

Is Nail Polish Toxic? Determining the Concentration of Organophosphates in Nail Polish

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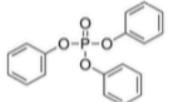
Abstract

Organophosphates can be harmful to humans by damaging acetylcholinesterase, which is an enzyme that is related to the controlling of nerve signals. To test these potentially harmful organophosphate plasticizers that are found in common nail polish brands, High Performance Liquid Chromatography (HPLC) was used. The standards were purchased and used to create a standard curve. This standard curve was then compared to different nail polish samples to identify and quantify organophosphates in popular nail polish brands: Sinful Colors, OPI, and Victoria's Secret. The findings show that the berry nail polish contained the most TPP and the teal nail polish contained the least amount of TPP.

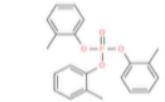
Background



In the 2000s, nail polish companies started phasing out a toxic chemical in their product called dibutyl phthalate. Some nail polish companies replaced dibutyl phthalate with different organophosphates, including triphenyl phosphate (TPP). However, the Food and Drug Administration (FDA) does not require cosmetics to conduct safety tests before they are approved for the market¹. Organophosphates are well known and widely used ingredients in insecticides, most of which are classified as harmful/hazardous to aquatic life. There have been some studies that showed that exposure to organophosphates may be related to lymphoma and leukemia². Their role in nail polish is as plasticizers which prevent the polish from chipping, hold the color of the nail polish better, and improve the flexibility.³ To determine the presence of potentially harmful organophosphate plasticizers in different brands of nail polish, HPLC was used. This work can give consumers a peek into the contents of their nail polishes and prove if they contain a chemical that can be potentially harmful.



Triphenyl phosphate (TPP)



Tris (methylphenyl) phosphate (TMPP)



2-Ethylhexyl diphenyl phosphate (EHDPP)

Methods



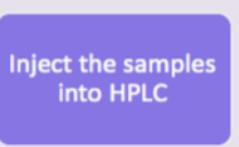
Dissolve nail polish in 1 mL of methanol



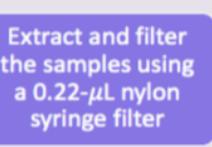
Extract samples twice using 4 mL of methanol and 5mL of acetone:acetate



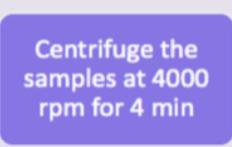
Shake the samples for 30 min on an orbital shaker



