Mass Spectrometry And Gas Chromatography Techniques Used To Identify Toxic Chemicals Leaching From BPA Free Plastic Polymers

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Abstract and Introduction

Synthetic polymers, commonly known as plastics, contain traces of compounds, which under the right conditions can become soluble and capable of dissolving or "leaching" from their parent material. These compounds are known to leach out of plastic when exposed to heat and/or UV light. Research suggests that under certain conditions such as scratching, heating, or even exposing to light, plastic additives can dissolve or "leach" into solution. This study examines dissolved organic chemicals, using gas chromatography, that potentially leach from BPA (Bisphenol A) free plastic bottles exposed to heat and UV light. BPA is known to acts as a hormone disruptor by mimicking estrogen. Gas chromatography was performed to detect leached compounds. The findings of this research may be beneficial to consumers interested in learning about the chemical contaminates capable of leaching from BPA-Free plastic and may be harmful to human health.

All of the bottles used were BPA-free with the recycle number 7 (referred to as "other") which are polycarbonate and epoxy resins plastics (that typically contain BPA). It has been known to cause health risks in newborns and growing fetuses. We chose to run our tests on BPA-free bottles in an effort to possibly identify if the BPA "substitute" used in manufacturing the bottles and other identified dissolved chemicals are potentially hazardous to consumer health.

Methods

Below are the experimental steps taken consecutively. (Bottle 1 was the control, Bottle 2 was exposed to heat, and Bottle 3 was exposed to UV light.) Each bottle was exposed to the respective condition simultaneously for 24 hours.

3 clear #7 BPA free plastic bottles filled with MQ H_2O half the volume of the bottle.

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Bottle 1 (DARK): Sample was left in a dark closet until day of analysis

Bottle 2 (HEAT): Sample was subject to a dishwashing cycle with soap and hot water and then placed in a dark closet until day of analysis.

Bottle 3 (UV LIGHT): Sample was subject to UV light outside for four hours on a sunny day with temperature fluctuating between ~70°F-75°F

↓

50 grams of each sample were emptied into 3, 250mL round bottom flasks. Another flask was filled with 50 grams of MQ H_2O as a control

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Each flask was completely frozen in a dry ice and acetone bath (-78°C) then freeze dried on the lyophilizer for several hours

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Washed 250mL round bottom flasks with DCM twice, then transferred into small vials and blown with nitrogen

↓

Washed with 20% MeOH and 80% MQ H_2O

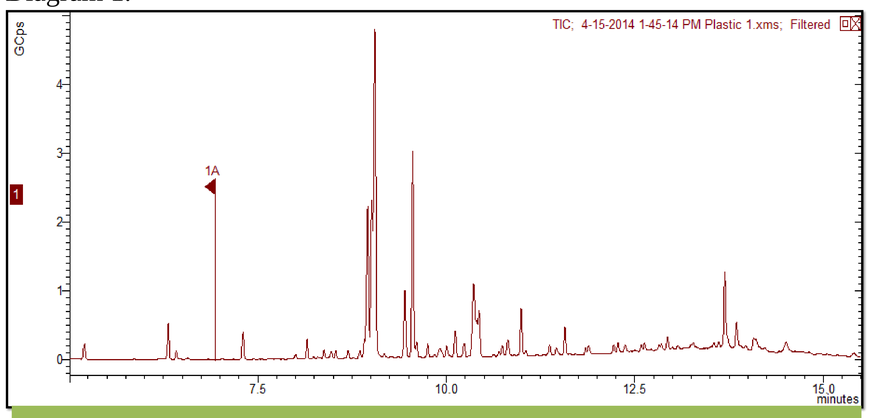
↓

Samples run through GC-MS machine and analyzed

Results

The significant compound found to leach out of all the bottles was 2-[1-(4-cyano-1,2,3,4-tetrahydronaphthyl)] Propanenitrile also known as SAN Trimer. What was most surprising besides the quantity was the fact that even the control sample leached the same compounds.

Diagram 1.



Chemical of Concern

Name	Formula	Peak [min]
2-[1-(4-cyano-1,2,3,4-tetrahydronaphthyl)] Propanenitrile **Aka: SAN Trimer (THNP)**	$C_{14}H_{14}N_2$	8.956

Discussion

SAN Trimer (THNP):

This compound displayed the highest peak in the above GC analysis. SAN Trimers like these are formed during the manufacturing process for polymers of acrylonitrile and styrene. Relatively new to modern toxicology, SAN Trimers have only been studied in depth within the past decade and a half. The Reich Farm Superfund Site contamination brought attention to the human toxicity of these compounds. Further studies have shown compounds like these to cause elevated rates of brain and central nervous system cancer in children under the age of five and under the age of twenty.

Conclusions and Further Study:

Evidence of leaching in BPA free bottles like these is clear, and confirms that potentially hazardous chemicals are constantly dissolving into consumer's bottled drinking water no matter the condition of the bottle. Quantification of the total amount of dissolved chemicals is necessary to further investigate the magnitude of the risk these leached chemicals have on human health. Also, further study of how the specific chemicals effect the body will give a better understanding of how to better address the health problems that result from ingestion.

Fig. 1. (above) Reusable plastic water battles used in experiment

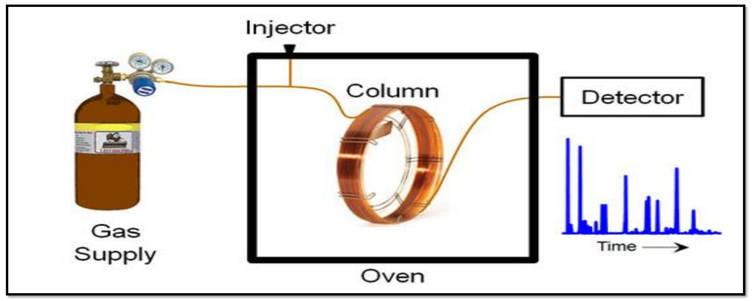


Fig. 2. (above) Gas Chromatography schematic.

Fig. 3. (above) Lyophilizer machine with samples connected

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