Lead contamination in candies have been recognized as a health problem since the 1800’s (Acum 1820). Since that time lead contamination has been reported in paints, children’s toys, and in foods. Lead poisoning has many physiological effects on cardiovascular function, reproduction and can also cause neurological damage to brain neurons resulting in encephalopathy. Children are more susceptible to lead poisoning due to the fact that their body systems, including brain and gastrointestinal tracts, are still developing. The provisional tolerable weekly intake (PTWI) set by the World Health Organization (WHO) is 25 mcg per kg of body weight (Rankin et al. 2005). This is equal to 0.35 mg of body weight per day. Assuming a 33 pound (15 kg) child consumes 20g per day of the Mars dark chocolate containing 0.06 mcg/g of lead, with absorption of 40% (ATSDR 1999), he or she would be acquiring 1.4% of the PTWI from this source alone. Chocolate can possibly increase blood lead levels among children if precautions are not taken.

Purpose and Objectives
The purpose of this study was to compare the chocolate products of three manufacturers from three different countries to discover the lead contamination in each product. The three countries selected for this study are United States, Europe and Japan. The objectives of this study was to first determine the lead levels in the chocolates produced by these manufacturers and whether these companies conform to FDA regulations. The second purpose was to evaluate the levels of lead contamination and whether they may prove harmful in children’s diet.

Methods and Materials
Sample collection and preparation. The manufacturers of chocolate chosen for this study included Mars Incorporated, and Hershey Company from the United States, Lindt and Sprung from Europe, and Royce Confectionaries from Japan. Both the milk chocolate and dark chocolate flavors of these manufacturing companies were prepared and tested. Two samples of each company’s milk and dark chocolate were prepared by using the COPAL standard preparation outlined in the Cocoa Producers Alliance protocol (2006). The samples of each prepared chocolate were digested with chosen chemical reagents to remove sugars and other additives in the products. This preparation provided the cocoa base product of the candies to be analyzed.

Milk and dark chocolate values were compared and seemed to show a difference in lead contamination. The dark chocolates that were tested showed to have a higher content of lead, whereas milk chocolate had a considerably lower level of lead contamination (Figure 3). The difference in lead contamination among milk and dark chocolates is significant according to the p-value of the data being less than 0.05.

The samples of digested chocolate preparations were tested using Atomic Absorption Spectroscopy (AA). The analytic method followed the methodology employed by the Cocoa Producers Alliance (COPAL 2006). The samples were aspirated through an acetyl flame in the AA spectrometer and lead readings were recorded. Each manufacturer’s chocolates, both dark and milk, were tested and aspirated three times. The contamination levels of the chocolate samples were reported in ppm (mg/L). The results of the chocolate samples were compared statistically by ANOVA.

As the FDA ruling is optional, one potentially significant source of lead in a child’s diet is chocolate products. Traces of lead in chocolate as a result of the soil cocoa beans are grown in. However, the levels of lead in cocoa beans from the plants are low compared to traces of lead in the final chocolate products (Rankin 2005). This suggests that most of the lead contamination in chocolates occur during processing of confectionery products. The U.S. Food and Drug Administration (FDA) has issued a recommended limitation of 0.1 ppm (parts per million) of lead allowed in chocolate and other confectioneries (COPAL 2005). This is equivalent to 0.1 mg of lead per gram of chocolate. However, the compliance of chocolate confectioneries to this FDA ruling is optional.

Although some manufacturers approached the limit of 0.1 ppm, none of them exceeded the recommended limit set by the FDA. However, this limit should be reevaluated according to the values of lead in some chocolates and the harmful effects that they may have on children if consumed in excess. The provisional tolerable weekly intake (PTWI) set by the World Health Organization (WHO) is 25 mcg per kg of body weight (Rankin et al 2005). This is equal to 0.35 mg of body weight per day. Assuming a 33 pound (15 kg) child consumes 20g per day of the Mars dark chocolate containing 0.06 mcg/g of lead, with absorption of 40% (ATSDR 1999), he or she would be acquiring 1.4% of the PTWI from this source alone. Chocolate can possibly increase blood lead levels among children if precautions are not taken.

Lead is a naturally-occurring substance and can contaminate foods from various avenues. Chocolate contamination may be due to different factors. According to this study’s data, dark chocolate has a significantly higher amount of lead contamination compared to milk chocolate. The difference between these two flavors are the amount of cocoa liquor in the added milk in the milk chocolate. Dark chocolate contains more cocoa liquor than milk chocolate. This difference in cocoa liquor amount may be the route of lead contamination in chocolates. Though further study and investigation is needed to confirm the actual mode of lead contagion, the processing of cocoa liquor may be reassessed as a possible route of lead contamination.

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