

## Concentrations of Metals in *Euthynnus affinis* and *Thunnus albacares* from Arabian Sea

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Concentrations of total mercury ( $\Sigma\text{Hg}$ ), cadmium, lead, copper, zinc, manganese, etc., were determined in two species of tuna viz., *Euthynnus affinis* and *Thunnus albacares* caught from the Arabian sea. The mean value of nine metals present in the edible muscle and other body components like liver, gut, etc., are presented. The levels of Hg, Cd, Cu, Zn, and Mn increased with length in *E. affinis*. The highest level of  $\Sigma\text{Hg}$  was around 0.17 ppm in *E. affinis*, while Cd showed a value of ~0.37 ppm. The levels of all other metals were below permissible limits recommended by international bodies. In these two species, none of the toxic metals exhibited a hazardous level. Regression analysis of metal content with length showed a positive correlation in *E. affinis*. From the viewpoint of food safety, tuna from Arabian sea does not cause any concern.

**Key words :** Heavy metals, *Euthynnus affinis*, *Thunnus albacares*

Degradation of quality of the aquatic environment due to chemical contaminants such as heavy metals, pesticides, etc., are of global concern. Trace metals particularly Hg, Cd and Pb are persistent pollutants and bioaccumulated by fish and shellfish with serious health implications. Toxic metals not only endanger fish recourses but also can reach human body through seafood (Walting, 1983). It is therefore most important to determine the concentrations of heavy metals in fish, shellfish and other marine organisms. Thus there has been an increasing concern over safety of seafood and consumers health.

Heavy metals cause deleterious effects on density, diversity and productivity of aquatic organisms (Moore & James, 1992). Catastrophical incidents of heavy metal poisoning by contaminated fish were reported from many parts of the world, particularly after the Minamata incident of Hg poisoning in Japan in 1953. Oysters collected from an estuary in Taiwan in 1989 were green in colour due to high concentrations of Copper. More

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than 50% of squid and cuttlefish exported to Italy had Cd content in excess of tolerance limit. Higher levels of Pb contamination were observed in dried fish from Nigeria (Anon, 1995).

As a result of environmental contamination from sources like industrial effluents, uncontrolled dumping of sewage and urban run off, it has become imperative that all the consignments of sea foods has to be monitored for various chemical contaminants. The impact of pollution on ocean can be long lasting, as the time scale for retention of materials is very long in marine system. Further the toxic materials get concentrated in living and non-living phases by biological and geological processes and ultimately returned to man through ingestion of seafood (Goldberg, 1975). The metal uptake of an organism depend on many factors like water temperature, dissolved oxygen, salinity, water hardness, pH of the medium, organic compounds present etc. Metal levels are also influenced by the general physiological behavior such as age, weight, mobility, and mode of development, sex and feeding habits, life cycle and life history. Seasonal variations of metals in the habitat water may also affect the levels of metals in the body of organisms (Forstner & Wittmann, 1979). Fish being an end consumer in aquatic food chain, its metal enrichment is highly significant. Occupational hazards involving heavy metals are well known (Browning, 1969), but it is evident that much lower levels of metals in diet may be implicated in human diseases.

Global tuna trade has witnessed a steady growth for past 10 years, with an average annual increase of 6.4% in export values. According to FAO, the total value of tuna imports and exports were US\$ 5.5 billion and 6.4 billion, respectively. Japan imported more tuna and frozen tuna in 2000. Tuna is the most popular seafood among US consumers amounting to 3.6 pounds per capita in 2000. Canned tuna market in EU countries witnessed a steady growth. Same is the case for Southeast Asian countries and these are the result of rising popularity of tuna sandwich and other convenient health products (Anon, 2002). However, the safety of product is of major concern in international markets, particularly the levels of certain heavy metals like Hg, Cd and Pb.

The main objective of the present study was to monitor the levels of some essential and non-essential trace metals in two species of tuna, *Euthynnus affinis* and *Thunnus albacares*, to find out if there is any health hazard by consuming them. An attempt was also made to find out the variation of trace metal levels with age/size in *Euthynnus affinis*.

### Materials and Methods

Two species of tuna, *Euthynnus affinis* and *Thunnus albacares* were collected from Fisheries Harbour, Thoppumpady, Cochin during September and October 2001. These samples were brought to the laboratory, washed with freshwater and dissections of the samples for various body parts like muscle, liver and gut were carried out at the earliest. These samples were homogenised and wet digested with conc. HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> (4:1 v/v), using "Bethge" apparatus to prevent the loss of volatile metals like Hg. Mercury was analysed using cold vapour technique in a mercury analyser (MA-5840, ECIL). Other metals were determined using flame AAS in Varian atomic absorption spectrophotometer (Spectra 220 model) using air-acetylene flame. Standard metal solutions of AAS grade obtained from Sigma Chemicals Co., USA were used as reference. The results of the analysis were statistically analysed and mean values are presented on wet weight basis.

