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Biochemical composition of fish and changes during processing and storage: A review

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The knowledge about the biochemical composition of fishes are plays vital roles in various fields. The authentic and the proper data of biochemical composition of fish is missing. Fish is important for the different fish related products. The biochemical composition of fish also plays vital roles in the preservation of fish and fish related products. When the changes occur in the different constituents of fish such as the proteins and lipids, the fish can easily spoiled stock and spoiled the quality. The body of fish is mostly made from water, protein, lipids and ash (mineral) this composition are called proximate composition (term does not any level of inaccuracy in the study). Water is most crucial component for all types of living organisms. Inside the body fluids the water acts as transporting medium for range of essential substance including nutrients, metabolites, etc and water is main constituents of the body fluids. The vast and heterogeneous group of organic compounds are lipids. The lipid is any biological substance that is obtained with solvent that having low polarity. The enzymes are the biological substance which crucial role in chemical digestion and universal found in living body. The enzymes involved in autolysis or endogenous biochemical reaction are responsible for the loss of quality in seafood. Understanding the seafood enzyme system can easily prevent the product of fishery. Proteins another important biochemical constituent plays key role in the construction and functioning of living organism.

Keywords: Fish, biochemical, biomolecule, proteins, lipid and digestion

INTRODUCTION

The knowledge about the biochemical composition of fishes are plays vital roles in various fields (Shoba, Candida et al., 2020). Due to the unusual nutritional nature of fish the consummation of fish and alertness of balance diet food increases dramatically from day to day. ((Arru et al. 2019). For the proper healthy and balance diet food it is essential to understand about the biochemical ingredient of fish which play

the vital role for dieticians (Stipanuk and Caudill, 2018). Animal used the fish and fish related products as source of food therefore it is extremely important for one to know the biochemical levels in fish body. So for this review paper has been has been design to highlight the biochemical nature of fish and its importance for body and health respectively. The authentic and the proper data of biochemical composition of fish is important for the different fish related products.

The biochemical composition of fish also plays vital roles in the preservation of fish and fish related products. When the changes occur in the different constituents of fish such as the proteins and lipids the fish can easily spoiled stock and spoiled the quality. (Shoba, Candida et al., 2020). The biochemical composition of fish also helps to technologist to preserved and storage the fish quality for the maximum time. On the bases of biochemical composition, the technologist can predict the optimum processing and storage conditions. (Abraha et al. 2018).

Proximate composition:

The body of fish is mostly made from water, protein, lipids and ash (mineral) this composition are called proximate composition (term does not any level of inaccuracy in the study) (Chowdhury, Hasan et al., 2019); (Ahmed, Ahmed et al., 2016). According to (Anandan, Mathew et al., 2017) and (Bachmann, Cortesi et al., 2017), the body of fish manly composed four major constituents which are water, protein, lipids and ash (mineral) which makes the edible portion of fish. The study of these water, proteins lipids and mineral in the fish muscles are called proximate analysis. (Ayanda, Dedeke et al., 2018); (Desta, Zello et al., 2019). The data of proximate composition are vital for (Danieli, Lussiana et al., 2019), in many application and investigation on the lines had been carried out from as early as the 1880s (Turko, 2018) ; (Hossain, Jamil et al., 2017).The accurate data about the biochemical composition of fish is absent due to this difficulty to obtain the data of biochemical composition which is may or may not this basic reason for this absence. The fishes are highly specialized group and huge divers and adapted themselves biochemically and evolution (Wilkins and Strecker, 2017), The fishes shows variations among the size, shaped, and external appearance etc. This group of fishes composed almost of 24000 species.(Paraschiv et al. 2020); (Keat et al. 2017). The habitat and food intake are symmetrically diverse among these fishes species.(Val, 2019). Some fishes are totally lived in sea water (Albouy, Archambault et al. 2019), But others fish species are restricted to fresh water (Tedesco et al. 2017). But a few species of fishes can live in both environments the fresh water and as well as marine environments (Tzadik et al. 2017). Some fishes are migrating from the sea water to fresh water for spawning. While some species are migrating from the fresh water to marine water for spawning. These two environments are different on the bases of

