Application Submitted

To:	Dr. Arlene Courtney
Program:	Ch 462 Experimental Chemistry
Title of Project:	Analysis of Lead Leaching from Ceramic Dinnerware
Suggested Timeline:	24hrs preparation, 4hrs analysis
Date Submitted:	26 January 2008
Principle Investigator	Proposal #5
Applicant's Contact Information	

Abstract:

Uranium based glaze was used as a colorant for many ceramic ware companies in the early 1900's. The most popular line of ceramic ware was the Fiesta red dinnerware released in 1936 by Homer Laughlin Company. Natural uranium consists of two radioactive and unstable isotopes, both in which decay to a more stable isotope of lead. As the ceramic ware is exposed to acidic food for a long period of time, lead leaching from the dishes poses more of a threat to human health. The purpose of the study is to analyze the amount of lead from the ceramic ware located at Western Oregon University. The concentration of leached lead from the dishes will be analyzed in accordance to the AOAC Official Method used by the FDA Elemental Analysis Manual. The primary method of detection will be the use of a flame atomic absorption spectrometer. The safety of the ceramic ware will be determined by comparing the experimental results of lead concentration to the FDA regulatory guidelines. It is important to prevent any exposure to lead as much as possible; this is why this document proposes to test the ceramic ware for the safety of the students at WOU.

A Proposal to Analyze Lead Concentrations from Ceramic Dinnerware

Introduction

A popular house ware product that was released in 1936 was the Fiesta line ceramic ware from Homer Laughlin Company. The most popular color that was produced from Homer Laughlin was the Fiesta red color. The red colorant used for the dishes was uranium oxide based. Homer Laughlin wasn't the only company to use uranium glaze during this time, in fact most ceramic ware companies that used orange/red colorant was radioactive (i.e. Bauer Pottery Company). The production of Fiesta ceramic ware was discontinued in 1973, however many pieces can still be found around the U.S[1].

Uranium consists of two isotopes in nature; U-235 and U-238, which have different half lives that decay to Pb-207 and Pb-206 respectively. Both uranium isotopes are radioactive and unstable, and will emit nuclear particles until it becomes lead [2]. The United States government has made numerous efforts to reduce the exposure of lead in the environment. In 1978 the use of residential lead-based paint was banned, and in 1986 the use of lead additives in gasoline was prohibited. The Clean Air Act of 1990 further helped by banning the sale of leaded gasoline and lead-containing solders for canned food. These efforts have helped reduce the amount of lead-blood levels in the U.S. population from 88.3% (1976-1980) to 2.2% (1999-2000). Regardless of this reduction, lead poisoning is still a huge public health concern. In 2005, the reported cases of lead poisoning in the U.S. were 45,000 [3].

According to the International Standards Organization, 24 hour exposure of acid to uranium glazed ceramic ware can produce measurable amounts of lead at room temperature[4]. In 2005, the U.S. Food and Drug Administration ("FDA") released a regulatory action guidance for

lead contamination in ceramic ware. The safe amount of lead consumed from various dishes is as follows; flatware (3.0ppm), small hollowware (2.0ppm), cups/mugs (0.5ppm), large hollowware (1.0ppm), and pitchers (0.5ppm)[5]. FDA Consumer magazine has reported the acceptable daily lead intake for children less than 6 years old is 6μg, for pregnant woman is 25 μg, and for adults is 75 μg. If lead is consumed, the body stores the lead mainly in bone where it can collect for many years. Lead affects the functioning of brain neurotransmitters, which can then affect other bodily systems and their functions. In children, high levels of exposure can be associated with anemia, affect kidney functions, and even produce seizures, coma and death. In adults, lead poisoning can contribute to high blood pressure and reproductive organ damage. In higher levels of exposure, adults can also experience severe brain defects, seizures, coma, and death. Once symptoms of lead poisoning occur, the damage is usually irreversible. FDA Consumer reported four contributors of lead poisoning come from; lead paint (top contributor), occupational hazards, drinking water, and ceramic ware[6].

Western Oregon University ("WOU") has presented ceramic ware bowls/plates manufactured from California Pottery and J. A. Bauer Pottery Company, which are believed to contain lead and could leach from contact with acidic foods. This document proposes a scientific procedure for analyzing the amount of lead from the ceramic ware located at WOU. The objective of this experiment is to:

1. Examine the levels of leached lead from ceramic ware at WOU.
2. Determine if the levels of lead meet the FDA's requirement for ceramic ware.

Justification

In 2006, the FDA released a portable lead test system that was issued to more than 115,000 certified care locations nationwide. This new device will provide health care providers easier access and more opportunities to detect and treat lead in humans before effects of damage occur[7]. However, this device only tests humans after they have been exposed to lead. The FDA has to approve newly created products for lead and other contaminants, but ceramic ware created years ago still lingers in shops ready for someone to buy. Exposure to lead needs to be prevented as much as possible, this is why this document proposes to test the ceramic ware for the safety of the students at WOU.

