An Introduction to UV–Vis Spectroscopy Using Sunscreens W

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We have introduced an experiment into the general chemistry laboratory in which students study the active ingredients in sunscreens using both quantitative and qualitative techniques. Since this experiment serves as the students' first contact with spectroscopy, it was desirable to limit the calculations to those involving dilutions and Beer's law of one compound. Most sunscreens contain a mixture of several active ingredients, each absorbing light in a different part of the UVB region *(1–2)*. However, some lotions contain a single ingredient: octyl methoxycinnamate (OMC), also called octinoxate.[1]

The extraction of OMC from the lotions was done using 2-propanol as previously described *(1, 3, 4)*. Spectra of standard solutions (made from pure OMC) and the extracts were taken on an Agilent 8453 UV–visible diode-array spectrophotometer. Advantage was taken of the spectrophotometer's "off-site" version of its data-processing program, so that once students had obtained their spectra they could analyze their data on a different computer. Upon viewing the entire spectrum of OMC, students could easily choose the best wavelength for creating a Beer's law plot to use in their data analysis.

In a second, qualitative part of this experiment, students were asked to devise a method to rank sunscreens by visually comparing the quantity of UV light absorbed by sunscreens of different SPF (sun protection factor) values.[2] The SPF of a sunscreen is an indicator of its ability to absorb UVB light (290–320 nm), with absorbance being proportional to $\log_{10}$SPF *(3, 5)*.

For this experiment, advantage was taken of the fact that UV light can cause fluorescence when it interacts with appropriate materials *(5)*. The students were given an assortment of small items such as fluorescent rocks, fluorescent plastic pieces, or chunks of plaster of Paris that had been painted with fluorescent paint.[3] The students had to devise a method to compare the protection given by different sunscreens when UV light was shone on these items.

Since some of our laboratory sessions meet at night, a source other than sunlight was sought. The UV light was provided by a simple handheld lamp such as the ones used for analyzing TLC plates.[4] The students chose several pieces of a particular kind of small fluorescent item, made sure they all fluoresced about the same degree in the absence of sunscreens, and then placed them in 10 mL beakers so they could line up 3–5 of them under the lamp simultaneously.

Although many comparison techniques were attempted by the students, the most successful was the use of equal-concentration extracts (in 2-propanol) of the sunscreens, with the small fluorescent items being submerged in these solutions.[5] They observed that sunscreens of low SPF allowed for more fluorescence than did those with high SPF.

Hazards

2-Propanol is flammable and should not be ingested. Care should be taken to prevent exposure of skin or eyes to UV light.

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WSupplemental Material

Instructions for the students are available in this issue of *JCE Online*.

Notes

1. Specifically, Neutrogena Sunless Tanning Lotion contains 6% OMC and Vaseline Intensive Care "Renew and Protect" Moisturizing Lotion contains 1.25% OMC.

2. Sunscreens containing more than one UV-absorbing compound were used in this exercise.

3. It was important to choose items that responded instantly to UV light. UV-beads (*6–8*) take variable quantities of time to attain their full color intensity when exposed to faint UV light, so they were very frustrating to use. The rocks, paint, and plastics mentioned here had an instantaneous response.

4. These lamps possess narrow emission bands at 254, 312, and 365 nm, representing UVC, UVB, and UVA light, respectively. We found this to be an easily-managed replacement for sunlight.

5. To facilitate this approach, students were provided with stock solutions of sunscreen extracts that were more concentrated than could be used to differentiate the sunscreens, so the students still had to dilute all of the solutions to find a distinction between sunscreens. All of the stock extracts had been made by extracting 20 g of sunscreen, with 1 liter of 2-propanol.

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