Levels of Cadmium in Seafood Products

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The concentrations of total cadmium were determined in 448 samples of processed fishery products comprising crustaceans, molluscs, marine fish and brackish water fish. Shrimp product, the major export item, contained on an average 0.122 ppm cadmium and 20% of crustaceans analysed did not contain cadmium on detectable level. Average content of cadmium in 68 marine fish of 9 species was 0.153 ppm and 35% of the samples did not contain the element. Of the total number of crustaceans analysed only 2% showed a level > 0.5 ppm. All the 174 samples of molluscan products, except 3 canned oysters, showed cadmium concentration far below the limit allowed. The average cadmium content in molluscan products was 0.552 ppm.

Cadmium is highly toxic to man and has been implicated as possible causes of hypertension, kidney ailments, skeletal deformation etc. The first reported cadmium poisoning of humans occurred in Japan in 1947. The poisoning was due to eating contaminated rice where highly polluted river water was used to irrigate paddy fields (Kobayashi, 1971). A high level of cadmium was also observed in squid and cuttle fish from that region. Heavy cadmium pollution from industrial wastes has also been reported (Forstner, 1980). The presence of cadmium in the marine environment may affect marine organisms and result in food chain enrichment which would undermine the quality and safety of seafood.

In marine organisms cadmium was first detected in the scallop, *Pectin maximus* by Fox & Ramage (1930). Some information are available on the cadmium content of marine fish from industrialised countries (Havre *et al.*, 1973; Peden *et al.*, 1973; Windom *et al.*, 1973). Kruger *et al.* (1975) reported the cadmium content in 12 species of blue shark, *Prionace glauca* caught in the north west Atlantic. High cadmium concentration up to 2.1 ppm were found in the muscle of sole *(Sole sole)* from the waters of Spain and Portugal (Stenner & Nickless, 1975) The levels of cadmium in fresh water fishes were also investigated (Lucas *et al.*, 1970; Lovett *et al.*, 1972). Molluscs, in general, concentrate large quantities of the metal in their body. Cadmium in molluscs has been reported from various parts of the world (Brookes & Rumsby, 1965; Pringle *et al.*, 1968; Nickless *et al.*, 1972). High concentrations of cadmium (173 ppm) was reported in oysters, *Crassostrea gigas* from the Derwent Estuary, Tasmania by Eustace (1974). The oceanic squid, *Symokectoteuthis oualaniensis* had 190 ppm (dry wt) cadmium in the body (Clark, 1986). Topping (1973) had determined cadmium in the abdominal muscle, gills and liver of the lobster, *Homarus gammarus.*

Information on the distribution of cadmium in Indian seafoods is scant. However, in recent years much emphasis has been given on the cadmium content of seafood especially in squid and cuttle fish exported from this country. In this paper data on the levels of cadmium in commercially processed fish and shell fish products are presented.

Materials and Methods

Samples of commercially important seafood, namely, shrimp, squid, cuttle fish, lobster tails, crab meat, clams, mussels and oysters and fishes like tuna, pomfret, pearl spot etc. (Table 1) were procured from fish processing factories in Cochin, Quilon and from retail outlets. The products included both frozen and canned materials. A total of 448 samples (292 samples of frozen

Table 1. *Levels of cadmium (ppm on wet weight basis) in Indian seafoods (Number of samples are shown in parenthesis)*

