Effects of Water Treatment on *Escherichia coli* Growth

JOCELYNE CHAVELAS, CHRISTY GONZALEZ, NATHAN SORENSEN, AND DR. JOHN RASMUSSEN
Dixie State University College of Health Sciences

Abstract

Over the past decades many diseases such as cancers, autoimmune disorders, and mental disorders have increased. Many causes for this increase have been proposed such as diet, vaccinations, and aluminum toxicity. When looking into diet as a cause, the use of microwaves for cooking could have potential for the rise seen in these disorders. There are many videos available on mainstream media outlets and articles online claiming that plants grown with water which was heated in a microwave show differences in health and growth rates when compared to plants that were grown with non-microwaved water. We wanted to test this theory in a controlled lab environment using tap water treated with a hot plate, microwave, and UV light and observed the effects in the growth of *Escherichia coli*.

Materials and Methods

1. Treat tap water via hot plate to 100 ºC, microwave to 100 ºC, and UV light for 1 hr. Mix thioglycollate powder with water samples by heating to just under boiling (98 ºC). Take pH once cooled.
2. Sterilize broth using with .022 µm sterile filters and inoculate with 1.5 x 10^8 cfu *E. coli* using a MacFarland standard. Incubate for 24 hrs. At 37 ºC.
3. Create serial dilutions with ratios of 1:10, 1:100, 1:1000, 1:10000 using sterile saline.
4. Grow dilutions on MacConkey agar plates split into quadrants (1 dilutions per quadrant). Incubate for 24 hrs. At 37 ºC.
5. Record and observe results.

Results

Table 1. pH values for all treated water samples.

	Hot Plate	Microwave	UV	Control
pH	7.2	7.6	7.8	8.3

Table 2. Bacterial growth estimates following 24 hour incubation period.

Dilution	Hot Plate	Microwave	UV	Control
1:10	4+	4+	4+	4+
1:100	3+	3+	4+	3+
1:1000	2+	2+	2+	2+
1:10000	2+	2+	1+	2+

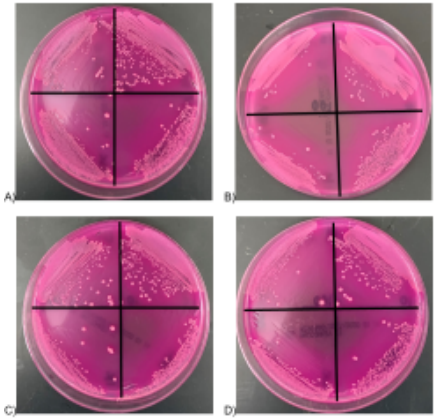

Figure 1 (right). MacConkey plates following 24 hour incubation. For all plates, top right quadrant = 1:10 dilution, top left quadrant = 1:100 dilution, bottom left quadrant = 1:1000 dilution, bottom right quadrant = 1:10000. **A)** Hot plate treated water sample. **B)** Microwave treated water sample. **C)** UV treated water sample. **D)** Control water sample (no treatment).

Discussion

In this experiment we wanted to investigate the idea that different treatments of water could affect bacterial growth. We wanted to test this as a response to several claims on social media that using microwaves to heat up food could kill important nutrients, and therefore be harmful. Several videos and articles on the internet have done experiments with microwaved water being used to water plants and have attributed poor plant growth to the proposed detrimental effects microwaves may have on the quality of the water. Our experiment was done to investigate these theories in a controlled lab environment.

We chose three traditional methods of sterilizing and/or boiling the tap water: via hot plate, microwave, UV light. Laboratory ceramic hot plates are similar to induction ceramic cooktops in that electricity is turned into heat that travels into the coils under the glass and makes the temperature increase. As the temperature of the ceramic increases, the water molecules begin to vibrate and the bonds between them begin to break, thus increasing the water temperature and killing bacteria and viruses that are susceptible to boiling temperature. Microwaves heat up water by channeling heat energy into it via electromagnetic radiation. The microwaves pass through the water and supply enough energy to make the molecules within vibrate at a higher frequency and produce heat energy. A UV light sterilizes water through UV radiation which destroys the genetic material of bacteria and viruses in the water. We hypothesized that if these methods are harmful, sterilizing and/or boiling the tap water would also destroy any nutrients in it and thus prevent growth of the E.coli in the broth.

Several studies have been conducted on heat and nutrient conservation. It is well known that certain nutrients such as proteins and water-soluble vitamins are heat-labile. This may be harmful when it comes to certain foods such as baby formula where it is crucial to maintain a high nutrient density (Kilshaw, 1982). However, there are other studies showing that heat may be useful in the pre-treatment of foods before they are commercially available because it may help in conserving some of the nutrients that could be otherwise lost without heat preservation (Pham, 2018).

Our results did not show any significant differences in the growth of the E.coli, suggesting that treatment of water or food using these methods does not kill any nutrients within it. Limitations of our study include not being to do proper colony counts due to having large lawns of bacterial growth on the plates, and not using another medium to test with the water such as plants or food.

Conclusions/ Future Directions

Although there is a popular belief that treatment of water or food with microwaves affects the growth of plants and destroys the nutrients in food, no specific evidence supports these claims. In this experiment, we treated water using three methods (heat, microwave, and UV light) to test their effects on microbial growth. Our results suggest that treatment of water does not affect liquid broth used to grow E.coli.

Research suggests that there may be both advantages and disadvantages to treating water and food with the methods tested in this experiment. Therefore, more research is needed to validate these claims. In future experiments it would be helpful to do further dilutions of the broth in order to perform the standard (viable) plate count method to be able to quantify the number of bacteria present in each dilution. We could have perhaps seen significant differences in the growth of the bacteria that we did not see in the present experiment. We would also have chosen another medium to use our water with such as food or plants due to the different nutrients found in them, compared to E. coli, that could be affected by the water.

References

Kilshaw, P. J., Heppell, L. M., & Ford, J. E. (1982). Effects of heat treatment of cow's milk and whey on the nutritional quality and antigenic properties. Archives of disease in childhood, 57(11), 842–847. https://doi.org/10.1136/adc.57.11.842

Pham, N. D., Martens, W., Karim, M. A., & Joardder, M. (2018). Nutritional quality of heat-sensitive food materials in intermittent microwave convective drying. Food & nutrition research, 62, 10.29219/fnr.v62.1292. https://doi.org/10.29219/fnr.v62.1292

Acknowledgements

We would like to thank the Medical Laboratory Science Program at DSU for providing us with the funding and facilities to complete our research, as well as Dr. John Rasmussen for his guidance in our project.