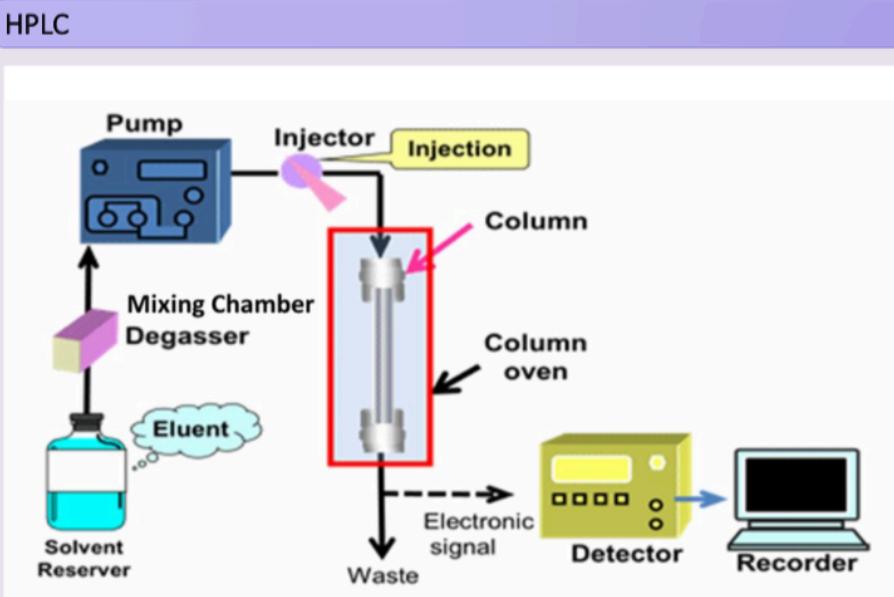
Inject the samples into HPLC



Extract and filter the samples using a 0.22- μ L nylon syringe filter



Centrifuge the samples at 4000 rpm for 4 min



Data



Figure 1: Revlon Grey Nail Polish

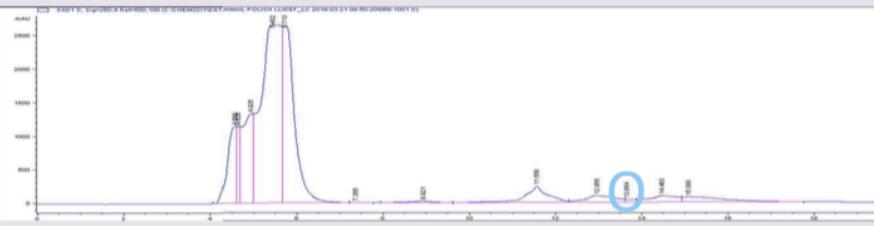


Figure 2: Loreal Purple Nail Polish

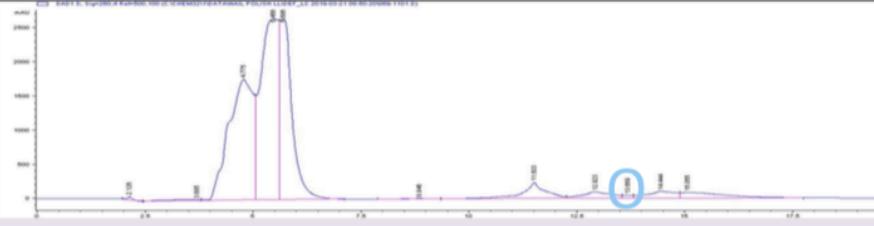


Figure 3: Loreal Teal Nail Polish

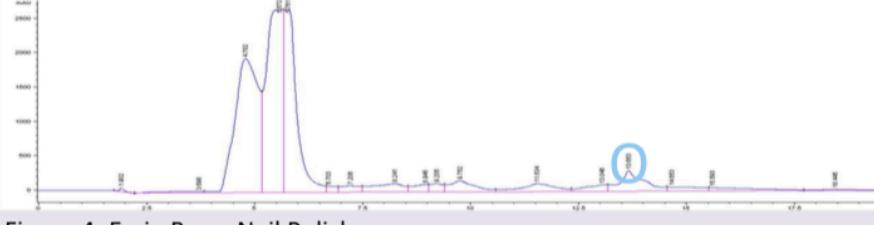


Figure 4: Essie Berry Nail Polish

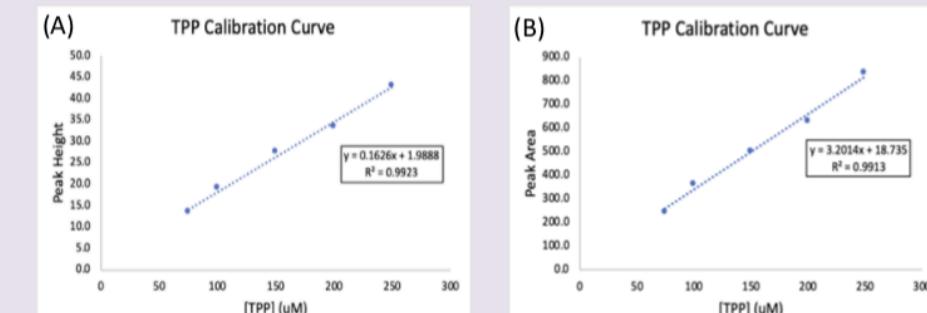
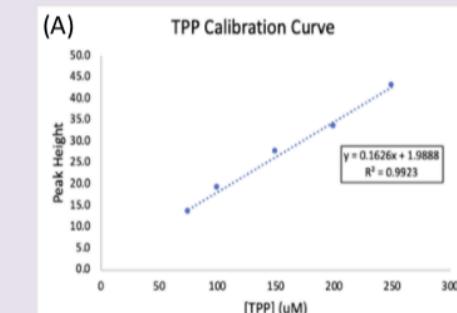


Figure 5: Averaged Standard Curves of TPP Using (A) Peak Height and (B) Peak Area

Nail Polish	Area	Height	[TPP] (μ M) from Area	[TPP] (μ M) from Height
Silver	2387.5	42.8	739.91	250.99
Purple	676.8	45.8	205.56	269.44
Teal	659.4	45.0	200.12	264.52
Berry	11521.0	302.5	3592.89	1848.16

Table 1: Calculated TPP Concentrations from Standard Curves A and B

Conclusion / Future Work

- Standard curve of TPP was created and a linear relationship was seen.
- Each of the samples contain small amounts of TPP in the micromolar to millimolar range.
- The berry nail polish had the highest concentration
- The majority of the samples fell outside of the standard curve.
- Also, the concentrations obtained from using the area under the peak and the peak height differed significantly.
- Thus, it is believed that the peak height is a more accurate representation of the true concentration of TPP in the nail polish samples.
- Extend the standard curve up to 500 μ M for a better representation of expected TPP concentration in samples
- Run samples in triplicate to ensure that the area under the peak and the peak height are accurate.
- Create standard curves of other organophosphates, tris(methylphenyl) phosphate [TMPP] and 2-ethylhexyl diphenyl phosphate [EHDPP], will be made using HPLC. Using the standard curves, concentrations of these organophosphates will be calculated in nail polish samples.

Acknowledgements:

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URCW

References:

1. Young, A. S.; Allen, J. G.; Kim, U.-J.; Seller, S.; Webster, T. F.; Kannan, K.; Ceballos, D. M., Phthalate and Organophosphate Plasticizers in Nail Polish: Evaluation of Labels and Ingredients. *Environmental Science & Technology* **2018**, 52 (21), 12841-12850.

2. Fallon Nevada: FAQs: Organophosphates | CDC HSB. <https://www.cdc.gov/nceh/clusters/fallon/organophosfaq.htm> (accessed 27 January 2019).

3. Kwapieniewski, R.; Kozaczka, S.; Hauser, R.; Silva, M. J.; Calafat, A. M.; Duty, S. M. Occupational Exposure to Dibutyl Phthalate among Manicurists. *J. Occup. Environ. Med.* 2008, 50 (6), 705–711, DOI: 10.1097/JOM.0b013e3181651571

Photos:
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