Performance Characterization of Hydrolyzed Jojoba Esters in Rinse-Off Hair Care Applications

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Abstract

This research explores the hair care benefits of hydrolyzed jojoba esters (HJE); an ingredient most commonly used in skin care formulations for its film-forming attributes and ability to fix small, active molecules (*e.g.* glycerin, titanium dioxide, and dihydroxyacetone) on the skin surface for long-lasting effects. It is difficult to find natural options that function similarly to silicones and quaternary nitrogen compounds, which are often used in hair care products to provide color and heat protection, reductions in wet and dry comb force, or frizz control and shine.

A series of ex-vivo, vehicle-controlled, environment-controlled, double-blind studies were performed to characterize the performance benefits of incorporating hydrolyzed jojoba esters into rinse-off shampoo and conditioner products. The results presented here indicate that hydrolyzed jojoba esters indeed have a beneficial effect within rinse-off hair care applications. This offers formulators an effective natural, biodegradable alternative to provide functions and benefits traditionally produced by silicones and quaternary compounds.

Deposition

Objective: To evaluate hydrolyzed jojoba esters at 1% in water for its potential to remain deposited on hair after rinse-off.

Method: Naturally curly, dark brown hair tresses were cleansed with a 10% sodium lauryl sulfate solution prior to use in the study. A solution containing 1% HJE was applied to hair tresses, rubbed, and rinsed. Hair tresses were then blown dry and extracted using ethanol. The extract was then analyzed using an Agilent 1100 Series HPLC.[1]

Results: It was determined that 4.7% ± 2.7% of the HJE applied to hair tresses remained on the hair after rinse-off.

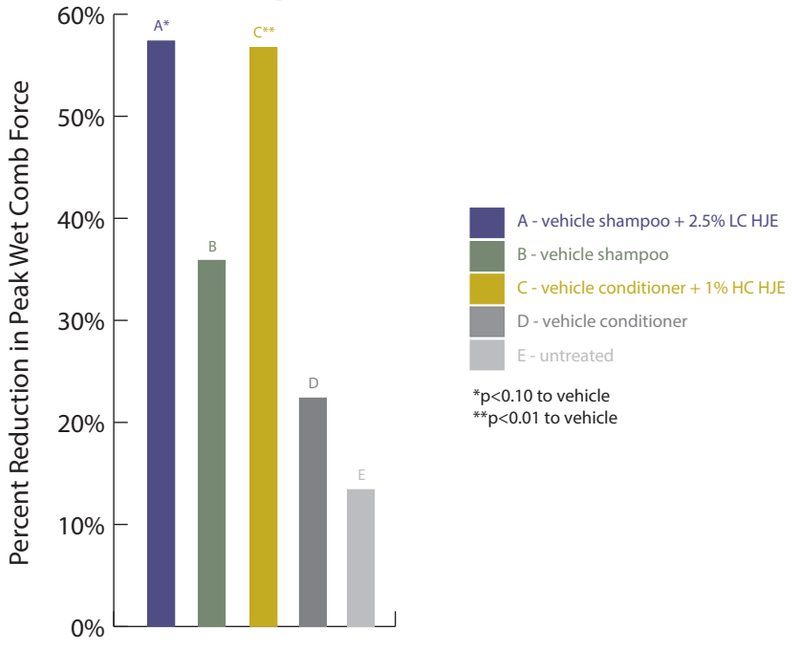
Reduced Wet Comb Force

Objective: To evaluate HJE [low concentration (LC) and high concentration (HC)][2] in a shampoo and rinse-off conditioner, respectively, for their potential to improve hair conditioning as measured by wet comb force.

Method: Naturally curly, dark brown hair tresses were damaged by double-bleaching and cleansed with a 10% sodium lauryl sulfate (SLS) solution prior to use in the study. A shampoo with and without 2.5% LC HJE and a conditioner with and without 1% HC HJE were applied to hair tresses, rubbed, and rinsed. Wet comb[3] force measurements were taken at baseline (pre-treatment) and post-treatment. An additional set of tresses were left untreated (*i.e.* double-bleached and cleansed with SLS, but did not receive test article treatment), and were also evaluated for wet comb force.

