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Proximate and Major Mineral Composition of Commercially Important Marine Fishes of Bangladesh

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Abstract: *Although fish is rich nutrient source for mass people of Bangladesh, still limited information available on the nutrient contents of edible marine fishes. This study was conducted with the aim to estimate nutrient contents of some selected major commercially important marine edible fishes Bay of Bengal. Proximate composition and mineral content of five fish species viz. Pampus chinensis, Lates calcarifer, Johnius argentatus, Harpodon nehereus, Lepturacanthus savala were determined. Proximate analysis revealed that moisture, protein, carbohydrate, lipid, and ash ranged from 78.25±0.12 to 87.3±0.15%, 7.4±0.05 to 14.5±0.13%, 1.4±0.01 to 2.21±0.10% and 1±0.03 to 2.8±0.10% and the maximum content belonged to H. nehereus, L. savala, P. chinensis, J. argentatus, L. savala respectively. The mineral profiles showed that among macro minerals potassium was abundant one followed by sodium, calcium, magnesium. Potassium, sodium, calcium, magnesium content ranged from* 198.199±0.22 *to* 700.218±0.15 *mg,* 190.743±0.10 *to* 466.733±0.35 *mg,* 40.182±0.13 *to* 200.113±0.27 *mg,* 130.784±0.24 *to* 152.577±0.22 *mg per 100gm and maximum amount belonged to L. calcarifer, H. nehereus, L. savala, P. chinensis respectively. Major micro mineral was Iron followed by Zinc. Iron and Zinc content varied from* 2.769±0.06 *to* 8.603±0.66 *mg,* 1.130±0.03 *to* 2.799±0.07 *mg per 100 gm with maximum amount found in P. chinensis and H. nehereus respectively. Copper, manganese, chromium, cadmium were found in very negligible amount. Cobalt and Lead was absent. The potential contribution of each species to Recommended Nutrient Intake (RNI) for adult (>18yr), pregnant and lactating woman (PLW), infants (7 to 23 months) were calculated. P. chinensis and J. argentatus could potentially contribute ≥20% of the recommended nutrient intake of Iron and magnesium for adult, PLW and infants from a standard portion and moreover marine fish species shows good combination of protein and minerals. This study might be helpful for better nutritional achievement in Bangladesh.*

Keywords: *Marine fish, proximate composition, mineral content, fatty acid profiles, Recommended Nutrient Intake.*

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I. Introduction

Fish is consumed by large portion of population as they have good nutrition value. In Bangladesh, fish is an incomparable animal-source food in the diet of millions, both in terms of quantity and quality accounting for approximately 60% of animal protein intake at 18.1 kg consumed per person per year and the frequency of consumption, far exceeding that of any other animal-source food [1]. A wide range of fishes (around 511 marine species) including shrimp is found in Bangladeshi part of Bay of Bengal [2] which account for the 16.28% of the national fish production [3]. Essential amino acids are found in good proportions in fish proteins. [4,5,6,7]. eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are also found in fish tissues [8,9] and these are reported to play important role such as prevention of cardiovascular diseases, cancers, rheumatoid arthritis, and inflammation [10,11]. Many important body functions such as acid-base balance, bone formation and catalyze many metabolic reactions are the functions of minerals.) [12, 13] and fish muscle and bones are the good sources of essential minerals [14,15]. In spite of the importance of marine fishes, very limited information on the biochemical composition of marine fishes of Bay of Bengal is available. Reports on the proximate composition on *Dasyatis americana, Dasyatis pastinaca, Dasyatis zugei* and *Gymnothorax favagineus* are only available [16].

The objectives of this study was to evaluate the nutritive value of five commercially important marine fish species *viz. Pampus chinensis*, *Lates Calcarifer*, *Johnius argentatus*, *Harpodon nehereus*, and *Lepturacanthus savala* in terms of their proximate composition, mineral composition and fatty acid profiles and in addition to estimate their potential contribution to recommended nutrient intakes (RNIs) during the first 1000 days of life and for infants from age 7 to 23 months [17,18,19].

