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Utilization of a Heatmapping Python Program to Visualize Improvements of Skin Hydration After Use of a Moisturizing Lotion or Cream

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ABSTRACT

Dry skin is both extremely common and an important concern for those who suffer from it. In addition to uncomfortable signs and symptoms, dry skin can be associated with pigmentary changes in individuals with darker skin types. This small single-center study applied a split-body methodology to compare the hydrating effects of a gentle moisturizing lotion vs a gentle moisturizing cream on arms over a 4-week period. Corneometry and digital photography were used to compare changes in skin hydration, and heatmaps were generated to visualize changes and augment the visible results seen in photography. Both the lotion and cream effectively achieved a rapid and sustained improvement in skin hydration. The products were well tolerated, with no adverse events reported.

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INTRODUCTION

Maintaining good hydration is an essential part of healthy skin. Skin hydration has been primarily assessed on facial skin; however, many individuals suffer from dry skin on additional areas of the body. Visually, this can be appreciated by roughness, flaking, or scaling (sometimes described as an "ashy" look in darker skin types). Sufferers may experience itchiness and even skin fissures. Symptoms and signs can vary based on age, health status, skin phototype, and environmental exposures. The American Academy of Dermatology (AAD) recommends applying moisturizers within a few minutes after cleansing, with the goal of trapping moisture.[1] Further, the AAD suggests using ointments, creams, or lotions with the caveat that ointments and creams may be more effective and less irritating than lotions.[1] Because patients have preferences for the type of formulation they wish to use (cream, ointment, or lotion), this study compares the moisturizing effects of a gentle lotion vs a cream to determine whether there may be differences in this particular product line's formulation types.[2]

Additional formulation differences, including preferred ingredients, can be very important in managing dry skin. This study evaluates two products that contain glycerin, panthenol, and niacinamide. Glycerin, a natural substance that is one of the skin's natural moisturizing factors (NMFs), acts as a humectant and attracts water into the skin's stratum corneum.[3] Glycerin also helps with retention of internal moisture within skin, which also enhances skin barrier function and overall skin health. It readily diffuses into skin and is a gentle, versatile ingredient that provides beneficial effects across a wide range of skin types. In 2020, Proksch et al summarized a meeting of specialists in dry skin management, encouraging the incorporation of humectants into topical emollients for patients with dry skin to help boost the activity of enzymes and NMFs in skin.[4] Panthenol (vitamin B_5) is a humectant that can enhance the production of cutaneous lipids and fibroblasts, translating to a stronger epidermal barrier.[5] Panthenol can also mitigate skin irritation and has anti-inflammatory actions.[5] Products that incorporate niacinamide can safely and effectively enhance skin brightness and overall skin appearance; niacinamide also helps smooth skin texture/roughness and restores the skin barrier.[6]

While hydration is important for all skin types, individuals with skin of color have a higher propensity for sequelae such as dyspigmentation.[7] Indeed, when present, postinflammatory pigmentary changes may be more concerning to the patient than the dry skin itself.[8] Therefore, the individual's skin type should influence the management strategy in regards to moisturizing product timing of initiation, ingredients, and product formulation.

The goal of this study was to visualize skin hydration via heatmap (colormap) on extremities in a variety of skin types, as was shown in a prior study of heatmapping facial skin after use of skincare products.[9] As with facial skin, understanding hydration on other bodily areas can be challenging due to environmental exposures (humidity, sunlight, and pollution) that affect water retention/loss.[10] As discussed by Voegeli et al, single-point measurements of skin hydration may not provide

an accurate bio-instrumental evaluation.[10] This has led to the implementation of heatmaps, a methodology that incorporates multiple data points into colorized images that correspond to corneometry readings and allow relatively simple visualization of differences.[10]

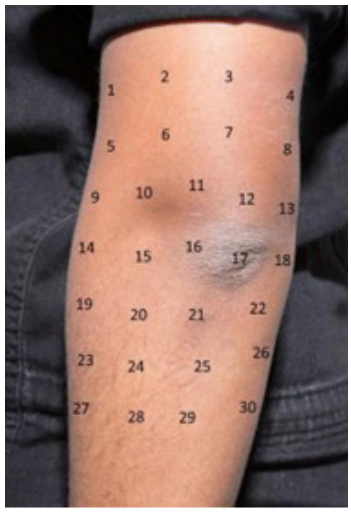
MATERIALS AND METHODS

In this 4-week split-body study, both moisturizing lotion or cream (Cetaphil® Moisturizing Lotion [ML] or Cetaphil® Moisturizing Cream [MC], Galderma LLP, Dallas, TX) were applied to each participant's arms (each to one randomly assigned arm per product) at least once daily and reapplied as needed. The study was conducted in accordance with the principles of the Declaration of Helsinki, and all participants provided written informed consent.

