



Analysis of Sunscreen UV Protection Utilizing UV-Visible Spectrophotometry

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ABSTRACT

Sunscreen is a staple in any household and with a variety of varying brands and SPF values it can be difficult to decipher which is the best choice. UV-visible spectrophotometry is one useful analytic method to compare the effectiveness of differing sunscreen samples. Absorbance of UVB and UVA radiation can be compared between the sunscreens by looking in the wavelength ranges of 290 to 320 nm (UVB) and 320 to 400 nm (UVA). Between the four varying sunscreens (Up & Up SPF 30 and 50 and Banana Boat SPF 30 and 50), the Up & Up SPF 50 showed greatest absorbance at all wavelength values.

INTRODUCTION

When exposed to UV rays for excessive time health complications can arise including change in pigment, wrinkled skin, atrophy, or malignancy as well as common types of cancer including basal cell carcinoma, squamous carcinoma and malignant melanoma[1]. Daily sunscreen use can help prevent keratinocyte cancers and death due to melanoma [2]. Determining just how much protection sunscreen is truly providing gives consumers an accurate representation of the investment they are making to protect their skin and overall health.

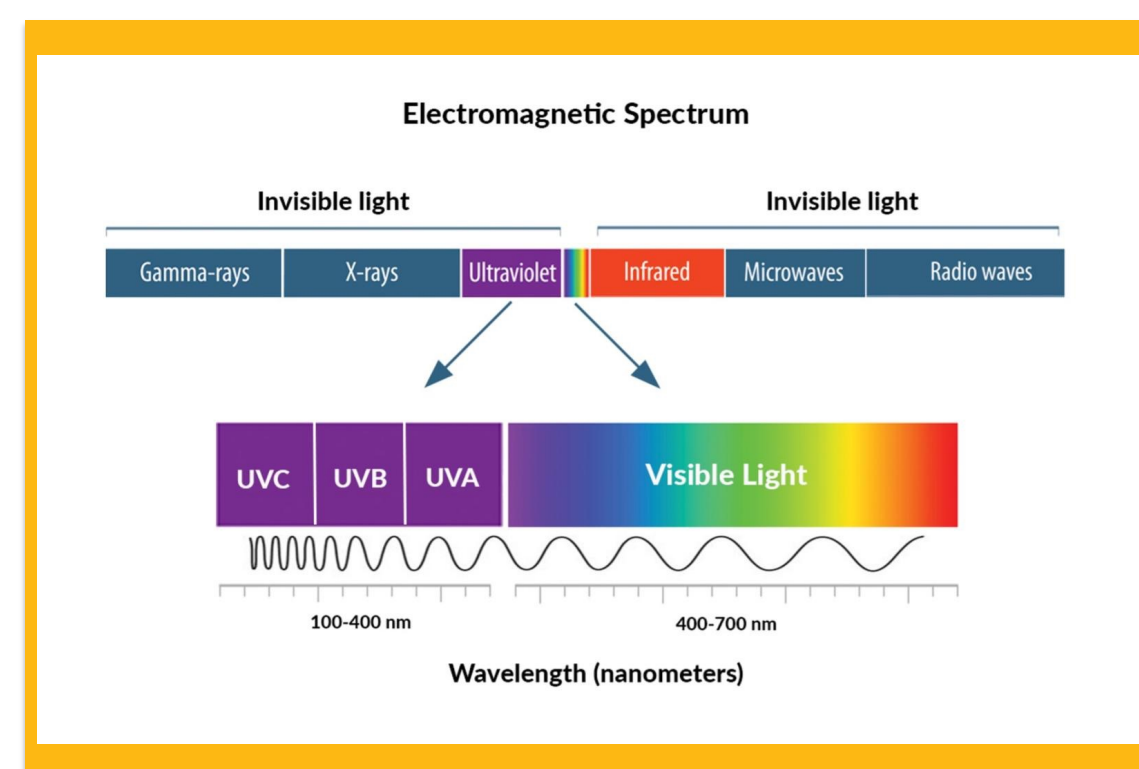


Figure 1. Diagram of light rays and wavelength from the National Eye Institute[3]; Light rays of interest include UVA, UVB, and UVC all which are released from the sun. UVB and UVA are of most interest as they reach earth's surface and are the light rays sunscreen attempts to protect against.