II. Materials and Methods

2.1. Collection of Samples

Five marine fish Species (*Pampus chinensis, Lates Calcarifer, Johnius argentatus, Harpodon nehereus* and *Lepturacanthus savala*) were collected from Fishery Ghat, Chittagong; one of the most commercial landing centers of Bangladesh during July 2015. From here marine fishes are supplied all over the country. All samples were fresh fish and caught within 0 to 36 hours after collection. All samples were immediately dipped into ice and transported in an insulated ice box to Bangladesh council of scientific and industrial research (BCSIR), Dhaka, Bangladesh. Upon arrival at BCSIR temperature of Ice box was checked to ensure whether it is within -4^0C to 0^0C. Total body weight and length (mean ± standard deviation) were measured for each sample. Samples were beheaded, gutted, washed and filleted. Only muscle portion was taken and homogenized as raw edible portion prior to analytical tests. The duration of this study was from July 2015 to January 2016.

Table-1: Physical Characteristics of Fishes

Local Name	Scientific Name	Length	Weight
Rupchanda	*Pampus chinensis (Euphrasen, 1788)*	22 ± 3.75cm	180 ± 20gm
Coral	*Lates calcarifer (Bloch, 1790)*	28 ± 4.30cm	260 ± 20gm
Poa	*Johnius argentatus (Houttuyn, 1782)*	21.5 ± 3.30cm	85 ± 20gm
Loitta	*Harpodon nehereus (Hamilton, 1922)*	23 ± 2.20cm	55 ± 10gm
Churi	*Lepturacanthus savala (Cuvier, 1829)*	67 ± 3.00cm	265 ± 50gm

2.2. Proximate Composition Analysis

2.2.1. Moisture

Moisture content was determined according to standard AOAC (1990) method. For which a known weight (10 ± 0.5 gm) of sample was placed in individual moisture basin and oven dried at 105^0C until constant weight was obtained [20].

2.2.2. Crude protein

Crude protein content was determined by micro Kjeldahl method. Nitrogen content using a micro-Kjeldahl apparatus (Automatic Kjeldahl Digester, DKL 8 Series, VELP Scientifica, Italy and Kjeltec 2100, Distillation Unit, FOSS Analytical, Denmark). Crude protein was estimated by multiplying nitrogen content by 6.25 [20].

2.2.3. Crude lipid

This was a method that was used to determine Lipid content of fishes. Approximately 5±0.2 gm of dried sample left after moisture determination was placed individually and kept in pre-weighted conical flask was filled with 10ml of chloroform-methanol (2:1) and kept for overnight. The solution was filtered and 0.50% NaCl solution (20ml) was added and allowed to stand for 46hours. Extraction was carefully collected and was evaporated to dryness at 105^0C. Total lipid content was determined gravimetrically [21].

2.2.4. Carbohydrate and Energy value

Total Carbohydrate and Energy were determined by following equation [22].

Total Carbohydrate = 100-(Moisture + Protein +Fat +Ash)

Energy value K cal/100gm = P×4.0 Protein K cal/100gm + F×9.0 Fat K cal/100gm +C×4.0 Carbohydrate K Cal/100gm.

2.3. Major Minerals Analysis

For mineral estimation, approximately 2±0.1 gm of wet sample were weighted into polypropylene screw capped tube and 10ml of concentrated HNO_3 (65%) and 3ml of 60% per chloric acid added according to AOAC method 975.03 [23]. it was left overnight to complete digestion. Then heating at 90^0C for 7 hours was carried out I digestion chamber. After complete of digestion, digests were filtered out into 25ml volumetric flask and made up to volume with ultra-pure water. After appropriate dilution Calcium Magnesium, Zinc, Iron, Copper, Nickel were determined in Atomic absorption spectrometer (AAS) with their standard solution by thermo scientific, iCE 3000 series, USA. All chemicals and reagents used in the analysis procedure were of analytical grade and purchased from Merck (Germany), BDH (UK) Sigma Chemical Co (St. Louis, MO, USA) Results are showed in Table as mean ± SEM.

