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Review Paper

Fish nutrition, potential health benefits and heavy metal research in India: Steps towards new horizon

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Abstract

Aquaculture production is increasing in recent years and predicted that it may contribute the sea food as per the increasing population demand globally in future. Among the aquaculture provisions, fish and shellfish are one of the major sources of essential nutrients for the growth and functioning of cell and have been widely accepted for the maintenance of a healthy body. However many notorious issues are needed to consider in this field includes metal toxicity, food safety and human health pertaining to fish and shell fish nutrition. These issues require evaluating in order to attain balance in safe and nutritious food production and sustainability in aquaculture. Fish production in India was increased more than tenfold since its independence in 1947. The production of fish from 1990 to 2010 has been increased two folds according to Food and Agriculture Organization (FAO) of the United Nations. Literature show that it is well known fact that fish and shell fish were extensively accepted as a good source of nutrients for the defense of a healthy body and major source of animal protein. It is also reported to diminish the risk of heart diseases, stroke and preterm delivery due to widely consumed in many parts of the world as a good source of omega 3 fatty acids. It is unfortunate that human beings without realizing the consequences of pollution do a lot of activities that terribly polluting the nature, resulting in deterioration of the healthy environment meant for future generations. Water contamination is one of the severe concerns that influence the marine ecosystem with high concentration of heavy metals and trace metals. According to Jingaram study the coastal or river water are contaminated by the dumping of industrial wastages. The metals accumulated in the water transmit a disease to the human by consuming the affected organisms like fish and shell fish claim that when the level of trace and heavy metal concentrations exceeds the stipulated level it turns out to be toxic. Very recently the Mc Lintock work was stated that the elevated level of metal concentration may bring shattering effect to the ecological balance by altering the range of organisms in water. The other end nutrition studies show that fish consumption has a positive impact on sleep in general and also on daily functioning which may be related to vitamin D status. Extensive literature explored that there is a gap of knowledge in the appropriate toxicity and contamination studies and survey on human through fish and seafood. More research focus is needed on metal toxicity and the knowledge to combat these challenges among the clinicians, dietitians and food researchers. Further efforts should make to widen the knowledge in this unmapped area of research.

Keywords: Aquaculture, Sea food, Nutrition studies, FAO, Diseases, Contamination.

Introduction

Malnutrition and starvation are two serious problems being faced by millions of rural poor in most of the developing countries including India. In south Asian countries protein energy mal nutrition is the major hindrance to attend nutrition security. Animal protein is playing a crucial role for proper growth, repair and maintenance of human body organs and tissues. Fish and shellfish are one of the major sources of essential nutrients including minerals, vitamins and protein for the growth and functioning of cell and have been widely accepted for the maintenance of a healthy body. The nutritional components from fish and shell fish are also playing a potential role to maintain balanced metabolism for the health benefits to consumers[1]. Studies show that about 31% of the total animal protein supply in the Asian region is in the form of fish protein. For the poorest segment of the population, fish is not only the most important animal protein, but often the only one[2]. In the developing countries like India the fisheries sector occupies an important place in the socio-economic development of the country envisage livelihood, nutritional security, employment generation and export earnings. India with a large coastal belt, ranks second in worldwide fish production particularly 3% growth for marine and 6% for inland sector with an annual growth rate of 5%[3]. Studies on fish and shell fish show that it is highly nutritional food and widely consumed in many parts of the world due to its health benefits. Reported data revealed that due to elevated amount of its omega 3 fatty acids, it helps to reduce the risk of heart diseases, obesity and increase the immune system function as well preterm delivery[4-6]. In India numerous fish and shell fish species are available for human consumption with its immense coastal line and tremendous potential marine food resources[7,8]. According to Fish research Institute (FRI) marine fish was divided into pelagic and demersal fish. Pelagic fish are associated with the surface or middle depth of body water and feeds on planktons[9]. Demersal fish feeds on benthic organisms[9]. Marine pelagic fish comprises of coastal fish and oceanic fish depending on the continental shelf they inhabit[10]. Reports show that these two types of marine fish are being consumed by most of the population in the world. Recent nutrition research studies have revealed that the essential nutrients and minerals in fish are beneficial for healthy functioning of heart, brain and reproduction. This was highlighted that the role of fish and shell fish in the functionality of the human body[11]. Nutritional studies on fish and shell fish relevant to the human health and American Heart Association (AHA) reports says that fish is a low-fat high quality animal protein and filled with omega-3 fatty acids, vitamins such as vitamin D and B2 (riboflavin). Fish and shell fish is also rich in immense source of minerals particularly calcium, phosphorus, iron, zinc, iodine, magnesium, and potassium[12]. According to AHA reports and its recommends, eating fish and shell fish at least two times per week as part of a healthy diet may lower blood pressure and help reduce the triglycerides and risk of a heart attack or stroke. The good choices of fish for omega 3 fatty acids are salmon, trout, sardines, herring, canned mackerel, canned light tuna, and oysters etc. Particularly two omega-3 fatty acids found in fish are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are essential for health perspective.

