STUDIES TO CHARACTERIZE HEAVY METAL CONTENT AND MIGRATION FROM RECYCLED POLYETHYLENE TEREPHTHALATE

A Thesis

presented to

the Faculty of California Polytechnic State University,

San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Agriculture

by

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December 2014

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ABSTRACT

Packaging Materials account for 31% of the world's municipal solid waste. Agencies like the Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease Registry (ATSDR) are pushing for the increased use of recycled thermoplastic materials. Polyethylene terephthalate (PET) is a commonly recycled thermoplastic which is used to package ready-to-eat fruits and vegetables. Most recycled polyethylene terephthalate (RPET) packaging materials contain heavy metal catalysts, the most common being antimony. The recent increased use of recycled plastic materials has been suspected as the source of increased human heavy metal exposure. In this study, cadmium, chromium, nickel, lead and antimony were quantified in post-consumer RPET rigid containers and films using inductively coupled plasma-atomic emission spectrometry (ICP-AES). Two hundred samples were tested of which 29 were found to be contaminated with heavy metals in the parts-per-million (ppm) range. Chromium was found in all the contaminated sample replicates at an average level of 8.18 ppm. Cadmium was found in all the contaminated samples as well. Lead was found in 90.4% of the contaminated samples and concentrations ranged from a low of 0.02 ppm to a high of 0.36 ppm. Nickel was found in 96.4% of the contaminated samples while antimony was found in 97.6% of the samples. Due to limited sample material, 22 of the 29 contaminated RPET rigid containers and films were tested for heavy metal migration into a 5% citric acid:water solution (w/v) or deionized water. Samples were subjected to prolonged storage at 7.2 or 22.2°C for 1, 7 or 14 days, or were exposed for 5 minutes to microwaves from a 1700-watt microwave oven set to 70% power before analysis.

Leachate values were at ppb levels but were often below the ICP-AES Limits of Detection which were at also the ppb level, whether calculated for deionized water or 5% citric acid in water. No measureable levels of heavy metal were detected for any sample exposed to water, regardless of treatment. For samples exposed to 5% citrate and stored or microwaved, only chromium and nickel leached at measurable levels, and the number of RPET's releasing measurable chromium and nickel increased with microwaving compared to the same plastics stored at 22.2 or 7.2°C. Since leaching was calculated as µg/L of heavy metal lost from the entire inner surface (1021 cm^2) of a retail salad bag, actual exposure to heavy metal would be much less than measured in this study as retail fruit and vegetable packages and microwaveable pouches usually contain very little liquid in order to increase food safety. The results therefore suggest the potential for little migration of heavy metal from recycled PET to whole or fresh-cut fruits and vegetables when held at ambient or refrigerated temperatures, or when microwaved.

ACKNOWLEDGMENTS

I would like to thank everyone who has helped me prepare for and produce this thesis. My parents have always been there for me and always believed I could achieve incredible things. My committee, especially Dr. Brown and Dr. Vorst, guided me along every step of the way to completing this thesis. I truly could not have done this without you two.

I would like to dedicate this thesis to my father, Ross Whitt, who succumbed to lung cancer on April 17th, 2013. He made me promise him that I would stick with school and complete this thesis after his death. I love you so incredibly much and miss you every day!

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