The FDA Elemental Analysis Manual uses a flame atomic absorption spectrometer ("FAAS") as the primary method of detecting lead concentrations from ceramic ware. The manual's method of analysis uses the AOAC Official Method for lead extraction from ceramic ware. This method also includes contamination control procedures, which will guarantee non-contaminated leached solutions to provide efficient results[8]. This manual will be used as a guideline when analyzing the ceramic ware from WOU, and the results from the FAAS will provide the necessary information for determining if FDA regulations are met. The time required for analysis is 24hrs leaching time, and possibly 4hrs of analysis. The chemistry lab at WOU will be open for this analysis and all equipment will be provided by WOU for easy access.

Literature Review

Many journal articles found during research for this proposal contained the same (or similar) analysis technique for determining lead from ceramic ware. This technique consisted soaking the ceramic ware in 4% acetic acid for 24hrs, then using an FAAS or inductive coupled

plasma atomic emission spectrometer ("ICP") for analysis. The research from Elledge et al, published in the Journal of Environmental Health, tested suspected ceramic vessels for lead. The vessels were tested with an ICP, but for lower levels of detection a graphite furnace atomic absorption spectrometer was used. From their results, 13 out of 25 vessels soaked with acetic acid failed FDA regulations[9]. This method of analysis was not used for this proposal, due to the unavailability of the ICP at WOU.

Other research reviewed was that of Cabrera et al, whose work was published in the Analytical Chemistry Journal. This article tested the concentrations of lead in dairy products, and the instrument used for analysis was an FAAS. The results from this study discussed how dairy products packed in glazed ceramic containers showed higher concentrations of lead than dairy products packed in different containers[10]. This procedure did not, however, test the lead content of the ceramic containers themselves and therefore was not used for this proposal.

The FDA is an agency that is part of the Department of Health and Human Services. It is the FDA's duty to ensure that products like; food, cosmetics, and medicines are safe to the general public[11]. The analytical testing of these products by the FDA assures that their elemental analysis manual will provide an efficient technique for lead analysis. Therefore, this proposal will use the same methods and materials as outlined from the AOAC Official Method in the FDA manual[12].

Methods

This procedure follows the AOAC Official Method for extraction of lead from ceramic ware[13].

Apparatus: a Buck Scientific 200A Atomic Absorption Spectrometer will be equipped with a light source specific to lead (hallow cathode). The instrument will be run at a wavelength of

283.3nm for solutions of high lead concentration, and 217.0nm for solutions of low lead concentration. The instrument response will be measured and recorded in absorbance. The gas supply for this instrument will be atomic absorption grade acetylene.

Materials: manual pipettes with a capacity range of 10µl-10ml and clear plastic tips will be used for the solutions. Plastic or Teflon lab-ware (beakers, graduated cylinders, sampler cups, containers etc.) will be used for all purposes except in preparation of standards and leaching solutions. For safety, vinyl gloves and protective eye-ware will be worn by all scientists performing this analysis.

Reagents: deionized water will be used for all water dilutions concerned with preparing any solutions, household detergent solution will be used for all purposes of cleaning plastic lab-ware. One volume of glacial acetic acid will be diluted with 24 volumes of water to produce 4% acetic acid in enough quantity for the analysis. A stock lead solution of 1000ppm will prepared by dissolving 1.5985g of lead nitrate diluted with 4% acetic acid to one liter (or commercially bought). Calibration solutions will also be prepared in concentrations of; 1ppm, 2ppm, 3ppm, 4ppm, 5ppm and 10ppm.

Sample Preparations and Leaching

The method blank and test vessels will be filled ¼ inch from the top with 4% acetic acid, and the volume of each extraction is recorded. Each vessel will then be covered to prevent evaporation, and leached for 24hrs at 22±2°C. After 24hrs if any evaporation occurred, 4% acetic acid solution will be added to compensate. The leach solutions will then be stirred with a plastic rod and transferred by pipette to a plastic container.

Instrument Calibration and Testing

The method blank is to be aspirated and the instrument set to zero. Each calibration standard will be aspirated starting with the lowest concentration first. After each standard is aspirated, the method blank will run again. The leached solution will then be aspirated three times with the method blank run in between. The absorbance recorded from each solution and standard will be plotted against concentration to determine the concentration of lead in the leached solution.

Western Oregon Universities Policies and Procedures

"WOU complies with Hazard Communication Procedures pursuant to OAR 437-155-015/1926.59(e) Federal "Right to Know" Law. This policy is designed to identify, educate, and establish a procedure for chemical hazards employees face in the workplace.[14]" The chemists performing this analysis has the education required as described by this policy.

Budget and Timeline

The time needed for this procedure is 24hrs for leaching and no longer than 4 hrs for analysis. The standards used will either be prepared fresh unless commercially prepared solutions are available. All of equipment and solutions required will be provided by the university. Some costs that WOU may encounter are:

- A 1L glass bottle of glacial acetic acid from J.T. Baker -- $87.15.
- 500mL glass bottle of 10% nitric acid from Mallinckrodt -- $25.05.
- 100mL bottle of 1000ppm lead stock solution from J.T. Baker -- $68.90.
- Deionized water from Mallinckrodt if needed*: 1L - 4L -- $16.70 - $43.20.

*Western Oregon University has treated water available for chemistry lab use.

References

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