

SYNERGISTIC SKIN PROPERTY INTERACTIONS BETWEEN ALPHA HYDROXY ACID AND SKIN MOISTURIZER IN A HAND DISHWASHING DETERGENT

E. H. Brumbaugh¹ (correspondence), M. L. Sigler², P. L. Casterton¹, J. M. Dornoff³

¹Access Business Group, 7575 Fulton Street East, Ada, Michigan, 49355, USA

²Thomas J. Stephens & Associates, Inc., 3310 Keller Springs Road, Suite 130, Carrollton, Texas, 75066, USA

³Amway Japan Limited 7-1, Udagawa-cho, Shibuya-ku, Tokyo, Japan 150-0042

SUMMARY

The use of both an Alpha Hydroxy Acid, Citric Acid, and a Skin Moisturizer, Glycereth-26, formulated into a hand dishwashing detergent have been shown to be synergistic in their effects on certain skin health parameters. Each ingredient was evaluated alone and together in a hand dishwashing detergent via a 9-week use test. Panelists washed dishes using the sponge method commonly used in Asian markets and a 1:7 dilution of the concentrated dish detergent. Panelist's hands were evaluated initially and at 3-week intervals for nine weeks. After nine weeks panelist's hands showed significant improvements in Moisture Absorption and Transepidermal Water Loss (TEWL). A synergistic effect on TEWL was found between the AHA and the Moisturizer. These effects, showing an improvement in the condition of the panelist's skin are impressive, particularly since they were observed from a dishwashing product that is highly diluted and at near neutral pH during the washing process.

Key words: Alpha Hydroxy Acid, Moisturizer, Citric Acid, Glycereth-26, Transepidermal Water Loss, Moisture Absorption, Skin, Stratum Corneum, Dish Detergent

INTRODUCTION

Alpha hydroxy acids have been used since the 1970's in skin treatments to promote exfoliation of skin and skin cell renewal.^[1] The first patents in this area were issued to Van Scott and Yu^[1] claiming increased rate of skin exfoliation and improvement of the appearance of the skin by reducing visible scaling often seen in dry skin. An AHA, as defined by Van Scott and Yu, is a low molecular weight carboxylic acid, C2-C6, with hydroxyl functionality in the alpha position relative to a carboxylic acid group.^[1] Common examples are citric, glycolic, lactic, malic, salicylic and tartaric acid.^[1, 2] Optimum use pH for stimulation of cell renewal is 3, with very little stimulation observed above pH 6.^[2] With increased exfoliation, increased rates of skin cell renewal are also observed which results in healthier looking skin.^[1, 2, 3]

Skin Conditioning Agents whose functions include moisturization have been used in cosmetics formulations for many years.^[4] There are many compounds with this reported function listed in the International Cosmetics & Ingredient Dictionary and Handbook.^[5] Some of the earliest examples are glycerine and urea.^[4] Skin moisturizers are reported to function by acting as humectants, drawing moisture from the air to the skin surface, as occlusive moisture barriers impeding moisture loss through the skin surface or as emollients serving to promote a softer appearance to the skin.^[3,5] Glycerine and Ethoxylated Glycerine are commonly used humectants in cosmetics for skin moisturization.^[5] AHAs are also known to have humectant properties and are useful as skin moisturizers.^[3] What is most common among skin moisturizers is that they are applied as leave on cosmetics or treatments resulting in high levels of deposition on the skin surface.

Hand dishwashing detergents contain high levels of surfactants designed to clean fats and oils from dishes. The surfactants used in these products exhibit defatting effects on human skin. This effect is most pronounced in the dry winter months when moisture loss through the skin is greatest. While some hand dishwashing products have claimed skin benefits in the past, the benefits have generally been directed at reducing the defatting effects of hand dishwashing detergents. In this paper a synergistic effect between a skin moisturizing agent and an AHA has been shown which results in increases in the magnitude of two parameters associated with healthier skin, skin moisture absorption and TEWL.

