An *In vivo Comparative Study on Ageing Skin: A Bio-Mimetic versus a Traditional Approach to Skin Moisturisation*

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Introduction

Skin dryness is a common condition in elderly individuals. The two main mechanisms to cosmetically alleviate this state rely on the effects of humectants and occlusive substances, mostly in combination. However, products nowadays aim to go beyond the simple humectant and occlusive effects and to deliver 'moisturising actives', such as skin-identical lipids, natural moisturising factor (NMF) components, lipid precursors, peptides and amino acids.

A relatively recent approach to increasing skin moisturisation is the bio-mimetic mechanism. This approach involves application of multi-lamellar lipid structures similar to the skin surface lipids which would promote the reconstruction of the lamellar structures of the stratum corneum and the restoration of the skin barrier function.

As defined by the Centre for Bio-mimetics at the University of Reading (2007), bio-mimicry is the abstraction of good design from nature and its use as inspiration for research.

Aim

To determine whether a bio-mimetic cream can deliver superior moisturisation to the skin of human volunteers aged over 60, compared to the effects of a conventional moisturiser containing high levels of petrolatum and mineral oil.

Materials and Methods

Test Products

An essential factor for the selection of skin identical lipids for a moisturisation study is their composition. Studies by Thornfeldt (2000) and Mao-Qiang et al. (1995) have shown the importance of lipid ratios and how topical applications of individual lipids or incomplete mixtures of lipids could interfere with barrier recovery instead of promoting it. Two commercially available bio-mimetic active ingredients containing approximately 2.5% active content of skin-identical lipids were selected for the formulation of test products. Both of the blends claim to have a composition similar to the skin surface lipids.

Skin Lipids	Active I	Active II
Triglycerides	Caprylic/Capric Triglyceride	Macadamia Triglycerides
Fatty Acids	Palmitic Acid	Vegetable Fatty Acids
Cholesterol	Phytosterols	Soja Bean Sterols
Ceramides	Ceramide 3	Safflower Ceramides
Phospholipids	Phospholipids	Soja Bean Phospholipids
Squalane	Squalane	Olive Squalane

Table 1. Comparison of the components of skin lipids and the two actives

Both actives claim to work by forming a protective barrier on the skin and restoring the missing lipids, thus providing care for dry and sensitive skin. They were formulated into an emulsion vehicle containing **Glycerine, Carbomer, Caprylic/ Capric Triglyceride, preserved water, Sodium Hydroxide, Disodium EDTA and Tocopheryl Acetate**, stabilised with an **Alkyl Polyglucoside emulsifier system.**

Study Design

This *in vivo* study was carried out in two stages.
Testing equipment:
- Corneometer CM825 (Courage + Khazaka electronic GmbH, Germany)
- Skin-pH-Meter PH905 (Courage + Khazaka electronic GmbH, Germany)

Stage I

The two prototypes were tested against a no-application site and a commercial product containing petrolatum and mineral oil as moisturising ingredients. 16 volunteers were recruited for a 4-hour blind skin hydration trial on the lower legs, using randomised intra-individual left-right comparison. The study was conducted after a one-week wash-out phase of no moisturiser application on the test sites.

Stage II

The better performing prototype from Stage I was then tested against the commercial product in a mini-regression study with 2 weeks product application (Monday to Friday) twice daily and a one-week regression phase. This included application of a bio-mimetic prototype on one lower leg (shin) and the back of hand (dorsal part), and a commercial product on the other lower leg and hand. 20 participants were recruited provided with the test products and a basic hand and body wash in order to standardise their cleansing routines. Skin hydration and pH measurements were recorded at baseline, after one and two weeks of product application, and at the end of the one-week regression stage.
At the end of the trial, the participants submitted a self-assessment questionnaire, which was used in order to compare instrumental results with the consumers' impressions of the two products.
The data obtained from the two trials were evaluated using the "R" software package for statistical computing. The results were checked for normality and the methods used consisted of 2-way analysis of variance (ANOVA), Student's t-test and binomial tests.

Results and Discussion

The analysis on the **short-term study** results revealed no statistically significant difference between the effects of the two bio-mimetic prototypes. However, both performed significantly better than the commercial product and the no application control site. This is visually demonstrated by Figure 1.

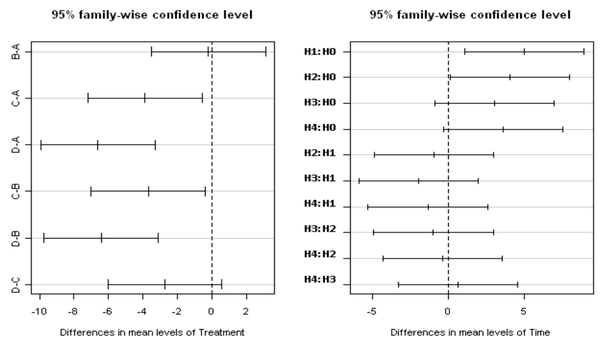

Figure 1. Tukey HSD test results for statistical significance between the different test products and the different time points: A- Active I; B- Active II; C- commercial product; H0- Baseline; H1, H2 and H3 – 1, 2 and 3 hours after application, respectively.

