ISSN : 2348-8069 Int.J.Adv. Res.Biol.Sci.2014; 1(3):94-98

International Journal of Advanced Research in Biological Sciences

www.ijarbs.com

Research Article

Studies on the fatty acid profile in Hilsa and plankton in Hooghly-estuarine system of West Bengal, India

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Abstract

Hooghly-estuarine system of West Bengal is one of the most important riverine system of India. One of the important commercial fish yields from this riverine system is Hilsa *Tenualosa ilisha*. The normal habitat of the fish is the lower region of the estuaries and the foreshore areas of the sea. It ascends the rivers mainly for spawning and spent fish as well as their progeny migrate down the rivers towards lower estuaries and coastal areas, which form the natural habitat of the species. During migration its body composition changes specially in terms of fatty acid profile. This fish has high content of ω_3 fatty acid which has various beneficial properties for the normal human body like anti-inflammatory, antithrombotic, hypolipodermic and vasodialatory properties. The lipid content of the hilsa body was found between 1.66 to 13.11%. The fish contains higher amount of polyunsaturated fatty acids. ω_3 value varied between 6.6% to 15.1% of the total lipid content in the hilsa body. ω_6 fatty acid was another important constituent of the fish body and the value varied from 2.35 to 3.65 % of the total lipid content in the fish body. In this respect hilsa is an important diet. The source of PUFA in fish body is plankton. The fish gut analysis shows the same type of plankton availability as in the water. Moreover, positive correlation found in the values of fatty acids of river plankton and hilsa gut. Same type of fluctuation was also found in river water plankton and hilsa body with seasonal changes. In the plankton body ω_3 value was found to be 16.57% to 25.75% and ω_6 value was 6.71% to 12.6% of the total plankton lipid content.

Keywords: Hilsa, plankton, polyunsaturated fatty acid, ω_3, ω_6.

Introduction

Hilsa, *Tenualosa ilisa* (Hamilton, 1822) of the subfamily Alosinae, family Clupeidae, order-Clupeiformes constitute a large scale of fishery in India. The Hooghly estuarine system which is constituted by the first offshoot of river Ganga- the Bhagirathi, flows southwards through the lower Ganga deltaic plane and joins Bay of Bengal in Sundarbans is considered as one of the most important estuarine system of India. This zone has heavy monsoonal discharge and long tidal zones (Nath *et al*., 2004). It is located in West Bengal between the latitude 21º31´ N and 23º30´ N and longitude 87º45´ E and 88º45´E.

Seafood in general contains lots of essential compounds. Fish is a good source of fatty acid which helps to maintain a good health. Hilsa being an anadromous fish contains high lipid percentage

in body. During this upstream migration its various body composition changes (Nath and Banerjee, 2012). The fish is mainly plankton feeder though the adult one dopes not feed much or completely stops feeding during migration (Pillay, 1958; Halder, 1970). The unique taste of this fish is believed to be attributed to the environment where it feeds. The monsoon rains in catchment area bring copious inflows to Hooghly river during the months of July and August which attracts the hilsa from the Bay of Bengal to the Hooghly river. *Hilsa* of freshwater origin is tastier than those of the sea. The uniqness in taste is due to the various fatty acids in the body (Nath and Banerjee, 2012; Mohanty *et al.*, 2011). Essential fatty acids, or EFAs, are fatty acids that humans and other animals must ingest because the body requires them for good health but cannot synthesize them (Goodhart and Shils, 1980). These acids occur in various structures especially in the cell membranes and cannot be synthesized from other sources. Omega 3 fatty acids are anti inflammatory, antithrombotic, hypolipidemic, helps in vasodialation and prevent coronary heart disease, type 2 diabetes. Omega 6 fatty acid, arachidonic acid is major precursor of prostaglandin, leucotrine etc and play vital role in cell signalling. Fish is a good source of these fatty acids especially the poly unsaturated fatty acids. Hilsa is such a kind of fish with high health benefits. But the question arises where from these animals get this nutritional components.

Phytoplankton and zooplankton of the water bodies form a large community. Aquatic ecosystem productivity depends on these plankton communities. The long stretches of Hooghly river is found to be highly productive and it forms the breeding ground for hilsa. Hilsa feeds on these plankton. The fatty acid profile of adipose tissue triacylglycerols is particularly useful as a trophic marker because these fatty acids accumulate over time, representing an integration of dietary intake over days, weeks or even months (Hendersen and Sargent, 1981; Iverson, 2009), whereas examinations of gut content of an animal provide only informations of last ingesta (Napolitano, 1999). The fatty acid profile of lipid in the body tissue will also reflect the availability of fatty acids in aquatic food chain (Sargent *et al.,* 2002). Lanca *et. al.* (2011) concluded that muscle fatty acid profiles of neutral lipids could be used as a signature of aquatic organisms diet. Bearing this in mind the main objective of this study to assess the transfer of fatty acids from plankton to hilsa.

Materials and Methods

For this study two seasons were selected, one is winter season and the other is monsoon season as hilsa is available during this two seasons. The planktons were collected from the long stretches of Hooghly estuary in between Barrackpore (North 24 Parganas 22º46´N and 88º20´E) and Tribeny (Hooghly, 22º59´N, 88º23´E) of West Bengal, India. A mechanized boat was used to collect the plankton samples from the subsurface water using plankton net during winter and monsoon months of 2012-13. The plankton population is a collection of both phyto and zooplankton. The samples were brought to the laboratory for identification and to analyze the lipid and fatty acid contents.

