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### Why Your Clothes Could be Killing You: The Detection of BPA in Clothing Using Fluorescence Spectrophotometry

Bella Bevel

*Ouachita Baptist University*

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J.D. Patterson  
School of Natural Sciences

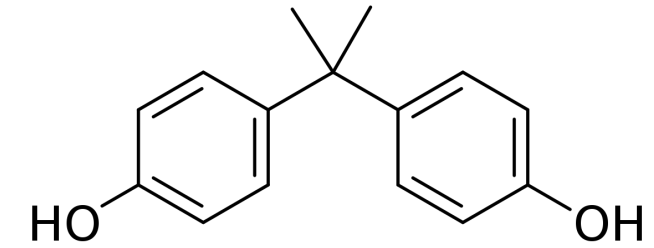
# **Why Your Clothes Could be Killing You: The Detection of BPA in Clothing using Fluorescence Spectrophotometry**

Ouachita Baptist University Department of Chemistry

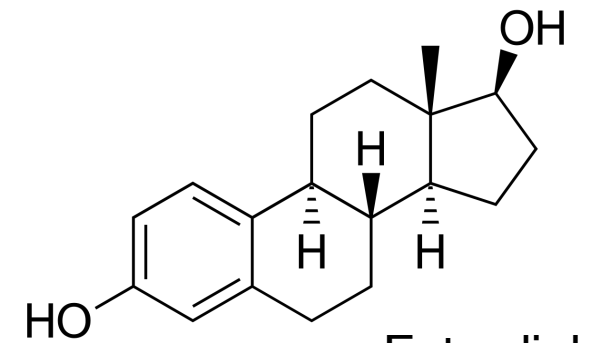
Isabella Rushing

# Background on BPA

- Originally considered as a replacement for estradiol in 1930s
- By the 1950s, BPA was used in production of plastic products
- Traditionally attributed to polycarbonate products, but has been found in items such as baby bottles, feminine hygiene products, food packaging, and toothbrushes
- Considered an endocrine disruptor and has been implicated in a variety of health issues including...
  - Cancer
  - In-vitro developmental disorders
  - Fertility problems (in males and females)
  - Diseases affecting the thyroid



Bisphenol-A



Estradiol

# Exposure to BPA

- Typically ingested through food, water, and contaminated air
  - More recently, consideration of direct tissue exposure through feminine hygiene products
- Consideration of health concerns by government began in the 1990s
  - BPA is still allowed to be used in many products and its use is vastly unregulated
- The US considers 5mg/kg of body weight “safe”
  - EU considers 2 ng/kg of body weight to be “safe”
  - Various news outlets have reported high levels of BPA in clothing, however published literature is scarce
- This could indicate a new avenue of human exposure: dermal absorption

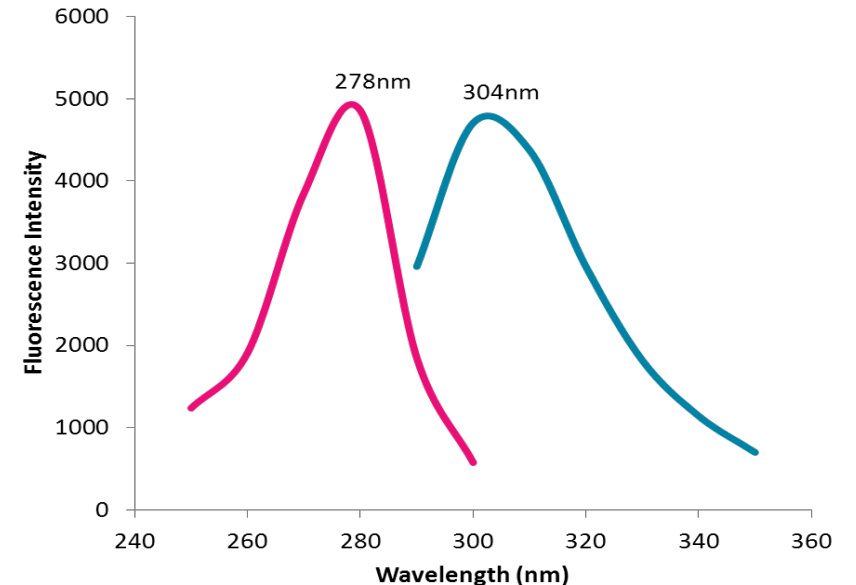
CDC (2017). *Bisphenol A (BPA)*. Centers for Disease Control and Prevention National

