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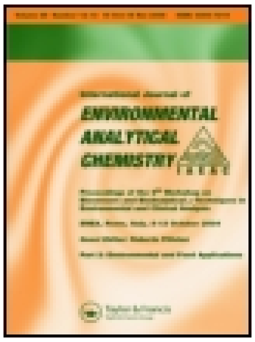

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ARTICLE

Assessment of the concentration levels of heavy and trace elements in fish using Proton-Induced Gamma Emission

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ABSTRACT

Fish plays an essential role in Bangladesh people's diet, being the leading and sometimes easily replaceable food of low-income households. Major and minor elements in fish are crucial for the biological process in the human body. The analyses of 18 distinct elements (Na, Mg, Al, Ca, V, Cr, Mn, Fe, Cu, Zn, Se, Br, Rb, Sr, Cd, I, Pb) in 6 selected fishes consumed by the people who live in the Savar region of Dhaka city in Bangladesh were conducted. The objective of the present analysis is to assess the concentration of heavy and trace elements in these fishes and provide up-to-date information if these fishes are safe to eat. The Proton-Induced Gamma Emission technique and the High Purify Germanium detector were used to detect the characteristic Gamma-rays from the target and then calculate the concentration of elements. In general, the highest concentrations range was typically found in K, Ca, and Fe, while the lowest concentrations range were found in V, Cd, and Pb. The findings were compared with the allowable limits of the International Atomic Energy Agency (IAEA-407) and the World Health Organisation/Food and Agriculture Organization (WHO/FAO).Fish are a key source of protein for millions of Bangladeshi citizens, particularly households with low incomes, so monitoring the toxicity level of fish is very crucial. The present analysis results indicate that these fishes are not entirely free of health hazards in consumption. Further study will provide crucial information on the relationship between the concentration of elements and human health.

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Heavy Elements; trace Elements; proton-Induced Gamma Emission; detector

1. Introduction

Bangladesh is a blessing for the rivers. This country has glorified a wide variety of fish, grown in an excellent bid. Aquatic animal food, like fish, is considered a healthy protein source. It also includes lipids and micronutrients, which are essential for human health. Compared to land-living species, fish consist of an immense volume of omega three long-chain

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polyunsaturated fatty acids (n-3 LC PUFA) [1].For a country like Bangladesh, fish consumption is essential as a large proportion of people cannot afford to eat red meat [2]. The high nutrient, vitamin A, D3, and B12 are acquired from fish. Fish have been the main food supply since the beginning of human civilisation. Fish are distinctive types of natural resources requiring special consideration due to their possible health consequences. We need to comply with this essential food staff's elementary profile and related material. Elemental assessment of the physicochemical origins of any substance would provide a systematic understanding of the intrinsic essence of the materials to be used and the desired quality of life to be attained. The chemical components of any substance have been identified as Major, Minor, and Trace elements, which may be useful for concentration purposes. Co, Cr, Cu, Fe, I, Mn, Mo, Nie, S, Se, and Zn referred to as essential and trace elements

As, Al, Br, Ba, Bi, Cs, Cd, Ge, Hg, Li, Pb, Rb, Sr, Si, Sm, Sb, Sn, Ti, and Tl are referred as a non-essential element. It does not consider essential, although various aspects of the proper dosage have beneficial pharmacological activity.Trace materials do not supply carbohydrates to the living organism but play an invaluable role in the body's pH balance, intracellular regularity which are used as a coenzyme and serve essential metabolic processes in the human cell [3].These elements may also be an essential part of the molecule of the enzyme or an enzyme activator. Trace elements are especially important because of the synthesis of hormones, vitamins and proteins, DNA and RNA. Fluctuation of living cells (deficiency or excess) may lead to various diseases caused by physiological conditions. Specific examination of fish is important for the correct use and diet planning. Countries such as Bangladesh became common due to increasingly new farming and industrial practices and rising urbanisation induced by air, water and food contamination. In developing countries like Bangladesh, it may also have adverse impacts on people's future health and well-being. Consequently, an analysis of the particular concentration of fish for production in health and safety is important [4].Fish are a rich source of the microelements that are important in the human body diet, such as calcium, phosphorus, iodine, zinc, selenium, and iron [5].The present research aimed to identify elements of six common fishes in the Savar region of Dhaka city, Bangladesh, namely *Mystusvittatus, Macrobrachiumrosenbergii, Heteropneustesfossilis, Channastriata, Puntius puntio* and *Tenualosailisha*(Table 1) through the PIGE analytical method. Although other analytical methods such as X-ray fluorescence (XRF), Atomic Absorption Spectrophotometer (AAS), proton-induced X-ray emission spectroscopy, and Neutron Activation Analysis (NAA), have been developed to determine the elemental analysis previously [6–9]. The purpose of the present analysis was to provide the latest information on the elemental concentration of heavy and trace element such fish samples and the obtained data was eventually

Table 1. List of the fish samples studied for elemental concentration analysis.

Local Name	Scientific Name	Family Name
Tangra	*Mystusvittatus*	Bagridae
Chingri	*Macrobrachiumrosenbergii*	Macrobrachium
Shing	*Heteropneustesfossilis*	Heteropneustidae
Shoal	*Channastriata*	Channidae
Puti	*Puntius puntio*	Cyprinidae
Elish fish	*Tenualosailisha*	Clupeidae

compared with the international permissible limits (IAEA-407 and WHO/FAO) to know human health risks from such fish consumption.

This research is successfully used by the Proton-Induced γ -ray Emission (PIGE) IBA analytic method in the Accelerator Facilities Laboratory at the Dhaka Atomic Energy Centre. The samples were dried, pressed to make, and irradiated with proton beam 2.55 MeV using 3.0 MeV Van de Graff Accelerator from the Bangladesh Atomic Energy Commission. During irradiation, the beam current was between 5 to 26 nA. The gamma-ray released in the irradiation was determined by the HPGe-detector.

2. Experimental

2.1. Proton-Induced Gamma Emission

The Proton mediated Gamma Emission is one of the interesting, nuclear-based analytical IBA techniques. PIGE is a nuclear reaction mechanism by applying a high voltage proton beam to induce changes in the structure or energy of a target nucleus. The principle behind the PIGE mechanism is gamma ray's emission due to nuclei's proton beam energy. The excitation in nuclear-state laws is caused by a proton beam in the MeV levels of intensity irradiating the sample. De-excitation refers to gamma-rays, which are unique nuclide properties. The gamma-ray released by a sample as energetic protons are bombarded with the signatures of the elements in the sample. The energy and intensity of the emitted gamma rays depend on the distance below the depth of the final nucleus. Cross-sections for ((P, γ), usually low, and cross-sections ((P,P,γ), typically higher. The intensities of the standard nuclear gamma line relative to their concentration in the target material. The special relationship between the energetic proton-bombing elements and the energy of the typical gamma-ray line released makes the proton-induced gamma-ray emission (PIGE) a valuable tool for elemental research. The PIGE method of elemental analysis involves measuring the characteristic gamma-ray yields of the elements in a sample bombarded with protons. The most essential papers summarising the physical context and explaining the basic mechanism of the PIGE system are those written by Bird and Williams [10]. PIGE is vital for identifying light elements found in limited concentrations in most medicinal, environmental, and biological samples.

2.2. Experimental set-up

The present study was conducted with a 2.55 MeV proton beam of 3 MV Van de Graaff Accelerator. In defining an excellent collimated beam, two tantalum collimators of 2 mm in diameter and a clean-up hole of 4 mm have been used. 1.12 mg/cm^2 thickness of Kapton Foils were accustomed to remove the proton beam from the air beam port for external beam studies. After losing the foil and air from the escape window to the sample, the proton beam energy was around 2.55 MeV for the external beam. The window frame was insulated from the beam port and the collimator. This arrangement is reproducible for the measurements of the total charge on the targets [11]. The machine was designed to hold the slide framework 35 mm for samples at a position of 45° according to the beam's direction, and the typical gamma-ray beam was observed at a 90° vertical angle. For the internal beam experiments, the pelletised samples were mounted on (20 × 25) mm aluminium target frames with a circular hole of 15 mm diameter at the centre. The frames were mounted on a target ladder, which could accommodate up to 10 samples at a time, and the ladder could be forward or backward manually for irradiation by the proton beam. The collimated proton beam bombarded the samples, and γ-rays emission created. The vacuum of the accelerator tube, beam path and scattering chamber was maintained at 1.2×10^{-5} psi for the collision-free beam. The chamber itself created a Faraday cup that was separated from the ground to determine the proton beam's intensity. In case of both the external and internal beam experiments, gamma-ray data collection and processing system consisted of a Princeton γ-tech High purify germanium detector by a resolution Full width at half maximum of 1.75 keV at 1332 keV, preamplifier, spectroscopy amplifier, Bias supply unit, ADC unit, Multi-Channel Analyzer and a computer with MAESTRO-32 software. The beam current was maintained within 5→30nA for the preset charge of 5→20 μC., the count rate was held below 2000 count per second to reduce the dead time.

2.3. Data analysis

The analytical data of the elements found in a sample and their concentrations are restricted within the spectrum of prominent Gamma-ray peaks. The main background contribution is natural background radiation, beam-induced radiation and beam-induced γ-lines from elements present in the samples taken under experiment. The trapping of γ-rays in the detector and charge collection losses contributes to the peaks' low energy tailing. The intersection of reaction in the available proton energies is chosen based on the detector efficiency. When the 'Proton Beam' is targeted on the specimens, the nuclear reactions occur for each of the elements present in the sample. However, only reactions that lead to high gamma radiation have been taken into account. For example, the19F(p, p′, γ)19 F reaction producing 110 keV γ -ray energy for 19 F, the reaction ^{19}F (p, p′, γ)^{19}F producing 197 keV γ -ray energy for ^{19}F, ^{23}Na (p, p′, γ)^{23}Na generating γ -ray energy of 440 keV for ^{23}Na, the ^{24}Mg(p, p′, γ)^{24}Mg reaction producing gamma-ray energy of 1369 keV for ^{24}Mg, the ^{28}Si(p, p′, γ)^{28}Si reaction producing gamma-ray energy of 1779 keV for ^{28}Si. The γ-ray line intensity ratios of an element are well determined for quantitative analysis of an unknown element. The main purpose of PIGE analysis is to identify the presence of unknown elements in the γ-ray spectrum from a sample and quantitative calculation of their concentrations from the measured γ-ray yields. Among many of the available computer codes, MAESTRO-32 (Ver. 6.05) was used for the unfolding of the PIGE spectra for the experiments. For elemental concentration calculation of each element, the quantities needed from a spectrum are the number of counts in the full-energy peaks. Software from MAESTRO-32 was also applied for data acquisition, display, identification of the elements through energy calibration, analysis of the γ-ray peaks and report generation. The certified, elemental concentrations of apple leaves, soil-7 (IAEA standard) were used as the reference value for the measurements. All the figures have been done by origin software. All the statistical analysis ((standard deviation) in Table 2 and Table 3 have been done by origin software.