Species	Range	Mean value	± S.D.
	(A) Frozen product		
Marine fish			
Mackerel tuna (7) *(Euthunnus affinis)*	0.022–0.118	0.053	0.04
Pomfret, black (9) *(Pampus niger* (BI)	0.100–0.812	0.0454	0.28
Pomfret, white (4) *(Pampus chinensis)*	0.000–0.13	0.047	0.06
Catfish fillets (6) *(Tachysurus* sp.)	0.087–0.302	0.179	0.09
Red snapper (6) (Lutjanus argentimaculatus)	0.000–0.345	0.16	0.18
Seer fish (4) *(Scomberomorus* sp.)	0.080–0.289	0.183	0.09
Brackish water fish			
Pearlspot (19) *(Etroplus suratensis)*	0.062–0.656	0.371	0.23
Mullet (6) *(Liza corsula)*	0000 –0.19	0.125	0.08
Crustaceans			
Prawns (37)			
a) *Metapenaeus affinis*	0000 –0.124	0.066	0.05
b) *M. dobsoni*	0.040–0.234	0.114	0.06
c) *M. monoceros*	0000 –0.093	0.049	0.04
d) *Parapenacopsis stylifera*	0.052–0.37	0.172	0.11
e) *Penaeus indicus*	0000 –0.22	0.087	0.06
Rock lobster tail (23) *(Panulirus homarus)*	00000–0.583	0.215	0.21
Crab (12) *(Scylla serrata)*	0.45 –0.696	0.536	0.11
Mollusc			
Cuttle fish fillets (48) *(Sepia pharanois)*	0.095–0.926	0.402	0.25
Squid tube (42) *(Loligo duvacelli)*	0.068–0.676	0.213	0.16
Mussel			
a) *Perna viridis* (14)	0.192–1.32	0.44	0.37
b) *P. indica* (6)	0.300–0.708	0.399	0.23
Oyster (9) *(Crassostrea madrasensis)*	1.270 –1.98	1.63	0.21
Backwater clam			
a) *Catelesia* sp. (26)	0.120–1.38	0.546	0.31
b) *Villorita* sp. (14)	0.153–1.10	0.49	2.28
	(B) Canned Products		
Marine fish			
Tuna *(Katsuwonus pelamis)* (15)	0000 –0.30	0.075	0.12
Marlin fillet (5)	0.130–0.41	0.25	0.13
Oil sardine (7) *(Sardinella longiceps)*	0000 –0.28	0.068	0.10
Mackerel (5) *(Rastraleger kanagurta)*	0 000–0.05	0.024	0.02
Crustaceans			
Assorted prawns (53)	0.000–0.430	0.134	0.12
Crab meat (56) *(Scylla serrata)*	0000 –0.46	0.155	0.13
Molluscs			
Oyster (9) *(Crassostrea madrasensis)*	1.39 –3.73	2.42	1.05
Mussel *(P. viridis)* (6)	0.23 –0.39	0.308	0.08

products and 156 samples of canned products) were analysed for their cadmium content, for a period of over five years, until 1987. In all cases the edible portions were separated, homogenised and sub-samples were wet digested according to standard methods (AOAC, 1975). The cadmium content was determined using Flame Atomic Absorption Spectrophotometer (Model Varian Techtron 1100 or GBC 902). The data were subjected to statistical analysis. Samples were drawn according to standard sampling technique.

Results and Discussion

The results of analysis of various seafood items for cadmium content are presented in Table 1. The distribution pattern of cadmium in some of the major products are presented in the Ogive's curves (Fig. 1a to 1c).

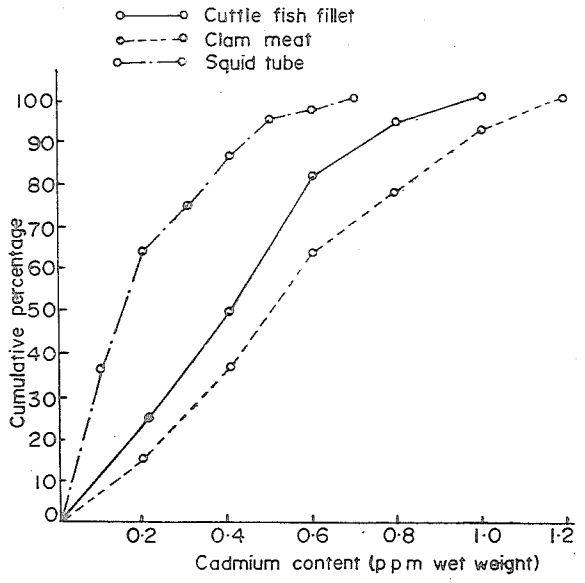

Fig. 1a. Distribution pattern of cadmium in frozen cuttle fish fillets, clam meat and squid tube.

