

# Retention of Sunscreen Actives is Improved in Formulas Containing Hydrolyzed

## Jojoba Esters as Measured by ATR-FTIR

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### Abstract

One proposed action of Hydrolyzed Jojoba Esters (HJE), Floraesters® K-100 Jojoba, in topical products is that it increases the activity of molecules that are beneficial to the skin. For example, in a controlled study, we were able to show that HJE works synergistically with glycerin to improve skin moisturization. HJE is a substantive material which demonstrates deposition on skin and hair, even in wash-off formulations such as body wash or shampoo. Its properties have been more recently explored in the sun care category at load levels of less than 1% in a test solution containing benzophenone-3 (0.5%), octyl methoxycinnamate (1.9%), and octyl salicylate (0.75%) dissolved in ethanol in solutions with and without HJE.

A calibration curve was created by treating subjects' volar forearms with test solutions of known concentrations of sunscreen actives followed by immediate evaluation with Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR-FTIR). Other subjects' forearms were treated with a test solution, some with and some without HJE. These subjects then immersed their forearms in turbulent, room-temperature fresh water or salt water four (4) times for twenty (20) minutes for a total immersion time of eighty (80) minutes. After the final immersion, the subjects' forearms air-dried and the sunscreen active ingredients remaining were quantified with ATR-FTIR using the calibration curve. Sunscreen actives in the HJE-containing test article remained on the skin in higher concentrations than did the sunscreen actives in the product without HJE.

HJE is a botanically-derived cosmetic ingredient which has been shown to improve the retention of sunscreen actives on the skin.

### Study Design

Ten (10) subjects had forty (40) micrograms of a test solution containing sunscreen actives placed on each arm and rubbed evenly in a 1" x 1" demarcated square. Three (3) additional dilutions (50%, 25%, and 12.5%) of this test solution were applied in the same manner. After a twenty-five (25) minute dry-down, ATR-FTIR measurements were taken of each test site. This data was used to generate a calibration curve for each of the sunscreens. This was done by using the spectrogram to determine the area under the peak for the known concentration of a particular sunscreen active, to create a dose-response (calibration) curve. A linear regression was then calculated for each sunscreen active. The data collected from each participant was averaged to create a single calibration curve.

The following day, two (2) test solutions were applied to the skin in the same manner as above containing one (1) of the following test articles: test solution only, test solution containing 0.2% K-100, test solution containing 1% K-20W, or test solution containing 2% Dermacryl® 79 (Indopco, Inc. DBA National Starch and Chemical Company, Bridgewater, NJ) (INCI: Acrylates / Octylacrylamide Copolymer). The test solutions were then allowed to air-dry for twenty-five (25) minutes followed by four (4) fresh water or salt water (sodium chloride, approximately the concentration of sweat, 1147mg/liter) immersions. Each immersion was twenty (20) minutes with twenty (20) minutes of air-drying in between. The test sites were then pressed against the measuring crystal of the ATR-FTIR for the sunscreen active concentration to be determined. This was done by again determining the area under the peak corresponding to a particular sunscreen and using the linear regression created previously to determine the concentration of a sunscreen active on the skin (mg/cm<sup>2</sup>).

ATR-FTIR has been used to follow effects on a molecular scale<sup>1</sup> and is a rapid and noninvasive technique which has been used in vivo to analyze chemicals on the stratum corneum.<sup>2</sup> For this particular study, any groups were monitored to detect the presence of the sunscreen actives.

Figure 1 shows an example of a participant with their arm on the ATR-FTIR.

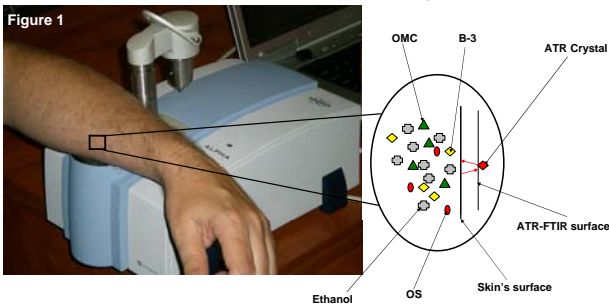


Figure 2 depicts the process of the ATR-FTIR. The ATR crystal exposes the molecules within a sample to infrared light upon contact with the ATF measuring crystal. The molecules will then absorb characteristic wavelengths (energy) and transmit all other wavelengths back through the ATR measuring crystal. (Red arrows represent energy being transferred.) The Fourier Transform (FT of FTIR) is then able to determine which characteristic wavelengths were absorbed and sort the wavelengths to produce a spectrogram with corresponding wave numbers.

