Nutritional Profile of Hilsa Fish [*Tenualosa ilisha* (Hamilton, 1822)] in Six Selected Regions of Bangladesh

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Abstract

This study was conducted to determine the nutritional value of hilsa fish from the six selected regions in Bangladesh. The moisture, protein, fat, carbohydrate and energy value were found 66.94 ± 7.34 to 72.04 ± 5.77%, 18.95 ± 3.97 to 20.56 ± 4.57%, 4.97 ± 0.89 to 8.21 ± 1.87%, and 3.08 ± 0.68 to 4.84 ± 1.22%, 0.35 ± 0.09 to 0.72 ± 0.05% and 128.38 ± 11.43 to 161.68 ± 13.21 kcal/100 g respectively. The pH, TVB-N and salt value were found 6.52 ± 0.07 to 6.84 ± 0.10, 2.01 ± 0.71 to 3.50 ± 0.33 mg/100 g and 2.05 ± 0.03 to 6.48 ± 0.07% respectively. The vitamin A and vitamin C value were found 33.50 ± 14.28 to 95.54 ± 11.69 µg/100 g and 11.20 ± 0.47 to 14.28 ± 1.93 µg/100 g respectively. The calcium (Ca), iron (Fe), phosphorus (P), magnesium (Mg), manganese (Mn), copper (Cu) and zinc (Zn) were found 144.21 ± 17.43 to 372.67 ± 17.44 mg/100 g, 9.04 ± 5.14 to 13.07 ± 5.17 mg/100 g, 118.17 ± 13.56 to 204.06 ± 5.89 mg/100 g, 34.18 ± 3.72 to 45.07 ± 9.22 mg/100 g, 8.54 ± 1.79 to 12.68 ± 4.3 mg/100 g, 0.95 ± 0.13 to 1.54 ± 0.29 mg/100 g and 0.94 ± 0.22 to 1.23 ± 0.19 mg/100 g respectively. These values are useful references for consumers in order to choose fish and shellfish based on their nutritional contents. These results also suggest that the proximate composition of hilsa fish greatly varies due to physiological reasons and changes in environmental conditions, i.e., spawning, migration, and starvation or heavy feeding.

Introduction

The River Shad, popularly known as hilsa is in great demand globally, specifically in the oriental world and enjoys high consumer preference. Its high commercial demand makes it a good forex earner. In Bangladesh, hilsa fish is mainly caught in the Padma (lower Ganges), Meghna (lower Brahmaputra), and Jamuna rivers. More than 10% of the country's total fish production comes from hilsa fish. Hilsa fish contributes a total of 346512 MT (Inland 114475 MT and Marine 232037 MT) in 2011-12 [1]. Foods from the aquatic environment are a unique source of the essential nutrients. Fish meat is basically composed of water (66-81%), protein (16-21%), carbohydrates (<0.5%), lipids (0.2-25%) and ash (1.2-1.5%) [2]; and is considered to have important biological value [3], due to the contribution of Essential Amino Acids (EAA) [4] and micronutrients [5], as well as, its high levels of fatty acids omega-3 and omega-6, higher than in most meat sold for human consumption [6].

Protein, fat and water content of fish are important to consumers, scientists and manufacturer for nutritional value, seasonal variations and considerations regarding processing [7]. The nutritional composition of fish varies greatly from one species and individual to individual, depending on maturity, feed ration, physical activity, sex and sexual changes related to spawning [8], environment and season. Fish is one of the main food constituents in our diet as it contains essential fatty acids, amino acids and some of the principal vitamins and minerals in sufficient a mounts for healthy living [9]. Carbohydrates and non-protein compounds are also important constituents but are present in small amounts and are usually ignored during analysis [10,11]. Fish and fish products are the most important sources of animal protein in the human diet. This protein is relatively of high digestibility compared to other protein sources. It comprises of all the ten EAA in desirable quantity for human consumption. Fish protein is very rich in such

amino acid as methionine, lysine and low in tryptophan compared to mammalian protein [12]. Fish is a rich source of essential nutrients required for supplementing both infant and adult diets [13]. Fish proteins are rich in EAA and required for the maintenance, growth, reproduction and synthesis of vitamins. Furthermore, some nutritional components such as, fish oil is one of the most important natural sources of polyunsaturated fatty acids having Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA), which have been proven to have useful effects on human body [14]. The fat content is varied with period of migration of the hilsa and this might be the reason for the different average fat values (7.5-26.93%) reported in *Tenualosa ilisha* by several researchers who might have sampled the fish at different times of migration [15]. The live weight of majority of fish usually consists of about water (70-80%), protein (20-30%) and of lipid (2-12%) [11]. In several earlier investigations it had been pointed out that the moisture has an inverse relationship with the fat content [16]. Additionally the fish muscle contains little saturated fat and significant amount of vitamin C along with minerals such as calcium, potassium, zinc, iron, phosphorus and copper.