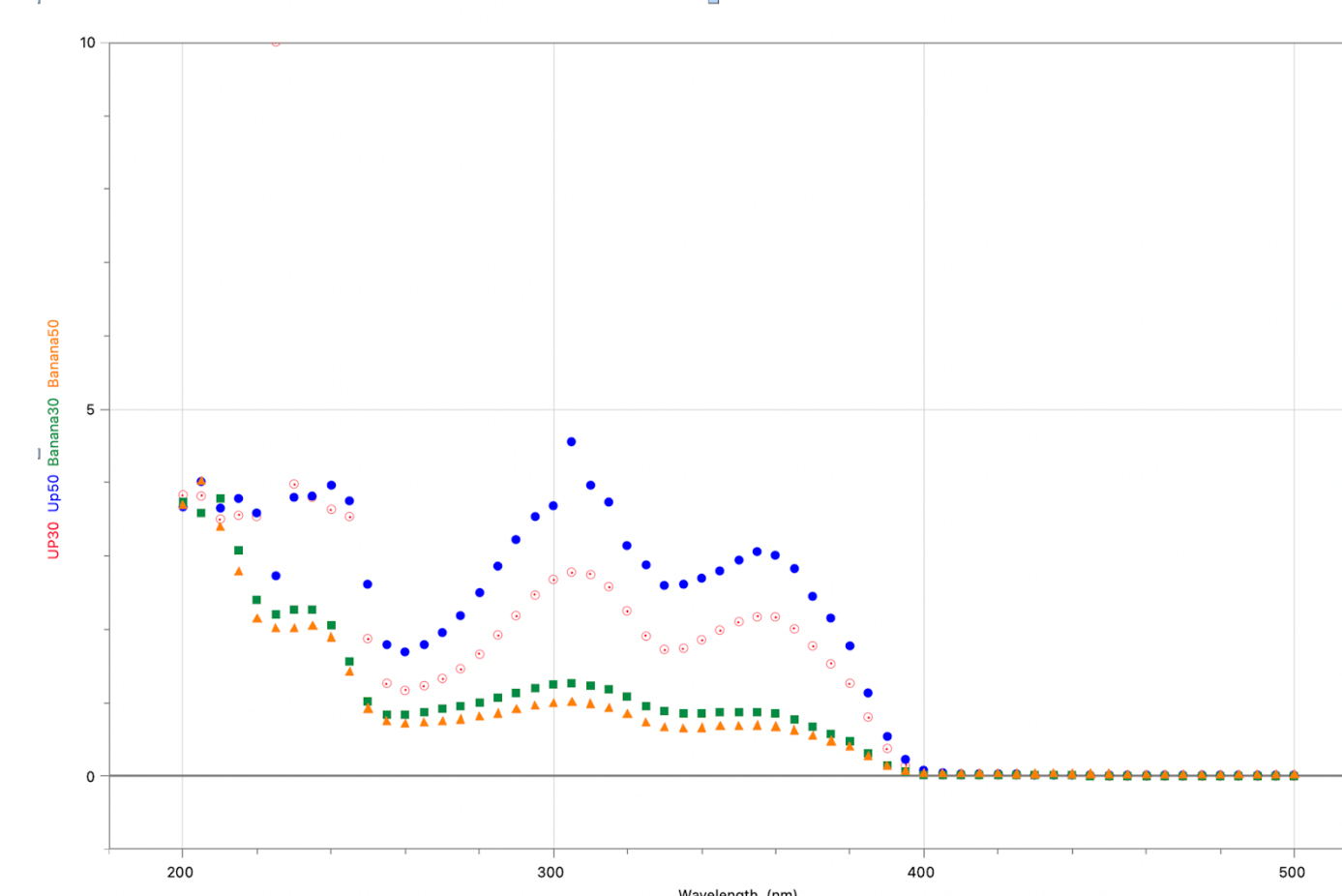
Of the four sunscreen varieties being tested it can be expected to see the name brand (Banana Boat) SPF 50 would show the greatest absorbance values specifically for the UVB wavelength range.

MATERIALS AND METHODS

The sunscreens used were the Up & Up sport sunscreen spray SPF 30 and SPF 50 as well as the Banana Boat sport ultra clear sunscreen spray broad spectrum SPF 30 and 50+. For each sample 0.1200 grams of sunscreen was mixed with 20 mL of 70% isopropyl alcohol. After the first round of UV-vis data collection resulted in excessively high peaks before 400 nm, the samples were diluted. These samples were then diluted with a factor of 100 to 1 to create 5mL samples. To gather the absorbance measurements a double beam UV-vis Spectrophotometer was used with 1 cm cuvettes with a 70% isopropanol blank to calibrate.