Table 2. Elemental concentrations (in ppm) of the analysed fish sample.

Elements	Tangra (*Mystusvittatus*)	Chingri (*Macrobrachiumfosenberg*)	Shing Fish (*Heteropneustesfossilis*)	Shoal (Channastriata)	Puti Fish (*Puntius puntio*)	Elish fish (*Tenualosailisha*)
Na	9.85 ± 2.64	27.25 ± 1.46	11.45 ± 1.36	9.23 ± 1.48	16.55 ± 1.22	23.45 ± 2.40
Mg	12 ± 3.90	10.42 ± 1.93	9.52 ± 0.99	11.35 ± 1.39	10.2 ± 2.20	7.23 ± 1.64
Al	5.19 ± 0.93	1.99 ± 0.16	0.82 ± 0.18	6.09 ± 0.98	1.19 ± 0.1	0.22 ± 0.09
K	53.35 ± 5.69	55.3 ± 2.13	57.41 ± 1.01	53.37 ± 2.49	153.35 ± 4.21	97.41 ± 4.77
Ca	98.34 ± 4.95	92.21 ± 1.98	99.21 ± 3.25	98.21 ± 2.02	198.34 ± 2.31	80.11 ± 3.35
V	0.11 ± 0.02	1.34 ± 0.32	0.44 ± 0.10	0.21 ± 0.05	0.1 ± 0.03	1.74 ± 0.16
Cr	3.25 ± 0.75	4.36 ± 0.50	2.45 ± 0.62	2.82 ± 0.33	3.05 ± 0.13	3.75 ± 0.09
Mn	19.19 ± 1.26	20.19 ± 1.71	21.19 ± 2.42	12.19 ± 2.48	10.19 ± .30	11.1 ± 0.57
Fe	138.05 ± 4.71	140.85 ± 1.83	97.85 ± 2.59	99.85 ± 2.77	109.05 ± 6.51	99.05 ± 2.95
Cu	2.98 ± 0.63	2.14 ± 0.47	2.5 ± 0.22	2.8 ± 0.39	2.08 ± 0.03	2.85 ± 0.06
Zn	39.59 ± 2.64	59.5 ± 2.44	34.5 ± 4.24	42.5 ± 2.75	36.59 ± 4.71	37.5 ± 1.97
Se	7.47 ± 1.23	2.15 ± 0.44	3.78 ± 0.37	7.34 ± 0.71	7.47 ± 1.11	3.71 ± 0.17
Br	71.09 ± 1.86	49.09 ± 2.01	60.34 ± 7.07	34.19 ± 3.77	76.45 ± 4.48	57.34 ± 6.89
Rb	4.15 ± 1.93	5.15 ± 0.80	3.15 ± 0.44	2.25 ± 0.67	4.15 ± 0.58	3.15 ± 0.58
Sr	15.15 ± 1.58	57.65 ± 2.26	34.65 ± 1.66	62.05 ± 5.81	53.15 ± 6.37	41.78 ± 5.15
Cd	1.35 ± 0.79	0.17 ± 0.03	1.97 ± 0.50	0.78 ± 0.19	0.35 ± 0.19	2.09 ± 0.56
I	3.7 ± 1.13	7.3 ± 0.69	0.5 ± 0.05	4.3 ± 0.60	2.5 ± 0.54	5.5 ± 0.38
Pb	0.102 ± 0.01	0.02 ± 0.006	0.02 ± 0.01	0.092 ± 0.03	0.112 ± 0.04	0.22 ± 0.04

Values are presented as mean ± SD ($N = 5$) for 18 elements in each fish. N = number of samples analysed for each fish

Table 3. Comparison elemental concentration (ppm) with international standard safe limit.

Elements	Mean	IAEA-407	Percentage (%) difference	P-Value	WHO/FAO	Reference for WHO/FAO
Na	16.29 ± 7.56	13.1	22%	0.348	NCV[b]	-
Mg	10.12 ± 1.66	2.72	115%	0.0001	NCV[b]	-
Al	2.58 ± 2.45	13.8	137%	0.00009	1	(WHO, 1989)
K	78.36 ± 40.51	13.1	143%	0.01	NCV[b]	-
Ca	111.07 ± 43.35	27	122%	0.005	NCV[b]	-
V	0.65 ± 0.70	1.43	75%	0.043	0.005–0.03	(WHO, 1996)
Cr	3.28 ± 0.68	0.73	127%	0.0002	0.1–0.15	(Lakshmanasenthil et al., 2013)
Mn	15.67 ± 5.02	3.52	127%	0.0019	0.5	(WHO,1985a)
Fe	114.11 ± 20.04	146	25%	0.011	43	(FAO, 2011)
Cu	2.55 ± 0.38	3.28	25%	0.005	0.5	(FAO, 1970)
Zn	41.69 ± 9.13	67.1	47%	0.001	30	(FAO, 1983a
Se	5.32 ± 2.38	2.83	61%	0.05	NCV[b]	-
Br	58.08 ± 15.25	94	47%	0.002	NCV[b]	-
Rb	3.66 ± 1.02	2.86	25%	0.11	NCV[b]	-
Sr	44.07 ± 17.43	130	99%	0.00006	NCV[b]	-
Cd	1.11 ± 0.81	0.189	142%	0.038	0.2	(Lakshmanasenthil et al., 2013)
I	3.96 ± 2.35	ND[a]	100%	0.009	NCV[b]	-
Pb	0.094 ± 0.07	0.12	24%	0.433	2	(WHO,1985b; FAO, 1983b)