The proximate analysis of food refers to the analysis of the total content of a food component, not taking account of the individual compounds making up that food component. The macro components

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are generally analyzed for their proximate amounts. The main objective of this study was to know the nutritional composition of hilsa fish at different regions to simple classification of the experimental fish on the basis of their nutritional value.

Materials and Methods

Sample collection and preparation

Hilsa fish were purchased from six selected regions (Barisal, Patuakhali, Bhola, Cox's Bazar, Chandpur and Shariatpur). Fish were 3-4 days post-captured on arrival at the laboratory in ice. At least twenty individuals from each region were used for analyses.

Proximate composition value

The proximate composition of fish samples were analysed in triplicate following standard procedures AOAC [17]: moisture content by drying in an oven at 105°C for 24 h; crude protein content (N x 6.25) by the Kjeldahl method using an Auto Kjeldahl System (KjeltecTM 2300 Foss Tecator AB, Hoganas, Sweden), lipid by ether extraction (Soxtec System HT6, Tecator AB, Hoganas, Sweden), ash by incineration in a muffle furnace at 600°C for 6 h. Carbohydrate content was calculated based on difference calculation.

Energetic value

The energetic value was determined indirectly using Rubner's coefficients for aquatic organisms: 9.5 kcal/g for lipids, 5.65 kcal/g for proteins [18] and expressed in kcal/g wet mass as described by Eder and Lewis [19].

pH value

pH value of the sample was determined with the help of a pH meter (Mettler Toledo 320-s, Shanghi, China) following standard method [20].

TVB-N value

The TVB-N value was determined by using Conway modified micro-diffusion technique [21].

Salt value

Salt content of the raw fish were estimated by Mohor method [22]. The minced fishes were weighed and salt was extracted with distilled water. Sample were kept overnight at 10°C. The filtrate with salt content was titrated against standard N/10 silver nitrate ($AgNO_3$) solution in micro burette using potassium chromate as an indicator.

Vitamins analysis

Vitamin A precursor were evaluated on oil extracts by spectrophotometry as previously described with some modifications [23,24]. In this respect, 0.1 g of oil extracted from each fish sample as described above, was diluted in an acetone/hexane mixture (70/30; v/v) and total carotenoid carried out by measuring absorbance at 470 nm against a blank sample. Standard curves made with pure vitamin A used for this purpose and the results expressed as mg vitamin A equivalent per 100 g fish sample. Vitamin C was analyzed by titration as previously described with some modifications [25]. In this procedure, 2 g of each sample was dissolved in a 25 mL volumetric flask containing 20 mL of distilled water. After mixing for 10 min using an agitator, the mixture was titrated with 2, 6 dichloro phenol indophenol solution using phenolphthalein as indicator. A standard sample of ascorbic acid (0.1 mg/100 mL) was used as reference and the results expressed in mg vitamin C/100 g.

Mineral elements analysis

The preparation of samples for mineral elements analysis followed a method described by AOAC [26]. Approximately 5 g of sample was weighed into acid-washed crucible and dried in oven 105°C for one day. Dried samples were then digested in furnace oven at 550°C overnight. The ash was digested in 5 ml of 65% nitric acid (HNO_3) by boiling for about two minutes and cooling to room temperature. The cooled solution was filtered through Whatman filter paper (No. 41) and made up to 25 ml with 65% nitric acid. A 10 ml were transferred into 15 ml polypropylene test tube for injection into inductively-coupled plasma-optical emission spectrometer (ICP-OES) (Perkin Elmer, USA). Samples were then analyzed for its micro minerals content (copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), calcium (Ca), phosphorus (P), magnesium (Mg). Sample blank (65% nitric acid) was analysed together with each batch of samples.

Data analyses

After experiment, all the collected data were summarized, scrutinized; tabulated and carefully subjected to the descriptive analyses using the computer software MS Word, Microsoft Office Excel 2007 and XL-stat version 16 for DMRT to understand the differences of the variables.

Results and Discussion

Proximate value of hilsa fish

The protein, fat, moisture and ash composition of all 6 regions are shown in Table 1. The total protein content in hilsa fish ranged from 18.95 to 20.56% and can be assumed to be of high dietary quality, being an animal-source protein [27]. The fat content ranged from 4.97 to 8.21%. Fat generally varies much more widely than other proximate components of fish, and usually reflects differences in the way fat is stored and may also be affected by seasonal/lifecycle variations and the diet/food availability of the species at the time of sampling [28]. Hilsa fish have a higher content of dark muscle which tends to be rich in fat [29]. The moisture content of hilsa fish ranged from 66.94 to 72.04%. Ash content ranged from 3.08 to 4.84%. Finally, the mean value of moisture, protein, fat and ash was 69.51%, 19.44%, 6.78% and 3.72% respectively in Figure 1.