MATERIALS AND METHODS

Four liquid hand dish detergents were evaluated in a double blind controlled usage study designed to compare the overall effects on the stratum corneum. The dish detergent is a proprietary formulation commercially sold as Dish Drops™ (Access Business Group International, LLC, Ada, Michigan, USA). The detergent formulation contains Sodium Laureth Sulfate as the primary active ingredient. The four test detergents used the same surfactant base formula with the following variables: 1) Base Formula, 2) Base + Glycereth-26 (Moisturizer), 3) Base + Citric Acid (AHA), 4) Base + Glycereth-26 and Citric Acid (Moisturizer + AHA). Glycereth-26 was used at 5% and Citric Acid was used at 0.95% in the dish detergent formulation. Final product pH was 6.3. Panelists were given samples of the dish detergent diluted 1:7 according to manufacturer's use directions in Japan. Panelists were instructed to wash dishes using the most prevalent method of dishwashing in Japan which involves squirting detergent onto a sponge, washing the dish under running water and rinsing. Panelists were also instructed to refrain from using hand lotions for the duration of the study. A baseline was determined at the initial visit by measuring transepidermal water loss (TEWL) and NOVA Dermal Phase Meter measurements on the back of the left hand.

The Servo Med Evaporimeter Model EP-2 (Servo Med AB, PO Box 129, s-511 21 KINNA, SWEDEN) was used to take TEWL measurements. The hand was placed on a flat table and Evaporimeter probe placed horizontally on the skin. Two sensors in the probe head sample relative humidity above the skin surface, allowing the rate of water loss to be calculated from the measured humidity gradient ($\text{g}/\text{m}^2/\text{hr}$). The instrument

records measurements over a period of about one minute. Values stabilize after approximately 40 seconds and a mean score was recorded from the final 15 seconds of measuring. TEWL measurements increase as the rate of water loss from the skin increases, indicating a compromise in the barrier. A decrease in TEWL measurements indicates an improvement in the skin's ability to retain moisture, or an improvement in barrier function. Prior to TEWL measurements, subjects equilibrated for approximately 20 minutes to ambient room temperature and humidity conditions. During the course of the study, the room was maintained at a temperature of 68°F to 74°F (20.0°C to 23.3°C) and relative humidity between 28% and 43%.

The NOVA Dermal Phase Meter (DPM) 9003 (NOVA Technology Corporation, 75 Congress Street, Portsmouth, NH 03801, USA) quantifies moisture content in the stratum corneum (SC) by an electrical impedance method. The measurement is unitless, but is proportional to the dielectric constant of the surface layers of the skin, and increases as the skin becomes hydrated. The Nova DPM was used to take Sorption-Desorption measurements as described by Tagami, et al.^[6] Subjects held the left hand flat on a table and a baseline Nova DPM moisturization measurement was obtained. A 10- μ l drop of water was placed onto the skin and spread so that it covered an area of approximately 1 cm in diameter. After ten seconds, the site was blotted dry, and Nova DPM measurements were repeated every 30 seconds for 3 minutes. The initial measurement immediately after water is removed from the skin is the water sorption property, or hygroscopicity of the skin. Dry, scaly skin does not bind or retain water easily, and would therefore produce low sorption values. As the integrity of the stratum corneum improves the skin becomes healthier; it is able to take up or absorb water more readily, producing higher sorption scores.

Subjects used their assigned dish detergent according to usage instructions for a period of nine weeks. The study lasted nine weeks with measurements taken initially and at 3, 6 and 9 weeks. The data reported here involves the initial and nine-week evaluations only. One hundred four Japanese subjects completed the study that was run in the low humidity climates of Dallas, Texas and Colorado Springs, Colorado. Results were compared statistically using a paired t-test with changes from baseline being significant at the $p < 0.05$ level. Panelists reporting adverse events were terminated from the study and eliminated from the analysis. Access Business Group International under the direction of Ernie Brumbaugh, Phil Casterton and Jeff Dornoff ran the study. Thomas J. Stephens and Associates, Incorporated conducted the actual study under the direction of Dr. Monya L. Sigler from April 11, 1998 until July 11, 1998.

