modified atmospheres (MA) increases shelf-life compared with those packaged under air or oxygen , but confers little or no additional shelf-life increase compared with vacuum packaging (Sivertsvik, et al., 2002).

The quality assurance of fish and products should be great interest for market thus there is some studies such as storage of frozen fish brings about a decrease of extractability of myofibrillar proteins. Retardation of the deteriorative changes of proteins in frozen fish is possible by avoiding high storage temperatures and oxidation of

lipids hematin compounds and other constituents promoting and by adding cryoprotectors like sugars, several organic acids, amino acids, or peptides (Sikorski et al., 2009).

There is one of studies about functional properties and value of fish proteins (Kristinsson and Rasco, 2000). Fish muscle has "white" and "dark meat". The white meat is generally more abundant, contains less lipids than the dark meat, Fish is also good source of in protein contents which contains essential amino acids. It is composed of about 18 to 23% of protein, depending on the species and time of harvesting.

ENVIRONMENT FACTORS AND EVALUATION OF FISH WASTE

The water pollution is harmful the agricultural products and creates hazard to food safety and human life. (Çağlarırmak, 2014). Water pollution is related to food safety from point of chemical and microbiological aspects. River, sea and lake pollutions cause to affect food safety negatively. On the other hand evaluations waste or by products of fish or other water products can help the maintain both good environment and economy.

The fish waste are about 18-30 million tons in the world. It was focused to evaluate these wastes or by products for production of functional products and biochemical compounds for consumptions of them (Çağlarırmak, 2012). By products of Sea products and fish are rich in high biologic active proteins, PUFAs, vitamins and minerals, essential amino acids and peptides. Elvevoll, E. (2004).

The environmental impacts of marine aquaculture within the European Union (EU) are regulated and managed by a variety of European Commission (EC) Directives and International Conventions. There are also more than 50 other EC Directives, Decisions and Regulations, which have an indirect effect on the monitoring and regulation of marine aquaculture (Arvanitoyannis and Kassaveti' 2007).

The recovery of chemical components from seafood waste materials, which can be used in other segments of the food industry, is a promising area of research and development for the utilization of seafood by-products. Researchers have shown that a number of useful compounds can be isolated from seafood waste including enzymes, gelatin, and proteins that have antimicrobial and antitumor capabilities. Chitosan, produced from shrimp and crab shell, has shown a wide range of applications from the cosmetic to pharmaceutical industries. (http://ift.confex.com/ift/2001/techprogram/paper_6188.htm).

The increasing demand for protein on a global scale turns the focus on under-utilized protein sources. According to the FAO, the amount of seafood caught worldwide in 1994 was approximately 100×10^6 tons, of which about 70–80% was by-catch and thereby not used for human consumption. In Norway, the by-catch was approximately 0.55×10^6 tons in 1994. The by-products from the fish industry have low storage stability if not frozen or preserved. In Norway, silage production has been carried out for several years to preserve the by-products from the fish-processing industry (Liaset, et al., 2000).

Fish muscle hydrolysate have some of functional properties such as unctional properties of fish protein hydrolysates are described, including
solubility, water-holding capacity, emulsification, and foam-forming ability. Possible applications of fish protein hydrolysates in food systems are possible in food processes. Obtained Fish byproducts can be used for protein hydrolysates that contribute to food systems for contributing functional protein ingredients and nutritional supplements as wella s functional properties
(Kristinsson and Rasco, 2000).

Raw herring (*Clupea harengus*), a waste product from the roe industry, was hydrolyzed, using an endopeptidase preparation from *Bacillus licheniformis* (Afonso and Desalination, 2002).

A process for the production of gelatin from fish skins established with a high quality gelatin that comprises the steps of: In practice, the present process employs much lower temperatures than known as usual , which results in a high quality product (e.g. absence of a fishy smell), (Grossman and Bergman, 1992) Patent, DE69007057T2,EP0436266A1, EP0436266B1
In their review, Mariod and Adam, (2013) explained production of fish originated gelatin which was obtained from fish skin and bones. They cleared that the fish gelatin was suitable for Extraction of gelatins from fish acceptable for kosher (Jewish) and halal (Muslim) products.

