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2. Proximal Composition of Various Food Fishes and their Nutritional Significance

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2.1 Introduction:

Fish are considered as nutritionally valuable part of the human diet because of the presence of both macronutrients (proteins, lipids and ash) and micronutrients (vitamins and minerals). These nutrients are indispensable in human nutrition and have proven to be involved in several metabolic functions.

The nutritional content can be used to rank different fish species based on their nutritional and functional benefits, allowing consumers to make better decisions according to their requirements. According to Ngasotter et al. (2020), the survey indicated that India is presently ranked third for overall fish production, which made the country one of the top fish producers in the world.

2.2 Proximal Composition of Food Fishes:

Proximate composition of fish includes determination of moisture, protein, fat and ash contents, which constitutes about 96%-98% of the total constituents of the fish body (Begum et al., 2012). The evaluation of these components is known as the ‘proximate composition' of fish. The study of these components gives us a clear understanding in assessing the energy value of the fishes.

One of the first and most basic procedures in estimating the nutrient content of a fish's entire body is to examine its moisture content. The proportion of moisture in food is an excellent indicator of its calorie, protein and fat levels (Barua et al., 2012).

Fish with lower moisture content has a higher fat and protein content, as well as a higher calorie density. These values differ significantly depending on the species, size, sexual status and season. The detection of minerals in fish is linked to ash.

The total inorganic content of fish is reflected in their mineral composition and the most effective technique to estimate it is first to quantify the ash content of the fish.

PROTEIN:

Due to the presence of essential amino acids (EAA), which are required by the fish for maintenance, growth, reproduction, vitamin synthesis and a high degree of digestibility, protein ranks second in the proximate composition of fish after moisture (Ahmed & Sheikh, 2017).

Fish protein, in comparison with mammalian protein, is very rich in amino acids such as lysine, methionine, but low in tryptophan. Proximal composition of vital fishes is shown in (Table 2.1). (Mohanty et al., 2017).

Table 2.1: Gross chemical composition of important food fishes from India. Data modified from: Mohanty et al., 2017

Species	Moisture	Crude Protein	Crude Fat	Ash
Ailia coila	82.8±0.2	12.9±0.5	1.8±0.0	2.0±0.0
Amblypharyngodo *molan*	76.2±1.1	16.3±0.8	4.3±0.0	4.0±0.9
Anabas testudineus	68.0±0.7	16.9±0.5	6.9±0.6	5.3±0.2
Barbonymus gonionotus	74.5±0.7	16.7±0.5	4.3±0.6	2.6±0.6
Barilius bendelisis	73.4±1.3	16.9±0.9	3.9±0.2	2.6±0.4
Catla catla	76.2±0.3	16.2±0.5	2.8±0.3	2.5±0.1
Cirrhinus mrigala	75.3±0.6	15.5±0.5	2.8±0.3	2.5±0.1
Cirrhinus reba	76.0±3.2	16.6±1.9	1.8±0.9	2.7±0.6

Species	Moisture	Crude Protein	Crude Fat	Ash
Chitala chitala	74.2±1.2	22.2±0.7	4.0±0.7	1.7±0.1
Clarius batrachus	75.9±0.7	16.4±0.3	3.7±0.4	2.3±0.0
Clupisoma garua	75.4±1.5	20.8±0.9	2.9±0.4	0.8±0.1
Crassostrea madrasensis	80.1±0.7	16.8±0.1	2.7±0.2	1.3±0.1
Cyprinus carpio	77.2±0.3	17.9±0.8	3.0±0.0	1.3±0.1
Epinephelus Spp	78.5±1.5	18.1±1.1	0.9±0.5	1.5±0.5
Etroplus suratensis	74.2±0.5	20.4±0.8	4.7±0.8	1.4±0.1
Euthynnus affinis	75.7±0.1	20.9±0.1	1.9±0.0	1.5±0.0
Fenneropenaeus indicus	82.2±0.9	16.4±0.3	0.7±0.4	1.4±0.1
Gudusia chapra	76.7±0.3	14.1±0.1	5.7±0.0	2.9±0.0
Harpodon nehereus	87.5±2.0	8.2±0.9	2.2±0.2	1.1±0.2
Heteropneustes fossilis	76.7±1.1	16.3±0.4	2.7±0.5	2.6±0.1
Johnius coitor	78.8±1.9	20.6±1.9	0.6±0.2	1.0±0.0
Katsuwonus pelamis	70.6±7.4	22.4±2.9	1.2±1.1	1.9±0.8
Labeo bata	74.6±2.7	15.2±3.1	3.6±1.3	3.1±1.6
Labeo dero	78.3±1.1	18.1±1.2	1.5±0.3	1.7±0.2