Biomonitoring Program. [https://www.cdc.gov/biomonitoring/Bisphenol\\_A\\_FactSheet.html#:~:text=General%20exposure%20to%20BPA%20at,results%20in%20short%2Dterm%20exposure.](https://www.cdc.gov/biomonitoring/Bisphenol_A_FactSheet.html#:~:text=General%20exposure%20to%20BPA%20at,results%20in%20short%2Dterm%20exposure.)

NIEHS (17 Jan, 2023). *Bisphenol A (BPA)*. National Institute of Environmental Health Sciences. <https://www.niehs.nih.gov/health/topics/agents/sya-bpa/index.cfm#:~:text=The%20primary%20source%20of%20exposure,majority%20of%20daily%20human%20exposure.>

# Research Background

- Determine if there is BPA in clothing, and if so, approximate how much
  - Athletic wear- polyester/spandex blends
  - Two of the most popular synthetic materials used in clothing
- How?
  - Fluorescence spectrophotometry
- BPA is a fluorescent compound
  - Excitation at 278 nm
  - Emission at 304 nm
- Draw BPA out of clothing and measure concentration of BPA at a wavelength of 304 nm



# Sample Preparation

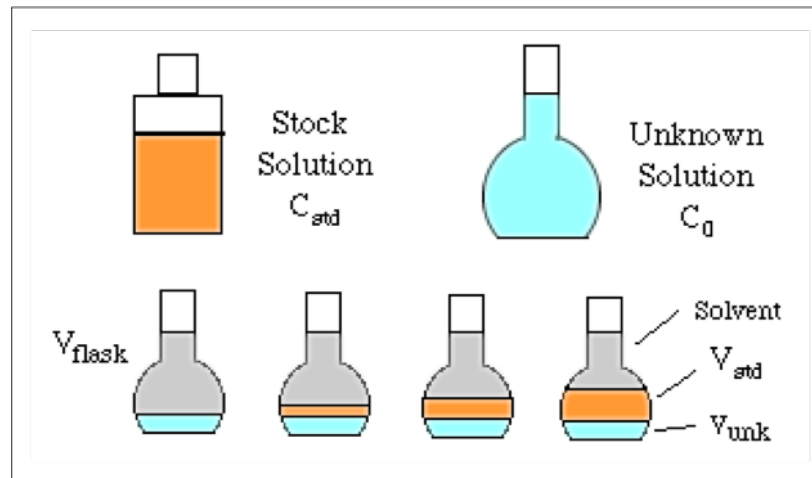
- Three test groups
  - 100% cotton
  - 95% polyester / 5% spandex
  - 90% polyester / 10% spandex
- Clothing cut into 4" x 1" strips
  - Three strips of cloth for each point of measurement
  - Cut into smaller pieces for easier submersion
- 10 beakers filled with 100 mL of 1:1 methanol water
- Cloth submerged in methanol water for various amounts of time
  - 0 min, 20 min, 40 min, 1 hr, 1.5 hrs, 2 hrs, 3 hrs, 4 hrs, 5 hrs, 6 hrs
  - Measured BPA leaching over time