Results: The shampoo containing 2.5% LC HJE reduced wet comb force 60% compared to the vehicle shampoo. The conditioner containing 1% HC HJE reduced wet comb force 153% compared to the vehicle conditioner. These results are indicative of a conditioning effect.

Figure 1: Wet Comb Force



Reduced Hair Dye Fading

Objective: To evaluate LC HJE in a shampoo and HC HJE in a rinse-off conditioner for their potential to improve hair dye color retention.

Method: Wool swatches were dyed with commercial red and brown permanent hair dyes. Swatches underwent 8 wash or condition / rinse treatment cycles using shampoos with or without 2.5% LC HJE or conditioners with or without 1% HC HJE, respectively. Change in color $(\Delta E)^4$ from pre-wash or condition was measured after every 2 cycles.

Results: Wool swatches dyed with commercial red or brown permanent hair dyes retained up to 35% more color when a shampoo containing 2.5% LC HJE was compared to a shampoo without LC HJE and up to 22% more color when a conditioner containing 1.0% HC HJE was compared to a conditioner without HC HJE.

Figure 2: Hair Dye Wash-Out with Shampoo

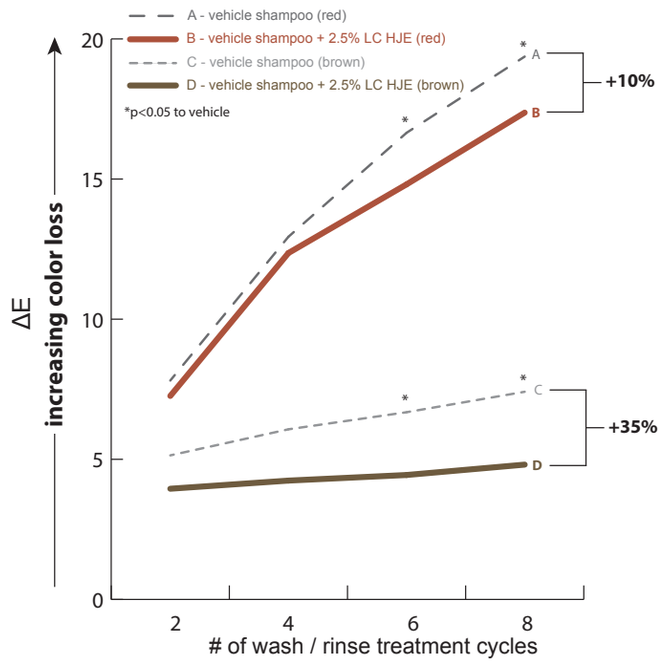
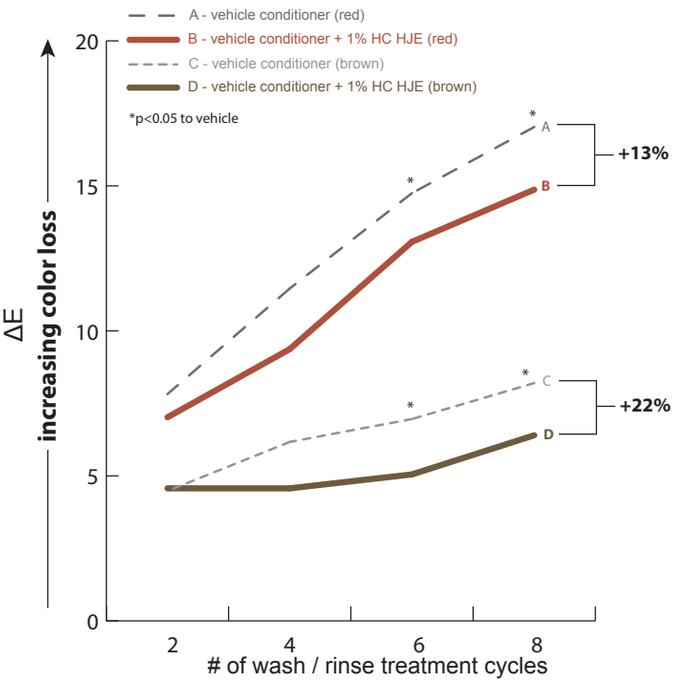