The individual amino acids play different roles in our body and hence are required in different quantities both in normal as well as clinical conditions.

Therefore, a detailed amino acid composition of different food fishes would be helpful in dietary recommendations to meet specific requirement of individual amino acids. In this context, the top three fishes rich in individual amino acids are given in Figure 2.1 for consumer guidance.

In general, it was observed that among the fishes studied, the Coldwater fishes are rich in lysine and aspartic acid, marine fishes in leucine, SIFs in histidine and the carps and catfishes in glutamic acid and glycine.

FATS:

Fat, the third most important component in fish muscle, is a major source of metabolic energy and is also implicated in several important functions, including the formation of cell and tissue membranes. The amount of fat content present varies among fish species. Fish lipids contain long-chain n-3 polyunsaturated fatty

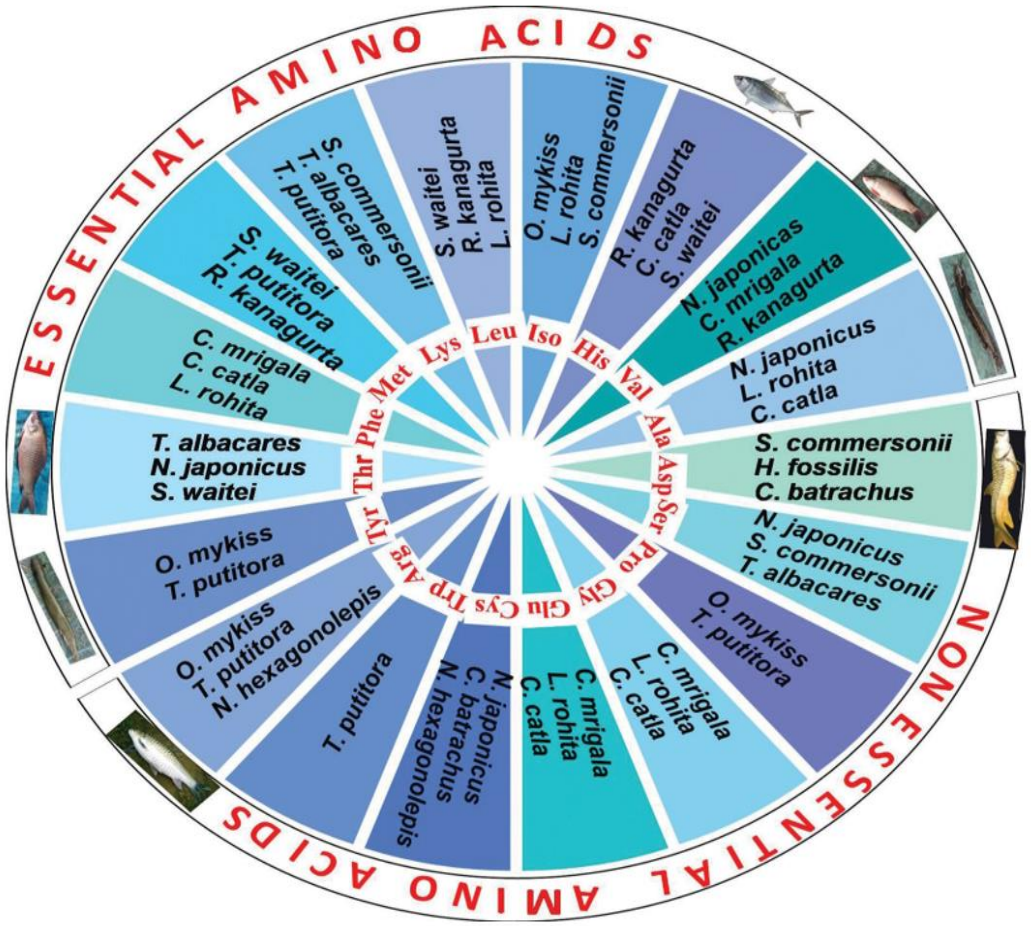

Figure 2.1: Classification of food fishes according to their richness in specific amino acids [Data source: Mohanty et al., 2014]