RESULTS AND DISCUSSION

Transepidermal Water Loss (TEWL)

TEWL is a measure of the functionality of the skin barrier. Healthy skin transpires water at a fixed rate. The rate varies between skin type, individual and location where the measurement is taken. Mean TEWL rate for Asian subjects on the back of the hand has been reported as 6.8 $\text{gm/m}^2/\text{hr}$ with a range of 6.2-7.1 $\text{gm/m}^2/\text{hr}$.^[7] Skin that is damaged will exhibit higher rates of TEWL. Products that improve the rate of TEWL are those

that reduce it from a higher than normal rate, indicating damaged skin, to a rate closer to normal. In this test neither the Base formula sample nor the sample with AHA improved TEWL. The test cell with the Moisturizer (Glycereth-26) improved TEWL significantly over both products without moisturizer. Surprisingly, the test cell with both AHA and Moisturizer (Glycereth-26) significantly improved TEWL over both products without Moisturizer and was also better than the product with Moisturizer alone. The magnitude of the increase over the product with Moisturizer alone indicates that there is a synergistic effect between the Moisturizer (Glycereth-26) and the AHA (Citric Acid) in terms of their effect on TEWL. Results can be seen in Table I and Figure I.

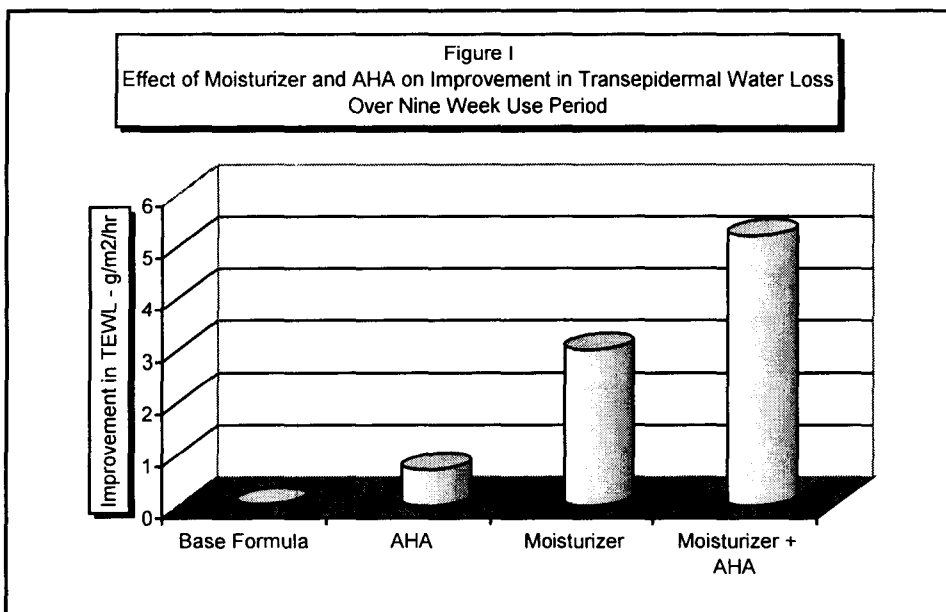
Table I

Effect of Moisturizer and AHA on Change in Transepidermal Water Loss

Formulation	Change in TEWL gm/m ² /hr	Statistical Significance
Base Formula	-0.04	NS
Base + AHA	-0.70	NS
Base + Moisturizer	-2.99	Sig
Base + Moisturizer + AHA	-5.19	Sig

