

Benefits of Naturally-Derived Ingredients in Sunscreen Formulas

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Benefits of Naturally-Derived Ingredients in Sunscreen Formulas

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Abstract

Finding natural alternatives to multifunctional synthetic ingredients can be challenging, particularly for sun care formulations. This research describes the water resistance and skin hydration provided by natural **Floraesters K-20W® Jojoba** (hydrolyzed jojoba esters) in a sunscreen formula. It also compares the skin hydration and dispersion of organic and inorganic sunscreen actives achieved by natural **Floramac® 10** (ethyl macadamiate) to other natural and synthetic emollients in sunscreen formulas. Hydrolyzed jojoba esters and ethyl macadamiate are innovative, naturally-derived ingredients that provide aesthetic and skin care benefits; proving themselves to be multifunctional, while also making the formulation of sun care products easier.

Sunscreen Formula

Table 1. Vehicle Sunscreen Formula

INCI Name	% wt./wt.
C12-15 Alkyl Benzoate	8.00
Potassium Cetyl Phosphate	3.00
Cetearyl Alcohol	1.00
Ethyl Macadamiate or Test Emollient	0.00 or 5.00
Sunflower Seed Oil Sorbitol Esters	2.00
Polyhydroxystearic Acid	0.00 or 1.00
Phenoxyethanol (and) Methylparaben (and) Ethylparaben (and) Butylparaben (and) Propylparaben (and) Isobutylparaben	0.80
Titanium Dioxide (and) Dimethicone	7.50
Acrylates / C10-30 Alkyl Acrylate Crosspolymer	0.10
Glycerin	1.00
Hydrolyzed Jojoba Esters (and) Water (Aqua)	0.00 or 5.00
Water	q.s.
Total	100.00

Footnotes / References

- The test material (referred to as Hydrolyzed Jojoba Esters or HJE throughout the document) is a 20% active dilution in water [INCI: Hydrolyzed Jojoba Esters (and) Water (Aqua)].
- SPF testing was conducted according to the US FDA Final Rule; 21 CFR Parts 201 and 310 by Suncare Research Laboratories, LLC (Winston Salem, NC).
- Corneometer CM 825 is a product of Courage + Khazaka (Köln, Germany).
- Hallbrite T-97, INCI: Titanium Dioxide (and) Dimethicone (The HallStar Company).
- The dispersing agent used was Polyhydroxystearic Acid produced by Innospec Performance Chemicals (Salisbury, NC).
- The Fineness of Grind Gage is a product of Precision Gage & Tool Company (Dayton, OH).
- Parsol® 1789 (Avobenzone) INCI: Butyl Methoxydibenzoylmethane (DSM Nutritional Products).
- Eusolex® 4360, INCI: Benzophenone-3 (EMD Chemicals).

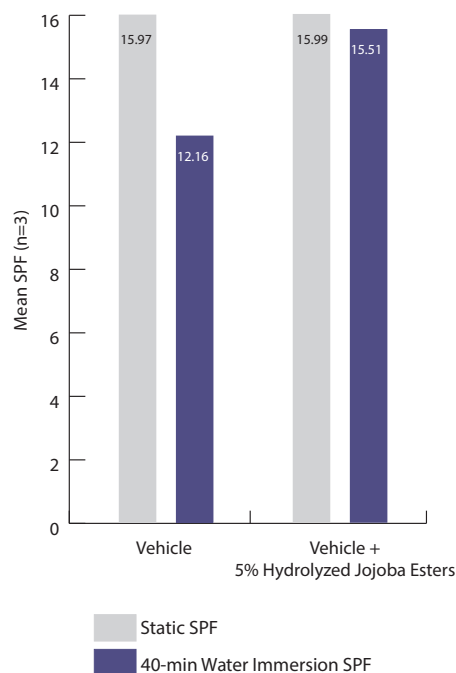
Improved Water Resistance

Objective: Determine the water resistance potential between a sunscreen with and without Hydrolyzed Jojoba Esters.¹