All the collected hilsa fish were observed to contain small amount carbohydrate. However, the carbohydrate content could be considered as insignificant instead, as the values were derived and estimated from the difference of other compounds. After all, the carbohydrate content in fish is generally very low and practically considered zero [30,31]. The total energy content varied greatly with a range of 128.38 to 161.68 kcal/100 g which is related to variation in fat content in the hilsa fish. Meanwhile, for energetic value, Moonfish had the highest value of 738 kcal/100 g and shellfish had energetic values that fall within small range 400-517 kcal/100 g [32].

pH value

The pH value of hilsa fish species was significantly fluctuated. The pH value ranged 6.52 to 6.84 in Table 1. These might happened due to the increase of total volatile basic nitrogen. The production of alkaline bacterial metabolites in spoiled fish which coincided well with the increased in total volatile basic nitrogen (TVB-N) might increase the pH level of samples [33]. The increase in pH in fish muscle occurred due to the storage period which was also associated with the state of rapid spoilage of fish [34]. Reduced pH may be caused by reduction or

cessation of microbial growth [35]. The pH of live fish muscle is close to 7; however, postmortem pH can vary from 6.0 to 7.1 depending on season, species, and other factors [36-38].
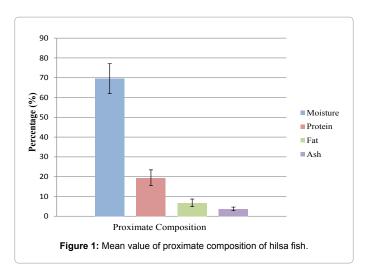
TVB-N value

TVB-N is a product of bacterial spoilage and the content is often used as an index to assess the keeping quality and shelf life of seafood products. The TVB-N value of hilsa fish was ranged 2.01 to 3.50 mg/100 g in Table 1; it indicates that fish sample was good quality for analysis. The level of 35 mg/100 g has been considered the upper limit, above which fishery products are considered spoiled [39]. In case of long term storage the TVB-N value will be higher [40].
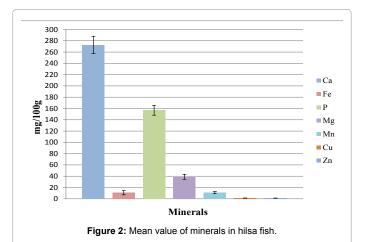
Vitamins value

Vitamin A and vitamin C content in hilsa fish was ranged 33.50-95.54 µg/100 g and 11.20-14.28 µg/100 g in Table 1 respectively. Total vitamin A content in hilsa fish was found 20 µg/100 g [41]. Vitamin C was found in case of cultural catfish was 82.2 µg/100 g [42].

Minerals value

Calcium, iron, phosphorus, magnesium, manganese, copper and zinc content in hilsa fish ranged considerably from 144.21 to 372.67 mg/100 g, 9.04 to 13.07 mg/100 g, 118.17 to 204.06 mg/100 g, 34.18 to 45.07 mg/100 g, 8.54 to 12.68 mg/100 g, 0.95 to 1.54 mg/100 g and 0.94 to 1.31 mg/100 g in Table 2 respectively. These results are within the range of fish and seafood reported elsewhere [43]. Similarly, calcium, iron, phosphorus, magnesium, manganese, copper and zinc content in hilsa fish was 220 mg/100 g, 1.90 mg/100 g, 300 mg/100 g, 27 mg/100 g, 0.25 mg/100 g, 0.12 mg/100 g and 1.20 mg/100 g respectively [41]. However, the mean value of calcium, iron, phosphorus, magnesium, manganese, copper and zinc content in hilsa fish was found 272.50 mg/100 g, 10.75 mg/100 g, 156.90 mg/100 g, 38.96 mg/100 g, 11.08 mg/100 g, 1.20 mg/100 g and 1.12 mg/100 g respectively in Figure 2.

Figure 1: Mean value of proximate composition of hilsa fish.

Figure 2: Mean value of minerals in hilsa fish.