FINDING 1: ABSORBANCE BY SPF VALUE

- Both Up & Up sunscreens showed similar peak patterns with peaks from 290 to 315 nm and from 315 to 380 nm
- Both Banana Boat sunscreens showed a similar peak pattern with an obvious peak in the range of 260 to 325 nm and a less obvious shallower less obvious peak
- Up & Up SPF 50 showed significant higher absorbance values to SPF 30
- Banana Boat sunscreens were nearly identical in values
- For the Up & Up sunscreens absorbance values were approximately 1 value higher for lower wavelength and double for higher wavelengths



- For the Banana Boat sunscreens the absorbance differences were 0.1 to 0.2 higher for low wavelengths and 0.01 to 0.02 higher for high wavelengths

Figure 2. Graph of absorbance levels for four different samples
Blue – Up & Up SPF 50
Red – Up & Up SPF 30
Green – Banana Boat SPF 30
Orange - Banana Boat SPF 50

FINDING 2: ABSORBANCE BY BRAND

For both SPF 30 and SPF 50 sunscreens the store brand, Up & Up, showed greater absorbance values for both the UVA and UVB radiation wavelength ranges. All sunscreens showed a scattered pattern for absorbance of some UVC radiation.

Table 1: Absorbance values for specific wavelengths in both UVA & UVB ranges

	Up & Up SPF 30	Banana Boat SPF 30	Up & Up SPF 50	Banana Boat SPF 50+
300.0003 nm	2.674675	1.240579	3.676106	0.973779
319.9911 nm	2.246514	1.074813	3.146533	0.81567
340.0098 nm	1.85499	0.854556	2.688409	0.631637
360.0137 nm	2.163869	0.843229	3.016202	0.648056

For SPF 30 sunscreens the Up & Up sunscreen showed absorbance values ≥ 1 that of the Banana Boat values.

For the SPF 50 sunscreens the Up & Up sunscreen showed absorbance values ≥ 2 that of the Banana Boat SPF 50+ sunscreens.

Both of the Up & Up SPF 30 and 50 showed more obvious and greater peaks in the UVA radiation wavelength range, where the Banana Boat sunscreens showed small bumps with no clear maximum absorbance values.

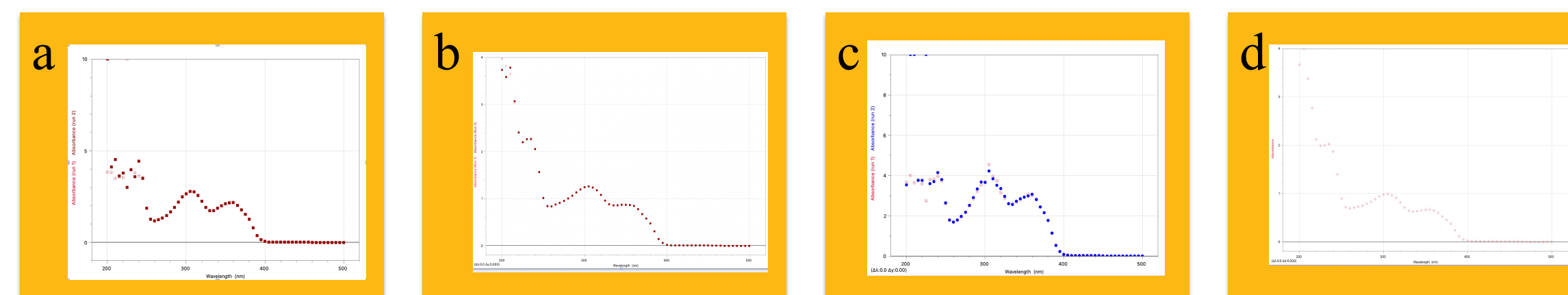


Figure 3. a shows absorbance for store brand SPF 30; b shows name brand SPF 30; c shows graph for store brand SPF 50, d shoes graph for name brand SPF 50