Mean ± SD ($N = 6$), N = Number of samples, ND[a]:Not Detected, NCV[b]: Non-certified Value, P-Value Calculated using T- Test

2.4. Measurement of the concentration of the elements

In this experiment, the MASTRO computer code was used to open the spectra. For context elimination, the null spectrum is removed from each simple spectrum. Then we find the net area/render of the peak in the spectrum with the aid of the MASTRO program. Furthermore, the spectra data were standardised with the load. In the following equation, the concentration of the elements was determined by setting the values of c_{st}, the standard concentration of the sample, s_{st}, the standard intensity of settlement and y_{st}, the standard yield.

$$C_s = C_{st}\frac{S_s Y_s}{S_{st} Y_{st}} \tag{1}$$

3. Results and discussion

We mash a significant amount of seafood, primarily fish, which can be recognisable component amounts. Prosperous nutritional evaluation, but the amounts of essential elements must not surpass appropriate fish intake limits. The potential advantage of fish usage is significant, and our use is recommended by the state, private organisations, and health agencies, which must require a continuous interaction on the risk advantage of fish consumption [12].The more investigative elements in the samples (main elements) are Iron (*Macrobrachiumrosenbergii*), Calcium, and Potassium (*Puntius puntio*). Iron was the most abundant mark-out element, while significant quantities of calcium and potassium were also found. The most significant elements were observed using a 2.55 MeV proton energy beam and a current range of 5 to 26 nA and IAEA-407 and WHO/FAO as reference material. Elements that were found included sodium, magnesium, aluminium, potassium, calcium, vanadium, chrome, manganese, iron, copper, zinc, selenium, bromine, rubidium,

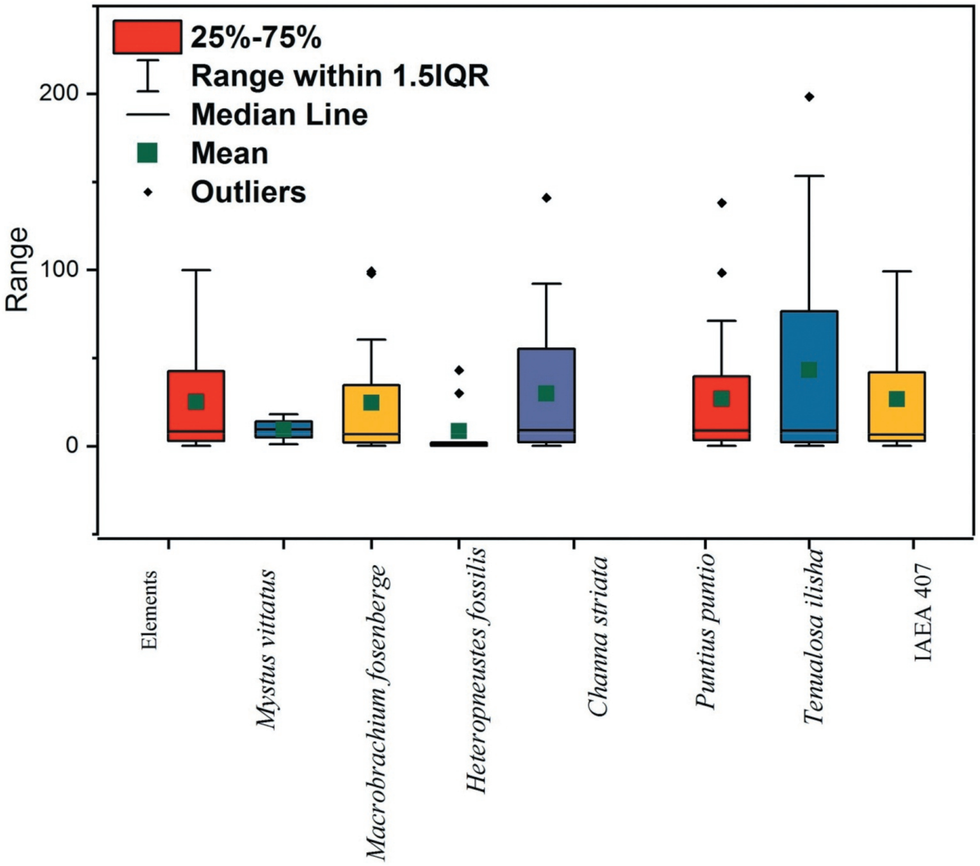

Figure 1. 18 elements scattered over six fishes. The tests are seen on the box map.

strontium, cadmium, iodine, and lead. The concentrations of 15 elements out of 18 are significantly higher ($p < 0.05$) than allowable limits of the International Atomic Energy Agency (Table 3). These 18 elements within six different fishes are shown using a side-by-side box plot (Figure 1). Figure 2, Figure 3 and Figure 4 have been shown the graphical representations of the comparison between elemental concentration and international permissible limits (IAEA and EHO/FAO).