Thread from leggings on a fluorescence microscope

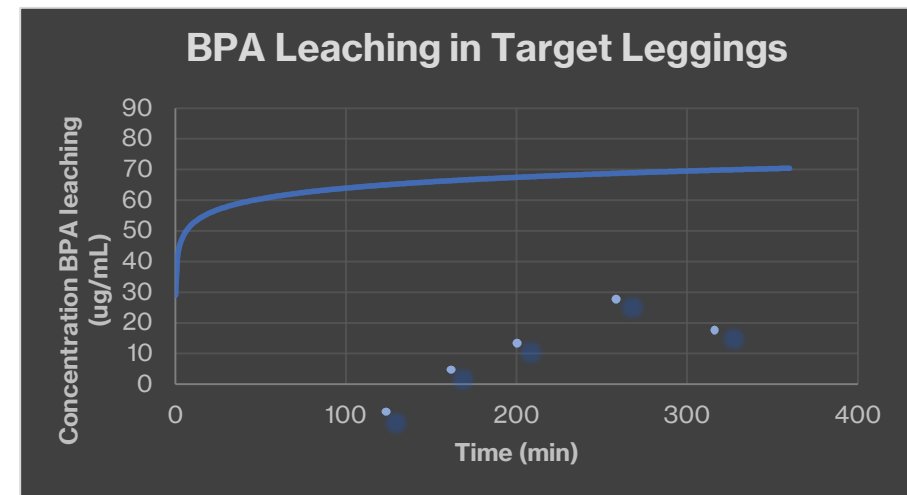
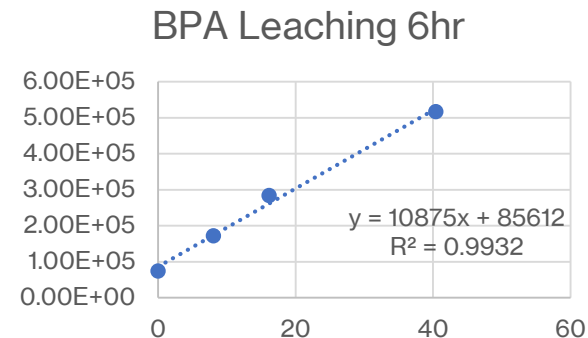
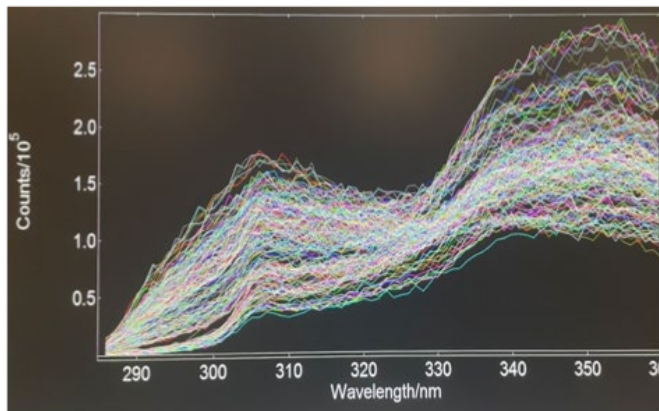
# Standard Addition

- Standard Addition Method used for analysis
  - Uses linear regression to increase experimental control
  - Addition of 5 mL test solution to 5-25 mL volumetric flasks for each time point
  - Made a stock BPA solution (approx. 40 ug/mL of BPA in 1:1 methanol water)
  - Add increasing amounts of stock solution to the 25 mL flasks
  - 0 mL, 1 mL, 2 mL, 5 mL, 7 mL
  - 1:1 Methanol water added until flask reached 25mL mark



