Removal of Pharmaceuticals from Water by Charcoal Filtration

Taylor Baum, Rachel Centofanti, Allison Guerrieri, Samantha Mock, Tayah Turocy
Advisor: Dr. Nina V. Stourman

Introduction

Pharmaceuticals often contaminate water which is a cause for concern because of the health effects these chemicals may inflict upon humans [1,2].
The objective of this study was to determine whether water bottles with charcoal filters could remove pharmaceuticals from water. Two anti-inflammatory drugs, Tylenol and aspirin, and two antibiotics, ampicillin and kanamycin, were tested (Fig.1). Solutions containing pharmaceuticals were filtered through three different systems: a BRITA water bottle filter, a BOBBLE water bottle filter, and a filter containing activated charcoal (Fig 2). For anti-inflammatory drugs, the amount of compounds remaining in the solutions after filtering was evaluated by High Performance Liquid Chromatography [3]. Disc diffusion sensitivity test on bacterial plates was used to observe the removal of antibiotics.

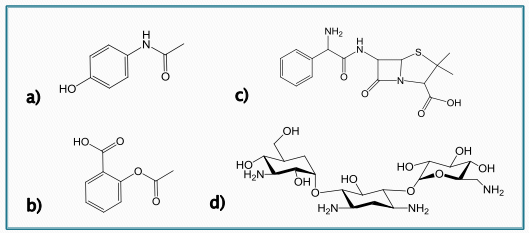

Figure 1. Structures of **a)** Tylenol, **b)** aspirin, **c)** ampicillin, and **d)** kanamycin.

Figure 2. Filtering systems: **a)** BRITA (**F1**), **b)** BOBBLE (**F2**), **c)** Activated charcoal filter (**C**)

References

1. P M. Bradley *et al.* Environmental Pollution 2014,193, 173-180
2. M.I. Vasquez *et al.* Journal of Hazardous Materials 2014 279,169-189
3. Rifai N *et al.* Clinical Chemistry 1996, 42:11,1812-1816

Preparation of Solutions of Tylenol and Aspirin

1mg/mL solutions of Tylenol or aspirin in water were prepared and then filtered through our three systems (Fig. 3).
The filtered solutions were mixed with 50% methanol in 1:1 ratio and analyzed using High Performance Liquid Chromatography (HPLC) (Fig. 4 and 5).

Figure 3. Preparation of solutions for filtering.

Analysis of the Filtered Solutions

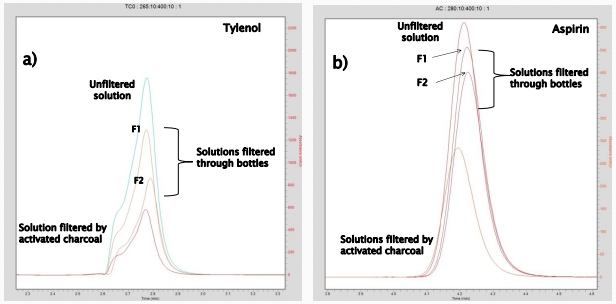

Figure 4. HPLC chromatogram for Tylenol **(a)** and aspirin **(b)** analysis in four solutions.

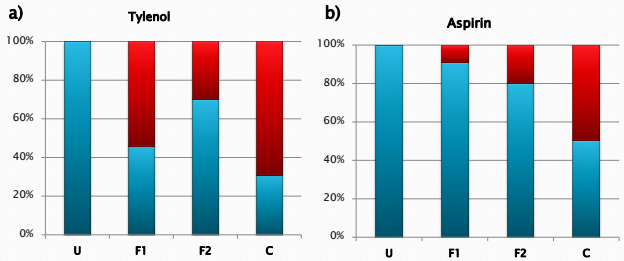

Figure 5. Percentage of Tylenol **(a)** and aspirin **(b)** that was filtered out (red) and remained (blue) in solutions:
U – unfiltered; **F1** – BRITA; **F2** – BOBBLE; **C** – activated charcoal.

Acknowledgments

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Preparation of Solutions of Ampicillin and Kanamycin

20 mg/mL solutions of ampicillin or kanamycin in water were prepared and filtered through our three systems. The filtered solutions were diluted several fold and spotted on the paper disks placed on the agar plate where *Escherichia coli* cells were previously spread. The amount of antibiotics left in the solutions was evaluated by measuring diameter of bacterial clearance around each disk after overnight incubation at 37°C (Fig. 6-9).

Analysis of Disc Diffusion Sensitivity

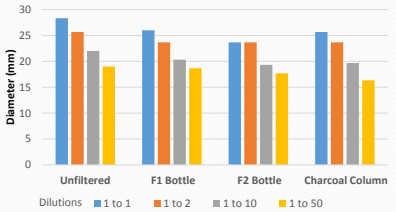

Figure 6. Diameter of bacterial clearance around discs with ampicillin.

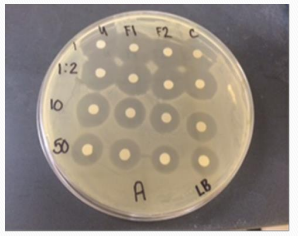

Figure 7. Bacterial growth around discs containing ampicillin.
U – unfiltered; **F1** – BRITA;
F2 – BOBBLE; **C** – activated charcoal.

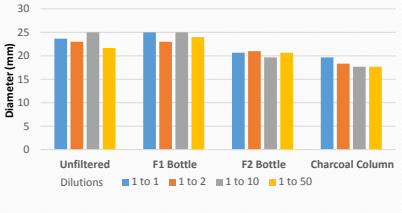

Figure 8. Diameter of bacterial clearance around discs with kanamycin.

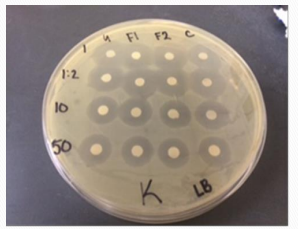

Figure 9. Bacterial growth around discs containing kanamycin
U – unfiltered; **F1** – BRITA;
F2 – BOBBLE; **C** – activated charcoal

Conclusions

Our results show that in the removal of both aspirin and Tylenol, the charcoal column was more efficient than the water bottle filters; however, neither the pure charcoal filter nor the water bottle filters effectively filtered out the antibiotics.