Parameters	Barisal	Patuakhali	Bhola	Cox's Bazar	Chandpur	*Shariatpur*
Moisture (%)	66.94 (±7.34)[a]	69.22 (±4.67)[c]	69.91 (±11.41)[d]	68.90 (±13.25)[b]	70.04 (±2.97)[e]	72.04 (±5.77)[f]
Protein (%)	20.56 (±4.57)[e]	19.24 (±3.66)[b]	19.56 (±2.54)[d]	18.95 (±3.97)[a]	19.35 (±4.91)[c]	18.98 (±4.44)[a]
Fat (%)	8.21 (±1.87)[f]	7.47 (±2.66)[e]	4.97 (±0.89)[a]	7.31 (±1.17)[d]	7.12 (±3.22)[c]	5.59 (±1.83)[b]
Ash (%)	3.64 (±1.17)[c]	3.72 (±0.97)[d]	4.84 (±1.22)[f]	4.26 (±0.83)[e]	3.08 (±0.68)[b]	2.77 (±0.63)[a]
Carbohydrate (%)	0.65 (±0.13)[d]	0.35 (±0.09)[a]	0.72 (±0.05)[e]	0.58 (±0.11)[c]	0.41 (±0.03)[b]	0.60 (±0.21)[c]
Energy (kcal/100 g)	161.68 (±13.21)[f]	148.30 (±7.95)[e]	128.38 (±11.43)[a]	146.60 (±5.99)[d]	145.81 (±9.93)[c]	131.15 (±11.64)[b]
pH	6.61 (±0.04)[b]	6.68 (±0.08)[d]	6.64 (±0.02)[c]	6.84 (±0.10)[e]	6.68 (±0.04)[d]	6.52 (±0.07)[a]
TVB-N (mg/100 g)	2.75 (±0.81)[b]	3.30 (±0.43)[d]	3.50 (±0.33)[e]	2.01 (±0.71)[a]	3.50 (±0.22)[e]	3.13 (±0.19)[c]
Salt (%)	2.92 (±0.04)[e]	2.29 (±0.31)[c]	2.45 (±0.17)[d]	6.48 (±0.07)[f]	2.05 (±0.03)[a]	2.22 (±0.01)[b]
Vitamin A (µg/100 g)	76.04 (±16.78)[d]	95.54 (±11.69)[f]	36.79 (±19.24)[b]	85.82 (±5.92)[e]	33.50 (±14.28)[a]	49.01 (±7.47)[c]
Vitamin C (µg/100 g)	14.28 (±1.93)[f]	11.69 (±2.29)[b]	12.68 (±3.19)[e]	11.20 (±0.47)[a]	11.73 (±1.19)[c]	12.48 (±4.52)[d]

*The values in the same row having similar superscripts did not differ significantly (p<0.05)

Table 1: Proximate composition, pH, TVB-N, salt and vitamins value in hilsa fish.

Parameters	Barisal	Patuakhali	Bhola	Cox's Bazar	Chandpur	*Shariatpur*
Calcium (mg/100 g)	372.67 (±17.44)[f]	217.06 (±24.78)[b]	322.91 (±7.39)[e]	281.55 (±14.52)[c]	144.21 (±17.43)[a]	296.59 (±9.57)[d]
Iron (mg/100 g)	13.07 (±5.17)[f]	11.92 (±4.36)[d]	12.08 (±3.34)[e]	9.11 (±2.17)[b]	9.26 (±1.96)[c]	9.04 (±5.14)[a]
Phosphorus (mg/100 g)	194.05 (±11.47)[e]	118.17 (±13.56)[a]	204.06 (±5.89)[f]	149.46 (±5.77)[d]	134.95 (±13.22)[b]	140.69 (±2.83)[c]
Magnesium (mg/100 g)	45.07 (±9.22)[f]	34.18 (±3.72)[a]	40.03 (±4.22)[e]	36.51 (±3.83)[b]	39.78 (±4.68)[d]	38.19 (±0.79)[c]
Manganese (mg/100 g)	8.54 (±1.79)[a]	12.03 (±1.19)[e]	12.01 (±1.05)[d]	12.68 (±4.31)[f]	9.68 (±2.33)[b]	11.52 (±1.25)[c]
Copper (mg/100 g)	0.95 (±0.13)[a]	1.11 (±0.15)[b]	1.32 (±0.03)[c]	1.54 (±0.29)[d]	0.95 (±0.03)[a]	1.32 (±0.24)[c]
Zinc (mg/100 g)	1.19 (±0.24)[d]	1.08 (±0.09)[c]	0.94 (±0.22)[a]	1.23 (±0.19)[e]	0.98 (±0.14)[b]	1.31 (±0.27)[f]

*The values in the same row having similar superscripts did not differ significantly (p<0.05)

Table 2: Minerals value in hilsa fish.

Conclusion

The data and information obtained in this study represent the first step towards understanding the nutritional profile of hilsa fish in different parts of Bangladesh. However, this study provides valuable information on variations in the immediate composition of hilsa fish and making a choice based on this information from the consumer's point of view.

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