2.4. Presentation of results

All proximate components and minerals were analyzed in triplicates and presented here as the mean ± SEM. All minerals were reported in metric units per 100 g raw, edible parts. Some nutrients were expressed as BDL means Below Determination Level.

2.5. *Statistical analyses of results*

Variations in proximate and mineral composition of fish were analyzed using one-way ANOVA followed by Tukey's HSD post hoc for multiple comparisons. Data were presented as mean ± SEM and evaluated by using the statistical software package of SPSS for Windows version 20.0 (SPSS, Inc) with the level of significance at $p< 0.05$. Microsoft Office Excel 2007 was used to make graphs.

2.6. *Calculation of potential contribution to recommended nutrient intakes*

The potential contribution of each species to RNIs of nutrients of interest during the first 1000 days was calculated first by assigning an average RNI target for each nutrient for pregnant and lactating women (PLW) to account for variations in requirements throughout the three trimesters of pregnancy and first 12 months of lactation, and for infants to account for variations in requirements throughout the period from age 7 to 23 months [24,25]; then by calculating the contribution from a standard portion of each species (50 g/day for PLW and 25 g/day for infants) as a percentage of the average RNI. The nutrients of interest considered here are iron, zinc, calcium. The RNIs for iron and zinc further vary according to estimated overall dietary bioavaibility which is dependent on a number of factors including the presence of animal-flesh foods, phytates and other factors; and are therefore provided according to four and three dietary bioavailability categories, respectively. The typical Bangladeshi diet based on polished rice, fish and vegetables is assumed to fit best with criteria used to define the '10% bioavailability' category for iron, and 'moderate bioavailability' category for zinc [24,25].

III. Result and Discussion

3.2. *Proximate composition*

The maximum (87.3±0.15%) moisture content was determined in *H. nehereus* followed by *L. calcarifer* (80.9±0.10%) while the lowest moisture content (78.25±0.12%) was determined in *P. chinensis*. Ash is a measure of the mineral content in fish. The highest ash content was determined in *J. argentatus* (2.8±0.10%) and the lowest was in *H. nehereus* (1±0.03). Lipid content was ranged from 1.4 to 2.21% found in *L. savala* and *P. chinensis* respectively. For moisture (%), protein (%), Ash (%) content there was no significance difference was found among five fish species from ANOVA at 5% significance level ($p<0.05$). But fat content was found significantly different from ANOVA at 5% significance level ($p<0.05$). Fat generally varies much more widely than other proximate components of fish, and usually reflects differences in the way lipid is stored in particular species but may also be affected by seasonal/lifecycle variations and the diet/food availability of the species at the time of sampling [26]. For example, bottom dwelling species such as the indigenous major carps are typically lean fish, storing fat in the liver [26], whereas, migratory fish such as Hilsa have a higher content of dark muscle which tends to be rich in fat [27]. The total Protein content in fish species ranged from 7.4-14.5% found in *H. nehereus* and *L. savala* respectively. The RNI (Regular Nutrient Intake) of protein for60kgs Body weighted person need 50gm protein/day [28]. In Bangladesh mean intake of Fish is 50g/p/day according to desirable dietary pattern for Bangladesh [29]. So 50gm of *P. chinensis, L. calcarifer, J. argentatus, H. nehereus* and *L. savala* could fulfill 14.1%, 14%, 12.1%, 7.4%, and 14.5% respectively to the daily requirement of protein.

