Automated Sun Protection Factor (SPF) Analysis of Sunscreen using UV-Vis

The increasing awareness of the risks of skin cancer with sun exposure requires that sunscreen products be appropriately tested and labeled. The numerous possible sunscreen formulations demands that a rigorous analysis method be available.

Introduction

Sunscreens work by either reflecting or absorbing the ultraviolet (UV) radiation before it reaches the skin. The UV-A and UV-B region (400 - 290 nm) is the spectral region that must be blocked for effectiveness of the sunscreen. Whether organic or inorganic, the active ingredient that shields the skin from the sun must be present in sufficient quantity and uniformity to ensure skin protection.

The traditional method for sunscreen analysis is based on a quantitative analysis of a diluted sample. A series of standards based on different concentrations of the active ingredient are measured and a quantitative method developed based on Beer's Law, **A** = **abc**. Where, **A** = the absorbance value of an analyte band; **a** = the absorptivity coefficient of the analyte band - a constant; **b** = the pathlength - generally considered a constant; and **c** = analyte concentration.

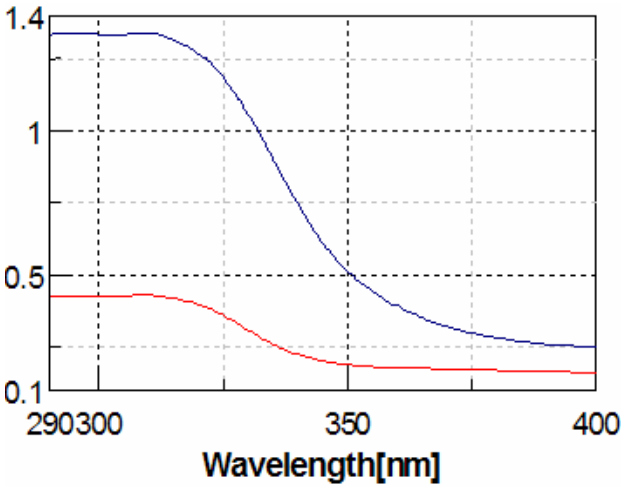

Figure 1. Sunscreen spectral scans.

By contrast, the *in vitro* method developed by Diffey and Robson[1] uses a UV transparent substrate, 3M Transpore™ surgical tape, to examine the final sunscreen formulation. No dilution and no standard preparation is necessary. Simply spread the sunscreen on the substrate, place the sample in the V-530 spectrophotometer and measure the spectrum.

Results and Discussion

Spectra of sunscreen formulations were collected over the spectral range 400 - 290 nm with a 0.5 nm data point resolution on a JASCO V-530 UV-Vis spectrophotometer. A fixed slit width of 2 nm was used with a 'Fast' detector speed and a scan speed of 400 nm/min. Sunscreen formulations were spread onto a 20 cm^2 piece of the 3M Transpore™ tape, the sunscreen covered substrate placed into the sample compartment and several spectra collected from different areas. Representative spectra of two different sunscreen formulations are presented as Figure 1.

product:		SPF B Trials			
company:		Sunscreen Maker, Inc.			
operator:		Working Everyday			
comments:		Latest Formulation			
wavelength [nm]	monochr. protection factor	measured absorbance	transmittance		
290	8.28	0.92	12.09	date(m/d/y):	4/11/02
295	8.37	0.92	11.95		
300	8.27	0.92	12.10		
305	8.26	0.92	12.11	UVA protection factor	3.5
310	8.36	0.92	11.96		
315	7.89	0.90	12.60		
320	7.21	0.86	13.87	UVA / UVB ratio	0.69
325	6.13	0.79	16.31		
330	5.06	0.70	19.76		
335	4.39	0.64	22.78		
340	4.04	0.61	24.73		
345	3.79	0.58	26.37		
350	3.60	0.56	27.78		
355	3.44	0.54	29.05		
360	3.33	0.52	30.00	TOTAL UVA (320-400 nm AVG)	
365	3.17	0.50	31.59	% released UVA radiation	33.10
370	2.94	0.47	33.97	% shielded UVA radiation	66.90
375	2.76	0.44	36.18		
380	2.64	0.42	37.85		
385	2.41	0.38	41.47		
390	2.04	0.31	49.05	SHORT UVA (320-360 nm AVG)	
395	1.72	0.24	57.99	% released UVA radiation	23.40
400	1.56	0.19	63.93	% shielded UVA radiation	76.60
SUNSCREEN PROTECTION FACTOR					7.1

An average sunscreen spectrum is calculated from the multiple sample spectra and the average submitted to a Windows© Excel® macro. The Excel® macro calculates the SPF rating and other relevant data for the sunscreen sample (Figure 2) which is printed as a single page report. The results can be used during formula development or for quality control.

Conclusions

The Diffey Robson *in vitro* SPF calculation is a simple, rapid and universal analysis method for the determination of SPF values of sunscreens using either inorganic and organic screening components. The versatility of the JASCO V-530 spectrophotometer can accomplish the SPF calculation in addition to providing a full suite of UV-Vis analysis capabilities.

1.) B.L. Diffey, J. Robson, *J. Soc. Cosmet. Chem.*, 40, 127-133, 1989.

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