

The Effect of Microwave Radiation on Polypropylene Used in Food Containers

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ABSTRACT

The following research was done to better understand the quality of plastics used in every day life. Microwave radiation was used because it is the most universally used source of radiation that may be responsible for the deterioration of plastic and its components. The question of whether or not any potentially hazardous organic compounds were being introduced into food by the plastic itself was also addressed. Although there were not any specific answers given to these questions, the quality of the plastics commercially available were evaluated. The results proved that the plastics used in everyday food containers are of good quality and do not leach enough hazardous material to be in anyway harmful.

Keywords: *Plastic, food safety, microwave radiation*

INTRODUCTION

Plastics have been a huge part of everyday life since the fifties. In fact, most people could not imagine life without plastic. The plastics industry is a relatively new industry. Plastics were not commercially available until Leo Baekeland distributed Bakelite in 1909. Today the industry offers hundreds of different types of plastics and millions of different products. The plastics industry has now grown to a multibillion-dollar business that shows no signs of slowing.

Although plastics are very helpful, society still seems to equate plastic with trash. One concern with using so much plastic is the safety of such an unnatural material. Many organic materials have been found to be carcinogenic if used excessively. Even the polyethylene used in plastics can cause health problems if ingested in large enough quantities.

The heavy use of recycled materials in plastic processing is also a major health concern. Since plastics are organic substances, they can pick up other organic materials during recycling. Many of these organic substances, such as toluene, diazinon, and chloroform are potentially hazardous to humans. These chemicals can leach into food from the containers if they are not properly sterilized. Many studies have been done to alleviate these concerns. The FDA has forced companies to spend millions of dollars to make sure the plastic we eat from is safe.

This experiment is designed to study common plastic dishware to find any organic materials, namely aromatic and chlorinated hydrocarbons, that may leach out into food. Since the companies that make plastic dishware have such high standards, no plasticisers or polymer waste is expected. However, the experiment may find something in the way of organic waste. The results will be compared to the strict FDA standards for recycled plastics and to the EPA requirements for drinking water. The data will then be used to decide if the plastic dishware we as consumers eat on is, indeed, safe.

MATERIALS AND METHODS

Three different types of microwaveable plastic dishware were used. They included Rubbermaid, Master Chef, and Rice Cooker. One liter of water was put into each dish and then put into the microwave for ten minutes. This time was chosen to ensure the water was boiling. This was done twice for each dish. Then the same was done with a liter of vinegar to see if possibly the pH of the water would change the results. These samples were then treated with Pentane to remove the organic waste from the water. The pentane was dehydrated with sodium sulfate and allowed to evaporate. Then the organic residue was weighed. A standard sample was run using glassware and put through the same procedure. Each sample also had a one-milliliter sample taken from it to be run through a Gas Chromatograph/Mass Spectrometer (GC/MS) machine to further the study of the organic waste.

RESULTS

After weighing each of the samples and comparing them with the standard, it was apparent that no reasonable conclusions could be drawn from this part of the research. As the table 1 shows, the standard had as much or more waste than two-thirds of the samples. This must be a result of the pentane used. Although the pentane used was 99.9% pure, there are still some impurities.

Table 1.

Sample	Company	Liquid	Waste
Standard		Water	2.2 ppm
A	Master Chef	Water	5.3 ppm
B	Rubbermaid	Water	1.6 ppm
C	Master Chef	Water	4.0 ppm
D	Rubbermaid	Water	2.3 ppm

E	Rice Cooker	Water	2.8 ppm
F	Rice Cooker	Vinegar	3.5 ppm
G	Rice Cooker	Water	2.1 ppm
H	Master Chef	Vinegar	1.3 ppm
I	Rubbermaid	Vinegar	1.1 ppm
J	Rice Cooker	Vinegar	1.8 ppm
L	Master Chef	Vinegar	1.6 ppm
M	Rubbermaid	Vinegar	1.0 ppm

The results of the GC/MS spectrums of each sample were mainly blank. Only two of the samples showed anything on the GC/MS spectrums. They were samples A and C, both of which were Master Chef water samples. Graph 1 portrays the results of one of the samples. Most of the peaks are noise either from the column used or from the pentane used. The Gas Chromatograph records the retention time of different molecules. Most of these retention time peaks are either of compounds found in the machine or in the pentane used. The peak at 17.85 however turned up differently. As graph II shows the computer library called the peak toluene. You will also note that the computer's accuracy was only 69%, which is not good enough for an accurate estimate. Graph III shows that the mass spectrometer gave the highest molecular weight as 197. This is almost double the molecular weight of toluene. This means whatever was found is not in the computer's library. Upon closer examination, the sample did have a high peak at 90-94, which is conducive to toluene.