Table: Proximate Composition of Selected Fish Species ($p<0.05$)

Sl. No.	Fish sp.	Proximate analysis				
		Moisture	Ash	Lipid	Protein	Energy
		%				K cal /100gm
1.	*P. chinensis*	78.25±0.12	1.651±0.07	2.21±0.10	14.1±0.17	93.13
2.	*L. calcarifer*	80.9±0.10	2.8±0.10	2.1±0.07	14±0.12	80.3
3.	*J. argentatus*	79.7±0.20	1.15±0.05	2.2±0.05	12.1±0.03	81
4.	*H. nehereus*	87.3±0.15	1±0.03	1.7±0.02	7.4±0.05	54.7
5.	*L. savala*	78.46±0.16	1.231±0.05	1.4±0.01	14.5±0.13	89.2

3.3. *Mineral composition*

Major mineral composition for all species are shown in table 3

3.3.1. *Iron*

Iron is an important micro mineral. Deficiency of Iron is associated with anemia and thus with reduced working capacity and impaired intellectual development. The range of Iron content was considerably varied from 2.769±0.06 to 8.603±0.66 mg/100gm with a mean value of 6 mg/100 gm. The highest Iron content was found in *P. chinensis* that may fulfill >25% of the RNI and lowest amount was found in *J. argentatus* that may fulfill around 10% of the RNI for adult, PLW and infants. All fish species without *J. argentatus* and *L. savala* may fulfill >15% of daily requirement of Iron for adult, PLW and infants. So these species can be served as good dietary source of Iron. This may have implications on public health issue of Iron deficiency in Bangladesh where 10.7% in preschool aged children and 7.1% in adult women are prevalent [13] that have the impact on physical and mental development, pregnancy complications, pre-term birth, and mortality.

Table- 3: Major Mineral Composition of Selected Fish Species

Minerals mg/100gm	Fish sp.				
	P. chinensis	*L.calcarifer*	*J. argentatus*	*H. nehereus*	*L. savala*
Nickel	BDL	BDL	BDL	0.1±0.02	0.022±0.01
Iron	8.603±0.66	2.769±0.06	5.320±0.03	4.310±0.06	3.559±0.2
Zinc	1.787±0.05	1.130±0.03	1.934±0.03	2.799±0.07	1.687±0.01
Cadmium	0.292±0.02	0.000	0.024±0.01	0.018±0.01	0.027±0.01
Chromium	0.471±0.15	0.353±0.06	0.564±0.05	0.406±0.04	0.498±0.05
Manganese	0.390±0.02	0.110±0.02	0.137±0.02	0.520±0.02	0.161±0.02
Copper	0.292±0.03	0.227±0.02	0.339±0.04	0.441±0.02	0.241±0.04
Calcium	121.491±0.15	40.182±0.13	118.786±0.12	129.806±0.21	200.113±0.27
Magnesium	152.577±0.22	133.991±0.25	143.476±0.15	144.750±0.11	130.784±0.24
Potassium	602.078±0.24	700.218±0.15	632.404±0.30	387.534±0.24	198.199±0.22
Sodium	403.974±0.13	190.743±0.10	397.842±0.28	466.733±0.35	337.589±0.50
Cobalt	BDL	BDL	BDL	BDL	BDL
Lead	BDL	BDL	BDL	BDL	BDL

3.3.2. Zinc

Zinc concentration varied considerably from 1.130±0.03 to 2.799±0.07 mg/ 100 g with a mean content of 1.96 mg/100 g. From ANOVA ($p>0.05$) there was no significant difference found among zinc content. These results are within the range of fish and seafood reported elsewhere [30]. It is harmful for human body if zinc concentration is above than 3mg/100gm [31] but in the result zinc is clearly below the permissible limit for human consumption. Zinc is essential for good health, but very high intakes can cause health problems such as liver and kidney damage [32]. The highest zinc concentration was found in *H. nehereus* that may fulfill 20% of the RNI of Zinc for adult and 17% for PLW and infants. The lowest amount of Zinc was found in *L. calcarifer* that may fulfill ≥7% of the RNI for adult, PLW and infants. All fish species without *L. calcarifer* may fulfill >10% of daily requirement of zinc for adult, PLW and infants from a standard portion. In light of recent estimates of a national prevalence of zinc deficiency in 57.3% of women and 44.6% of pre-school aged children in Bangladesh [19], *H. nehereus* followed by *J. argentatus*, *P. chinensis*, *L. savala* could contribute significantly to dietary zinc intake, also taking into consideration that zinc in animal-source foods is highly bioavailable [24,25].

