Bull. Environm. Contam. Toxicol. 20, 328-331 (1978)

Trace Metals in Some Fish Species of South Carolina

A. K. Koli, S. S. Sandhu, W. T. Canty, K. L. Felix, R. J. Reed, and R. Whitmore
Department of Natural Sciences, South Carolina State College, Orangeburg, S.C. 29117

INTRODUCTION

The recent discovery of relatively high levels of mercury in fish in North America has now focused intense concern on numerous of other potentially toxic metals such as cadmium, copper, iron, zinc, manganese, mercury and others which may be ubiquitous in ecosystems. This in turn, has stimulated a spiraling number of surveys and other investigations of their effects.

Much is known of the gross symtomology and pathology resulting from overwhelming doses of metals in biological systems. Instead, the emphasis here will be on possible effects of long-term or lifetime exposure of living systems to trace concentrations of toxic metal contaminants. The largest part of the total body burden of most metals in biological species is usually from the diet. A good portion of the world's diet consists of fish in one form or another. Many of the world's great gastronomic masterpieces are based on fish.

Many potentially dangerous chemicals ultimately find their way into surface waters which are natural habitats for fish. The fish which live in polluted water may accumulate pollutants from water via their food chain. The possible presence of pollutants in fish is a matter of concern. The presence of heavy metal (trace metal) pollutants such as Cd, Cu, Hg, Fe, Zn, and Mn could create health problems if ingested over a long period of time. Since nutritionally and recreationally fish constitute a most important segment of the aquatic ecosystem, toxic metals in fish are obviously of great concern.

Our determination of background trace metal levels in marine fauna was part of a wider environmental baseline investigation carried out in some selected fish species of South Carolina fisheries.

MATERIALS AND METHODS

Sample Collection

Samples of fish from freshwater and saltwater sources of rivers, lakes, and ocean from the state of South Carolina were collected. Lakes include Marion, Moultrie, Murray, Clark Hill,

0007-4861/78/0020-0328 $01.00

Keowee, Wateree, Jocassee, Greenwood, Hartwell, Wylie and Robinson. The fish collected were Bass, Catfish, Mudfish, Trout, Shrimp, and Silver Snapper. The whole fish were placed in plastic bags and frozen in a freezer.

Dry Digestion

In laboratory, the fish samples were thawed, dissected and small pieces of muscle tissue were placed on clean dry glass plates. The samples were dried in an oven at 105°C for 48 hours (Bohn and McElroy 1976). The dried samples of each species were weighed on Metler balance and placed in clean dry Erlenmeyer flasks. Sample flasks were digested in a constant temperature stirring water bath at 58°C until clear solution in reagent-grade nitric acid. The digests were diluted to 100 ml with deionized water.

Determination of Trace Metals

Trace metal levels of Fe, Zn, Mn, Cd, and Cu were determined by flame atomic absorption using a Perkin-Elmer Model 306 spectrophotometer. Determination of trace metals were measured as absorbance and were converted to parts per million (ppm). Mercury determination was based on the wet digestion technique described by Hatch and Ott, 1968, and Uthe et al 1970, using Coleman MAS-50 mercury analyzer.

TABLE I

Trace Metal Content of Some Fish Species of South Carolina

	ELEMENT					
Species	Copper (ppm)	Iron (ppm)	Zinc (ppm)	Manganese (ppm)	Cadmium (ppm)	Mercury (ppm)
Shrimp	0.01	7.4	5.2	0.25	0.03	0.23
Silver Snapper	0.13	0.60	0.44	0.02	<0.01	0.34
Brown Trout	0.20	0.63	0.59	0.03	<0.01	0.51
Mudfish	0.12	0.30	0.40	0.03	<0.01	0.63
White Bass	0.10	0.50	0.03	0.12	<0.01	0.12
Catfish	0.08	0.31	0.02	0.09	<0.01	0.19

