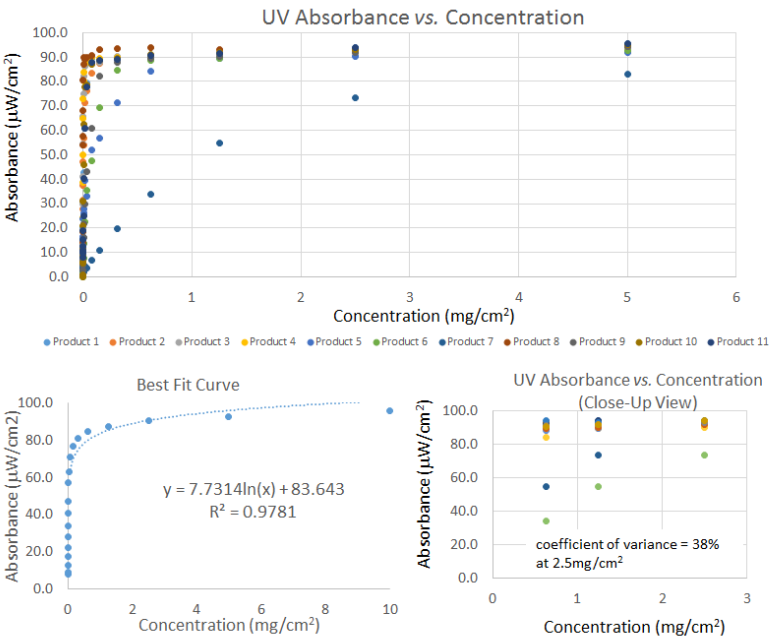
UV Absorbance of Sunscreen Products: Concentration Dependence and Comparison of Efficacy using an *In Vitro* Technique

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Problem: When used properly, sunscreens protect skin from the harmful effects of UV radiation. Sun Protection Factor (SPF) is an *in vivo* technique widely used to compare UVB-blocking ability and is the FDA-approved method of testing products. Sunscreens are tested at a concentration of 2 mg/cm^2, however, investigations show that users typically apply insufficient amounts to achieve full protection. Amounts of 0.39 to 1.0 mg/cm^2 have been found under natural conditions. The relationship between SPF and concentration has been described as both logarithmic and linear. Furthermore, Consumer Reports recently tested 65 products and found wide variation in efficacy, even when used at the recommended concentration. 43% of products failed to achieve the SPF claim on the label. To shed light on these issues, we measured the UV absorbing properties of 11 SPF-30 products and compared the concentration dependence using *in vitro* technique. Methods and Results: An ultraviolet spectrophotometer (General UV513AB) was used to measure UV light (μW/cm^2). UVA/B light was focused on dilutions of each product, (0 to 5 mg/cm^2) and the amount of transmitted light measured in triplicate. The absorbance vs. concentration curves are shown in the Figure. The relationship between absorbance and concentration was logarithmic approaching an asymptote at higher concentrations that are commonly applied to skin. Of concern was high variability in absorbance between products at recommended concentrations (coefficient of variance 38% at 2.5 mg/cm2). Conclusion: This *in vitro* experiment is consistent with previously published *in vivo* studies suggesting that sunscreens effectively block broad-spectrum UV light, however, there is high variability between brands, and it is essential to use recommended doses because there is a strong relationship between concentration and absorbance.



Recent Publications

1. Petersen B, Wulf HC (2014) Application of sunscreen- theory and reality. Photodermatol Photoimmunol Photomed 30:96-101.
2. Jansen R, Osterwalder U, et al (2013) Photoprotection: part 2. Suncreen development, efficacy, and controversies. J Am Acad Dermatol 867:1-14
3. Consumer Reports (2016) Summer survival guide; Your burning questions, answered. July: 21-29
4. Cole C (2014) Sunscreens - what is the ideal testing model? Photodermatol Photoimmunol Photomed 30:81-87
5. Santos Caetano JP, Abarca AP, et al (2016) SPF and UVA-PF sunscreen evaluation: are there good correlations among results obtained *in vivo, in vitro* and in a theoretical sunscreen simulator? A real life exercise. Int J Cosmet Sci 38:576-580

Ariel G. Silverman is a Junior at Weston High School, Weston, MA. This experiment evolved from a high school research project.
Eric S. Silverman is an Associated Professor of Clinical Medicine at Boston University School of Medicine. He is the CEO and Chair of Collaborative Health Accountable Care Organization. More importantly, he is the father of two redheads and a strong proponent of liberal sunscreen use. He was troubled after reading the Consumer Reports, Summer Survival Guide. This abstract describes a family research project to compare the efficacy of sunscreen products and illustrates the importance of proper use.

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Notes/Comments: