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# Undergraduate Research Article: Determination of Cadmium, Cobalt, and Lead in Oysters From Southwest Louisiana by Flame Atomic Absorption Spectrometry

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**ABSTRACT** Flame atomic absorption spectrometry was used to determine cadmium, cobalt, and lead in oysters collected from an oyster field in West Cove, Southwest Louisiana, in two separate months (November and December) in 2007. In November, the mean, standard deviations, and range of the concentrations ( $\mu\text{g/g}$ ) of cadmium were  $58.6, \pm 15.3, 34.7\text{--}78.5$ ; of cobalt were  $27.5, \pm 3.9, 22.2\text{--}32.8$ ; and of lead were  $212.6, \pm 39.7, 131.0\text{--}269.2$ . In December, the mean, standard deviation, and range of the concentrations ( $\mu\text{g/g}$ ) of cadmium were  $73.7, \pm 26.3, 24.7\text{--}107.8$ ; of cobalt were  $46.9, \pm 8.0, 32.6\text{--}57.4$ ; and of lead were  $279.6, \pm 69.2, 147.3\text{--}355.0$ . Differences in concentrations for all three metals in the colder waters of December were noted.

**KEYWORDS** cadmium, cobalt, flame, lead, oyster aas

## INTRODUCTION

Recent work from this laboratory has focused on environmental research studies in McNeese State University, metals research laboratory.<sup>[1,2]</sup> Of particular interest has been metal determination in a variety of seafood including crabs and crawfish.<sup>[3–5]</sup> This work continues and extends in this area with the focus on the determination of cadmium, cobalt, and lead in oysters. These three metals have a history of being found in this area due to poor or no enforcement of environmental laws until the early 1970s. A recent review provides information on metal determination in oysters.<sup>[6]</sup>

Atomic spectroscopy methods are well used and established for trace metal determination. Preliminary work showed flame atomic absorption spectrometry (FAAS) provided adequate sensitivity and that the more sensitive methods of graphite furnace atomic absorption spectrometry (GFAAS) or inductively coupled plasma-mass spectrometry (ICP-MS) were not necessary. Some work was performed with inductively coupled plasma-optical

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emission spectrometry (ICP-OES) but the sensitivity was comparable to that of FAAS. Therefore almost all the work was performed using FAAS.

## MATERIALS AND METHODS

### Collection and Sample Preparation of Oysters

A sack of oysters (approximately 150 oysters per sack) was obtained from Hackberry Seafood (241 Main Street, Hackberry, LA) in November and December 2007. The oysters were harvested from an oyster-growing area known as West Cove located near a heavily industrialized area in the southwest part of Calcasieu Lake in Southwest Louisiana. The oysters were stored in a freezer, and 15 oysters were selected randomly from the sack and then shucked and weighed. The oysters were dried for 48 hr at 110°C and weighed to obtain a dry weight. The dried oysters were ground to a fine powder using mortar and pestle. Approximately 250 mg were accurately weighed into a Teflon digestion bomb, to which approximately 6 mL of 70% HNO<sub>3</sub> were added. The bomb was then placed in a conventional microwave oven for 60s at 30% power. The digestion bomb was vented and replaced in the microwave oven for a further 30s at 100% power. After cooling for approximately 5 min, 4 ml of H<sub>2</sub>O<sub>2</sub> were added to the bomb to break up the fats. Foaming occurred upon the addition of the H<sub>2</sub>O<sub>2</sub> and subsided after a few minutes. The digestion bomb was placed in the microwave oven for another 30s at 30% power. After cooling, the solution was filtered to remove undissolved sand and sediments, added to a 50-mL (or 10.0-mL) volumetric flask, and diluted to volume with deionized water. Serial dilution was performed using 1000-µg/mL stock solutions (SCP Science, Champlain, New York) to produce calibration curves from 0.05 to 5 µg/mL. A solution detection limit for all three metals was around 0.05 µg/mL, which converts into a detection limit of around 10 µg/g using the following equation:

$$\mu\text{g/g} = \frac{\mu\text{g/mL} \times \text{volume of flask(50.0mL)}}{\text{accurate mass of sample(g)}} \quad (1)$$

Using a smaller volume and accurate mass of 10.0 mL and 500 mg, respectively, would reduce the detection limit to around 1 µg/g.

## Quality Control

Accuracy was initially attempted by using National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) 1566b oyster tissue (Gaithersburg, Maryland) (valid until June 01, 2010). The values of the standards (mg/kg = µg/g) were 2.48 ± 0.08 for cadmium, 0.371 ± 0.009 for cobalt, and 0.308 ± 0.009 for lead. A final volume of 10.00 mL and an accurately weighed mass of 500 mg were used for the oyster standard. The results (mean of three separate trials with precision less than 5% for all three metals) were as follows: 2.48 ± 0.08, versus 2.55 for cadmium. Cobalt and lead were below the detection limit. The spiking of samples with 0.25 ppm (50 µg/g) produced recoveries for all three metals in the range 92–106%.

## Instrumentation

A Spectra AA-220 FS atomic absorption spectrometer (Varian Associates, Palo Alto, California) with air-acetylene flame was used. Instrumental and operating parameters were standard as provided by the manufacturer.

## RESULTS AND DISCUSSION

The results of the determination of cadmium, cobalt, and lead in 15 randomly selected oysters (from a sack of oysters) are given in Table 1 for both November and December sampling periods. The results (mean, standard deviation, and range) are summarized in Table 2. Initial observations were that the results of all three metals were higher than expected. Several authors<sup>[7,8]</sup> have reported values of low µg/g concentrations for lead and cadmium in various types of oysters from around the world. It was also observed that the oysters had quite a range of metal concentrations, up to three times in the case of cadmium. Once the oysters were shucked, it was noted that there was quite a difference in size with the edible meat. It was postulated that the overall size of the oyster could play a factor in its ability to accumulate a higher concentration of metal.

One area of concern is how homogeneous the oyster sample is. This question was posed in this work with considerations of a larger sampling of oysters, more sampling periods (weekly as opposed to two monthly), or use of the complete

**TABLE 1** Concentration of Cd, Co, and Pb (in  $\mu\text{g/g}$ ) From Two Sampling Periods—“November-11” and “December-12”—for 15 Randomly Sampled Oysters From a Bag of Oysters

Sample no.	Sample weight (g)	Cd	Co	Pb
11.1	0.2563	34.7	24.2	171.7
11.2	0.2520	33.3	22.2	131.0
11.3	0.2567	37.4	23.0	136.4
11.4	0.2526	48.3	27.3	221.7
11.5	0.2549	45.5	24.3	204.0
11.6	0.2558	67.6	32.8	222.8
11.7	0.2534	58.8	27.2	201.3
11.8	0.2548	62.4	29.4	251.2
11.9	0.2497	78.5	28.0	208.3
11.10	0.2545	75.1	31.8	243.6
11.11	0.2525	63.3	30.1	229.6
11.12	0.2513	71.6	20.1	234.8
11.13	0.2597	58.5	28.1	219.5
11.14	0.2530	70.8	28.9	269.2
11.15	0.2542	73.2	32.7	243.9
12.1	0.2512	24.7	32.6	147.3
12.2	0.2502	39.7	33.2	171.9
12.3	0.2530	46.6	39.5	201.6
12.4	0.2518	48.5	40.9	230.3
12.5	0.2510	54.6	45.8	263.0
12.6	0.2520	68.5	44.8	246.0
12.7	0.2540	73.0	46.8	248.0
12.8	0.2537	68.0	48.4	305.3
12.9	0.2559	87.1	44.7	316.2
12.10	0.2537	97.3	57.1	343.0
12.11	0.2559	102.5	51.1	332.2
12.12	0.2507	97.6	57.4	355.0
12.13	0.2501	101.2	51.4	342.7
12.14	0.2501	58.3	57.0	346.6
12.15	0.2551	107.8	52.9	345.0

Note. Sample no. indicates the sample’s month by the number before the decimal point and the day of the month by the number after the decimal point.”

oyster as opposed to an accurate mass of 250 mg. We discussed these options but did not implement them in this work.

It is impossible to determine a single factor that could have caused the higher-than-expected

**TABLE 2** Summary of the Results (Mean,  $\pm$  Standard Deviation, and Range) for 15 Randomly Selected Oysters From an Oyster Sack for Cd, Co, and Pb Concentration ( $\mu\text{g/g}$ ) From November 2007 and December 2007 From West Cove, Southwest Louisiana

Period	Cd	Co	Pb
Nov.	58.6, $\pm$ 15.3, 34.7–78.5	27.5, $\pm$ 3.9, 22.2–32.8	212.6, $\pm$ 39.7, 131.0–269.2
Dec.	73.7, $\pm$ 26.3, 24.7–107.8	46.9, $\pm$ 8.0, 32.6–57.4	279.6, $\pm$ 69.2, 147.3–355.0

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concentrations. It is possible that the oysters accumulated the metals over a period of time. Oysters are known or suspected to be able to concentrate metals from the environment and as noted earlier, this area has a known history of metals contamination. Previous studies have shown that the waters in this area are not particularly high in concentration of these or similar metals.<sup>[1,2]</sup> It was also noted that the concentrations of all three metals were higher in December than November. In December, the water is much colder.

Although difficult to quantify, Hurricane Rita in this area on September 23–24, 2005, has had a direct impact of the fragile ecosystems and could have resulted in churning up of soils and sediments from the pre-1970s period. These soil and sediments are known to have significant concentrations of numerous heavy metals that could be bioaccumulated by the oysters.

This preliminary work has shown the feasibility of determining selected metals in oysters from Southwest Louisiana. A more intensive and rigorous study of oysters over a longer period (November 2009 through April 2010), including the area they inhabit and determinations of other selected heavy metals, is in the planning stage and will be reported in due course.

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The major work in this paper was performed by Chad A. Thibodeaux, who graduated from McNeese State University with a B.S. in Chemistry in May 2008. He is currently in the second year of the Ph.D. program in Chemistry at Louisiana State University, Baton Rouge.

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