Sodium: In the human body, a small amount of sodium is required for muscle contraction and relaxation, nerve impulses, and proper mineral and water balance. However, excess sodium in the diet may lead to cardiovascular disease, high blood pressure, a calcium deficiency stroke, some of which may be drawn out of the bone [13].The maximum sodium level in *Macrobrachiumfosenberg* (27.25 ± 1.46ppm) and the lowest sodium level in *Channastriata* (9.23 ± 1.48 ppm) have been present in all other fish species (Figure 1, Table 2).The measured value of Na higher than IAEA-407 international safe limits (Figure 4,Table 3).

Magnesium: Magnesium can perform essential preventive and therapeutic roles in various conditions, including osteoporosis, diabetes, preeclampsia, bronchial asthma, cardiovascular diseases, and migraine. This research has shown that Mg has been

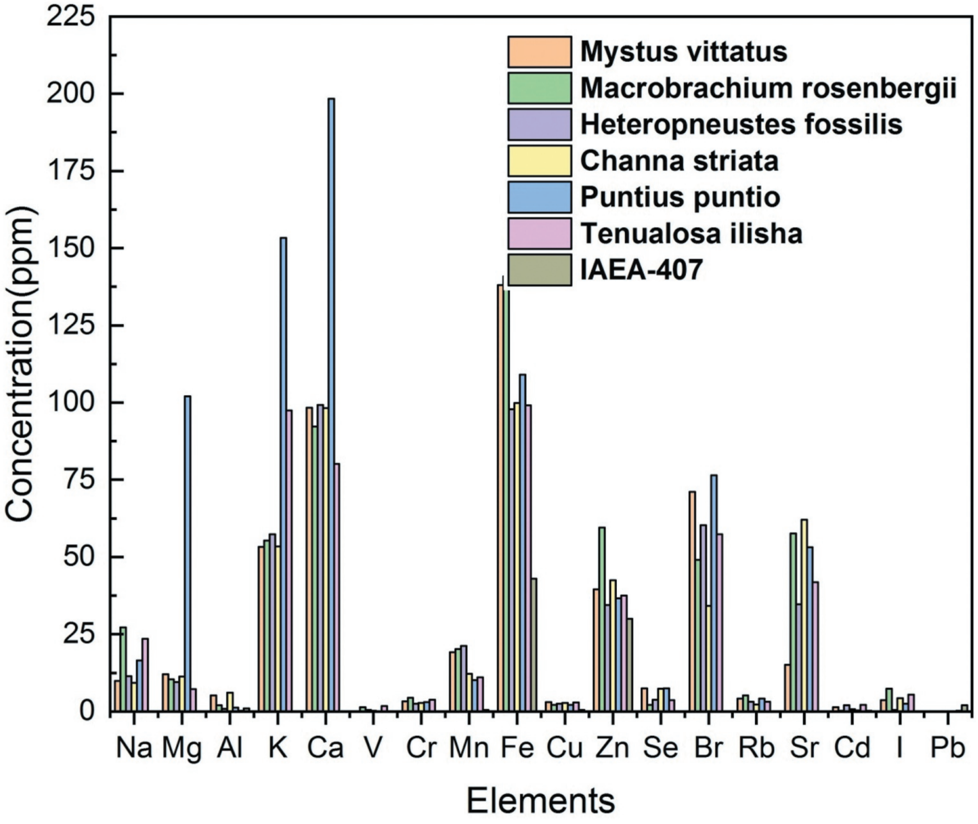

Figure 2. Experimental concentration of each sample relative to the IAEA-407.

detected in all fish specimens. The amount of Mg in the community was 7.23 ± 1.64–-12 ± 3.90 ppm and considerably more than in the other six samples in *Mystusvittatus* (12 ± 3.90 ppm). Mg helps with more than 300 enzyme reactions and improves the activity of the immune system in the human body [14].The average concentration of Mg was 10.12 ppm, which exceed the proposed IAEA-407 acceptable limit for human consumption (Table 3).

Aluminium:The highest Al content was found in *Channastriata*(6.09 ± 0.98 ppm) while the lowest one was *Tenualosailisha*(0.22 ± 0.09) (Figure 2, Table 2).The legally permissible dose of al is 1 ppm, as reported by FAO/WHO(World Health Organization, 1989) and 13.8 ppm reported by IAEApermissible limits. Aluminium is a chemical compound essential for healthy bones in the stomach and prevents the absorption of phosphate into the stomach [15].

Potassium: For adults in good physical condition, 2000 mg/day is the minimum requirement for potassium. Potassium is the intracellular ion eyes produced in the blood and induces a sequence known as 'hyperkalemia' when the kidneys are not involved enough [16].Table 2 shows the samples for potassium have identified in all samples (53.35 ± 5.69 ± 2.13–153.35 ± 4.21ppm). The average concentration of K content was 78.36ppm (Table 3) where the IAEA reported 13.1 ppm. The experimental value of K was substantially higher as compared to the safe limits of the IAEA-407 (Figure 2).Muscle