# Sample Analysis

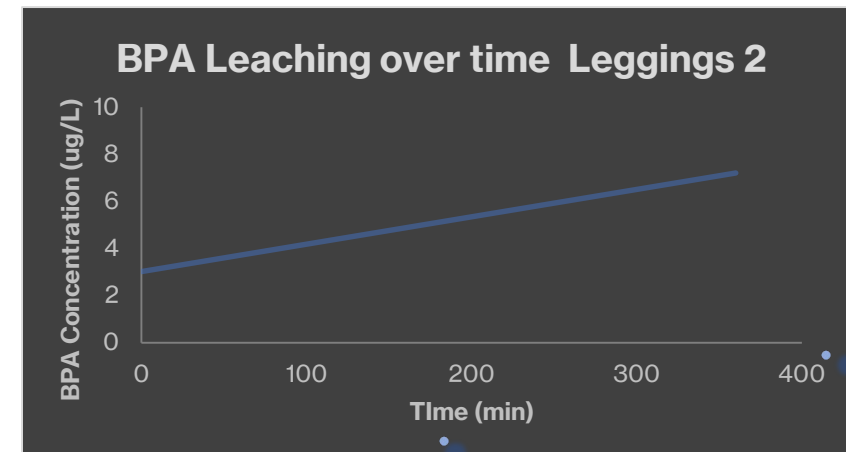
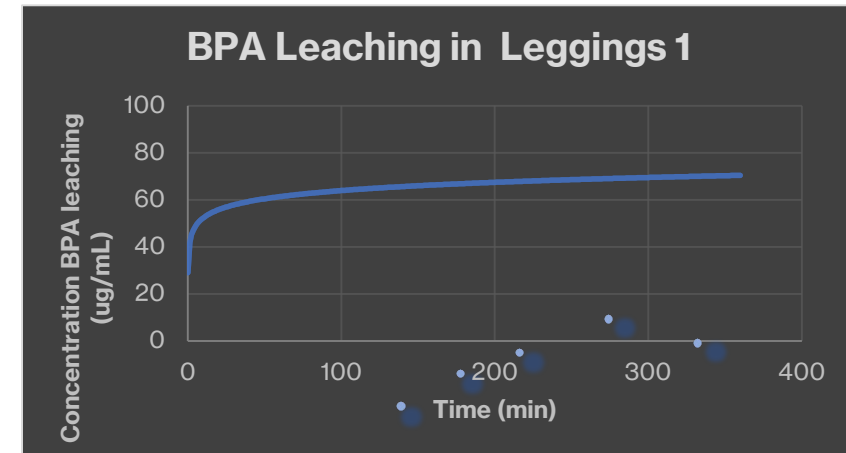
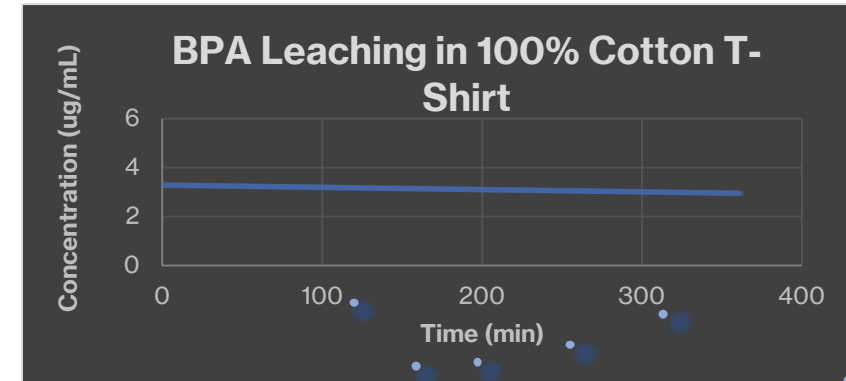
- Analyzed using Edinburgh Instruments FS-5 Spectrofluorometer
- Samples from each flask analyzed in quadruplicates
- Plotted concentrations from each flask for each time point
- Determined the X-intercept using the fit line (linear of least squares analysis)
  - Absolute value of X-intercept = BPA concentration in test solution
- Combined total all points to make one graph
  - This showed total BPA leaching over time