The mean values of cadmium in five species of frozen marine fish were lower than 0.20 ppm; whereas in black pomfret the mean value was 0.454 ppm. Canned marlin fillets registered an average value of 0.25 ppm and all other canned fishes showed values <0.10 ppm. Of the 68 marine fish products (frozen and canned) analysed, 35% did not have any detectable amount of cadmium in their muscle, 22% had Cd content < 0.1 ppm and 25% showed a level > 0.2 ppm. The remaining samples had values in between 0.1 and 0.2 ppm. Among the two backwater fish species analysed pearl spot had higher mean value for cadmium and often exceeded the limit of 0.2 ppm (Table 1). Two samples of mullet had values exceeding 0.2 ppm. However, in these two species the lower range of values fall in between 0 and 0.06 ppm.

In all, 181 samples of crustaceans and 174 samples of molluscs were analysed for cadmium content. The prawn samples (90 Nos.) both frozen and canned had an average value of 0.122 ppm Cd. Around 73% of the prawn products registeted a value below 0.2 ppm for the metal, the highest recorded value was 0.41 ppm. Specieswise distribution of cadmium in prawns showed that *Parapenaeopsis stylifera* has the highest mean value for the metal followed by *Metapenaeus dobsoni* (Table 1). The distribution pattern of cadmium in both frozen and canned prawns are identical (Fig. 1b, 1c).

In processed crab meat cadmium content was far below the limit; the mean concentration in canned products being 0.155 ppm. The distribution pattern of Cd in canned crab meat is quite identical to that in canned prawns (Fig. 1c) and the value was < 0.5 ppm in all the samples. However, whole frozen crab meat showed a slightly higher average value of 0.536 which may be attributed to contribution from other body components such as gonad that contain higher

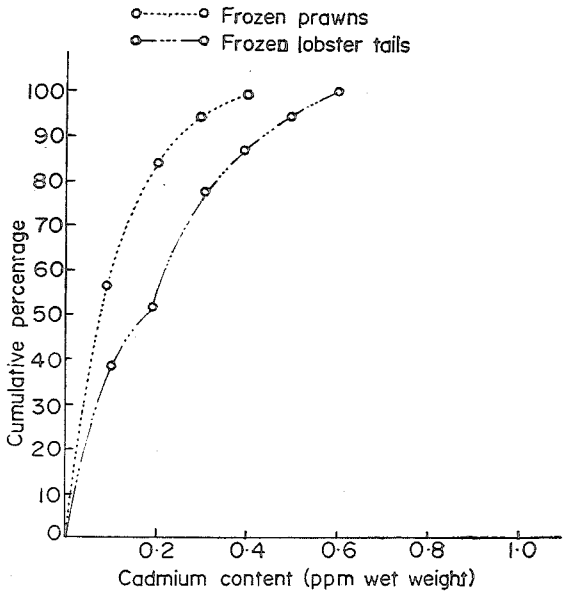

Fig. 1b. Distribution pattern of cadmium in frozen prawns and lobster tails.

levels of Cd. In the case of frozen lobster tails around 95% of the samples had the metal concentration <0.5 ppm and a single sample had a value 0.583 ppm (Fig. 1b).

Molluscs, in general, had higher levels of cadmium in their body compared to other organisms. The oyster, *Crassostrea madrasensis* exhibuted the highest value for Cd content and in canned oyster the mean value exceeded 2.0 ppm. However, the level in all the frozen samples was below the limit. In the two backwater clams, *Catelesia* sp. and *Villorita* sp. the variation in cadmium content was identical and around 50% of the samples registered values below 0.5 ppm. Cadmium content in both the species of clams was below the limit. The two mussels *Perna viridis* and *P. indica* were found to contain more or less equal levels of the metal with a mean value of 0.43 ppm.