Table-1: Aquaculture Production by Continent wise- In Million Tones.

Continent	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	CAGR
Africa	0.5	0.5	0.6	0.6	0.8	0.8	0.9	1.0	1.3	1.4	10.84
Americas	1.8	1.8	2.1	2.2	2.4	2.4	2.5	2.5	2.6	2.9	4.88
Asia	32.4	34.2	36.9	39.2	41.8	44.2	47.0	49.5	52.4	55.5	5.53
Europe	2.0	2.2	2.2	2.1	2.2	2.4	2.3	2.5	2.5	2.7	3.04
Australia	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	7.17

CAGR: Compound Annual Growth Rate. Source: Food and Agriculture Organization-2012[13,14].

Table-2: Top ten Aquaculture producer countries-in Tones.

Country	Production	Country	Production
China	3,67,34,215	China	3,86,21,269
India	37,85,779	India	45,73,465
Vietnam	26,71,800	Vietnam	28,45,600
Indonesia	23,04,828	Indonesia	27,18,421
Bangladesh	13,08,515	Bangladesh	15,23,759
Thailand	12,86,122	Norway	11,38,797
Norway	10,08,010	Thailand	10,08,049
Egypt	9,19,585	Egypt	9,86,820
Myanmar	8,50,697	Chile	9,54,845
Philippines	7,44,695	Myanmar	8,16,820

Source: Food and Agriculture Organization-2012[13,14].

Table-3: Fish Production in India from 2000 to 2012-in Tones.

Year	Marine	Inland	Total
2000-01	2811	2845	5656
2001-02	2830	3126	5956
2002-03	2990	3210	6200
2003-04	2941	3458	6399
2004-05	2779	3526	6305
2005-06	2816	3756	6572
2006-07	3024	3845	6869
2007-08	2920	4207	7127
2008-09	2978	4638	7616
2009-10	3104	4894	7998
2010-11	3250	4981	8231
2011-12	3372	5294	8666

Source: Agricultural Statistics-2013[15].

The aquaculture is expanding at a rapid countenance where in global fish production is out pacing population growth. All time highest production of fish was observed in 2012 and is projected to increase by 62% by the year 2030 to meet the dietary demands of emerging global middle class[16].

In evolution society fish production, aquaculture and marine field are predominantly exaggerated by several pollutants. Among the diverse environmental pollutants heavy metals (hvm) are one of the causative agents of many health problems and contribute a serious health hazards to humans when these metal accumulated fish and shell fish is being consumed by them. Previous studies show that, especially hvm of Nickel (Ni), Arsenic (As), Cadmium (Cd), Mercury (Hg) Zinc (Zn) and Lead (Pb) create long term problems when compare with an assortment of substances entering the soil, inland waters and the ocean as squander products[17]. Among the 20 heavy metals, the inorganic arsenic, cadmium and lead are in the top six hazards present in toxic devastate sites[17,18]. The accumulated hvm in diverse coastal and marine water are cross the threshold in to the organisms and circulate in food chain also remain in the ecosystem in sediments for longer and influence on human health. Research studies pertaining to the relation between heavy metal toxic effects on human health is still scares particularly in developing countries. The food scientists, nutritionists and health professionals impose to give attention in this particular area of research. The explored results may help to know the grounds of the increasing levels of hvm and trace metals in the environment and their entry into the food chain and the overall health effects. The available literature reveals that the entry of hvm and trace metal toxicity is a result of long term, low level exposure to pollutants through air, water and numerous consumer food products. Human body systems in which toxic elements can induce impairment and dysfunction includes the blood and cardiovascular, excretion routs, endocrine, energy production pathways, enzymatic, gastrointestinal, immune, nervous and reproductive path ways. The main target sites of toxic heavy metals are membrane or structural proteins, enzymes or DNA molecules. These toxic elements replace metabolically pertinent cations and anions and altering their functions. This is called “molecular mimicry” however they cannot perform the minerals function and slow down any activity at the binding site affecting cellular function[19-21]. World Health Organization (WHO) report reveals that exposure to toxic elements thorough food chain is a major risk factor for disease burden[22].