### Results

**Table 1. Relative Increase in Benzophenone-3 Retention (compared to test solution containing only sunscreen actives)**

	0.2% K-100	1% K-20W	2% Dermacryl 79
Fresh Water	14%	32%	-15%
Salt Water	147%	99%	12%

Table 1 represents the percentage of sunscreen active benzophenone-3 remaining after fresh water or salt water immersion of the each test solution relative to the test solution containing only sunscreen actives. These percentages are based on the average concentrations of benzophenone-3 remaining on the skin after immersion.

**Table 2a. Average Concentration (mg/cm<sup>2</sup>) of Sunscreen Actives Remaining on the Skin Following Immersion in Fresh Water**

	B-3	OMC	OS
Applied amount	24.3	92.3	36.4
0.2% K-100 (n=10)	8.4	72.7	2.6
1% K-20W (n=7)	9.6	0.0	2.0
2% Dermacryl 79 (n=7)	6.2	0.0	2.1

**Table 2b. Average Concentration (mg/cm<sup>2</sup>) of Sunscreen Actives Remaining on the Skin Following Immersion in Salt Water**

	B-3	OMC	OS
Applied amount	24.3	92.3	36.4
0.2% K-100 (n=10)	16.0	76.9	2.5
1% K-20W (n=7)	12.9	3.4	2.1
2% Dermacryl 79 (n=7)	7.3	0.0	2.0

Tables 2a and 2b represent the average amount of sunscreen actives retained on the skin after fresh water or salt water immersion.

**Figure 3. Benzophenone-3 ATR-FTIR Spectrum**

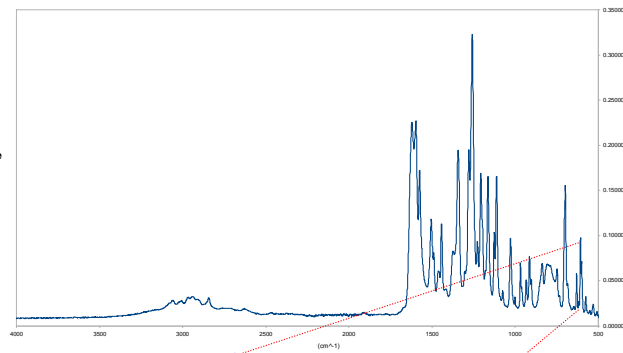


Figure 3 represents an example spectrum

**Figure 4**

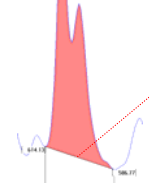


Figure 4 represents the peaks corresponding to characteristic wave numbers of benzophenone-3 used to quantify the concentration of benzophenone-3. The pink area represents the area under the curve.

**Figure 5. Percentage of Benzophenone-3 Retained**

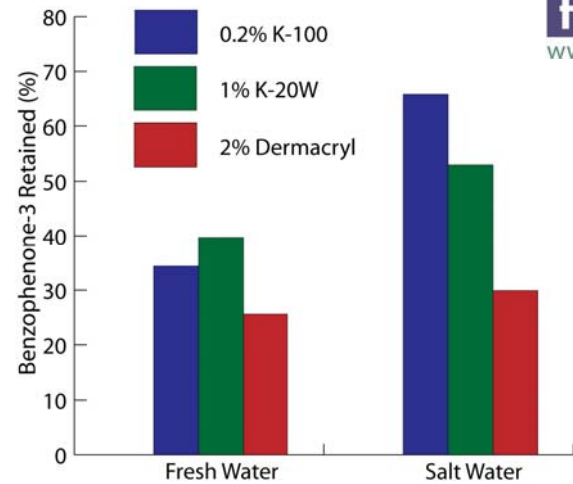


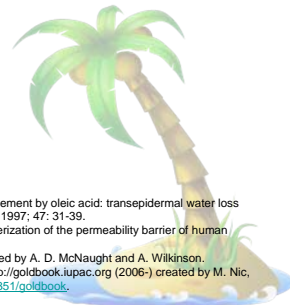
Figure 5 represents the percent retention of benzophenone-3 remaining on the skin after fresh water or salt water immersion.

## Conclusions

- Floraesters K-100 Jojoba (hydrolyzed jojoba esters) increased the retention of benzophenone-3 in fresh water and salt water
- Floraesters K-100 Jojoba retained the octyl methoxycinnamate in fresh water and salt water
- Floraesters K-20W Jojoba (hydrolyzed jojoba esters) also increased the retention of benzophenone-3 in fresh water and salt water
- Sodium chloride in the salt water provides a salting-out effect, increasing the substantivity of the Hydrolyzed Jojoba Esters.<sup>3</sup>
- Hydrolyzed Jojoba Esters perform as well as, or better than, Dermacryl 79 (acrylates / octylacrylamide copolymer) at its prescribed usage levels

### References

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