The second spectrum that showed positive results is graph IV. This graph shows a much smaller amount of waste. All of the peaks were identical according to the mass spectrometer. These results are in graphs V and VI. The computer's library had a difficult time placing this molecule as well. The compound methyl isobutyl ketone, like toluene, has a molecular weight of 100. As graph V shows the compound in question should have a molecular weight of about 208 after fragmentation. This peak also has a strong peak at 57 and 85, which could also represent methyl isobutyl ketone.

DISCUSSION

In the results from graph 1, there were very small amounts of what appeared to be toluene. The compound cannot be toluene since its molecular weight is so much smaller than the mass spectrometer showed. The only solution that could be found was that the toluene came from a much larger molecule fragmented by the GC itself. The exact nature of the small amount of waste proved to be beyond the scope of the machine used. The only thing known for sure is that the waste was very small.

The results indicated support of the original hypothesis. No evidence was found of any harmful chemicals leaching into food from the plastic dishware. Although little was found in the way of previous

research on this subject, it appears from the research that the FDA has control on the manufacturers of plastic dishware. The results were compared to both the FDA requirements for recycled plastics and the EPA requirements for clean water. In addition, the machine used for this experiment has been experimentally proven to find known substances above a concentration of one part per billion. Since this passes all FDA and EPA tests, the plastic containers used are safe.

ACKNOWLEDGEMENTS

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LITERATURE CITED

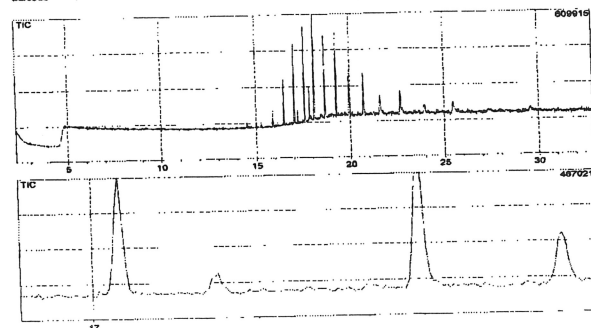
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Graphs

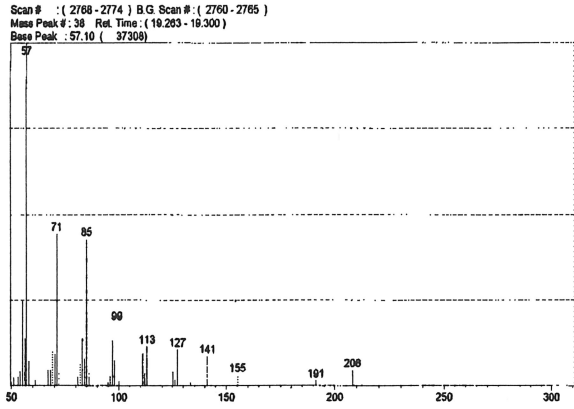
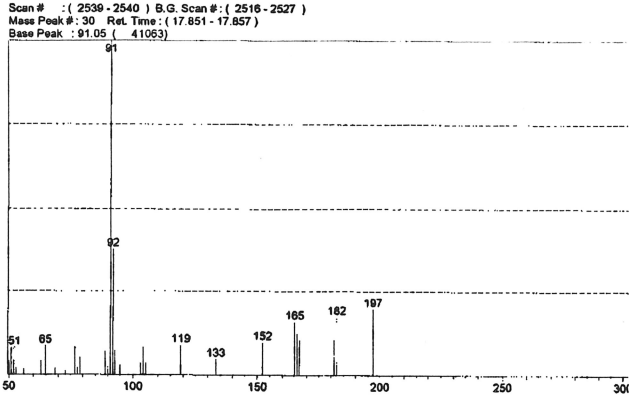
I.