temperature variations, salinity, pressure, and the presence of nutrients etc which deeply effect on the biochemical composition of fishes. The specific group of fishes or the same species shows difference in the biochemical composition. Sometime the difference occurs in single or many species which take at different times or under various circumstance.(Silva, Lucas et al., 2018). In sometime the variations occur in proximate composition of various parts of same type of fishes which is another kind of variation (Suganthi et al. 2015). Agreeing with (Xu et al. 2020), the amount of oil present in fish muscle is commonly increases from the posterior region towards the anterior region and also low weighted and red muscles having different in their biochemical composition (Ahmed and Ahmad, 2020).The data about proximate composition of fish which is present in literature of a species will not consider as absolute values this data just shows that the range or average and most of time water, proteins, lipids, and ash (minerals) make approximately 96-98 % of entire fish tissue components.(Hua, Cobcroft et al., 2019).The range of various values of these constituents of some common species of fishes of Asian coastal water are shown below table.

Water	65-90 %
Protein	10-22 %
Fats	1-20 %
Minerals	0.5-5 %
(Aberoumand and Ziaei-Nejad, 2015)	

In small amounts the nucleotides, vitamins, carbohydrates, and other non-protein nitrogen containing compound also present (Joseph and Bindu, 2017). These small amounts of nucleotides, vitamins, and carbohydrates, also crucial for the growth and developments of the organisms and keeping balance other system (Xa et al. 2020).

Water in fish tissue

Water is most crucial component for all types of living organisms. Inside the body fluids the water acts as transporting medium for range of essential substance including nutrients, metabolites, etc and water is main constituents of the body fluids (Lorenzo, Serra-Prat et al., 2019) It is essential for the normal working of the most biological molecules. For example, if water is present in sufficient quantity then proteins keeps its own original state and normal functions. The

quantities of water in fish flesh are widely different but most cases the range lies between 70-90% (Williams, 2018). The Bombay duck (*harpodon nehereus*) is example of those species that contain huge amount of water and present commonly in Indian north-west costal lines and the muscle of this specie containing approximately 90% of water (Jeyakumari, Murthy et al., 2017). the water that found in fish tissue occurs in two states, sometimes formed bond with protein and also found in free state (Granke, Does et al., 2015). Both states of water are crucial biological function if the is water remove from the fish tissue by various way this absence of water will affect the quality, mainly the test of processed products (Ram, Chand et al., 2017).

The amount of water and lipids is apposite relationship to each other in the fish tissue combining the percentages of these two components make approximate 80% (Svenning, Dalheim et al., 2019). The combining percentages of oil and water are not same everywhere but the range is approximately 78-85 % (Cliff, 2016).

Lipids

The vast and heterogeneous group of organic compounds is lipids. The lipid is any biological substance that obtain with solvent that having low polarity (Feingold and Grunfeld, 2015).

The above definition is not much accurate all those compound that are extracted with 'fats solvents' such as hexane, petroleum, ether, chloroform, and ethyl alcohol are categorized in lipid (Ferreira-Dias, Osório et al., 2018). The alcohol (aliphatic), Waxes, phosphoglycerides, steroids, sphingolipids, fatty acid, glycerides and combination of the above lipids with carbohydrate, peptides, protein all these types are included in lipid group (Puri, 2018). The phosphoglycerides and triacylglycerol are the main constituents of lipid which present in fish tissue both composed of long chain of fatty acid. Sometimes other constituents with minor amounts are also present. (2018) ;(Xu, Mu et al., 2016).

The lipid shows more variations as compared with protein (Harayama and Riezman, 2018). The range of large amounts fish fats is 16-18% which usually occurs small amounts (0.5%) of fats also present (Williams, 2018). (Danielsen, Hedeholm et al., 2016) have described that in few species decrease the lipids content at time of spawning and increases their lipids contents during feeding time. Most site for the lipids storage is fish muscle in fatty fish such as oil sardine, mackerel, herring, etc (Petricorena, 2015) ; (Duarte, Silva et al.,

2020). These species show great variation in their lipid content during the season and sexual maturity. (Hellessey, Ericson et al., 2018). Most important study on seasssional changes in lipids and amino acids contents was arranged by (Šimat, Hamed et al., 2020) who described that during the period of June-July the lipids and oil quantity of *sardinella longicep's* muscle is approximately 3-4% and increases dramatically to approximately 18% in the period of November-December. The animals store fats for energy when large amount of energy produce during the food broken down the extra energy store in the form of fats and used during the time of need (Girousse, Virtue et al., 2018). In some cases, fishes store the fats as a fats depot which is varying in different species. This fats depot mostly composed of triacylglycerol. The fats depot occurs in various region of body including liver and adipose tissue (Gepner, Shelef et al., 2018).

