

TRACE METALS IN SEAFOODS

by

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ABSTRACT

Eight trace metals (Ag, Cd, Cr, Cu, Hg, Ni, Pb, Zn) in muscle of six popular sportfish caught near two major discharges of municipal wastewater in southern California were similar to levels measured in control specimens. In contrast, several invertebrates from around the Los Angeles County outfall system contained elevated metal concentrations. The highest elevations were for Cr in black abalone and rock scallop, with muscle tissue levels in outfall specimens exceeding those in controls by about a factor of 10.

However, Hg concentrations in invertebrates from this region were generally an order of magnitude below the FDA guideline of 0.5 ppm, and median values in fish muscle did not exceed this limit. Distinct metals contamination was also observed in two major harbors. Levels of Cu in four tissues of intertidal mussels collected near a vessel painting facility were 8 to 10 times those in coastal controls, and elevated concentrations of most other target metals were found at one or more harbor stations. Vessel-related activities are believed to be the major cause.

Moreover, since accumulation is the net result of uptake and loss processes, the patterns we obtained may also reflect differences in mercury depuration rates of the individual tissues. In this regard, the relatively rapid changes in tissue mercury concentrations found for gonads at all depths near the end of the experiment indicate that depuration may not be as difficult for mollusks under stress conditions as has been observed in laboratory studies (Miettinen et al. 1970; Mellinger 1972; Cunningham and Tripp 1973). The possibility of spawning cannot be ruled out as a cause for the observed results.

SUMMARY

1. Eight trace metals (Ag, Cd, Cr, Cu, Hg, Ni, Pb, Zn) measured by atomic absorption spectrometry (AAS) in muscle tissue of six popular sportfish caught near the JWPCP and OCSD municipal outfalls were not concentrated significantly above levels measured in island and coastal control specimens.
2. In contrast, the edible portions of several invertebrate seafood organisms collected in the JWPCP discharge zone concentrated a number of these metals several-fold above natural levels. The largest contamination factors measured by AAS were for chromium in molluscs; median levels in muscle of black abalone and rock scallops were 10 times background. Muscle of crabs from around the outfalls typically contained 6 times as much nickel as occurs naturally, and levels of this metal in black abalone, rock scallops, and red sea

urchin (gonads) were 2 to 3 times natural concentrations. Median muscle concentrations of silver in black abalone, rock scallop, and spiny lobster were approximately 3 times controls, and cadmium levels in rock scallops and spiny lobsters were 2 to 3 times controls. The JWPCP rock scallops also contained twice as much copper and mercury in their adductor muscle as did the island specimens; however, the mercury concentrations were an order of magnitude below the FDA guideline of 0.5 ppm.

3. These findings are consistent with those obtained from an independent analytical technique, optical emission spectroscopy (OES).

Intertidal mussels collected at the base of the JWPCP outfalls were found by OES to concentrate all of the target metals* except zinc above normal levels in the soft tissues (muscle, gonad, digestive gland, or "remainder"). Contamination factors for the latter three tissues for silver ranged from 4 to 8; for copper, from 2 to 4; for chromium, from 2 to 3. Corresponding factors for lead and tin in gonad tissue exceeded 3 and 8, respectively. In addition, mercury concentrations, measured by cold vapor AAS in muscle and digestive gland tissues of such mussels, averaged 4 times the levels found in island specimens. Again, the mercury levels were generally an order of magnitude below the FDA guideline.

* Tin was also concentrated above control levels.

4. The OES method also uncovered extensive metals contamination of mussels in two different types of harbors in the Bight. Specimens collected in Newport Harbor near a large vessel repainting facility contained levels of copper in four tissue classes that were 8 to 10 times those found in nearby coastal controls. PCB levels in these harbor mussels were 9 times controls. Corresponding contamination factors for zinc ranged from 3 to 4, and for chromium, tin, and lead in gonadal tissue, the factors were 7, >18, and >13, respectively. All of these contaminants are, or have been, used extensively in various vessel-related materials such as bottom antifouling paints and primers or hydraulic fluids. Because recreational boating is the major activity occurring in Newport Harbor, this is strongly suspected to be the dominant source of the contamination. In San Diego Harbor, highest levels of copper and tin, were measured near the Commercial Basin, the location of major vessel repainting and repair yards. In addition, PCB concentrations in mussels from this site were 20 times above the coastal baseline. Further, abnormally high levels of cadmium were measured in mussels collected from the Commercial Docks. Thus, the OES technique has proved to be very valuable in locating regions of metals contamination through analysis of molluscan bioindicators such as intertidal mussels. However, with the exception of copper and zinc, the levels of the target metals measured by AAS in fish tissues are generally too low to be measured by OES.

5. Despite the extreme contamination of bottom sediments by mercury around the JWPCP outfalls, with concentrations occurring up to two orders of magnitude above normal, six different species of benthic organisms (covering four phyla) showed no significant accumulation of this known toxicant in their body tissues. Levels found in muscle and liver tissue of Dover sole (means of 0.04 and 0.11 mg/wet kg) were in good agreement with results of earlier studies. Thus, it appears that the wastewater mercury that is carried to the soft bottom in this region is largely refractory and in a biologically unavailable state. In contrast, the filter feeding mollusks (rock scallop and byssal mussels) living on hard substrate inshore of the discharge, or cultured in the water column, apparently did concentrate mercury by factors of 2 to 4. However, levels in the outfall zone specimens were still an order of magnitude below the FDA guideline of 0.5 ppm.
6. In general, rock scallops from the JWPCP zone depurated for one week in the laboratory lost less than half of a given metal from the three tissues analyzed. Major exceptions included digestive gland silver and gonadal zinc, for which median concentrations decreased by factors of 3.6 and 4.7, respectively. However, depuration did not appear to have any important effect on levels in the edible muscle tissue.