FOOD SAFETY IN FISH NUTRITION

When harvested in a clean environment and handled hygienically until consumption, fish is very safe. Unfortunately, unhygienic practices, insufficient refrigeration and sub-standard manufacturing practices can be at the origin of many outbreaks of fish-borne illnesses.
Fish originated health risks are summarized as infections and toxications. Some of them come from contaminated from fish intestine as a live agent or produce enterotoxications known as toxi-infection).Microbiological quality assurance is the one of the main topic for safety of fish nutrition, development of agents or toxins determines the becoming infections or intoxications. Fish and fish product originated diseases must be eliminated from fish. Food safety of fish begins from sea, lake or river growing medium and finishes consumer fork. That is typical approach for food safety patterns and food safety standards (Çağlarırmak, 2012). FAO, 1999, and 2000 reported following statements and descriptions for microbiology of fish; food infections of fish, the causative agent (bacteria, viruses, or parasites) must be ingested alive, and then it invades the intestinal mucous membrane or other organs (infection) or produce enterotoxins (toxi-infection). It is worth noting that, apart from *Vibrio*species, *L. monocytogenes* and *Cl. botulinum* that are part of the indigenous fish flora, microbiological contamination can come kinds of factors such as the environment, the handlers or the water. Hygiene and sanitation conditions must be essential and valid for fish process or consumption, marketing and storage. Protection from the environment, personal hygiene, education of fish handlers and water treatment (e.g. chlorination) and providing cold chain (Food and Agriculture Organization of the United Nations, http://www.fao.org/fishery/topic/1522/en).
Fisheries and Aquaculture Department). The main fish originated diseases can be given as follows; Bacterial infections; *Listeria monocytogenes, Salmonella sp., Escherichia coli, Vibrio vulnificus, Shegella sp.* Viral infections; Hepatitis A virus, Norovirus, Hepatitis, Parasitic infections; Nematodes (round worms), Cestodes (tape worms), Trematodes (flukes), Toxi-Infections; *Vibrio cholerae, Vibrio parahaemolyticus Escherichia coli, Salmonella sp.And ıntoxications are* Microbial toxins; *Staphylococcus aureus, Clostridium botulinum,* Biotoxins; Ciguatera, Paralytic shellfish poisoning (PSP), Diarrheic (DSP), Amnesic (ASP), Neurotoxic (NSP), Histamine, Chemical; Heavy metals: Hg, Cd, Pb. Dioxines and PCBs. Additives: nitrites, sulfites. **(**Food and Agriculture Organization of the United Nations, 1999, 2000). http://www.fao.org/fishery/topic/1522/en

2. CONCLUSION

There is very important reality that fish consumption contribute to human nutrition by providing balanced and functional nutrition because of it contains quality protein content, polyunsaturated fatty acids (PUFA), minerals and vitamins. It is well known that PUFAs support the cardiovascular system even can prevent the some of heart vascular system symptoms such as heart attacks and infarctus.
A consistent source of fish is essential for the nutritional and financial health of a large segment of the world's population. Fish also has substantial social and economic importance. The FAO estimates the value of

fish traded internationally to be US$ 51 billion per annum. Over 36 million people are employed directly through fishing and aqua culture (FAO, 2000), and as many as 200 million people derive direct and indirect income from fish (Garcia and Newton, 1997). These data illustrate that a consistent source of fish is essential for the nutritional and financial health of a large segment of the world's population.

Evaluation of by products and wastes of fish contains essential nutrients e.g. PUFAs, minerals, essential amino acids or similar bioactive compounds that are functional components for human life, and contribute to economical incomes of countries and protecting environment.

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