3.3.3. Calcium

Calcium content was ranged considerably from 40.182±0.13 to 200.113±0.27 mg/ 100 g with a mean content of 120.15 mg/100 g. These results were within the range of fish and seafood reported [30]. The highest and lowest calcium content was found in *L. savala* and *L. calcarifer* respectively that would fulfill around 10% and 2% of the RNI of calcium for adult, PLW and infants accordingly. Four other fish species except *L. calcarifer* may fulfill >5% of the RNI of calcium for adult, PLW and infants. Due to calcium deficiency rickets develops, and it was estimated to affect 550,000 children in 2008 [33], and in a study in two rural sub districts of Bangladesh, it was estimated no women or young children had diets adequate in calcium, attributable to low food intake and low dietary diversity [34]. Marine fishes are not one of the excellent sources of calcium because of they are not consumed with bone only edible portion (muscle) are consumed.

3.3.4. Magnesium

Magnesium is an important macro mineral. It needs to maintain for bone health, is required for energy metabolism, and acts as a part of the protein-making machinery. Magnesium content was ranged considerably from 130.784±0.24 to 152.577±0.22 mg/ 100 g with a mean content of 141.7 mg/100 gm. These results were within the range of fish and seafood reported before [30]. The highest and lowest magnesium content was found in *P. chinensis* and *L. savala* respectively. Total five species may contribute ≥25% of the daily magnesium requirement of adult and PLW and ≥60% of infant's requirement from standard portion. So these five marine fishes were excellent sources of magnesium.

3.3.5. Potassium

Potassium is one of the macro minerals. Potassium is indeed to synthesis protein and muscle tissue. Heart activity depend on Potassium as does muscle contraction. Potassium content was varied from

198.199±0.22to 700.218±0.15 mg/100gm. Highest amount was found in *L. calcarifer*. *L. calcarifer, J. argentatus* and *P. chinensis* may would fulfill >5% of RNI for adult and PLW and >20% for infants.

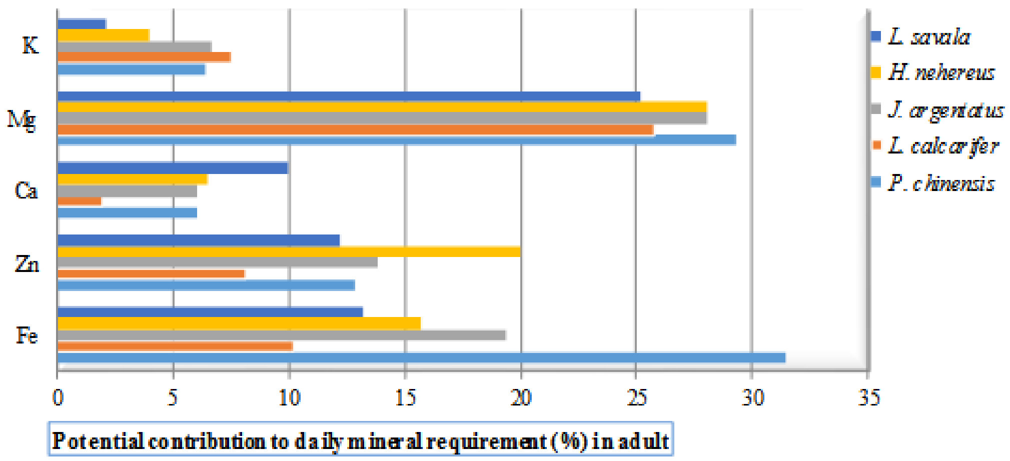

Fig. 1 Potential contribution to daily nutrient requirement for mineral from a standard serves of fish for adult.
(a) Daily average nutrient requirement of Adult (>18yr) for Magnesium, Calcium, Zinc, Iron is 260, 1000, 7, 13.7 mg/day respectively (BIRDEM, 2013).
(b) Standard serve of fish for adult is 50g/day.