Statistical Method - Paired t-test @ p<0.05

A reduction in TEWL in an improvement in TEWL



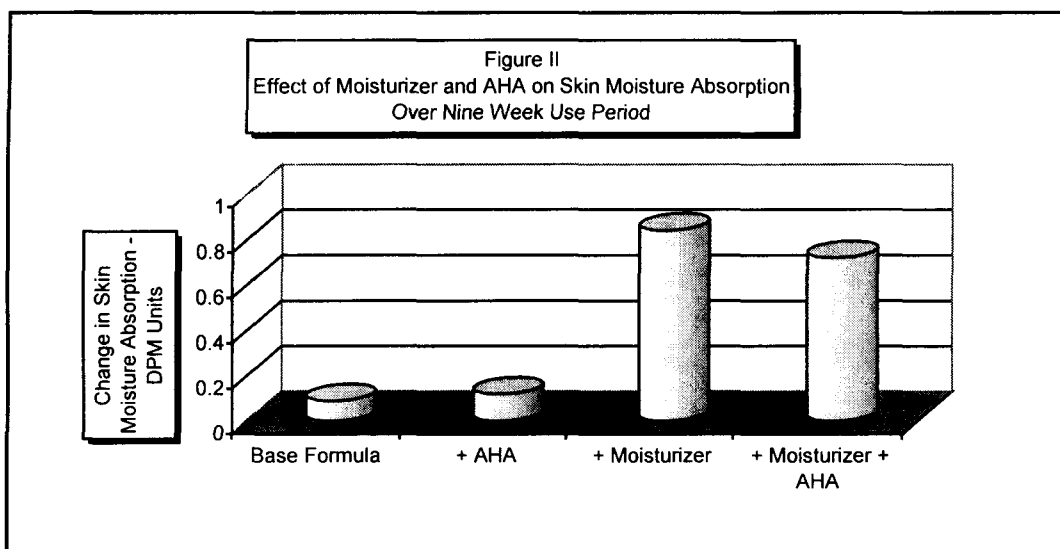
Moisture Absorption Rate

The Nova Dermal Phase Meter (DPM) assesses moisturization of the skin via an impedance measurement. The values are unitless and are proportional to the dielectric constant of the skin which increases as it becomes more hydrated. Mechanistically skin hydration can be improved with a moisturizer applied to the skin that draws moisture from the air, a humectant type moisturizer. In this test procedure, moisture was added to the skin surface and absorption was measured via electrical low frequency, 30 Hz, impedance measurements, DPM units, of the stratum corneum. As might have been expected, neither test cell without moisturizer increased moisture absorption. Both treatments with moisturizer significantly increased moisture absorption when compared to treatments without moisturizer. There was no significant difference between the Moisturizer and Moisturizer + AHA treatments. Thus, the increase in moisture absorption rate is a function of the Moisturizer alone. The surprising result, though, was the apparent substantive absorption of the Moisturizer onto the skin at very low use rates from a wash-off type of product. See Table II and Figure II.

Formulation	Change in Moisture Absorption DPM Units	Statistical Significance
Base Formula	0.09	NS
Base + AHA	0.12	NS
Base + Moisturizer	0.84	Sig
Base + Moisturizer + AHA	0.72	Sig

Statistical Method - Paired t-test @ $p < 0.05$

An increase in skin moisture absorption is an improvement in skin moisture absorption



Conclusions:

1. The use of a Moisturizer plus an AHA, in this case Glycereth-26 and Citric Acid, in a liquid hand dishwashing formulation results in a product that exhibits improved skin health parameters in long term use tests.
2. The combination of Moisturizer (Glycereth-26) and AHA (Citric Acid) improved transepidermal water loss (TEWL).
3. Improved Moisture Absorption, traditionally correlated with the use of a Moisturizer alone, was observed for those treatments containing the Moisturizer (Glycereth-26).
4. Improved skin properties, normally attributed to leave on cosmetic treatments have been observed in low dose repeated use hand dishwashing applications. Skin health effects of the moisturizer, Glycereth-26, indicate that the moisturizer is substantive to the skin at very low use dilutions in wash off products. Skin health effects, associated with the AHA, Citric Acid, have been demonstrated at relatively high use pH for AHA products, 6.2-7.0 and at very low use levels, <1%.

A patent has been granted for use of a moisturizer and an AHA in hand dishwashing detergents, US Pat 6479442 B1.

- 1 Van Scott, Eugene, J., Yu, Ruey J., US Patent 3984566, 1976
- 2 Smith, Walter P., Hydroxy Acids and Skin Aging, *Soap/Cosmetics/Chemical Specialties*, Sept., (1993), pp54-76
- 3 Ash, Micheal, Ash, Irene, *Handbook of Cosmetic and Personal Care Additives*, Second Ed., Synapse Information Resources, (2002)

- 4 Loden, Marie, Maibach, Howard I., *Dry Skin and Moisturizers Chemistry and Function*, CRC Press, (2000)
- 5 Wenninger, John A., McEwen, G. N., *International Cosmetic Ingredient Dictionary*, The Cosmetic, Toiletry and Fragrance Association, (1995)
- 6 Tagami, H., Y. Kanamaru, K. Inoue, S. Suehisa, F. Inoue, K. Iwatsuki, K. Yoshikumi and M. Yamada, Water sorption-desorption test of the skin *in vivo* for functional assessment of the stratum corneum, *J. Invest. Dermatol.* 78, 425-428 (1982)
- 7 Pinnegoda J, Tupker R A, Agner T, Serup J. Guidelines for transepidermal water loss (TEWL) Measurement., *Contact Dermatitis*, 22, (1990) 164-178