Assessments were performed at baseline, 30 minutes post-application, week 1, and week 4, with hydration measurements taken by Corneometer (Courage + Khazaka electronic GmbH, Germany) at 30 predefined points around the elbow (Figure 1). Additional assessments included standardized photography of the test area by VISIA-CR (Canfield Scientific, Inc, NJ), macroscopic imaging of the test area by Dino-Lite Microscope (AnMo Electronics Corporation, Taiwan), and standard safety assessments.

Pycharm, a Python programming software (JetBrains, Prague, Czech Republic), was used to interpolate hydration values to colors, along with Adobe® Illustrator® and Adobe® Photoshop® (Adobe Inc, San Jose, CA) to blend colors into a gradient heatmap. A rainbow color scale was applied in which colors trending toward green-blue indicated greater hydration, while those with more yellow-red tones indicated more dryness.

FIGURE 1. Points of measurement with the corneometer.



RESULTS

In this small imaging study, 7 participants with dry skin were enrolled, of which 5 participants completed the 4-week assessment period, with demographics shown in Table 1. Of note, the participant population was diverse in Fitzpatrick skin type, race/ethnicity, and age, and the majority of participants were female.

Figures 2 through 4 present clinical imaging results for participants in the study. Visible changes from dry skin to greater hydration were apparent in all images.

Both products were safe for application, and no adverse events were reported during the study.

TABLE 1.

Participant Demographics				
	Gender	Fitzpatrick Skin Type	Race/Ethnicity	Age
Participant 1	Female	V	African American	27
Participant 2	Female	IV	Middle Eastern	27
Participant 3	Female	VI	African American	39
Participant 4*	Female	I	Caucasian	N/A
Participant 5	Male	III	Asian	51
Participant 6	Female	II	White/Caucasian	25
Participant 7#	Female	II-III	Hispanic	47

*Participant 4 completed baseline and 1-week assessments; #Participant 7 only completed baseline and 3-week assessments.

FIGURE 2. Heatmap and macroscopic imaging of a participant with skin type V showing changes from baseline to week 4.