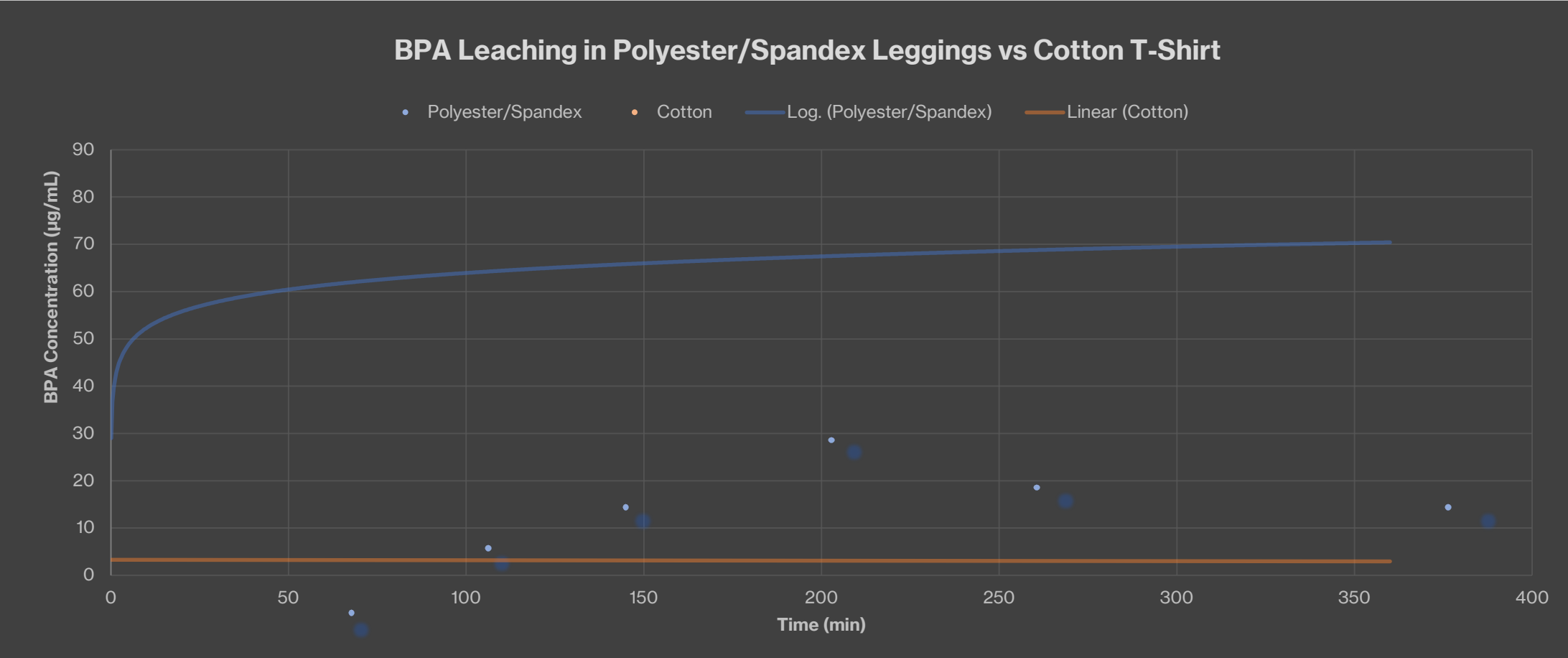
# Sample Comparison

- Compared the leaching of three test groups
- 100% cotton shirt
  - No BPA leaching
  - Expected result
- 95 % polyester / 5% spandex
  - Logarithmic graph
  - Approximately 73.43 ug/mL BPA leached after only 3 hours
- 90% polyester / 10% spandex
  - Linear graph
  - Unexpected results
  - Results possibly due to spandex/BPA interaction



# Final Comparison

- Compared Results of the Control and the 95% polyester / 5% spandex clothing



# Implications

- People are being exposed to extremely high levels of BPA in everyday clothes
- Scaling of samples to real clothes

Shirt Size	S	M	L	XL
Shirt Area	1,200 in <sup>2</sup>	1,350 in <sup>2</sup>	1,525 in <sup>2</sup>	1,675 in <sup>2</sup>
Total BPA	734 mg	826 mg	933 mg	1025 mg

- For an average American man (89.7 kg), the “safe” amount of BPA is 493 mg/day
- For an average American woman (77.5 kg), the “safe” amount of BPA is 388 mg/day
- This means that a single shirt contains over 2 times the “safe amount of BPA” that someone can be exposed to in a day! Just from a shirt!

# Future Research

- This finding requires urgent study of this issue
- New directions include...
  - Test different brands of clothes
  - Clothing from different manufacturing sites
  - Washing
  - Leaching of BPA in sweat
  - Effects of time/wears on BPA leaching

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