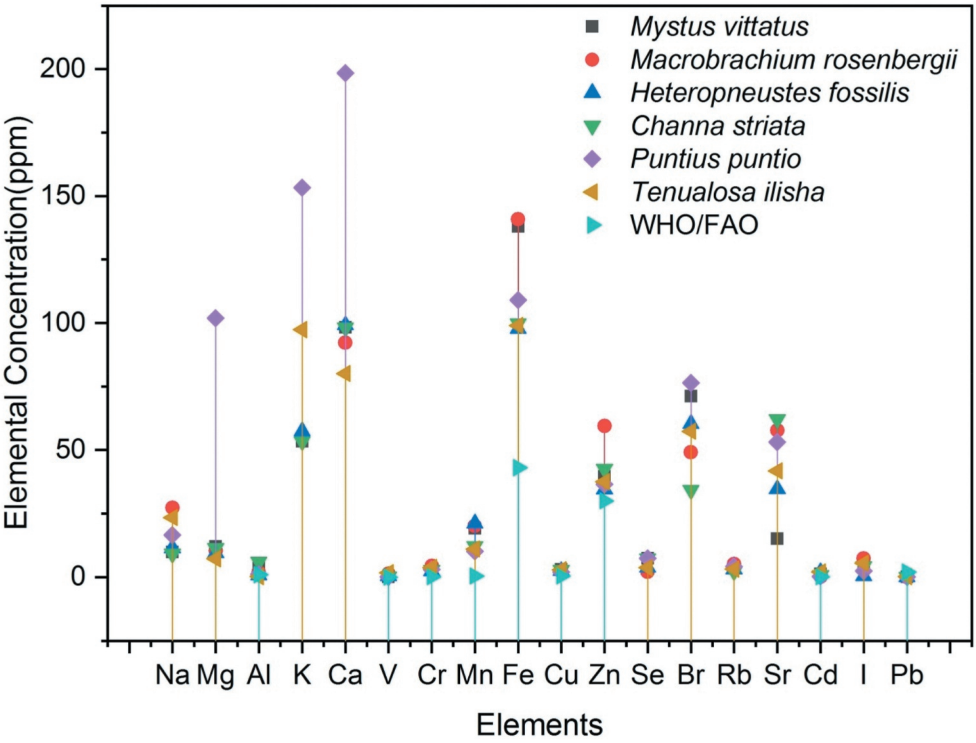

Figure 3. Experimental performance compared with FAO/WHO standard.

cramps, loss of appetite, and erratic heartbeats are initiated due to K deficiency, and boost heart function is crucial.

Calcium:Calcium is essential for the most commonly associated synthesis and production of bone. It helps control nerve transmission, muscle function, hormone output, vascular contraction, the blood circulatory system, and other tissues. Calcium hydroxyapatite (Ca_{10} $[PO_4]6[OH]$ $_2$) is present in bones and teeth, which is 99% body. A large fraction of the calcium parathyroid hormone (PTH) is an endocrine vitamin D metabolism, essential for maintaining adequate amounts of ionised calcium on the serum. Bone tissue provides the base of calcium as a reservoir for these critical metabolically needs by bone refashioning. Calcium consumption in the first 2 months of life for infants fed by calcium is approximately 33.7 ± 2.0 mg/100 kcaline [17].For these novices, calcium netting with measured urinary calcium and endogenous excretion levels estimated to be 68 ± 38 mg/day.*Puntius puntio*contain highest concentration (198.34 ± 2.31) and lowest concentration was found in *Tenualosailisha (80.11 ± 3.35 ppm)*.Figure 2 indicates that the mean concentration of Ca in fish samples was 111.07 ppm, which is higher than the acceptable IAEA-407 standards.

Vanadium: There are several diseases in the range of 0.1pm-1.75ppm in all fish samples, with the highest level of V (1.74 ± 0.16) in *Tenualosailisha* and *Puntiumpuntio* (**Table-2**) with the lowest concentration (0.1 ± 0.03ppm). Vanadium was observed as mild diarrhoea, nausea, and stomach cramps for experimental diabetes. It has been stated that the stomach limit is approximately 13 mg vanadium/day [18]. The average concentration