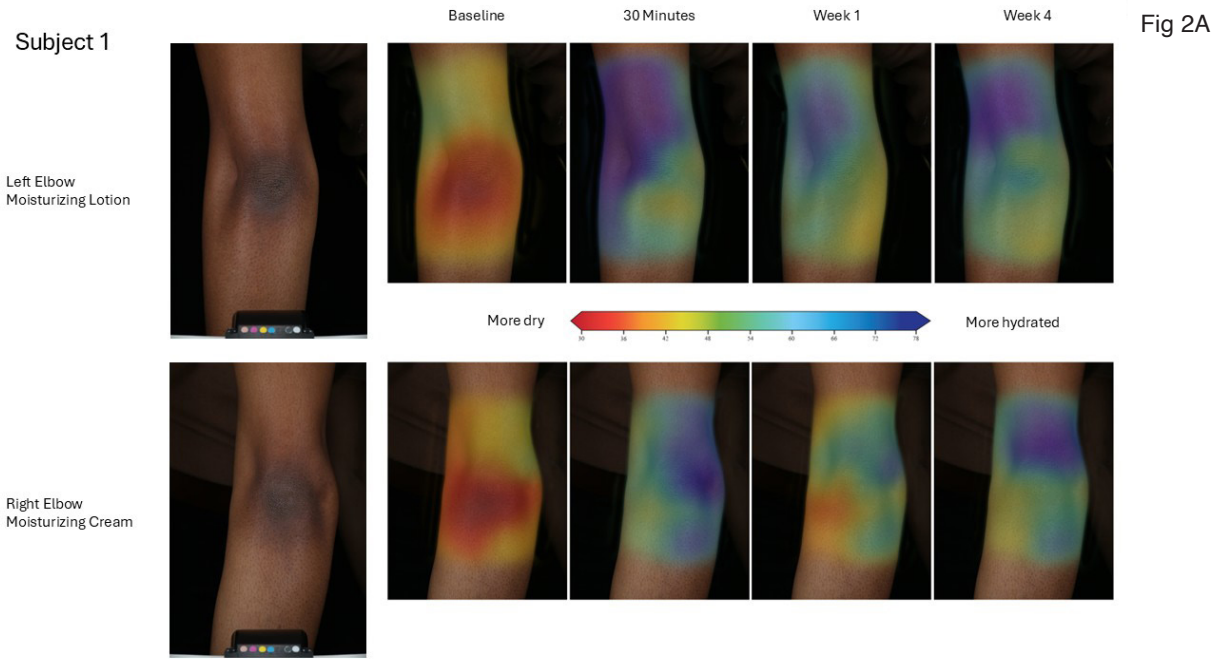


FIGURE 3. Heatmap and macroscopic imaging of participants with skin type III.

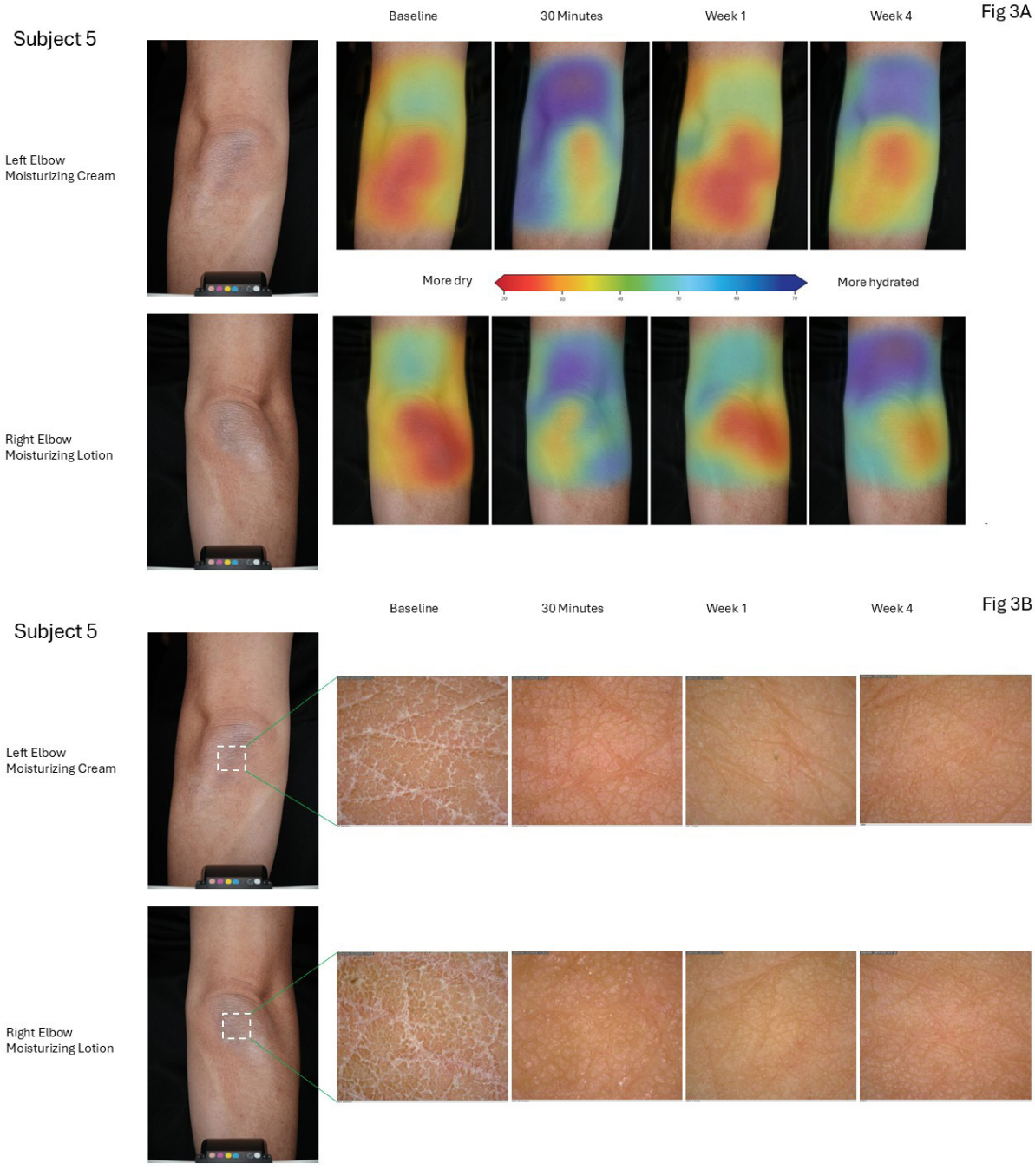
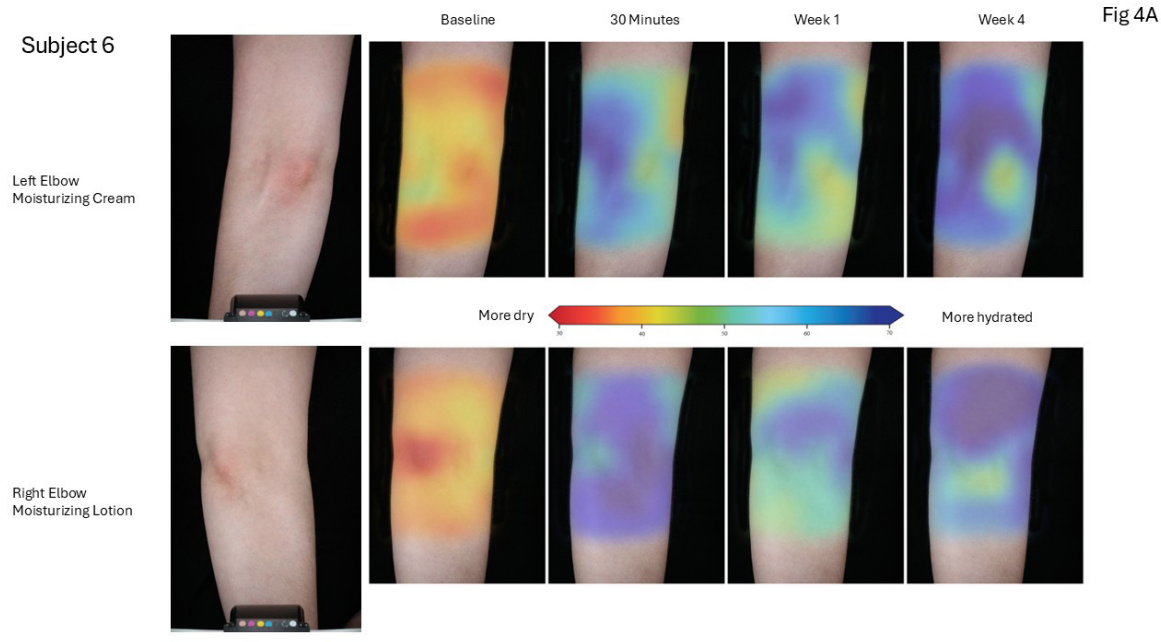


