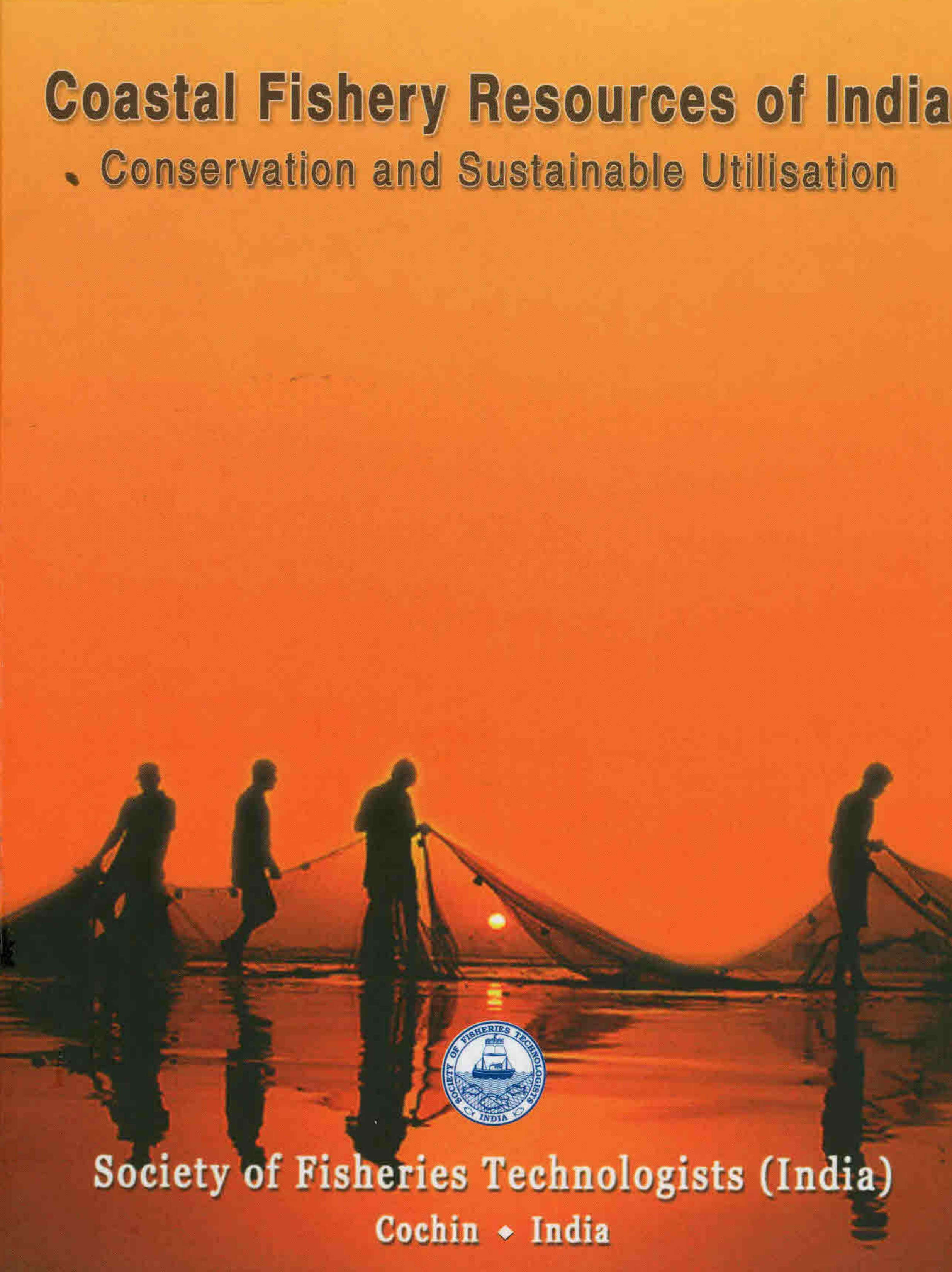
Coastal Fishery Resources of India

Conservation and Sustainable Utilisation



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Determination of Total Mercury in Finfishes and Shellfishes using Direct Mercury Analyser

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Introduction

Heavy metal contamination of the environment, particularly, the aquatic environment is of great public health significance in the modern world. Mercury occurs naturally in the environment. Mercury or its compounds have been used in chlor-alkali plants and as fungicides in agriculture and horticulture. It is found in minute quantities in all living organisms. Trace metals can be accumulated in fish via food chain and water. Aquatic organisms are extensively used in pollution monitoring programmes (UNEP, 1993; Uthe *et al.*, 1991). Fishes are considered as good indicators for heavy metal contamination in aquatic systems because they occupy different trophic levels at different growth stages (Zhang *et al.*, 2007). Once mercury enters the ecosystem, naturally occurring bacteria convert it to a form called methyl mercury or dimethyl mercury by a process known as biomethylation or bacterial methylation. Methyl mercury is toxic to human beings and predatory fishes such as large tuna, swordfish and shark can have mercury concentrations in their bodies that are 10,000 times higher than those of their surrounding waters (NRDC, 2010). EU and US regulation of 1997 made residue monitoring mandatory for seafood. Contamination may occur at any stage of production, processing and marketing. Regulatory limits are set for some of these contaminants.

In this study, the total mercury content in the edible portion of selected finfishes, shellfishes and frozen and freeze-dried shellfish products, collected from fish markets and fish processing factories in and around Cochin, have been determined using Direct Mercury Analyser (DMA) system and the hazard level is evaluated against the maximum residual limit for human consumption.