Design: The Minimum Erythema Dose (MED) is the lowest UV dose required to produce perceptible erythema. The MED for each subject was measured and used to determine the proper UV exposure during testing of the sunscreen formulas. The static SPF value was calculated using the MED of sunscreen protected skin (MEDp) relative to the MED of unprotected skin (MEDu) on each subject using the following equation: MEDp/MEDu. For the 40-minute immersion test, subjects sat with the testing site submerged in a water bath for two 20-minute immersion periods prior to UV exposure, and SPF was calculated in the same manner as above.² (n=3 male and female subjects)

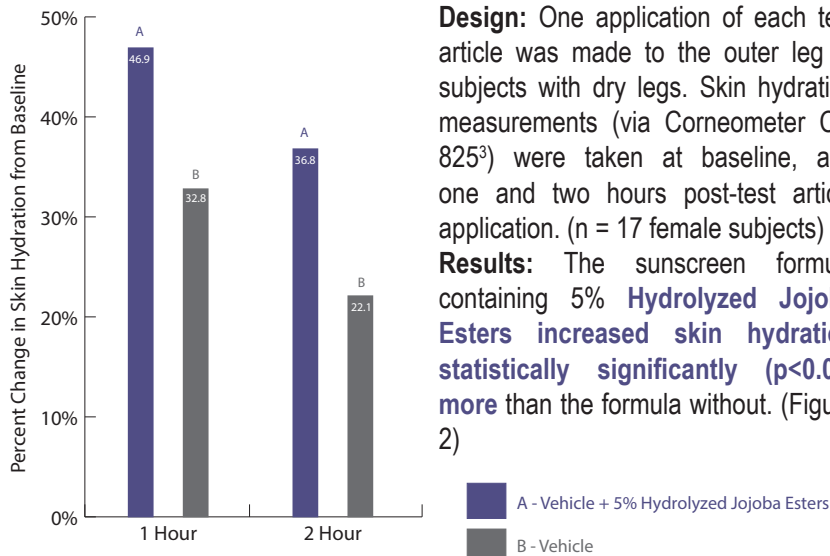
Results: After 40 minutes of water immersion, the sunscreen formula containing 5% **Hydrolyzed Jojoba Esters had a 28% higher SPF** and maintained an SPF rating of 15 (which was not seen in the vehicle formula). (Figure 1)

Figure 1. Static and 40-Minute Water Immersion SPF



Improved Skin Hydration

Figure 2. Skin Hydration



Objective: Determine the skin hydration potential between a sunscreen with and without Hydrolyzed Jojoba Esters.

Design: One application of each test article was made to the outer leg of subjects with dry legs. Skin hydration measurements (via Corneometer CM 825³) were taken at baseline, and one and two hours post-test article application. (n = 17 female subjects)

Results: The sunscreen formula containing 5% **Hydrolyzed Jojoba Esters increased skin hydration statistically significantly (p<0.05) more than the formula without.** (Figure 2)

Improved Dispersion

Objective: A comparison of ethyl macadamiate (EM) to other emollients [Capyrylic/Capric Triglyceride Oil (CCT), Coco-Caprylate (CC), Cyclopentasiloxane (CPS), Finsolv TN (FTN), and Isopropyl Myristate (IPM)] to minimize quantity and size of titanium dioxide⁴ (7.5%) particles [with and without a dispersing agent⁵ (DA)].