FIGURE 4. Heatmap and macroscopic imaging of a participant with skin type II.



DISCUSSION

As shown in the images, increases in hydration after product application were demonstrated at 30 minutes, 1 week, and 4 weeks of usage via clear color shifts from yellow-red to green-blue. Both ML and MC were associated with a rapid and long-term improvement in hydration in participants with a range of skin phototypes and ages. Notably, the skin of the elbow tends to be drier than surrounding areas, and the tested ML and MC both improved hydration in this area, which can be hard to treat.

Heatmaps are valuable to allow visualization of hydration results in a readily appreciable format, to incorporate data about larger skin areas, and facilitate interpretation of skin health. Heatmapping results have been reported for facial hydration, but less commonly hydration of skin on extremities.[9] We feel the use of this technique adds an important facet to the understanding of both skin dryness and hydration that remains somewhat poorly understood. Improvements in skin hydration translate to improvements in skin texture. In our study, the skin around the elbow appeared smoother and healthier as demonstrated by macroscopic imaging.

While formulation differences can be important with moisturizers, this study showed that this product line's lotion and cream, incorporating glycerin, panthenol, and niacinamide, both effectively improved hydration. This is useful for clinicians to be aware of, since individuals have varying preferences in the type of formulations they prefer to use. Further, these preferences may change somewhat throughout the year, along with the seasons.

DISCLOSURES

The authors are employees of Galderma Laboratories, LP.

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