Figure 3: Hair Dye Wash-Out with Conditioner



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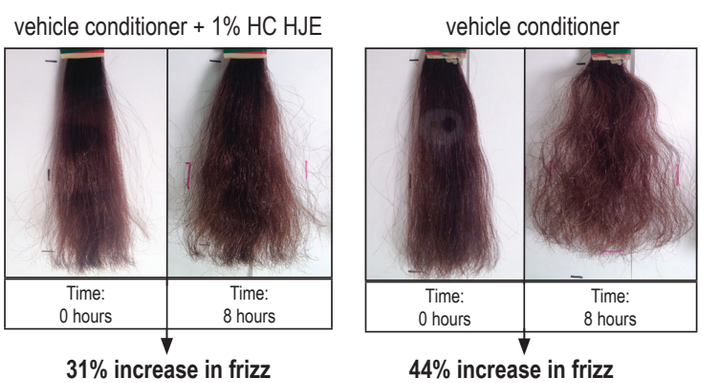
Reduced Frizz

Objective: To evaluate HC HJE in a rinse-off conditioner for its potential to reduce frizz.

Method: Naturally curly, dark brown hair tresses were cleansed with a 10% sodium lauryl sulfate solution prior to use in the study. A conditioner with and without 1% HC HJE was applied to hair tresses, rubbed, and rinsed. Tresses were then blown dry and flat ironed to remove the curl pattern. Post-straightening, the hair tresses were immediately hung in the humidity chamber and subjected to 8 hours of increasing humidity, with a range from 73-99% relative humidity and a temperature of 26-30°C. Photos were captured before and after humidity exposure, and used to determine the total area of each tress at time 0 and after 8 hours of exposure.

Results: Hair tresses treated with a conditioner containing 1% HC HJE produced 30% less frizz when compared to tresses treated with the vehicle conditioner.

Figure 4: Images used for Frizz Analysis



Vehicles

Shampoo	
Ingredient	**%wt./wt.**
Water	q.s.
Disodium Laureth Sulfosuccinate	12.00
Cocamidopropyl Betaine	8.00
Decyl Glucoside	8.00
Sodium Lauroyl Sarcosinate	8.00
Acrylates Crosspolymer-4	3.00
Methyl Glucose Caprate/Caprylate/Oleate (and) Propandiol	2.00
Sodium Cocoyl Isethionate	2.00
Glycol Distearate	1.50
Phenoxyethanol (and) Capryl Glycol (and) Ethylhexylglycerin (and) Hexylene Glycol	0.75
Guar Hydroxypropyltrimonium Chloride	0.70
Fragrance	0.65
Aminomethyl Propanol	0.38
Disodium EDTA	0.10

Conditioner	
Ingredient	**%wt./wt.**
Water	q.s.
Glyceryl Stearate (and) Cetearyl Alcohol (and) Sodium Stearoyl Lactylate	6.00
Cetyl Alcohol	2.00
Ethyl Macadamiate	1.00
Ethylhexyl Methoxycinnamate (and) BHT	1.00
Polyglyceryl-2 Stearate	1.00
Propanediol	1.00
Prunus Amygdalus Dulcis (Sweet Almond) Oil	1.00
Theobroma Grandiflorum Seed Butter (and) Tocopherol	1.00
Phenoxyethanol (and) Capryl Glycol (and) Ethylhexylglycerin (and) Hexylene Glycol	0.75
Fragrance	0.50
Tocopheryl Acetate	0.50
Citric Acid	0.20
Cetyl Hydroxyethyl Cellulose	0.10
Disodium EDTA	0.10

