References


Photostability of UVA/UVB Sunscreens Under Extreme Tropical Sun Exposure

TECHNICAL BULLETIN
Neutrogena Dermatologics

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**Introduction**

With increasing evidence of the damaging potential of UVA on the skin comes the awareness for the importance of broad-spectrum UVA/UVB sun protection. Avobenzone (butyl methoxydibenzoylmethane) provides the broadest UVA absorbance than any other chemical or physical sunscreens. However, avobenzone can be chemically unstable upon UV irradiation if not properly formulated (Figure 1). It has also been reported that avobenzone can enhance the degradation of UVB protection agents in sunscreens.

A sunscreen system combining avobenzone and oxybenzone and containing diethylhexyl 2,6-naphthalate has been developed to provide maximum broad spectrum UVA/UVB protection that is photostable. In this study, the stability of this patented photostable sunscreen system (PSS), when exposed to direct tropical sunlight in an in-life environment, was evaluated by benchmarking to two other broad-spectrum UVA/UVB sunscreens.

**Objective**

To evaluate the in-life photostability of sunscreen products under extreme tropical sun exposure.

**Materials and Methods**

**Test Products**

<table>
<thead>
<tr>
<th>Sunscreen Product</th>
<th>Label SPF</th>
<th>Active Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Product (PSS)</td>
<td>55</td>
<td>Avobenzone, Homosalate, Oxybenzone, Octocrylene</td>
</tr>
</tbody>
</table>
| Benchmark 1  
|                   | 60+       | Avobenzone, Terephthalide Dicamphor Sulfonic Acid, Drometrizole Tisiloxane, Octocrylene, Cyclopentasiloxane, Titanium Dioxide |
| Benchmark 2  
|                   | 50        | Homosalate, Octinoxate, Octocrylene, Oxybenzone, Zinc Oxide |

* Marked in Europe.
** Commercially available in the U.S.

**In-Life Sun Exposure Photostability Evaluation**

Study was performed in Kona, Hawaii (Latitude 21 degrees N) on a sunny July day using a modified method of Lebowli, et al. (1995). Sunscreens were applied as an even film (2 mg/cm²) onto clear polymethylacrylate (PMMA) plates (25cm²). Transmittance of UVA and UVB through the PMMA plates with and without sunscreens, and direct irradiances of UVA and UVB were measured at 30-minute intervals for 6 hours from 8 AM to 2 PM, using a radiometer. Transmittance through a clear PMMA plate without sunscreens was used as 100% control. The relative transmittance values were calculated and plotted as a function of sun exposure time for each sunscreen.

**Results**

- UV Irradiances From The Sun During The Study. UVB intensities were 2.18 to 3.3 mW/cm² for UVB and 0.08 to 0.28 mW/cm² for UVA. The latter correlated with direct exposure times for 1 MED of 21 to 60 minutes of unprotected exposure for people with Fitzpatrick type II skin.

  **Figure 1. Breakdown of Avobenzone by UV irradiation**

  **Figure 2. UV Irradiances From The Sun Over Time**

  **Figure 3. UVA Penetration Through Sunscreens As A Function of Sun Exposure Time**

  **Figure 4. UVB Penetration Through Sunscreens As A Function of Sun Exposure Time**

**Conclusions**

- The test product containing the patented photostable sunscreen system with avobenzone was shown to be stable in screening out UVA and UVB under the study conditions.
- All three sunscreens tested are stable with respect to UVB protection.
- Under the in-life conditions tested in the study, the sunscreens were subjected to direct tropical sunlight which contains the entire UV spectrum and other types of sun radiation (e.g.: IR, visible). Thus the PSS sunscreen was proven to provide stable UVA/UVB screening protection under this acid test condition.

**Figure 2. UV Irradiances From The Sun Over Time**

**Figure 3. UVA Penetration Through Sunscreens As A Function of Sun Exposure Time**

**Figure 4. UVB Penetration Through Sunscreens As A Function of Sun Exposure Time**

UV Irradiances From The Sun Over Time

- Benchmark 1: 60+ Avobenzone, Terephthalide Dicamphor Sulfonic Acid, Drometrizole Tisiloxane, Octocrylene, Cyclopentasiloxane, Titanium Dioxide.
- Benchmark 2: 50 Homosalate, Octinoxate, Octocrylene, Oxybenzone, Zinc Oxide.

Changes in UVB Transmittance of Sunscreen Formulations under direct tropical sun exposure. In Figure 4, all three sunscreens are stable with respect to UVB.

**Figure 3. UVA Penetration Through Sunscreens As A Function of Sun Exposure Time**

**Figure 4. UVB Penetration Through Sunscreens As A Function of Sun Exposure Time**

**Time Course of UVB Transmittance of Sunscreen Formulations under direct tropical sun exposure. In Figure 4, all three sunscreens are stable with respect to UVB.**