Fresh hilsa fishes were collected from the fishermen from study sites in two seasons i.e. winter and monsoon months of 2012-13. Fishes were brought to the laboratory in iced condition and after removing fins, scales and viscera, fish tissue were homogenized and analyzed to estimate total lipids and fatty acid contents. Also the plankton were collected from the fish gut and was identified using microscope. The fishes were separated according to their size and maturity. In winter two groups of hilsa were found, one group is juvenile (10g) to young hilsa (200g) and the other is between 200g to1200g and it forms mature groups. On the other hand in monsoon season most of the fishes were found matured. No juveniles were found at this time.

Total lipids were extracted from the dried plankton sample, following the method of Bligh and Dyer (1959). Total lipids of various samples were dissolved in anhydrous methanol and corresponding methyl esters of the fatty acids were prepared (Christie, 1982). Purification of fatty acid methyl esters was done by thin layer chromatography

(Mangold, 1969; Misra *et al.*, 1984). Identification of fatty acids were done by comparing their retention times those of the standards after Gas liquid chromatography (Ackman and Burgher, 1965).

The statistical analysis was done following standard methods (Snedecor and Cochran, 1967).

Results

The plankton sample of the riverine water is a composition of phytoplankton and zooplankton community. Phytoplankton community mainly comprised of *Spirulina*, *Spirogyra*, Diatoms etc. Whether the zooplankton community is composed of *Cypris*, *Cyclops*, *Brachionus* and eggs of some groups.

Total lipid and the various classes of fatty acids found in plankton and hilsa in different seasons are presented in the Table 1. In case of plankton the total lipid content was found to be higher in monsoon period than winter. ω_3 and ω_6 value were higher in winter time. Mean ω_3 value in plankton was 25.75 and 16.73 in winter and monsoon period respectively. ω_6 values were 12.6 and 6.82 in winter and monsoon period respectively. Saturated fatty acid content was higher in plankton during monsoon (57.9) than the winter time (43.52).

Discussion

When the lipid percentage was measured it was found that in winter season juvenile hilsa contains 1.66% lipid and that of mature hilsa contains 5.15% lipid. But in monsoon season in mature hilsa the lipid content has been found to increase and it is about 13.11%. At this time juveniles and immature fishes were not noticed. But the ω_3 contents were found to be higher in winter. It is about 15.1 and 13.35 in immature and mature fishes of winter respectively and the value drops to 6.6 in mature hilsa during monsoon time. During monsoon period in hilsa monoene (MUFA) contents were increased compared to winter time hilsa (Table 1). ω_6 value and total saturated fatty acid values did not fluctuated much during this study period in various fish groups.

Table 1. Lipid and Fatty acid profile in plankton and hilsa

	Lipid content in body	**% age of fatty acid in lipid**					
		PUFA			**Monounsaturate**	**Unsaturate**	**Saturate**
		ω_3	**ω_6**	**ω_5**			
Winter plankton	0.96	25.75	12.6	1.90	15.10	55.70	43.52
Winter Juvenile hilsa	1.66	15.1	3.65	2.0	25.93	46.68	52.85
Winter mature hilsa	5.15	13.35	2.9	0.2	33.8	50.25	49.37
Monsoon plankton	1.49	16.73	6.82	0.10	18.3	41.96	57.9
Monsoon Mature hilsa	13.11	6.6	2.35	0.3	37.35	46.6	51.56

The gut contents of the hilsa were analysed. It is seen that the winter juveniles and young hilsa feed vigorously. Their gut is filled up with mainly zooplankton. Phytoplanktons were also present and most of the parts were fragmented. In case of mature fishes the gut content shows a reduction in plankton contents. In mature fishes during monsoon season it was seen that the gut was almost nil and filled with sand particles and debris.

It was found that fatty acid profile in plankton and hilsa are highly correlated (r = 0.81). It suggests the plankton fatty acids are the soul source of the highly beneficial fatty acids of hilsa and both shows same kind of changes during seasonal variations. Low ω_3 and ω_6 contents in mature hilsa during monsoon are related to the fact that at this time it was found that adult fish gut was found almost nil because it has stopped feeding during breeding time. Plankton may not synthesize fatty acid at this time as they do not get proper amount of nutrients from the water due to dilution of the water. During monsoon season plankton density is less and fish may not get sufficient amount of plankton.

Long chain ω_3 fatty acid is an important factor for zooplankton (Muller-Navarra *et al.,* 2004). It is seen the Hooghly riverine water has a rich of plankton community. Algae are the organisms that possess the enzymes for ω_3 (C20:5 and C22:6) production (Iverson, 2009). EPA and DHA are usually synthesized de novo by algae, while higher trophic organisms obtain these important molecules through bioaccumulation or by converting long chain ω_3 PUFA precursors such as α-linolenic acid 18:3ω_3 to DHA (20:5 ω_3) and EPA (22:6 ω_3) via elongation and desaturation (Veloza, 2005). Thus human enzymes also can then convert these short chain fatty acids to other fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which are building blocks of the brain and nervous system. These are needed for the integrity of every cell membrane in the body. It is important for the health of vital organs such as the heart, brain and retina. However, this bioconversion is usually too slow to meet the metabolic demands of the organisms. Quantity of DHA and EPA in algae varies significantly between major taxonomic groups. For example diatoms are rich in EPA (Sargent and Whittle, 1981). In the present study diatoms were found in the gut of hilsa. Hilsa obtains EPA, DHA and other fatty acid directly from the plankton and also through body mechanisms they produce some of them. On the other hand, this fish serves as a good fatty acid food supplement. During this study period it is seen that the sole source of the fatty acid in the hilsa body is the water plankton.

Acknowledgments

Authors are grateful to UGC for providing fund in Major Research Project (UGC FNo.38 - 198/2009 (SR) and to the Principal, Serampore College for giving permission to do the work. Thanks are due to Prof. Samir Banerjee, University of Calcutta for inspiring us to do the work.

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