acids (n-3 PUFA), of which eicosapentaenoic acid (EPA, 20:5 n-3) and docosahexaenoic acid (DHA, 22:6 n-3) play a significant part in human nutrition and also promote better health. In this context, the fishes studied are arranged

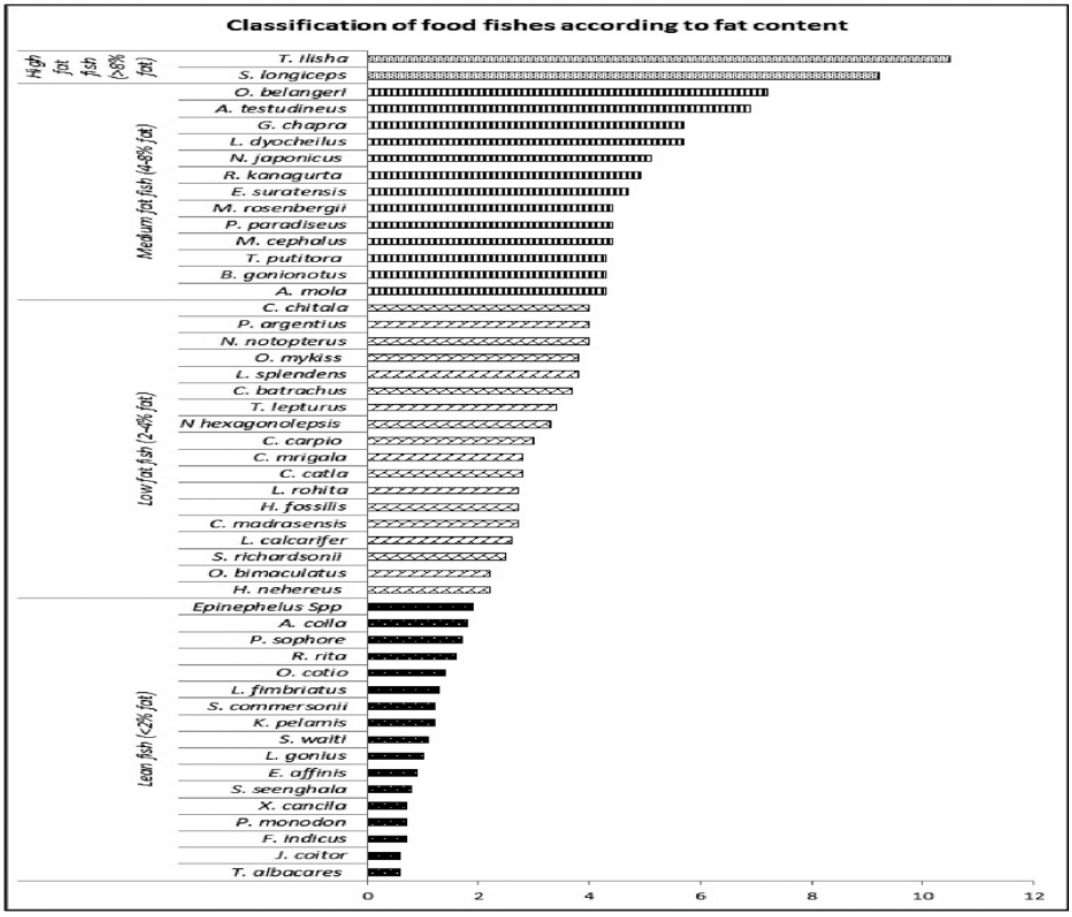

Figure 2.2: Classification of food fishes according to fat content. The fishes have been categorized depending on their fat content i.e. high fat fish,>8% fat; medium fat fish, 4–8%; low fat fish, 2-4%; lean fish, <2% fat of total body weight. Data source: Modified from Mohanty et al. (2016b).