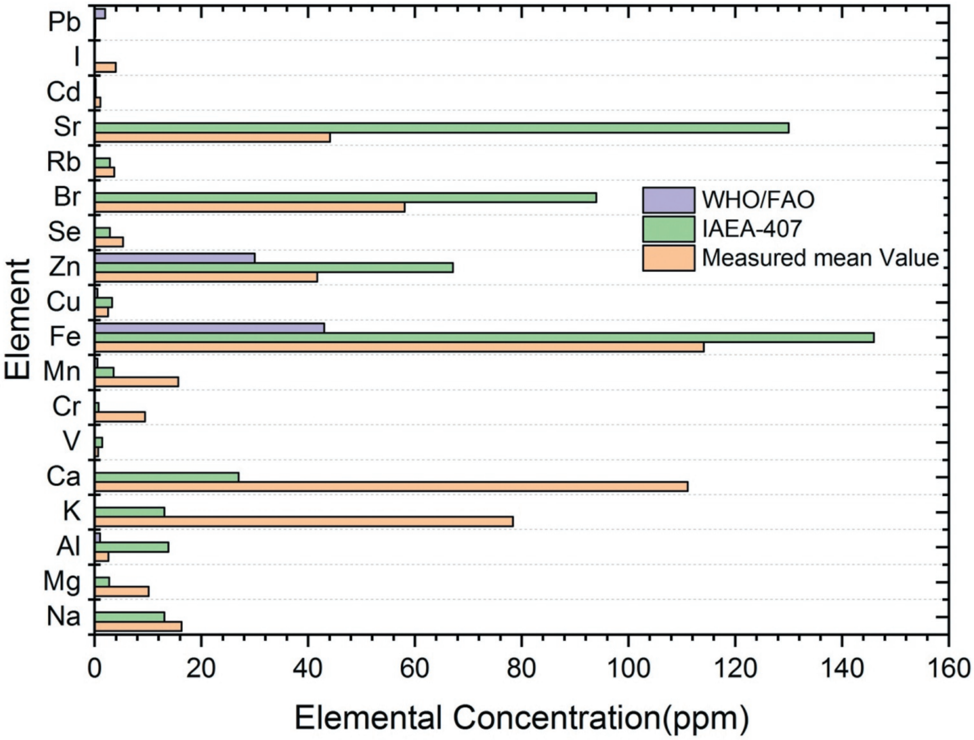

Figure 4. Comparison of experimental mean value with the international safe limit of the IAEA-407 and WHO/FAO.

of V (0.65 ppm) was found in fish species. This value is below the IAEAacceptable limit but exceeds the tolerable WHO/FAO range limit (Figure 4,Table 3).

Chromium: Breath shorter, cough, wheezing, coughing, runny nose, various health conditions are known in the body for elevated chromium levels. The chromium (VI) compounds study report deals with small intestines and stomach issues. The study of population living areas with high chromium (VI) levels in potable water is most significant. In all the samples analysed, Cr found. The maximum concentration of Cr was in *Macrobrachiumfosenberg(4.36 ± 0.50)*, while the minimum was (2.45 ± 0.62 ppm) (**Table-2**) in *Heteropneustesfossilis*. The durability of the Cr range is 0.1–0.15 (mg/kg or ppm) [19], urged by Lakshmanasenthil et al. 2013(WHO/FAO Norm Limit). The Cr values are higher relative to the international safe limit (IAEA-407 and WHO/FAO) (Table 2, Figure 4).

Manganese: Typical levels of urine are from 1 to 8 ug/L; blood 4–15 Ug/L, and serum 0.4–0.85 Ug/L (fluid component of the blood) for the normal range of manganese. Staff is exposed to common problems of health, such as the nervous system due to high manganese levels [20]. In *Heteropneustes fossils* (21.19 ± 2.42ppm), the maximum Mn concentration was measured, and Puntius puntio (10.19 ± .30ppm) was found in the samples tested (Table 2). The average Mn level was found to be comparatively high compared to the data reported for the IAEA-407(Figure 2). Mn levels higher than the observed fish samples of the currently studied were recommended by the World Health Organization (WHO) (0.5 mg/kg or ppm) (Figure 3).

Iron: This low concentration of iron-binding proteins in lymphatic's, blood, and external contaminants such as bronchial mucus and milk [21] has a substantial increase in Fe's involvement. Iron levels in the body tissues must be stabilised safely due to the arrangement of free fundamentals, as excess iron can contribute to tissue injury. The metabolism of Iron Deficiency includes a wide variety of diseases with various clinical symptoms, from anaemia to iron excess, as one of the world's most common diseases [22]. In the range of 97.85 ± 2.59 − 140.85 ± 1.83 ppm, we found the most significant iron in the highest amount of iron in any fish. TheIAEA (International Atomic Energy) and WHO/FAO, the maximum permitted concentration for Fe is 146 ppm and 43 ppm, which is higher and lower than our measured value for human consumption, respectively(Figure 4, Table 3).

Copper: The lack of Cu will contribute to increased levels of blood fat. All fish samples were tested for Micro Mineral Cu. The highest Cu content was found in *mystusvittatus* (2.98 ± 0.63ppm); the lowest Cu was seen in *Puntius puntio*(2.08 ± 0.03ppm). The mean concentration of Cu level was reached well above the appropriate WHO/FAO limit of 0.5 mg/kg (FAO/WHO, 1970) while this value is beneath proposed IAEA limits in all fish settings (Figure 4, Table 3). Thus, the risk of excessive Cu for people in this region is high [23].

Zinc: Zn, with three vital biological roles as structural, catalyst, and regulatory ion, is the most imperative trace element in the organism. Zinc has necessary implications for oxidative stress; homoeostasis, apoptosis, immune function and age, and severe public health issues are associated with zinc deficiency. Foods with low bioavailability, malnutrition, and certain diseases, are much more frequently endangered than zinc-based intoxication. In comparison, zinc deficiency is widespread and adverse to the production, growth, and immunity of nerves, but in rigorous cases, it is lethal, while injection by excessive experience is atypical [24]. The minimum and maximum content of Zn were 34.5 ± 4.24 ppm in *Heteropneustesfossilis* and 59.5 ± 2.44 ppm in *FosenbergMacrobrachium*, respectively. The maximum permissible concentration of Zn is 67.1 ppm according to IAEA-407. The average measured value (41.69 ppm) falls below as compare to the proposed acceptable IAEA-407 (Figure 3) human intake limits when this value transcends WHO/FAO safe limits (Table 3).

Selenium:The enormous environmental value, metabolism and state of selenium, dietary nutrition, thyroid hormones, functions in the body, oxidative metabolism, and defensive mechanisms and an antioxidant agent are focused on the current knowledge [25]. In all fishes, *Macrobrachiumfosenberg, Mystusvittatus*, and *Puntius puntio*, the most crucial element of Selenium, in **Table 2**was found between 2.15 ± 0.44–7.47 ± 1.11 ppm. The IAEA Act stated permitted Se concentration is 2.83 ppm, which is lower than our observed values selected fish species (Figure 2).