Materials and Methods

Samples consisted of 15 finfishes, 8 crustaceans, 5 bivalves and 2 cephalopods procured from fish markets and 10 assorted frozen fishery products obtained from fish processing plants in and around Cochin. The samples were placed in ice, brought to the laboratory, washed and sorted to species level. The samples were either taken immediately for analysis or frozen stored until analysis. All reagents used were of analytical grade (AR Grade). Working standards of mercury were prepared by diluting concentrated stock solutions (Merck, Germany) of 1000 $mg.l^{-1}$ in ultra-pure water (MilliQ, Millipore-USA). The secondary working standards were prepared on the day of analysis.

The edible portions of the meat from the samples were separated and homogenized using an ultra turex homogenizer and 0.5 g of homogenate was taken for ΣHg analysis. Mean value of three replicates were taken, for presenting the results. The Direct Mercury Analyzer (DMA-80, Milestone Inc., Italy) integrates functions of thermal decomposition, catalytic reduction, amalgamation, desorption and atomic absorption spectroscopy to rapidly treat and analyze solid or liquid samples for mercury. In the DMA-80 system, the sample is initially dried in an oxygen stream passing through a quartz tube located inside a controlled heating coil, prior to combustion. The combustion gases are further decomposed on a catalytic column at 750°C. Mercury vapour is collected on a gold amalgamation trap and subsequently desorbed for quantization using atomic absorption spectrometry at 254 nm.

Results and Discussion

The concentration of total mercury (ΣHg) in the edible portion of the fishes, crustaceans, molluscs and frozen seafood products are presented in Tables 1 and 2. Total mercury content in finfishes range from 35 to 277 ppb. The ΣHg level was higher in shark (230 ppb) and swordfish (277 ppb) which is to be expected as they are predatory fishes occupying high trophic level. Among the shellfishes, lobsters gave ΣHg values ranging between 44 and 141 ppb. The ΣHg content estimated in frozen whole lobsters ranged between 56 and 96 ppb and for the frozen lobster tail, the value was 141 ppb.

The maximum residual levels of ΣHg prescribed by EU, USFDA and Japan are 0.5, 1.0 and 0.4 ppm, respectively (Lakshmanan, 2009). The maximum level of ΣHg detected during the present study (277 ppb) was far below the permissible limit set by the national and international standards.

Table 1: Total mercury content in finfishes, crustaceans and cephalopods

Sample	ΣHg* (ppb)
Finfishes	
Ambassis sp.	35.95±0.44
Caranx caranx	40.80±0.22
Cynoglossus cynoglossus	37.06±0.29
Etroplus maculatus	38.97±0.47
Lactarius sp.	35.77±0.27
Lutjanus fulviflamma	61.07±0.48
Nemipterus japonicus	38.64±0.44
Pampus argenteus	37.90±0.48
Parastromateus niger	37.55±0/62
Rachycentron sp.	98.66±0.87
Rastrelliger kanagurta	37.33±0.89
Saurida tumbil	36.35±0.72
Scoliodon sp.	230.19±2.89
Sphyraena sp.	81.00±0.37
Xiphius sp.	277.11±2.01
Crustaceans	
Macrobrachium rosenbergii	1.23±0.003
Metapenaeus dobsoni	10.02±0.03
Metapenaeus monoceros	ND
Panulirus homarus	44.01±0.11
Parapeneopsis stylifera	ND
Fenneropenaeus indicus	ND
Penaeus monodon	ND
Puerulus sewelli	47.29±0.14
Bivalves	
Crassostrea madrasensis	9.08±0.05
Paphia malabarica	31.03±0.11
Perna indica	10.03±0.09
Perna viridis	11.07±0.05
Villorita cyprinoides	7.12± 0.06
Cepahalopods	
Loligo sp.	52.84± 0.78
Sepia sp.	106.32±1.55

*Mean of three values; ND: Not detected

Table 2: Total mercury content in frozen seafood samples

Sample	ΣHg* (ppb)
Frozen lobster tail	141.00±1.2
Frozen lobster whole	96.00±0.99
Frozen cuttlefish whole	56.56±0.56
Frozen squid whole	47.13±0.78
Frozen cleaned cuttlefish whole	19.72±0.77
Frozen squid tubes	10.43±0.22
AFD clam	83.79±0.65
Block frozen *Fenneropenaeus indicus* PUD	0.51±0.003
Block frozen *Fenneropenaeus indicus* PD	ND
Frozen *Penaeus monodon* whole	ND

*Mean of three values; ND: Not detected

Lakshmanan (2003) reported that ΣHg content estimated by Atomic Absorption spectrophotometer (AOAC, 2006) was <0.1 ppm in majority of samples examined and the levels ranged between 0.03 to 0.336 ppm. The same study also reported that ΣHg was 0.007 ppm in the edible muscles of squid and cuttlefish and 0.3 ppm for clams and mussels. MPEDA (1985) conducted a survey of mercury levels in fish and fishery products and reported values ranging from 20 to 700 ppb. Earlier studies in finfish, cephalopods, bivalves and crustaceans using cold vapour technique reported similar values as in present study (Marcotrigiano and Storelli, 2003; Ubalua *et al.,* 2006).

Conclusion

The results of the study give valuable information about ΣHg content in finfishes and shellfishes sourced from markets and processing factories in and around Cochin. The ΣHg content in the organisms gives an indirect indication of the pollutant level in the environment. The study has shown that the ΣHg level in the finfishes, shellfishes and frozen seafood analyzed, ranged from below detection level to 277 ppb only. As the detected levels are well below the prescribed residual limits, the fish and shellfish from this region, in general, are safe for human consumption with regard to mercury poisoning. The DMA was found to be a fast and convenient system for ΣHg determination, with several advantages.

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