-according to their fat content into three different categories for consumer guidance (Mohanty et al., 2012a; 2012b; 2016b).

As can be seen from Figure 2.2, the fat content of the fishes varied markedly among the fishes (0.6-10.5%).

Tenualosa ilisha, the migratory fish contain the highest amount of fat (10.5%) followed by Sardinella longiceps (9.2%).

Among the major freshwater fishes cultured across the country, C. catla, L. rohita and C. mrigala contain 2.8, 2.7 and 2.8% fat respectively (Mohanty et al., 2016b). Among the SIFs, majority of the fishes were under the medium fat category (4-8%).

2.3 Nutritional Significance:

Fish is high in a range of nutrients, including omega-3 fatty acids, proteins, selenium, iodine, vitamin D, and taurine. Current dietary recommendations from several governing authorities suggest eating fish one to three times per week.

Proteins and Amino Acids Indian diets are very low in protein, with the exception of regions where seafood is readily available. All nine amino acids are found in fish, making it a good source of protein.

Fish has a special blend of superior proteins. The majority of the Food Fishes contribute up to 30% of daily value of protein, which is quite higher than most of the highly consumed pulses that eaten in large quantities. It has been discovered that fish proteins improve postprandial levels, fasting lipid profiles, and both. It has been proposed that dietary proteins control lipid metabolism, slow down lipid production and absorption, and increase lipid excretion.

2.4 Omega 3 Fatty Acids:

Omega-3 fatty acids can be obtained in large amounts by eating fish. These vital nutrients maintain the health of our heart and brain. DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid) are two omega-3 fatty acids that are present in fish. All types of fish contain omega-3 fatty acids, however fatty fish have the highest concentration.

Salmon, trout, sardines, herring, tinned mackerel, canned light tuna, and oysters are a few healthy options. Lean fish is also a source of n-3 fatty acids, as it contains about 260 mg of n-3 per 100 g.

The biological activities of EPA and DHA include preserving the integrity of the cell membrane, regulating inflammatory processes, and reducing the release of pro-inflammatory cytokines, which have an impact on thrombosis and lipid metabolism.

An intake of two to three portions/week of a variety of seafood provide a recommended intake of EPA and DHA (250.0 mg/d).

As it is one of the richest sources of omega -3 fats, it helps offset the cholesterol risk by lowering triglycerides and may also increase the good cholesterol or HDL and hence protect us against heart diseases and stroke.

2.5 Micronutrients:

The major nutritional problems that have serious consequences are iron, vitamin A and iodine deficiencies in addition to the deficiency of calcium and vitamin D. Micro &Macro nutrient rich food fishes are depicted in fig., 3A.

VITAMIN A The SIFs Amblypharyngodon mola (555.0 µg/100g), Anabas testudineus (89.8 µg/100g), Puntius sophore (70.9 µg/100g), marine fish Epinephelus spp. (379.3 µg/100g), Sardinella longiceps (346.4 µg/100g), and migratory fish Tenualosa ilisha (260.7µg/100g) are rich in vitamin A. Food fishes rich in Fat soluble vitamins including Vitamin A is illustrated in fig 3B.

Iron:

Iron is needed to maintain the haemoglobin in our blood and also for a healthy gastrointestinal function, healthy immune system, and regulation of body temperature.

Iron deficiency anemia (IDA) is a condition which affects more than two billion people globally, among which women and children are more common. Iron rich food fishes are shown in figure 2.3.