RESULTS AND DISCUSSION

Fish species, Shrimp, Silver Snapper, Brown Trout, Mudfish, White Bass, and Catfish, were analyzed for trace metals of iron, zinc, manganese, cadmium, copper, and mercury. It was found that iron, zinc, manganese, and cadmium levels were higher in Shrimp than any other species analyzed. Copper level was surprisingly lower in Shrimp than any other species analyzed (Table I). It seems that saltwater rather than freshwater fish, Shrimp and Silver Snapper have more trace metal content than freshwater species, Trout, Mudfish, Bass, and Catfish (Table I). Sand and mud eating habits of Shrimp may have contributed to these higher concentrations. Those species for which fish of widely differing weights were analyzed, larger fish had higher trace metal levels than smaller fish (Table I).

Metals may exist in water in several forms, ionic, elemental, hydroxides, sulfates, chlorides, and nitrates. Sulfates of heavy metals are much less toxic to fish than the chlorides and nitrates (DONALD 1972). Aside from the nature and concentration of metals, their toxicity to fish are affected by many factors. The nature and condition of the fish are important factors also. The species age and general condition of fish will affect their foraging, metabolic and excretory capabilities. Fish also exhibit avoidance reactions to specific metals, and their ability to detect and avoid them has been shown (DONALD 1972).

Trace metals from water may be absorbed across the entire body surface of fish as well as the gills (DONALD 1972). Accumulation of trace metals by fish depend on size, age, species, sex, and environment of fish. Hardness of water has been shown to decrease the toxicity of some metals to fish (DONALD 1972). Toxic effect of heavy metals is an additive phenomenon.

SUMMARY

Samples of fish from freshwater and saltwater sources of ocean, rivers, and lakes over the state of South Carolina were collected. The fish collected were Shrimp, Silver Snapper, White Bass, Catfish, Mudfish and Trout. The sample flasks were incubated in a constant temperature stirring water bath at 58°C until clear solution in reagent-grade nitric acid. Triplicate samples of fish muscle tissue were analyzed by wet digestion and dry digestion methods. Trace metal levels were determined by flame atomic absorption using a Perkin-Elmer Model 306 spectrophotometer. Mercury determination was made by Coleman MAS-50 mercury analyzer. A significant finding of this report is that saltwater fish have more trace metal levels than freshwater fish, and larger fish have higher trace metals than smaller fish. Iron and zinc levels were much higher in Shrimp than any other species analyzed.

ACKNOWLEDGEMENTS

The authors thank Mr. H. L. Hauser, Associate 1890 Research Coordinator, Peter Nelson, Research Chemist at Water Pollution Laboratory, and Dr. J. H. Arrington, Chairman of the Natural Science Department for their help in this research. This work was supported by CSRS Grant No. 701-15-08A, U.S. Department of Agriculture in Cooperation with Cooperative State Research Service, USDA.

REFERENCES

BOHN, A., and R.O. McELROY: Trace Metals in Artic Cod and Selected Zooplankton from Strathcona Sound, Northern Baffin Island, J. Fish, Res. Board Can., 33, 2836 (1976).

DONALD, J.L.: Trace Metals in Soils, Plants, and Animals. Advances in Agronomy, 24, 267 (1972).

HATCH, W.R., and W.L. OTT: Determination of Sub-Microgram Quantities of Mercury by Atomic Absorption Spectrophotometry, Anal. Chem., 40, 2085 (1968).

KOLI, A.K., W.R. WILLIAMS, E.N. McCLARY, E.L. WRIGHT, and T.M. BURRELL: Mercury Levels in Freshwater Fish of the State of South Carolina, Bull. Env. Con. and Tox., 17, 82 (1977).

UTHE, J.F., F.A.J. ARMSTRONG AND M.P. STAINTON: Mercury Determination in Fish Samples by Wet Digestion and Flame Atomic Absorption Spectrophotometry, J. Fish. Res. Board, Can., 27, 805 (1970).