Depends on the functions, the hvm further classified as As, Cd, Pb and Hg are toxic heavy metals where as Ni, Vanadium (V) and Cobalt (Co) is probably essential. Copper (Cu), Zn Iron (Fe) and Manganese (Mn) are considered as essential hvm. The main passageway of the admission of the toxic metals in human body is all the way through food. These metals are of particular concern in relation to destructive effects on human health after their entry through food chain. These toxic metals cannot be degraded or destroyed and are natural components of earth crusts. Studies show that even low levels of the toxic metals can cause health problems like osteoporosis, kidney dysfunction and hyper tension with cadmium and it is a latent carcinogen. WHO reported that Pb is a non-essential hvm and implies that Pb is not involving any notorious function in biochemical processes and considered as toxic. According to WHO and International Agency for Research on Cancer (IARC) estimations, over 120 million people are over exposed to Pb all over the world and 99 percent of the most serious cases are in the developing world[17,18]. Pb causes cognitive impairment in children and increases cardiovascular disease in adults[23]. As per the Food Safety Authority of Ireland (FSAI) the toxicity of these metals is in part due to their accumulation in biological tissues and a process known as bioaccumulation. This process of bioaccumulation of metals occurs in all living organisms as a result of exposure to metals in food and the environment, including food animals such as fish, shell fish and cattle as well as humans. Hvm is associated with naturism particularly with the accumulation of Pb. The main symptoms from naturism are anaemia, hematopoietic, renal toxicity and peripheral neuropathy. The other important toxic metal arsenic determination from marine biological tissues is cumbersome due to the presence of several interferences. The predominant organic arsenic species in fish tissues was arsenobetaine. The toxic form of arsenic found in the food and water are the inorganic As (III) and As (V) and these two were measured as carcinogen by IARC[18]. Zinc is an essential mineral used as a dietary supplement and helps in sensory functioning, immunity and growth in human. Several enzymes are depending on the zinc to catalyze chemical reactions. Zn plays an imperative responsibility in construction of proteins and cell membrane[23]. Around 2-4 grams of Zn is found throughout the body and the majority of the Zn is set up in brain, muscle, kidneys, bones and liver and higher concentrations are found in prostate and parts of the eyes. Zn containing enzymes of carbonic anhydrase and carboxy peptidase take part in a vital role in the process of regulating carbon dioxide and digestion of proteins[23]. The meticulous organ, where zinc is significantly involved in cell death is the brain, and cytotoxicity in consequence of ischemia or trauma, abdominal cramps, vomiting and nausea occurred involves the accumulation of free zinc[24].

Since a decade attention was drawn in to measure the hvm and trace metal concentrations in food and marine samples and their role in human health. Food contains a wide range of metallic elements and these are playing an important role along with other biochemical pathways to maintain the health. Considering the health benefits there has been an increasing awareness in determining the metal levels in fresh water and marine environment particularly in fish and shell fish as it was well noted that omega 3 fatty acids and other important nutrients including protein, vitamins and minerals.

Table-4: Concentration of heavy metals in fish commonly consumed in India - µg/100g [1,30].