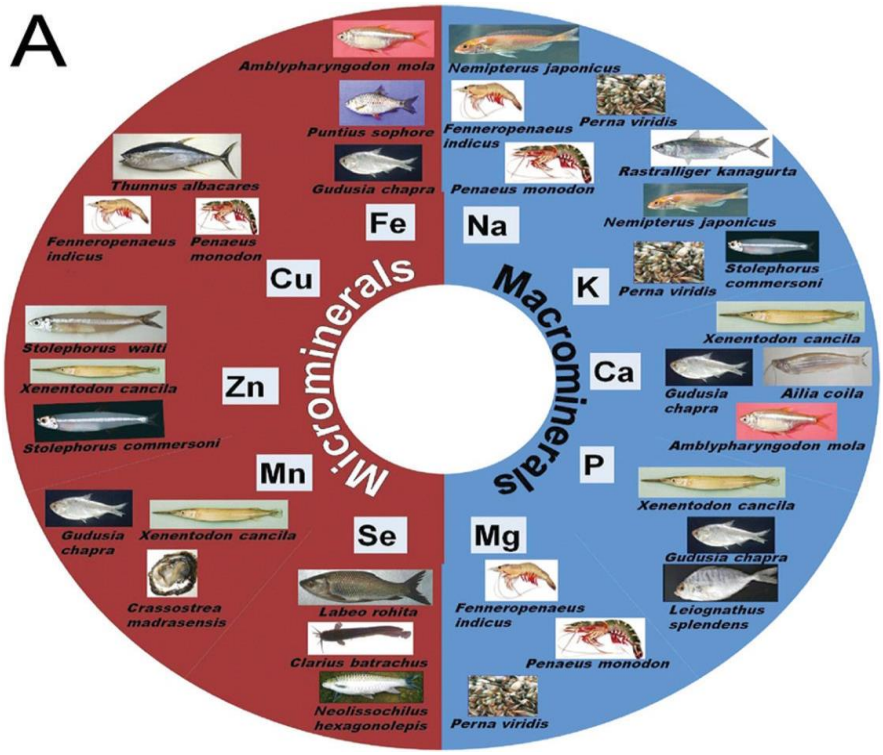

Figure 2.3: A- Micronutrient rich food fishes. A) The fish species rich in macro and micro minerals