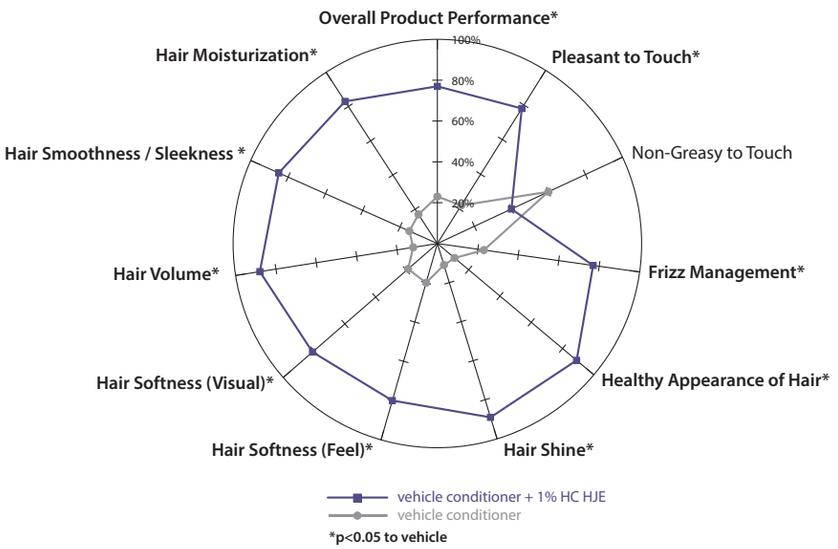
Consumer Preference

Objective: To evaluate HC HJE for its potential to enhance consumer perception when used in a rinse-off conditioner.

Method: Naturally curly, dark brown hair tresses were damaged by double-bleaching and cleansed with a 10% sodium lauryl sulfate solution prior to use in the study. Female consumers (n=29) evaluated hair tresses treated with 1 application of each conditioner test article.

Results: Seventy-seven percent (77%) of consumers preferred hair tresses treated with a rinse-off conditioner containing 1% HC HJE compared to the vehicle conditioner.

Figure 5: Consumer Preference of Conditioner



Conclusions

The presented research indicates that overall, hydrolyzed jojoba esters are ideal for hair care applications. The film-forming and water-resistant attributes of hydrolyzed jojoba esters on skin[5] translates to hair, as shown by the **deposition** on hair tresses after rinse-off. Conditioning benefits such as **wet comb force reduction** and **frizz prevention** are a few of the attributes quantified by this research. It is theorized that the substantive, lipophilic film coats the hair and smooths the cuticles, which allows for easy glide with a comb as well as protection from humidity. Additionally, the data suggests that the film **prevents color loss** from the inside of the hair fiber. The characteristics of hydrolyzed jojoba esters shown in this research qualifies them as multifunctional ingredients for hair care products.

Footnotes / References

1. The Agilent 1100 Series HPLC (Santa Clara, CA, USA), consisted of a septumless injector, an isocratic pump, and an Alltech/Grace 2000 ELSD (Columbia, MD, USA).
2. Test articles referenced throughout are identified by the INCI names as follows: HC HJE [INCI: Hydrolyzed Jojoba Esters (and) Jojoba Esters (and) Water (Aqua)] and LC HJE [INCI: Hydrolyzed Jojoba Esters (and) Water (Aqua)].
3. Comb force was conducted using the Test Resources Q Series (100Q) Universal Testing Machine from Test Resources, Inc. (Shakopee, MN, USA).
4. Color loss was calculated from L*a*b* values using the following equation: $\Delta E = \sqrt{[(L^*_2-L^*_1)^2 +(a^*_2-a^*_1)^2 +(b^*_2-b^*_1)^2]}$.
5. Oliphant T and Harper R. Hydrolyzed Jojoba Esters Improves Water Resistance of Sunscreen Formulas. Society of Cosmetic Chemists 2015 Sunscreen Symposium. September 2015. Poster.