Bromine: Bromine is a widely used chemical compound in baking products, flame retardants, soda, prescription medications, tablets, colouring, and plastics. The Br average concentration was lower (58.08 ppm) than the ones recorded in IAEA-407. People can absorb organic brine from food, skin, and breathing. Bromine has a mist of irritable throat, fluid condition and eyes in the human tissue. Bromine vapours with breathing are highly toxic [26].Table 2 reveals the maximum Br content was found in *Puntius puntio (*76.45 ± 4.48 ppm) while the minimum was in*Channastriata (34.19 ± 3.77ppm).*

Rubidium:All six fish samples tested were positive for Rb. Table 2 shows that, *Macrobrachiumfosenberg* was the highest concentration (5.15 ± 0.80 ppm), and

Channastriata was the lowest concentration (2.25 ± 0.67 ppm). Rb is usually found in animal tissue so during its distribution and excretion behaviour is similar to potassium [27]. The overall concentration of Rb was above the IAEA safe limit for human intake (Figure 2).

Strontium: The water-insoluble compounds can be converted into aquatic soluble above the water-insoluble threats to human health [28]. In all the samples from 15.15 ± 1.58 ppm to 62.05 ± 5.81 ppm, strontium was found where the measured value was below as compare IAEA safe limits (130 ppm). Strontium chromate is often known to be a threat to human health in small quantities.

Cadmium:Table 2 shows the highest levels of Cd in *Tenualosailisha* (2.09 ± 0.56ppm) have been calculated for the fish picked, while the lowest levels of Cd are *Macrobrachiumfosenberg*(0.17 ± 0.03 ppm). Cd first transported to the liver via the blood, where proteins connected to complexes were transported to the kidney. The maximum permitted Cd level limit in the human body is 0.2 ppm and 0.189 ppm, as suggested by the WHO/FAO (Lakshmanasenthil et al. 2013) IAEA, respectively. This study showed the mean concentration of Cd was higher (Figure 4) as compared to both international safe limits. Long-term consumption of Cd may contribute to the toxicity of heavy metals to human's health.

Iodine: The *Macrobrachiumfosenberg* was found to contain the highest I (7.3 ± 0.69 ppm), and the lowest was *Heteropneustfossilis* (0.5 ± 0.05 ppm) in the measured iodine concentrations (Table 2) in fish specimens. It is a building material for the development, the nervous system, and thyroid hormones [29].

Lead: All six fish samples were identified with Pb. *Anabas testudineus* (0.22 ± 0.04ppm) found the highest Pb, and *Macrobrachiumfosenberg and Heteropneustesfossilis* (0.02 ± 0.006 and 0.02 ± 0.01ppm) reported the lowest concentration. Pb is an extremely toxic metal that affects almost all the organ and systems in the body, whether inhaled or swallowed. The nervous system, in adults as well as infants, is the crucial subject of Pb toxicity [30]. Long-term exposure of adults in some tests to assess nervous system function ('Lead in Air,' Britannica Online Encyclopaedia) may decrease performance. The average value of Pb was beneath the both allowable limits for the concentration of Pb detente in the fishery samples of this report(Figure 2, Figure 3). No health threats due to Pb for the local population which detected in the examined fish samples.

In presented analysis, overall, the elemental concentration of several heavy and trace elements was higher than those from the International Acceptable Limit i.e. WHO/FAO. These elements are biologically active in the earth's surfaceand are used for various manufacturing and economic purposes [31].Many industries (Tannery, Pharmaceutical, Textile, Dyeing, Food and Beverage Industry Prone Area) are located in savar, which is the main reason for raising the toxicity of heavy metals in all fish samples due to high levels of chemical waste mixed with the river in the savar region.

4. Conclusion

In short, we consume a wide range of foods, mainly fish that can be detected in concentration of heavy and trace elements, although the possible value of fish intake is very crucial in terms of nutritional content. The concentration of the components in 6 fish can be assumed that they were all known to be an abundant source of heavy elements i.e.

K, Ca, Na, Fe, Mg, and other essential trace elements, i.e. Cu, Mn, Cr, I, Se, Zn.In contrast with our measured value, the Pb was less almost all samples than the safe limit of IAEA-407 and WHO/FAO.The average K (53.35 ± 5.69 ppm to153.35 ± 4.21 ppm), Ca (80.11 ± 3.35 ppm to 198.34 ± 2.31), Cr (2.45 ± 0.62 ppm to4.36 ± 0.50 ppm) and Mn (10.19 ± .30 ppm to 21.19 ± 2.42 ppm) concentration in this study exceeded allowable limits. Levels of Cd in almost every fish species were above the proposed acceptable limit (IAEA-407 and WHO/FAO) for human consumption. Long-term ingestion of these fishes can contribute to heavy metal toxicity in human. Findings provide useful knowledge about the metal content of fish available on Bangladesh's local market and merely alert us as well as our perspective generation. The study will provide adequate information to evaluate the significance of the problem related to the human health. Further intensive work is needed in this region to fully evaluate the health implication.

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Disclosure statement

The authors announce that they have no interest in competing with other researchers.

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