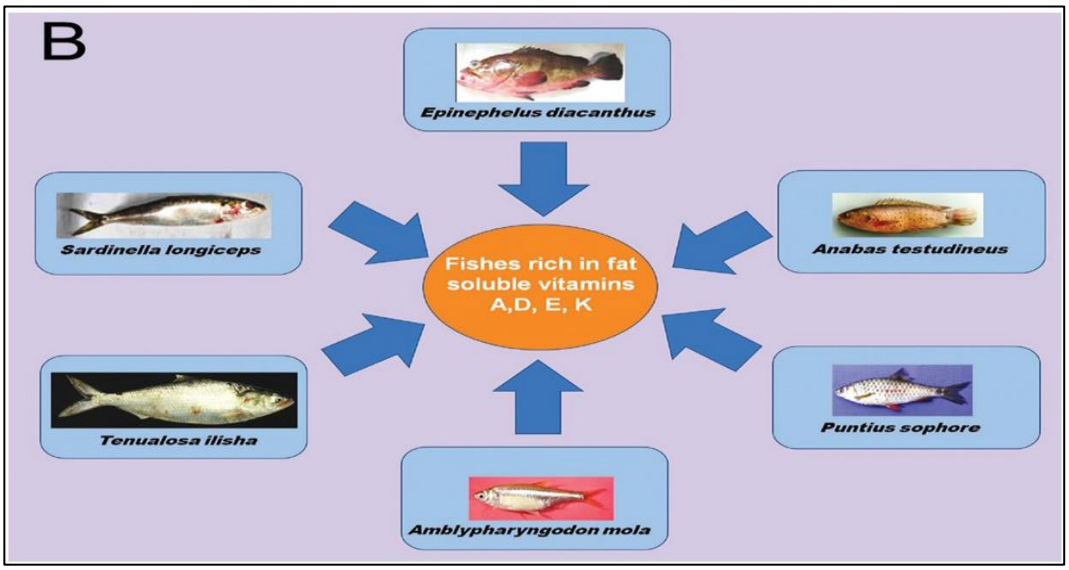

Figure 2.4: B –Food fishes rich in Vitamin A

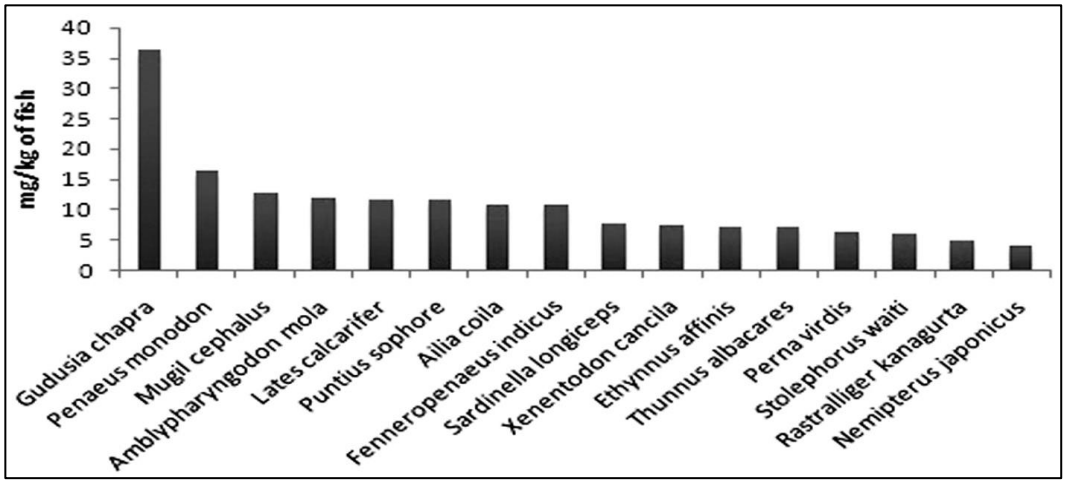

Figure 2.5: Food fishes rich in iron

Calcium and vitamin D Calcium deficiency causes weakening of bones which leads to bone fractures. Fish especially the small indigenous fishes are rich sources of calcium.

The small indigenous fishes like Xenontodon cancila, Gudusia chapra, Ailia coila, A. mola, Puntius sophore are some of the calcium rich fishes. The absorption of calcium is dependent on Vitamin D especially (calciferol) which is essential for calcium homeostasis. Fish, in this context, can play an important role to serve as a natural dietary source for vitamin D. A number of Indian food fishes like A. mola, Puntius sophore, S. longiceps, Epinephelus Spp. are species rich in vitamin D and can serve as a good source of vitamin D (Mohanty et al., 2017). Some of the food fishes rich in both calcium and vitamin D are listed blow (Table 2).

Astaxanthin Fish such as salmon is rich in Astaxanthin. Astaxanthin is a member of the carotenoid family and it is rich in antioxidants.

Astaxanthin is a compound linked to several powerful health effects. Astaxanthin appears to lower the risk of heart disease by reducing the oxidation of LDL (bad) cholesterol and increasing levels of HDL (good) cholesterol.

Table 2.2: Fishes rich in calcium and Vitamin D

Fish Species	Calcium (mg/100g)	Vit D (IU/100g)
Xenentodon cancila	5310±23.5	–
Gudusia chapra	3440±10.4	–
Aillia Coila	2410±14.7	–
Neolissochilus Hexagonolepis	1175±27.6	–
Puntius sophore	944.6±55.4	16266.4±84.2
Amblypharyngodon mola	841.7±40.2	93122.4±89.2
Sardinella Lohgiceps	523.9±45.6	21288.0±25.3
Perna Virdis	522.6±38.7	404.3±11.2
Fenneropenaeus indicus	429.7±7.4	–
Penaeus monodon	419.3±3.2	–
Oncorhynchus mykiss	418.6±99.1	–
Schizothorax richardsonii	414.7±99.1	–
Cyprinus carpio	409.3±25.6	–
Leignathus splendens	330.8±40.3	597.6±21.2
Mugil cephalus	263.9±6.7	–
Anabas testudineus	252.6±45.7	64.4±23.2
Lates calcarifer	241.9±4.3	–
Cirrhinus mrigala	222.5±15.7	152.3±25.3
Clarias batrachus	222.3±3.3	30.9±10.2
Katsuwonus pelamis	206.3±47.8	435.5±45.3
Labeo rohita	205.7±4.8	84.4±11.2
Heteropneustes fossilis	164.4±21.5	111.7±14.2
Epinephelus Spp	162.1±10.6	23445.9±52.3
Catla catal	161.1±4.4	59.5±12.5