Phospholipids associated with globular protein make the mosaic structure which plays crucial role in plasma membrane such as movement of verity of materials outside and inside the cell and the permeability of plasma membrane. Similarly, the phospholipid component of lipid and acts a key constituent of plasma membranes (Fisher, Vasquez-Medina et al., 2018). The cells of living body work properly in the presence of different kinds of phospholipids (Lordan, Tsoupras et al., 2017).The phospholipids do not show much variations as compared with fats depot. Generally it exists in the range of 0.5-1% of fish tissue (Domaradzki, Florek et al., 2019).

Changes to lipids during processing/storage

The hydrolysis and oxidation are the two different modifications occurs in lipids during the time of preservation and processing of fish (Jeong, Han et al., 2019). The lipids hydrolyzed gives free fatty acids and this free fatty acid denatured the protein (Ježek, Abdullah et al., 2019). When the proteins are denatured they loss their properties, quality, and especially the texture (Bao and Ertbjerg, 2019). The lipids hydrolyzed in the presence of lipases enzyme and the action this enzyme is very low at low temperature (Wang, Li et al., 2019). Due to this hydrolysis the product of fish kept at low temperatures about -18 to 20 OC (Oke, Idowu et al., 2018).

However, the oxidation of lipid is a thoughtful and not simple phenomenon (Ito, Sono et al., 2019).. The lipids easily oxidized due to presence of large quality of unsaturated fatty acid in fish tissue (Mathew, Raman et al., 2019a); (Mathew,

Raman et al., 2019b), the action of some oxidizing agents or oxygen will start oxidation and at high temperatures and the presence of catalysts such as copper, or iron will increase the oxidation processes. Though the free radical mechanism this oxidation processes will proceed (Huang and Ahn, 2019). Due to this oxidation in fish products produce the oxidative rancidity which gives bad taste to fishery products and even the products become toxic when the complex oxidation proceeds (Vieira, Zhang et al., 2017). this oxidation proceeds through the free radical mechanism. When the absorption of oxygen increases the hydro peroxides will produce which is the main component of oxidation. (Losada-Barreiro and Bravo-Diaz, 2017). The hydro peroxides decomposed into volatile and non-volatile products such as carboxylic acid, ketones, alcohols, aldehyde etc (Hwang, 2017). The number and nature of decomposed products depend upon the relative position of double bond being to oxidized and the circumstance under which the hydro peroxides undergoes decomposition. Due to these changes the taste become rancid. The polymerization also takes place when the highly unsaturated fatty acid become oxidized under such circumstance fishes and their oil become completely obnoxious (Jamshidi, Cao et al., 2020).

The process of oxidation is mediated by various agents such as air, high temperature, and catalysts (Zott, Garrido-Barros et al., 2019). The absence of these conditions the rate of oxidation will be minimum. This oxidation can also prevent by using of antioxidants (Gulcin, 2020). The antioxidants reduce the damage done by oxidation and also restrict the proceeding the free radical chain reaction (Turgut, Işıkçı et al., 2017). During the fish oils processing the different synthetic and natural antioxidants such as propyl gallate, tocopherols, butylated hydroxytoluene, butylated hydroxyanisole, etc are used approximately 0.1-0.2% (Zehiroglu and Sarikaya, 2019).

The composition of fatty acid in fish lipids

The fatty acid is the main components in many lipids molecules such as phospholipids, glycerides, wax esters. Very complex fatty acids are found in fish lipids. (De Carvalho and Caramujo, 2018). The fatty acid which found in fish tissue containing carbon atoms ranging from 10-22 atoms while unsaturated fatty acid the double bonds are ranging from 0-6 these compounds are usually found (Bowen-Forbes and

Goldson-Barnaby, 2017). The fatty acid with even number of carbon atoms whether unsaturated or saturated are usually more occur in lipid molecule as compared with odd number of carbon atoms which is less. The unsaturated fatty acids containing more than one double bonds often called polyunsaturated the methylene group separates the double bonds among one another and also possess cis-configuration (Loef, Schoones et al., 2019). The trans isomers are found very less almost equal to zero. (Kaçar, 2019). Who determines the 5 or 6 double bonds in per molecule of fatty acids is occurring generally and very common in fish these fatty acid very rare found in lipids molecules of other terrestrial animals or plants. Due to this reason the fatty acid of fish is unusual

Due to this great of variation in fatty acid the fish lipids also shows huge variations. Sometimes the amounts of fatty acid of single species are different from the another. Even within a same species also shows variation. The food intake, spawning migration etc may affect the composition of fatty acid. When the fish oils produced at large scale are shows much variations even from same species. The fatty acids composition is not constant from the year to year even in same species. The fatty acids composition in lipid is not constant for other tissue lipids. The depot lipids having more saturated fatty acids as compared with the lipids of muscles tissue (Jackson and Jewell, 2020).