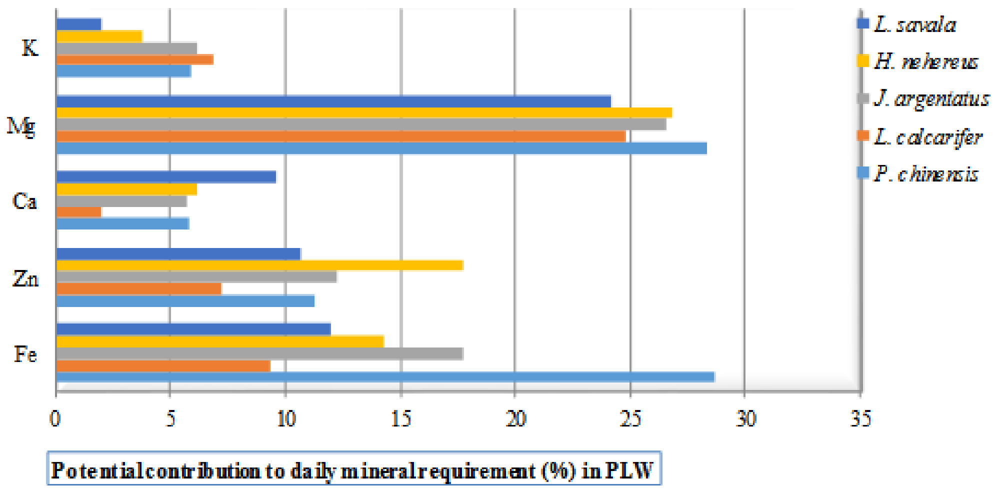

Fig. 2 Potential contribution to daily nutrient requirement for mineral from a standard serves of fish for PLW.
(a) Daily average nutrient requirement of PLW for Magnesium, Calcium, Zinc, Iron is 260, 1040, 7.9,15 mg/day respectively (FAO, 2004)
(b) Standard serve of fish for PLW is 50g/day.
(c) PLW, pregnant and lactating women.

3.3.6. Sodium

Sodium regulates the electrolyte and acid-alkali balances, the conductive capacity of the nerves, muscle contractions and the production of adrenaline and amino acids. Sodium content was varied from 190.743±0.10 to 466.733±0.35 mg/100gm. Highest sodium content was found in *H. nehereus* followed by *P. chinensis, J. argentatus, L. savala, L. calcarifer* More uptake of Sodium is not good for health. The RDA for Sodium is up to 1500mg/day to adult the result is within the range. In marine fish sodium is much higher may be due to salt concentration. The highest sodium content was found in *P. chinensis* and *J. argentatus* this may be due to their habitat, food habit