Common Name	*Binomial name*	Name of the Heavy metals				
		Nickel	Arsenic	Cadmium	Lead	Zinc
Channa marulius	*Masto symbollon*	11.65±0.66	04.26±0.44	0.32±0.37	4.06±0.7	122.2± 2.02
Roho labeo	*Lebio rohita*	06.35±0.72	52.91±0.55	0.46±0.25	4.72±0.6	696.0± 1.24
Pomfret-White	*Pompus argenteus*	14.83±0.63	58.61±0.28	0.55±0.35	7.74±0.7	568.1± 1.52
Pomfret-Black	*Pompus argenteus*	16.83±0.72	68.95±0.42	6.17±0.90	3.57±0.6	757.2± 2.31
Cat fish	*Arius sona*	06.61±0.75	68.64±0.96	1.13±0.80	8.77±0.8	513.7± 2.07
Silver Pomfret	*Stromateus sinensis*	68.01±0.77	66.65±0.77	1.25±0.50	8.71±0.7	518.8± 1.85
Soleole	*Rastrelliger kanagurta*	05.23±0.65	03.75±0.49	0.35±0.21	10.82±0.9	695.1±2.82
Tigar prawn	*Panaeus monodon*	10.38±0.35	40.58±0.45	0.35±0.51	2.66±0.8	1144± 3.85
Scamil prawn	*Macrobrachium rosenbergii*	8.07±0.80	20.47±0.65	2.37±0.6	3.56±0.5	1456± 2.51
Kilal	*Heterandria formos*	6.42±0.96	93.10±2.30	1.02±0.50	10.39±0.88	720.6±1.56
Hilsa	*Hilsa hilsa*	6.21±0.87	8.25±0.25	0.76±0.20	17.63±0.90	645.1±1.01
Tuna fish	*Katsuwonus pelamis*	14.56±1.43	5.30±0.45	1.13±0.45	1.73±0.40	356.5±2.71
Betki white	*Lates calcarifer*	7.09±0.61	17.11±1.76	0.33±0.25	6.10±1.25	423.4±2.08
Betki Black	*Lates calcarifer*	6.14±0.68	18.20±1.41	0.72±0.36	7.66±0.85	564.2±3.63
Mullet	*Mugil cephalous*	15.38±0.93	89.78±1.87	0.71±0.26	15.51±1.07	38.51±0.85
Macheral	*Rastrelliger brachysoma*	7.17±0.50	256.2±5.38	0.60±0.20	70.33±0.75	570.3±3.80
Shark	*Scoliodon sorrakowah*	12.36±1.56	477.5±3.61	0.71±0.25	7.93±0.47	430.7±0.92
Bangda	*Scomberomorous guttatus*	9.63±0.57	109.41±1.40	1.33±0.59	7.30±0.91	1206±1.67

The trace and heavy metal ranges are dissimilar in fish and shell fish and different aquatic environment. It is depends on several factors including the passageway of metal[24]. The principal entry of HVM in fish and shell fish is from water sources, food sources and sediment.

It is depends on the ecological needs, metabolism and water contamination gradient. Environmental factors such as salinity, PH and temperature are also playing a responsibility in metal contamination. The Agency for Toxic Substances and Disease Registry (ATSDR-2011) states that just because a food (fish or shell fish) contains a certain level of metal does not mean the body absorb or retain it.

Apart from the diverse anthropogenic activities, the rapid industrialization and over growing urbanization are also one of the major factors for hvm toxicity. Recent scientific studies also indicated that the degree of toxic manifestation of different metals on dose, duration, route of administration and other physiological factors specially nutrition[25]. Measurement of metal contamination of fish and shell fish are essential to resolve the safety aspects of consumption. But the pertinent data on heavy and trace metals from sea foods and aquaculture is still insufficient. Research into fish, shell fish, aquaculture and sea food nutrition and heavy metal toxicity started in earnest around the middle of the 20th century.

But the gaining of more knowledge about the nutrition of fish and shell fish still needs to be given priority to assist in the continued development and improvement of sustainable practices in aquaculture. In this connection the food scientists and nutritionists are emerging need to develop the data on the heavy metals and trace metals from fish, shell fish and commonly consumed foods. In food and aquaculture sources the allowed quantity of hvm is defined by WHO, The European Union, The Canadian Natural Health Products Directorate, the U.S. FDA (tolerable daily intake), U.S. Pharmacopeia, U.S. EPA (drinking water)[17].

As per the recommendations given by world health organization the daily intake levels of nickel is from 0.10 to 0.30 mg/kg and arsenic as inorganic form of up to 0.015 mg/kg of body weight. The maximum tolerable levels of cadmium are 0.05 to 5.5 mg/kg and the safer levels of lead are from 0.5 to 6.0 mg/kg in fish respectively. The recommended dietary allowance (RDA) for zinc is from 8 to 11 mg/day[26]. As per the national sample surway report 2011, the consumption of fish and shell fish in India is below the recommended levels.

It has been observed that the coastal states are in advance in the consumption of fish and shell fish when compared with the other states. The report from the National Nutrition Monitoring Bureau (NNMB), National Institute of Nutrition (NIN, ICMR)[27] was also shows that the average household consumption of fish and shell fish in India was extremely low when compare with the WHO/FAO recommended levels.

The Table-5 shows that most of the human organs are affected by heavy metal toxicity. Generally these metals interfere with a number of body functions such as hematopoietic system, central nerve system, liver, heart and kidneys.

Metal compounds are increasingly introduce in the environment and could finally accumulate in a biotic system. Previous studies show that the heavy metals which do not have any functions in metabolism of cells are potentially harmful.