The large number of fatty acid found in fish lipids. In some species these fatty acids number is reached to approximate 50 including all isomers. Among these some are saturated fatty acids such palmitic acid and steric acid which commonly present in Indian water fish while the palmitoleic and oleic acids are monounsaturated acid and arachidonic acid, docosahexaenoic acids and eicosapentaenoic acid are main constituents of polyunsaturated (MacGibbon, 2020).

Seafood Enzymes

The enzymes are the biological substance which crucial role in chemical digestion and universal found in living body (Kour, Rana et al., 2019). The fish are poikilothermic and their enzymes are adopted for cold environments and enzymes of fish and other aquatic organisms are poorly studied (Biabani Asrami, Sudagar et al., 2019).

The enzymes involved in autolysis or endogenous biochemical reaction are responsible for the loss of quality in seafood to understand the

seafood enzyme system can easily prevent the product of fishery. (Sreelekshmi, Elavarasan et al., 2018); (Abraha et al. 2018).

The large number and important enzymes are extract and identified in fish and shellfish. Some fishes such as Gold fish and shrimp containing an enzymes that modified the carotenes to Xanthophylls (example Red astaxanthine) (Singh and Benjakul, 2018). The Astxanthine fish having stimulating effect on the immune system. A few fishes do not the change the inosine into hypoxanthine, insitu in post-mortem muscle often these species are called Inosine accumulator. Some species also have antioxidant enzyme such as hepatic catalase, glutathione S transferase, glutathione peroxidase. In some animals like mollusks the muscles have accumulate other metabolites instead of other lactose (eg anaerobic glycolysis the pyruvate, succinate, alanine, octopine) having different enzyme pattern (Valdez, 2018); (Zhukova, 2019).

In some fishes the dark muscles contain elevated amount of newly cysteine protease. The phenolase commonly occur in crustacean species effect the browning movement and helpful to seafood technologist. In some fishes possess thiaminase, carnosinase found in Anguillidae and the gadoid fishes have TMAO dimethylase (Yada et al. 2012). The physical properties of seafood can effect on the presence of various enzyme. Some crucial enzymes such as endogenous and exogenous proteolytic enzyme and trans glutaminases are effect the seafood texture and also helpful for the energy metabolism and initiate the rigor mortis. The enzyme that involved the nucleotide broken down are well studied during the post mortem these enzymes affect the seafood quality. The ATP levels decreases immediate after death and the muscles change into rigor mortis (Asha, 2003).

The ATP and ATP like compounds are catabolized, indicate the final eating quality of fish. Various enzymes are involved in the ATP catabolism in the post mortem these enzymes are including ATPase, xanthine oxidase, AMP deaminase, Inosine nucleosidase and 5 nucleotidase. The ATP initiate the chain reactions and final degrade into IMP in post mortem muscle different compounds are involved in ATP catabolism the ATP convert into ADP, ADP to AMP, AMP to IMP (Sokolová, 2017).

The myosin ATPase another important enzyme that indicate the quality of fish and destroyed the protein. The protein not undergoes denaturation if the myosin ATPase is present in

inactive form the application of this method may be increases in future (Raposo, Gomes et al., 2020).

The marine animals produce some useful byproducts such as fish guts which is also the source other enzyme (Marti-Quijal, Remize et al., 2020); (Välmaa, Mäkinen et al., 2019). According to (Gimenes, Silveira et al., 2019) At elevated heat destroyed the proteins substrates. Some digestive enzyme like proteinases which found in certain marine animals which work best at low temperatures. These proteinases are more superior as compared with commercial proteinases and use many food processors (Basso and Serban, 2020).