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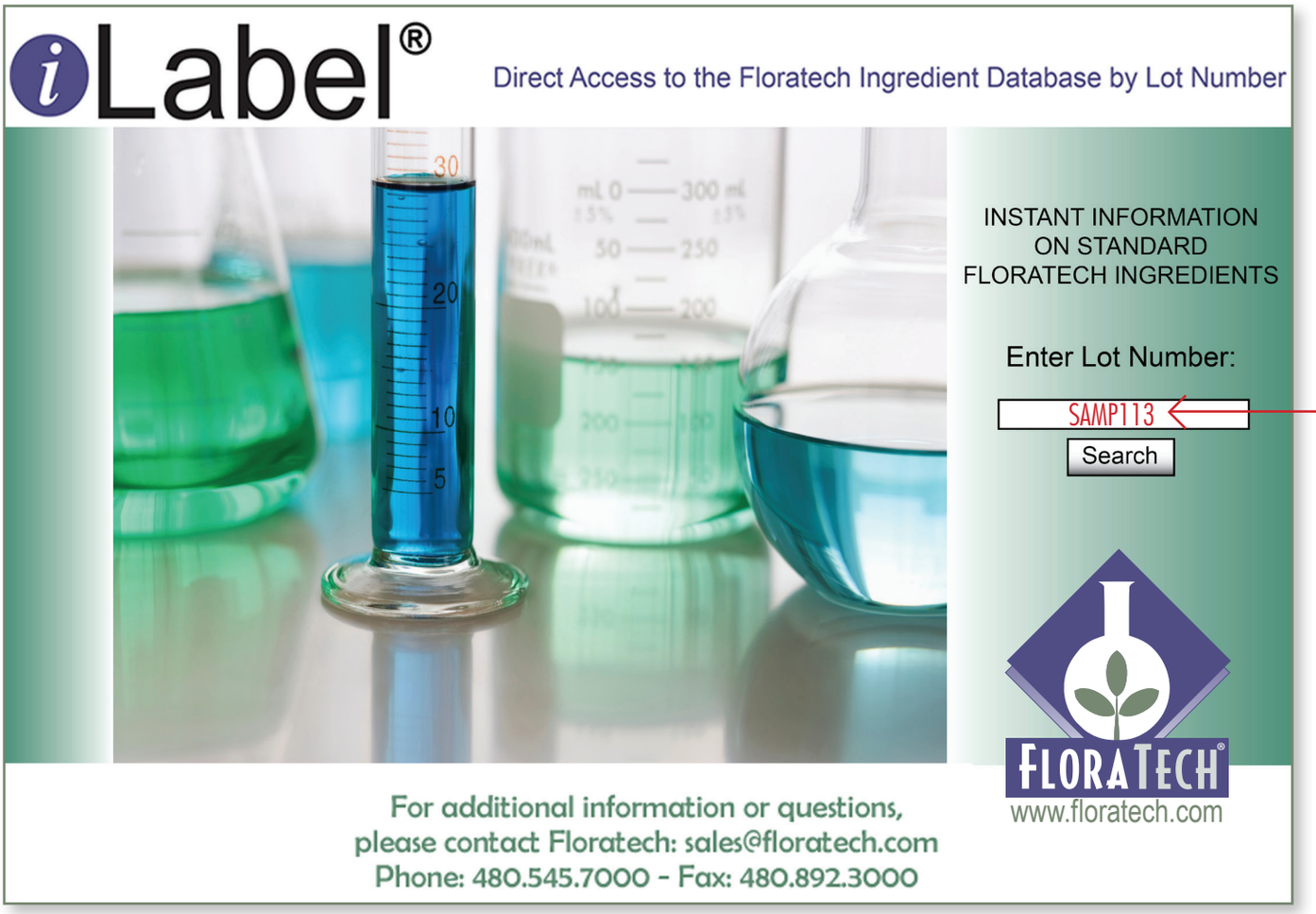

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