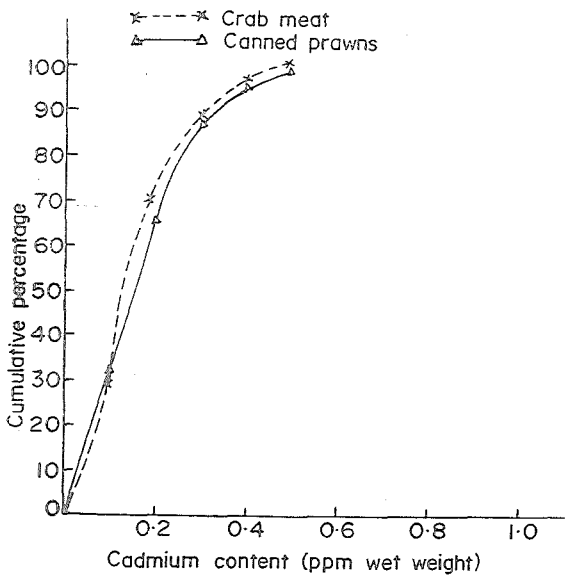

Fig. 1c. Distribution pattern of cadmium in canned prawns and crab meat.

In cleaned squid tubes and cuttle fish fillets the cadmium content was far below the limit with average values of 0.213 and 0.402 ppm respectively (Table 1). The distribution pattern of Cd in cuttle fish fillets and squid tubes are shown in Fig. 1a. In squid tubes, 95% of the samples indicated a value below 0.5 ppm and in cuttle fish fillets around 70% had the value below 0.5 ppm.

The range of cadmium concentrations found in the present study is comparable to those found in seafood by other workers. Havre *et al.* (1973) gave values ranging from 0.05 to 0.13 ppm in fish. Forstner (1980) opined that most food stuffs from less contaminated areas contain less than 0.1 mg Cd/kg, whereas liver, kidney and shellfish can show much higher concentrations. In the present study also the cadmiun contents were found to be consistently higher in molluscs than in other organisms. The order of cadmium content was as follows:

Molluscs > Brackish water fish > Crustaceans > Marine fish.

The relatively higher values of the metal in molluscs may be attributed to their sedentary and filter feeding habits. Higher values were reported for molluscs from various parts of the world. Nickless *et al.* (1972) observed a maximum of 60 ppm Cd in *Mytilus edulis* from Bristol channel and Pringle *et al.* (1968) gave an average content of 15.5 ppm (dry weight) in the oyster, *Crassostrea virginica.* Mullin and Riley (1956) found the level of Cd in the order of 1.5 ppm in the muscle of various molluscs and Topping (1973) registered a value of 0.3ppm, for the abdominal muscle of the lobster, *Hommaras gammarus.* However, it must be noted that the cadmium content observed for molluscs in the present study are many times lower

Table 2. *Cadmium content in seafood from some developed countries**

Seafood	Cd, ppm dry weight	Country
Muscle of various fish	0.08–1.67	U.K.
Oyster	0.10–7.8	U.S.A. (Eastern)
Oyster	0.20–2.1	U.S.A. (Western)
Oyster (Canned)	3.31	New Zealand
Crab	5.0–33.1	U.K.
Crab	22	Europe
Mollusc	2–50	Europe
Various sea fish	0.1–0.6	Europe
Freshwater fish	0.2–1.2	Europe

* Reproduced from Forstner (1980)

than those reported from other regions (Brookes & Rumsby, 1965; Pringle *et al.*, 1968; Nickless *et al.*, 1972; Eustace, 1974). The cadmium content of seafood from certain countries are given in Table 2. The arbitrary upper limit set up by various countries for cadmium content in fish, shell fish and the fish products are compiled by FAO (1983) and some of the standards are reproduced in Table 3.

Table 3. *Permitted limit of cadmium in seafoods (FAO, 1983)*

Government Agency	Cd, ppm wet weight basis
1. Department of Health Australia	2.0 ppm in molluscs and the mollusc content of molluscs products, (exception: Tasmania 2.5 ppm and New South Wales 5.5 ppm) 0.2 ppm for fish and fish content of fish products. (Exception: 5.5 ppm in New South Wales and South Australia)
2. Germany/FRG	0.5 ppm in edible part of fresh water fish
3. New Zealand	1.0 ppm in fish/fish products.
4. Hong Kong	2.0 ppm in fish, crab, oyster and prawns & shrimp
5. Switzerland	0.1 ppm in imported canned fish, crustaceans and molluscs.

Based on the present observation, it can be generally concluded that the Indian Seafoods are safe with respect to their cadmium content.

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