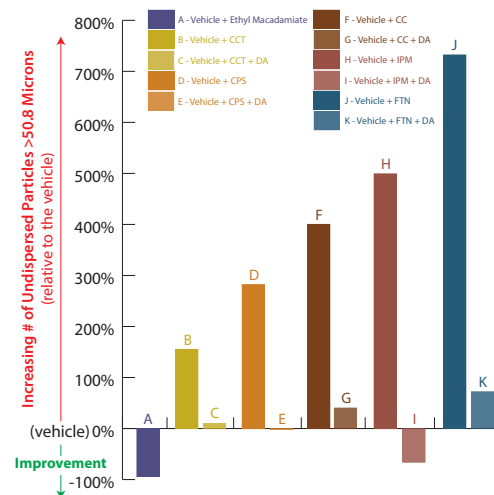
Table 2. Undispersed Particle Counts (total number)

Test Emollient	Undispersed Particle Count
Vehicle	233
A - Vehicle + Ethyl Macadamiate	46
B - Vehicle + CCT	954
C - Vehicle + CCT + DA	1393
D - Vehicle + CPS	1252
E - Vehicle + CPS + DA	1271
F - Vehicle + CC	1581
G - Vehicle + CC + DA	1805
H - Vehicle + IPM	1350
I - Vehicle + IPM + DA	298
J - Vehicle + FTN	2266
K - Vehicle + FTN + DA	1933

Design: One application (0.2ml) of each test article was made to the Fineness of Grind Gage.⁶ The sample was then scraped across the gage and particle quantity (by size) was determined by counting undispersed particles.

Results: The test article containing 5% **Ethyl Macadamiate produced fewer large (>50.8 microns) undispersed particles** than any other emollient both

Figure 3. Percentage of Large Undispersed Particles (>50.8 microns)



with and without a dispersing agent. (Figure 3) The test article containing 5% **Ethyl Macadamiate produced fewer total undispersed particles** than any other emollient both with and without a dispersing agent. (Table 2)

Improved Solubilization

Objective: A comparison of Ethyl Macadamiate (EM) and Finsolv TN (FTN) to solubilize Benzophenone-3 and Avobenzone.

Design: Avobenzone⁷ and Benzophenone-3⁸ were mixed at a 10% concentration by hand into each test emollient at room temperature (RT). Solutions rested at room temperature for one hour before solubility evaluations were conducted: soluble (S) or insoluble (IS, i.e. visually apparent crystallization). If the sunscreen was insoluble at room temperature, the solution was slowly heated to 70°C with mixing (stir bar) and additional solubility evaluations were conducted. Solutions then rested at room temperature for seven hours to determine if the sunscreens would remain soluble when the solution cooled down to room temperature. Sunscreen concentrations were increased in intervals of 5% until sunscreens were insoluble at room temperature after being heated to 70°C.

Results: **Avobenzone was soluble in both Ethyl Macadamiate and FTN (with heat) up to a concentration of 25%.** Additionally, Avobenzone was soluble in Ethyl Macadamiate (with heat followed by cooling) up to a concentration of 20%. (Table 3) **Benzophenone-3 was soluble in both Ethyl Macadamiate and FTN (with heat) up to a concentration of 20%,** and with heat followed by cooling up to a concentration of 15%. (Table 4)

Table 3. Solubility in Avobenzone

Sunscreen concentration in EM	RT	70°C (initial)	70°C (7 hours)	Sunscreen concentration in FTN	RT	70°C (initial)	70°C (7 hours)
10%	IS	S	S	10%	IS	S	S
15%	IS	S	S	15%	IS	S	S
20%	IS	S	S	20%	IS	S	S
25%	IS	S	IS	25%	IS	S	S

Table 4. Solubility in Benzophenone-3

Sunscreen concentration in EM	RT	70°C (initial)	70°C (7 hours)	Sunscreen concentration in FTN	RT	70°C (initial)	70°C (7 hours)
10%	IS	S	S	10%	IS	S	S
15%	IS	S	S	15%	IS	S	S
20%	IS	S	IS	20%	IS	S	IS

Conclusions

- Incorporating **Hydrolyzed Jojoba Esters** within a sunscreen formula resulted in improved SPF retention following 40-minute water immersion.
- **Hydrolyzed Jojoba Esters** increased skin hydration within a sunscreen formula.
- **Ethyl Macadamiate** enhances dispersion of inorganic sunscreens and solubilization of organic sunscreens.

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