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*** CLASS-5000 *** Report No. = 1 Data : LEVI4C 003 99/03/05 15:30:51
Sample ID : 4c
Sample Amount : 1
Dilution Factor : 1
Type : Unknown
Operator :
Method File Name : LEVI.MET
Vial No : 4
Barcode :
  
```



II.



III.

<Unknown Spectrum>
 Data : LEVHC.D03
 Mass Peak # : 35 Ret. Time : (17.851 - 17.857)
 Scan # : (2539 - 2540) B.G. Scan # : (2516 - 2527)
 Base Peak : 91.05 (41063)

<Hit List>

No	SI	Mol.Wgt.	Mol.Form./Compound Name	CAS No.	Entry	LIB#
1	69	92	C ₇ H ₈ Toluene	108-88-3	796	2
2	68	92	C ₇ H ₈ Toluene	108-88-3	795	2
3	68	92	C ₇ H ₈ Toluene	108-88-3	793	2
4	68	92	C ₇ H ₈ Toluene	108-88-3	794	2
5	68	92	C ₇ H ₈ Toluene	108-88-3	965	1

Toluene \$\$ Benzene, methyl \$\$ Methacide \$\$ Methylbenzene \$\$ Methylbenzol \$\$ Phenylmethane \$\$ Antisul 1a \$\$ T
 \$\$ Methane, phenyl- \$\$ NCI-C07272 \$\$ Toluene \$\$ Toluene \$\$ Toluolo \$\$ Rcra waste number U220 \$\$ Tolu-sol \$\$
 94

Library Name
 (1) NIST62.LIB (2) NIST12.LIB

VI.

<Unknown Spectrum>
 Data : LEVHC.D03
 Mass Peak # : 43 Ret. Time : (19.263 - 19.300)
 Scan # : (2768 - 2774) B.G. Scan # : (2760 - 2765)
 Base Peak : 57.10 (37308)

<Hit List>

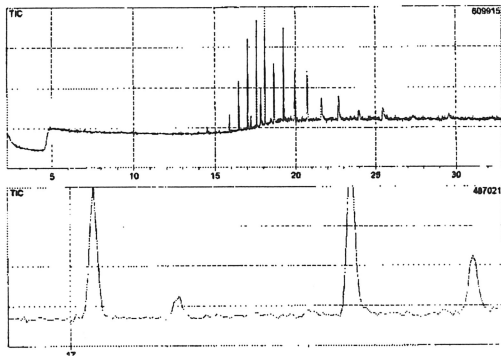
No	SI	Mol.Wgt.	Mol.Form./Compound Name	CAS No.	Entry	LIB#
1	64	100	C ₆ H ₁₂ O Methyl Isobutyl Ketone	108-10-1	1114	2
2	63	100	C ₆ H ₁₂ O Methyl Isobutyl Ketone	108-10-1	1526	1
3	60	100	C ₆ H ₁₂ O Methyl Isobutyl Ketone	108-10-1	1118	2
4	58	100	C ₆ H ₁₂ O Methyl Isobutyl Ketone	108-10-1	1117	2
5	56	100	C ₆ H ₁₂ O Methyl Isobutyl Ketone	108-10-1	1116	2

Methyl Isobutyl Ketone \$\$ 2-Pentanone, 4-methyl- \$\$ Hexone \$\$ Isobutyl methyl ketone \$\$ Isopropylacetone \$\$ MIBK
 \$\$ MIBK \$\$ 2-Methyl-4-Pentanone \$\$ 2-Methylpropyl methyl ketone \$\$ 4-Methyl-2-oxopentane \$\$ 4-Methyl-2-pentanone \$
 \$ iso-CAH9COCH3 \$\$ 4-Methylpentan-2-one \$\$ Methylpentan-2-one \$\$ Methyl butyl ketone \$\$ Hexon \$\$ Isobutyl-methyl
 eton \$\$ Ketone, isobutyl methyl \$\$ Methyl-isobutyl-cetone \$\$ Methylisobutylketon \$\$ Methylisobutylketone \$\$ Methyl
 ozobutylketon \$\$ 4-Methyl-pentan-2-on \$\$ 4-Methyl-2-penta

Library Name
 (1) NIST62.LIB (2) NIST12.LIB

IV.

==== CLASS-5000 ==== Report No. = 1 Data : LEVHC.D03 990305 15:30:51
 Sample : 46
 ID :
 Sample Amount : 1
 Dilution Factor : 1
 Type : Unknown
 Operator :
 Method File Name : LEV.MET
 Vial No. : 4
 Barcode :



V.