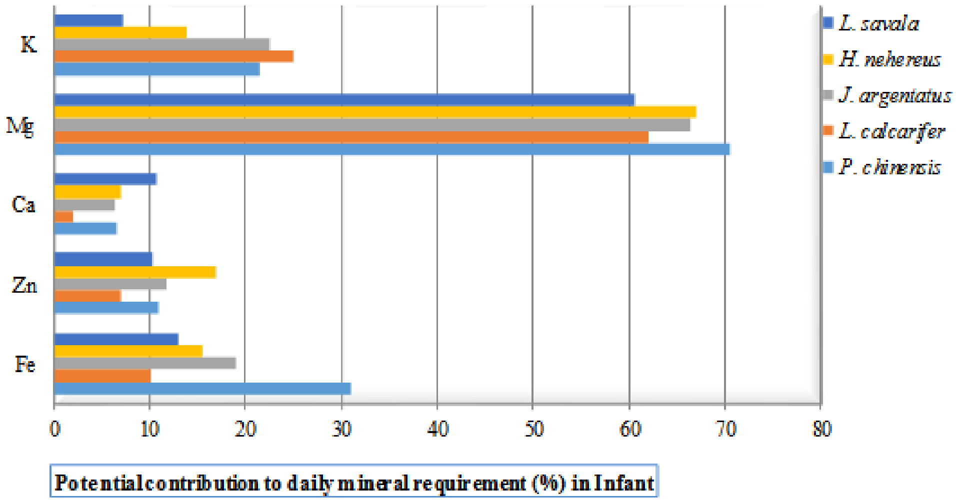

Fig. 3 Potential contribution to daily nutrient requirement for mineral from a standard serves of fish for infants.
(a) Daily average nutrient requirement of infant (7-23 month) Magnesium, Calcium, Zinc, Iron is 54, 467, 4.1,7 mg/day respectively (FAO, 2004).
(b) Standard serve of fish for infant is 25g/day.

3.3.7. Copper, Manganese

Manganese and Copper was present very lower in amount as trace elements in fish. The permissible limit for Manganese is 0.54mg/100gm and Copper is 1mg/100gm [35], the result is within the limit.

3.3.8. Chromium, Cadmium, Nickel, Cobalt, Lead

Chromium content was found from 0.353±0.06 to 0.564±0.05 mg/100gm. That is quite similar the findings [36]. More chromium contained indicates environmental pollution as chromium content was very low in amount it indicates the environmental condition of the area of fishing was good. Cadmium concentration was found in vey lower in amount 0.018±0.01 to 0.292±0.02 mg/100gm. It may be noted that cadmium was absent in *L. calcarifer*. According to FAO (1983) the permissible limit of cadmium is 0.5mg/100gm. The result is below the range of permissible limit. Cadmium is a toxic metal that can be present in fish organism at high concentrations [37]. In this Experiment Cobalt and Nickel are totally absent in all of the fish samples. Only Nickel was present In *H. nehereus* is 0.1±0.02 mg/100gm and *L. savala* 0.022±0.01 mg/100gm which indicates the pollution status of the source may be low or accumulation of metals was within the limit of acceptance.

IV. Conclusions

From the comparison of nutritional composition of studied fish samples it is evident that marine fishes are good sources of essential nutrients especially iron, zinc, and magnesium. *P. chinensis* and *J. argentatus* is very rich in protein, energy and essential minerals whereas it may contribute significantly ≥20% of RNI and *H. nehereus* may fulfill ≥15% of the RNI of iron and magnesium whereas maximum zinc content was found in *H. nehereus* and it could fulfill ≥20% of the daily requirement of zinc for adult, PLW and infants. Total five fish species may significantly contribute >25% of the RNI of magnesium for both adult and PLW and >60% for infants. Marine fish does not exhibit calcium rich animal source diet comparison with iron, zinc, magnesium in terms of regular nutrient intake scale from a standard portion. Maximum calcium was detected in *L. savala* which may contribute ≥10% of RNI of calcium for three categories. *L. calcarifer* showed low food value compare with four other species, it may would meet ≤10% of RNI of iron, zinc, calcium, and potassium for adult and PLW.

To get the knowledge of nutrient content of fish is very necessary now-a day. From this study, fishes can be chosen for getting high protein, lipid and essential mineral supplement in diet as per requirements. Thus marine fish consumption should be promoted specially among pregnant-lactating women and children so that it can be presumed that marine fish potentially contribute in makeup of nutrient demand of mother, child and malnourished population. From this study, guideline can be formulated to have better nutritional diet to maintain good health. And this guideline should be spread out among mother, child and general community for better supplementation of nutrition. The outcome of this study will help to have knowledge on nutritional security of Bangladesh and promote consumption of marine fishes.

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