SUNSCREEN ACTIVE INGREDIENTS

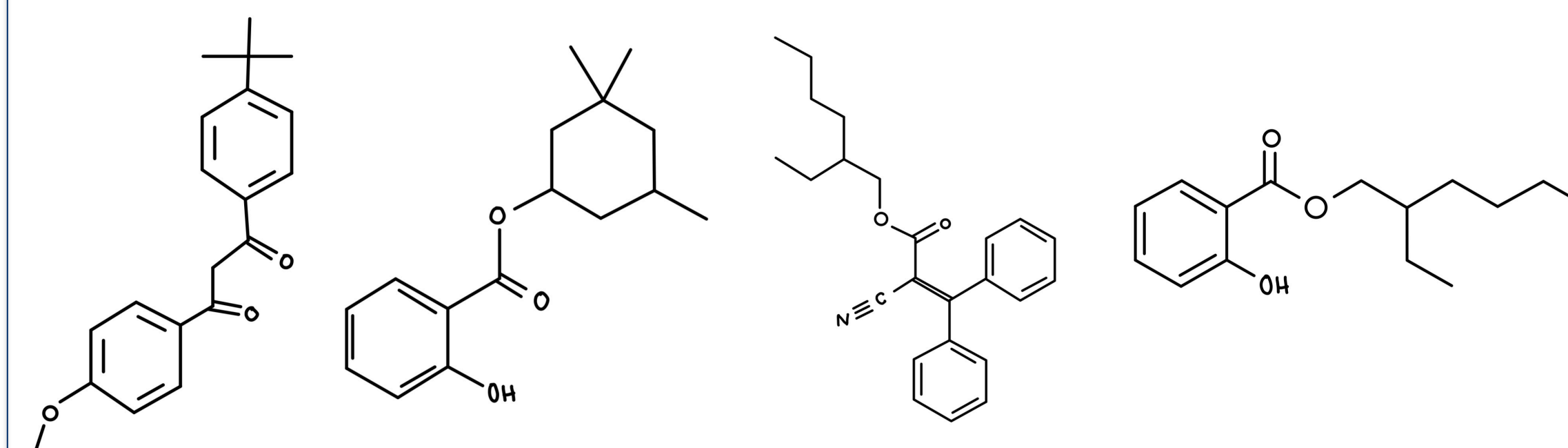


Figure 4. Chemical structures of active ingredients from left to right Avobenzone, Homosalate, Octocrylene, and Octisalate all redrawn from PubChem [4]

- Up & Up SPF 30 – Avobenzone(3.0%), Homosalate(10.0%), Octisalate(5.0%), Octocrylene(2.0%)
- Up & Up SPF 50 – Avobenzone(3.0%), Homosalate(10.0%), Octisalate(5.0%), Octocrylene(4.0%)
- Banana Boat SPF 30 – Avobenzone(2.0%), Homosalate(6.0%), Octocrylene(6.0%)
- Banana Boat SPF 50 – Avobenzone(2.7%), Homosalate(9.0%), Octisalate(4.5%), Octocrylene(6.0%)

CONCLUSIONS

Considering the idea that high price tag means better product as well as the thought that in theory a higher SPF value would provide more protection, it would be a fair assumption to make that the name brand, Banana Boat SPF 50 plus sport spray sunscreen would perform the best. Therefore, it could be expected that this sunscreen would have the highest absorbance values; however, the complete opposite occurred as this sunscreen had the lowest absorbance values. In fact, the Banana Boat brand all together showed lower absorbance values for both UVB and UVA radiation than the store brand, Up & Up sunscreens.

Comparing the two Banana Boat sunscreens there was little difference in the performance of the two when analyzed by UV-vis with the higher SPF showing ever so slightly lower values. Both Banana Boat sunscreens also showed slightly higher absorbance of UVB radiation compared to UVA radiation. When comparing the two Up & Up sunscreens there was a significant difference in the performance of the two with SPF 50 showing, as expected, higher absorbance values. Both Up & Up sunscreens did show a similar pattern with having higher absorbance of UVB radiation in comparison to UVA radiation. In the end all of the data points to one clear winner, when searching for the sunscreen that will provide the most protection against the sun's harmful rays, the Up & Up sport spray SPF 50.

LITERATURE CITED

- ¹D'Orazio J, Jarrett S, Amaro-Ortiz A, Scott T. UV radiation and the skin. Int J Mol Sci. 2013 Jun 7;14(6):12222-48. doi: 10.3390/ijms140612222. PMID: 23749111; PMCID: PMC3709783.
- ²Testing and Evaluating Aerosol Sunscreens. ARPANSA. (n.d.). <https://www.arpansa.gov.au/understanding-radiation/radiation-sources/more-radiation-sources/sun-protection-sunscreen>
- ³U.S. Department of Health and Human Services. (n.d.). *Protecting your eyes from the Sun's UV light*. National Eye Institute. <https://www.nei.nih.gov/about/news-and-events/news/protecting-your-eyes-suns-uv-light>
- ⁴U.S. National Library of Medicine. (n.d.-b). *Homosalate*. National Center for Biotechnology Information. PubChem Compound Database. <https://pubchem.ncbi.nlm.nih.gov/compound/Homosalate#section=Drug-and-Medication-Information>

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