Seafood, nutrition and human health

Previous studies pertinent to fish, shell fish and other seafood's, these species were highly nutritional components and benefits to human health associated with the consumption and noted for multiple bodily organs and physiological functions. Tacon et al[28], reported that the estimated global population likely to increase nine billion by 2050.

This indicates that, about 50% more food will be needed to sustain the quality of human life by 2050. Present reports on increasing growth rate of fish, shell fish and aquaculture food production is also led to surge the increasing population growth and meet the demand. The development of aquaculture only possibly will fill up the gap between demand and supply and mitigate pressure on capture fisheries, which have been steadily declining[29]. The benefits of consuming a diet rich in seafood are based on high levels of nutritional components which are beneficial to human health[29]. Fish is also a carrier of toxins, hormones and antibiotics. Therefore aquaculture industry became subject of public health scrutiny and the other numerous benefits includes being the main supply of seafood for the world from a nutritional, economic and social standpoint [29].

It is well known fact that fish, shell fish and aquaculture products are highly nutritional foods which give tremendous health benefits. But according to Stefanie M Hixson, 2014 study the composition of fish and shell fish feed affects the final composition of the nutritional aspects in fish. FAO United Nations states that at least half of the world's recognized fish stocks are fully exploited and 32% are overexploited or depleted. Fish nutrition certainly has an impact on the aquaculture industry. Further research in this area is needed to optimize and give the directions for fish meal preparation. Because the nutrition derived from fish source has direct implication on consumer's health and therefore has to evaluate in provisions of safety.

It is obvious that the use of fish meal (FM) and fish oil (FO) must be significantly reduced in aquaculture feeds in order to be environmentally sustainable. Bridging the gap between problems and solutions in aquaculture will require insight and creative applications through research can help the aquaculture industry develop sustainably, and efficiently produce good quality food for a growing human population.

Table-5: Heavy metals toxicity on human health[21].

Name of the metal	Effected Organs on Human health									
	Kidney	Nerve	Lung	Blood	Bone	Reproduction	Skin	Heart	Gut	Liver
Ni		√	√				√			
As		√	√	√		√	√	√	√	√
Pb	√	√		√		√	√		√	
Cd	√	√	√		√			√	√	
Cr			√				√			√
Hg	√	√	√			√			√	

Table-6: Nutritional composition in commonly consumed fish in India-g% [1,30].

Common Name	*Binomial name*	Moisture	Minerals	Protein	Fat
Channa marulius	*Masto symbollon*	75.85±0.81	1.027±0.21	15.28±0.35	5.8±0.37
Roho labeo	*Lebio rohita*	76.29±0.93	1.076±0.11	16.39±0.45	5.4±0.85
Pomfret-White	*Pompus argenteus*	75.15±1.51	1.067±0.23	14.72±0.78	9.5±1.34
Pomfret-Black	*Pompus argenteus*	75.26±0.82	0.956±0.12	17.78±0.85	6.2±0.46
Silver pomfret	*Stromateus sinensis*	73.42±1.24	1.054±0.17	17.57±0.51	6.7±0.57
Soleole	*Rastrelliger kanagurta*	75.65±1.41	1.124±0.68	17.81±0.72	5.9±0.67
Tigar prawn	*Panaeus monodon*	76.11±0.82	0.717±0.37	14.24±0.37	9.1±0.99
Scamil prawn	*Macrobrachium rosenbergii*	74.99±0.79	0.816±0.35	15.43±0.42	9.8±0.86
Kilal	*Heterandria formos*	77.92±0.92	1.210±0.21	14.19±0.57	6.4±0.55
Hilsa	*Hilsa hilsa*	77.41±1.36	1.392±0.33	13.96±0.34	7.3±0.15
Tuna fish	*Katsuwonus pelamis*	74.65±1.92	1.376±0.37	15.28±0.29	6.4±0.77
Betki white	*Lates calcarifer*	76.82±1.40	1.214±0.25	14.84±0.35	5.4±0.08
Betki Black	*Lates calcarifer*	74.99±0.97	1.521±0.76	15.99±0.75	6.2±0.55
Mullet	*Mugil cephalous*	77.79±2.59	1.082±0.14	16.24±0.32	4.5±0.06
Macheral	*Rastrelliger brachysoma*	75.88±1.58	1.128±0.35	16.68±0.67	6.7±0.45
Shark	*Scoliodon sorrakowah*	73.88±1.87	1.476±0.25	16.11±0.45	6.4±0.88
Bangda	*Scomberomorous guttatus*	75.49±0.99	1.099±0.24	17.33±0.25	5.7±0.45

Both marine fish and fresh waters fish are equally delicious. Ana Carolina Fernandes et al study on fish consumption and uses demonstrated that preventive effect of fish consumption related to cardiovascular diseases, depression, cataract and some types of cancer. Evidences of a relation between exposure to mercury and an increase in the risk of neurological disorders, but not of cardiovascular diseases, were also found. Given the importance of fish consumption, its possible risks is important to conduct more longitudinal studies that assess both the benefits and risks of fish consumption for the human health. Studies also emphasize the need for policies to reduce exposure of fish and seafood to hvm and other contaminants.

Health Benefits of fish as dietary source

Recently USA population study reveals that the relation between frequency of fish consumption and benefits for heart diseases. This study states that a consumption of fish frequency ≥1 time a week was associated with a reduction in the progression of atherosclerosis in women[32]. The other study from Sweden states that lean fish consumption of ≥3 times a week reduced stroke risk in women[33]. Iso et al in Japan[34] published a study on fish consumption at 8 times a week was associated with lower risk of myocardial heart attack and non-fatal coronary disease when compared with a once-a-week consumption. These studies demonstrate that fish consumption at least once a week can be a protective factor for heart diseases and other related health problems. These findings may be due to the omega-3 fatty acids contribute to reduce the likelihood of blood clotting, and consequently, the risk of heart attacks and stroke[35]. Consumption of sea foods and fish reduces age-related macular degeneration, functions as an anti depressant and prevents acne[36,37]. Sea food consumption also help an improved more positive outlook on life and boost cognitive function in aging women and may lower the risk of developing Alzheimer's disease[38] and positive benefits on birth weight because it enhances fetal growth and development and lower risk of childhood onset type-1diabetes[39], asthma and aid in reducing preterm delivery and essential for central nervous system development[40]. Considering the health benefits, it is recommended that fish consumption from 2 to 3 times a week is good for health.

Conclusion

Ecological and environmental issues have provoked over the last two decades, threatening extensive devastation of flora and fauna in many parts of the world including India. The occurrence of hvm in the aquatic environment is a major concern because of their toxicity and threat to plant and animal life disturbing the natural ecological balance. The specific problem associated with the hvm in the environment is their accumulation through food chain and persistence in nature. In fact hvm pollution and its management has been a major global concern for environmentalists due to their non-biodegradable and hazardous nature. These hvm are accumulating in sea foods also including fish and shell fish. Fish and shell fish nutrition is positively impact and important on human health. Fish absorb metals through ingestion of water or contaminated food. Heavy metals have been shown to undergo bioaccumulation in the tissue of aquatic organisms. On consumption of fish, shell fish and other aquatic organisms these metals are transferred to human being and may cause various physiological disorders. Sea food is captivating an important role, because nutritional quality food is in demand in future[41]. However food safety is of highest importance therefore diligent research and stringent regulations must be required in terms of aquaculture studies. Presently human beings are having enormous influence on the biosphere relative to its ability to provide an appealing home for us and for valued species like fish and shell fish. It is extremely important to understand that ecotoxicological knowledge and activities are no more or less important than our industrial knowledge and activities. Human have the right to clean water and an aesthetically pleasing environment, but it is degrading day by day with the developing technologies. The water quality deterioration is seen increased in the industrial areas and the extent of contamination exceeds the limit of portability standards prescribed by WHO. The balance maintenance between nutritious safe food production and technologies to develop production practices in the society is a challenging task in front of nutritionists, health professionals and environment scientists[42-47]. In connection with the toxicity of hvm recently Indian journal of Medical research published a special issue on metal toxicity and health implications and pointed out that metal toxicity is completely ignored by medical professionals while practicing[48]. This statement indicates that more awareness is needed to update the current information on metal toxicity and to tackle the aforesaid challenges among the medical fraternity. The signs and symptoms of metal toxicity depend on duration of exposure, type of metal, condition of work place, socio economic status and consumption of contaminated fish, shell fish or food and history of disease. Widespread literature explored that still there is a huge gap of knowledge in proper toxicity studies and survey. The available data on effects of metal contamination on human through fish and seafood consumption is very meager. India is the one of the largest producer as well as exporter of fish and therefore it is ranked second in aquaculture. Thus further efforts need to be made to widen the knowledge in this unmapped area of research.

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