### Results and Discussion

Results of the analysis are presented in Tables 1 to 4. In the case of *Euthynnus affinis*, the average Hg content in the edible muscle was 0.091 ppm and this is only 1/10<sup>th</sup> of the US FDA limit of 1 ppm. There is not much variation in Hg among the three body parts analysed viz., liver, gut and muscle. The levels of Cd were very high in liver, compared to muscle. Levels in edible muscle were far below the FDA limit of 3 ppm. Pb was absent in many of the muscle samples analysed. Only traces were found in liver.

Table 1. Trace metal levels in edible muscle of *Euthynnus affinis*

Metal	No. of Samples	Range	Mean±SD
Hg	12	0.032 – 0.170	0.091±0.161
Cd	15	0 – 0.367	0.151±0.152
Pb	15	0 – 0.853	0.221±0.33
Cu	15	0.951 – 2.125	1.506±0.475
Zn	15	12.85 – 29.83	20.428±7.729
Ni	15	0.919 – 1.872	1.343±0.339
Cr	15	0.251 – 0.914	0.497±0.192
Fe	15	6.75 – 14.9	11.019±2.883
Mn	15	0.10 – 0.324	0.108±0.073

Table 2. Trace metal levels in edible muscle of *Thunnus albacares*

Metal	No. of Samples	Range	Mean±SD
Hg	10	0.011 – 0.090	0.04±0.025
Cd	10	0 – 0.108	0.029±0.039
Pb	10	0 – 0.667	0.210±0.229
Cu	10	0.660 – 1.560	1.066±0.338
Zn	10	8.5 – 15.2	12.458±4.320
Ni	10	0.919 – 1.872	1.343±0.339
Cr	10	0 – 0.541	0.305±0.185
Fe	10	6.75 – 14.9	11.019±2.883
Mn	10	0.450 – 1.203	0.819±0.251

Table 3. Trace metal levels in body parts of *Euthynnus affinis*

Sample	Body Parts	Trace metals (ppm)						
		Hg	Cd	Pb	Cu	Mn	Ni	Zn
1	Muscle	0.0319	ND	ND	1.457	0.1714	1.1603	12.65
	Liver	0.0321	2.5605	ND	1.5521	1.0644	0.8344	20.71
	Gut	0.0373	1.1411	ND	1.3425	1.1859	1.0143	20.79
2	Muscle	0.0527	ND	ND	2.0324	0.1202	1.8721	13.86
	Liver	0.0397	2.8241	ND	2.9976	1.3909	0.4372	21.26
	Gut	0.0231	2.2998	ND	2.5371	5.3641	0.1911	19.64
3	Muscle	0.0599	ND	0.2496	1.3379	0.1198	1.1831	15.48
	Liver	0.0531	6.4329	ND	4.5397	2.9825	0.7361	20.04
	Gut	0.0392	0.2258	ND	1.1759	5.4447	1.1403	23.85
4	Muscle	0.0903	0.1586	ND	1.1378	0.1541	0.9191	16.98
	Liver	0.0972	9.0013	0.144	3.8014	0.6193	1.1018	20.99
	Gut	0.0324	1.8281	ND	1.2705	0.1296	1.5947	28.67
5	Muscle	0.0574	ND	0.8354	2.1199	ND	1.5769	16.83
	Liver	0.0943	5.7089	ND	2.8801	0.7886	1.5258	28.71
	Gut	0.0351	0.6691	ND	0.5855	0.2151	0.8603	32.12

Table 4. Regression analysis of heavy metal concentration and size in *Euthynnus affinis*

Metal	Body length (cm)	Body weight (g)	Conc. range (ppm)	SD	r
Hg	28-55	500-2000	0.029-0.064	0.012	0.9849*
Cd	28-55	500-2000	2.561-7.032	1.846	0.9734*
Pb	28-55	500-2000	0-0.678	0.234	0.9585*
Cu	28-55	500-2000	1.551-5.429	1.514	0.9891*
Mn	28-55	500-2000	1.064-3.561	0.916	0.9961*
Zn	28-55	500-2000	19.881-31.577	3.604	0.9354*

\* Significant at  $p < 0.001$

In the case of other metals like Mn, Zn, Ni and Cu also, the levels in muscle part were well below the permitted limit. Manganese was found to be higher in gut and Zn has maximum value in liver. Ni and Cu were found higher in muscle than in liver and gut. The observed distribution pattern is shown below:

Hg : Muscle > Liver > Gut  
 Cd : Liver > Gut > Muscle  
 Mn : Gut > Liver > Muscle  
 Ni : Muscle > Liver > Gut

It is seen that the metal levels in general, were lower in *Thunnus albacares* than in *Euthynnus affinis*. It was observed that the mercury content in edible muscle increases with size of the fish from 0.019 in 28 cm fish to 0.057 for 55 cm fish (Table 4). The table values indicate a clear correlation between size of fish and the levels of metal, for most of the metals analysed. Regression analysis of the metal levels with body length in *Euthynnus affinis* indicated a significant positive correlation of metal levels with increase in body length.

From the study, it is observed that none of the trace metals was found to be above tolerance limit prescribed by national and international agencies in both the tuna species. However, higher levels of metals in liver and gut suggest that it is preferable to remove visceral parts before consumption.

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