Fish Species	Calcium (mg/100g)	Vit D (IU/100g)
Trichiurus lepturus	159.7±60.1	316.3±13.2
Crassostrea madrasensis	145±25.7	451.6±12.3
Tenualosa ilisha	119±45.7	9549±85.2
Tor putitora	116±70.6	–
Sperata seenghala	64.1±21.6	7494.8±56.3
(Adapted from: Mohanty et al.,2016a)		

2.6 Conclusion:

Knowledge of the proximate composition of fish plays a paramount role in knowing the nutritive profile of the fish and also acts as an indicator for assessing nutritional status, physiological condition and quality of the fish.

It also provides the most reliable information about the nutrient content of different fish species. The study of the proximate composition of fishes ensures whether the fishes meet the requirements of food regulations and commercial specifications or not and also helps in assessing how these parameters vary from species to species which in turn aids in preventing any non-communicable diseases owing to its nutritional composition.

2.7 References:

1. Ahmed, I., & Sheikh, Z. A. (2017). Study on the seasonal variation in the chemical composition, hematological profile, gonado-somatic index and hepato-somatic index of snow trout, Schizothorax niger from the freshwater Dal Lake, Kashmir. American Journal of Food Technology, 12(1), 1–13. https://doi.org/10.3923/ajft.2017.1.13
2. Begum, M., Akter, T., & Minar, M. H. (2012). Analysis of the proximate composition of domesticated stock of pangas (Pangasianodon hypophthalmus)

in laboratory condition. Journal of Environmental Science & Natural Resources, 5(1), 69–74.

3. Ngasotter, S., Panda, S. P., Mohanty, U., Akter, S., Mukherjee, S., Waikhom, D., & Devi, L. S. (2020). Current scenario of fisheries and aquaculture in India with special reference to Odisha: A review on its status, issues and prospects for sustainable development. International Journal of Bio-Resource & Stress Management, 11(4), 370–380. https://doi.org/10.23910/1.2020.2126a
4. Mohanty, B. P., Ganguly, S., Mahanty, A., Sankar, T. V., Anandan, R., Chakraborty, K., Paul, B. N., Sarma, D., Dayal, J. S., Venkateshwarlu, G., Mathew, S., Asha, K. K., Karunakaran, D., Mitra, T., Chanda, S., Shahi, N., Das, P., Das, P., Akhtar, M. S., … Sridhar, N. (2016). DHA and EPA content and fatty acid profile of 39 food fishes from India. BioMed Research International, 2016, 4027437. https://doi.org/10.1155/2016/ 4027437
5. Mohanty BP, Mahanty A, Ganguly S, Mitra T, Karunakaran D, Anandan R (2017) Nutritional composition of food fishes and their importance in providing food and nutritional security. Food Chem. https://doi.org/10.1016/j.foodchem.2017.11.039
6. Mohanty BP, Paria P, Das D, Ganguly S, Mitra P, Verma A, et al. (2012a) Nutrient profile of giant river-catfish Sperata seenghala (Sykes). Natl Acad Sci Lett 35(3): 155-161.
7. Mohanty BP, Paria P, Mahanty A, Behera BK, Mathew S, Sankar TV, et al. (2012b) Fatty acid profile of Indian shad Tenualosa ilisha and its dietary significance. Natl Acad Sci Lett, 35: 263-269.
8. Mohanty BP, Sankar TV, Ganguly S, Mahanty A, Anandan R, Chakrabarty K, et al. (2016a) Micronutrient composition of 35 food fishes from India and their significance in human nutrition. Biol Trace Elemt Res doi: 10.1007/s12011-016-0714-3. Mohanty BP, Sankar TV, Ganguly S, Mahanty A, Anandan R, Chakrabarty K, et al. (2016b) DHA, EPA content and fatty acid profile of 39 food fishes from India. Biomed Res Int doi:10.1155/2016/4027437.