In pharmaceutical and food industry the lipases enzymes are commonly used for various purpose. These lipases are used for manufacturing of oils and fats and preparation of pure drugs. ((Patel et al. 2019). The lipases of fish are used for the teste, flavor and for drugs (Navvabi et al. 2018). The biosynthesis of eicosanoids and deterioration of fish controls by the important lipolytic enzymes called phospholipases but the fish phospholipase has been less studied and little knowledge is available Furs et al. 2015). The smell of freshly harvested fish is due to the position of peroxidation of polyunsaturated fatty acids by 12 and 15 lipoxygenases (Hirst and Richter, 2016). The lipoxygenase which is extract from the fish and used for the fish like aroma in various food products but other than fish sources.

The enzymes of fish and shellfish are used on biotechnological application in various food industry and feed. The complicate and expensive production process because of extreme low concentration of enzyme (Caruso et al. 2020).

These enzymes are more useful in future in biotechnology process like recombinant DNA or genes technology. Another important application of this enzyme produce direct mutation, this enzyme case minor alteration in the gene sequencing (Ravikumar et al. 2015).

The amino acids are joint together formed complex, large polymers of nitrogen containing organic compound are called protein and these proteins are present every types of plants animals cells (Shah et al. 2020). The term proteins mean first which derived from the Greek word. These proteins are vital group of compounds they play verity of roles in living organisms (Steele, Gorczynski et al., 2019). The protein plays key role in the construction and functioning of living organism. The enzymes are proteins and these

enzymes help in the physical and chemical activities of living organism (Lellis, Fávaro-Polonio et al., 2019). The amount of proteins in fish muscle is about 16 to 18 % and the proteins are the second major constituent in the muscle tissue of fish. If the proteins levels drop below from the 15% it will be considered that the present in small quantity, not so much variations occur in proteins. However, the levels of protein change in tissue during the feeding habits and spawning cycle (Datta, Anand et al., 2017).

Classification of proteins

On the bases of solubility of proteins in the solution of salt, the proteins are divided into three major categories. Only small quantity of proteins are dissolve in salt solution with extremely low ionic concentration approximately <0.15 these proteins are called Sarcoplasmic proteins, the myogen globulin are place in this class (Yu, Zhang et al., 2017). This small concentration most occupied by enzymes which essential for muscle metabolism and percentage about 25 to 30% of total proteins. Small quantity of sarcoplasmic proteins are found in Demersal species while elevated amount of sarcoplasmic proteins are found in pelagic like Kanagurta, sardinella, longiceps, and Rastrelliger etc (Radoslav and Danica, 2018).

The myofibrillar proteins are soluble in solution with great ionic strength about >0.5 , the troponins, actin, actomyosin, myosin, and tropomyosin etc all these proteins are responsible for muscle physiology and fall on myofibrillar proteins category and they formed approximate 65% of total muscle proteins (Månsson, 2020). The myofibrillar proteins are essential for the muscle physiology. The properties of myofibrillar quantity are associated with gelling properties of fish flesh and the rheological features of the gel and also crucial for surimi related products and surimi (Ahmed, 2017). In teleosts the stroma proteins are about 3% of total proteins as compared with elasmobranchs which contain 10%. The stroma proteins are soluble in acidic and basic solutions but insoluble in neutral salt solutions. The stroma proteins are formed the Connective tissue of muscle (Chanarat, 2015). The collagen proteins are resembling with stroma proteins and occur in various region of the body such as air bladder and skin etc. the low quantity of stroma proteins are gives texture property to fish muscle tissue (Muthukumar, Sreekumar et al., 2018).

This review conclude that the fish biochemical

nature showed that this animal is best choice for food to be consumed as fish bio constituents showed that they are present in the balance proportion and quantity. However it has been suggested that further investigation and experimentation are needed for the improvement of fish bio elements by improving various enzymes activities and other genomic via adopting various reliable biotechnological techniques and implying recent scientific strategies. These improvement and development in the fish biochemical constituents are mandatory to meet the present over populated nutrition demands.

CONCLUSION

Biomolecules like Proteins, lipid, carbohydrates and nucleic acids along with some vital minerals contents are the major body constituents of a fish and other animals including plants. The biochemical composition of fish body is lay very important role in performing all physiological activities like growth, reproduction respiration and metabolism.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

BA present the idea, AMY has supervised AMA and D.N the experiment SRQ ABK, AAZ and INU performed the experiments and wrote the manuscript. AUK, INK and ISK reviewed and FAK reform the manuscript. All authors read and approved the final version.

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