There was no significant difference between the results of the commercial product and the no application control after single application, which indicate that occlusive agents work better after repeated application.

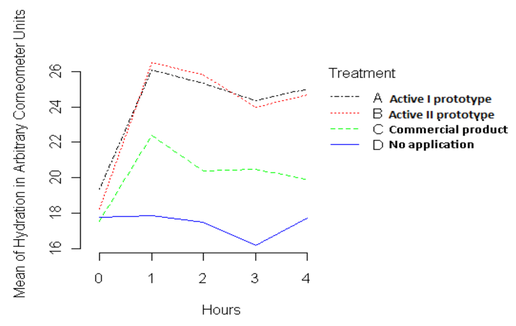

Figure 2. Changes in the SC hydration during the 4-hour study for three test products and a no-treatment control (n=16).

The **long-term study** showed significantly better performance of the bio-mimetic prototype on both leg and hand sites, compared to the commercial product. The skin hydration values for the bio-mimetic prototype continued to increase even in the regression phase, while the commercial benchmark values were declining. This effect was observed on both test sites (Figures 3 and 4).

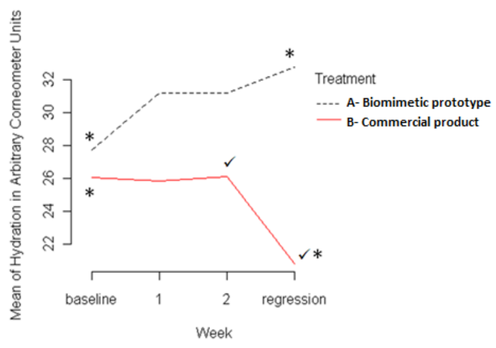

Figure 3. Changes in skin hydration during a 3-week regression study on the back of hands (n=20)
* Statistical significance between the baseline and the end of regression (week 3) values
✓Statistical significance between week 2 and end of regression (week 3) values

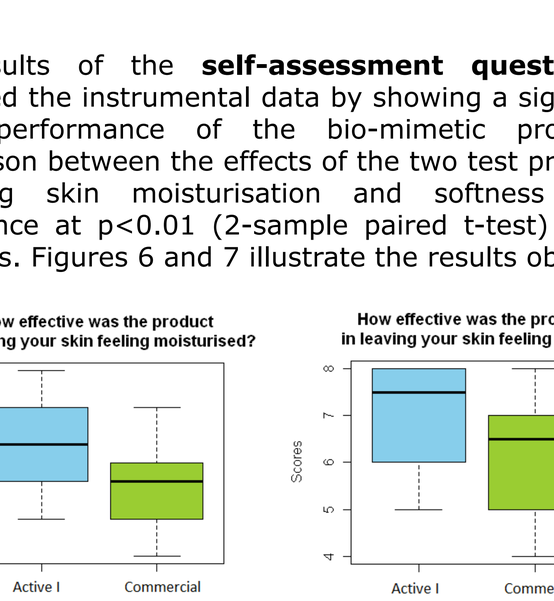

Figure 4. Changes in skin hydration during a 3-week regression study on the lower legs (n=20)
* Statistical significance between the baseline and the end of regression (week 3) values
+ Statistical significance between week 1 and week 2 weeks values
✓Statistical significance between week 2 and the end of regression (week 3) values

The results correspond to a similar study by Prasch et al. (2000). It was argued that the bio-mimetic cream has improved the skin hydration by increasing the order of the alkyl chains of the skin lipid film, while a conventional w/o emulsion has had a negative effect on that order.

Regarding the **skin pH measurements**, there was no significant change for any of the products on any test sites.

The results of the **self-assessment questionnaire** supported the instrumental data by showing a significantly better performance of the bio-mimetic product. A comparison between the effects of the two test products in delivering skin moisturisation and softness showed significance at $p<0.01$ (2-sample paired t-test) for both questions. Figures 6 and 7 illustrate the results obtained.

Figure 6. Self-Assessment of skin moisturisation

Figure 7. Self-Assessment of skin softness

Sensory scale used: 1(not effective); 5(no change); 9(very effective)

It is important to note that the negative effects observed for the commercial product during the regression phase were not detected by all panellists. This shows that computerised equipment could sometimes identify changes that might not necessarily be recognisable by the human eye and touch.

Conclusion

This study has demonstrated that using products based on lipids identical to those that make up the natural skin barrier can improve the skin hydration to a greater extent than a conventional o/w emulsion based on occlusive materials and humectants.

In addition, it has shown that using bio-mimetic moisturisers is an effective and long-lasting method to alleviate dry skin condition in people over 60.

References

- Centre for bio-mimetics (2007)- 'What is biomimetics?' University of Reading.
- Mao-Qiang, M., Brown, B.E., Wu-Pong, S., Feingold, K.R., Elias, P.M. (1995)- Exogenous Nonphysiologic versus Physiologic Lipids. Divergent Mechanisms for Correction of Permeability Barrier Dysfunction. Archives of Dermatology. 131: 809-816.
- Prasch, T., Knübel, G., Schmidt-Fonk, K., Ortanderl, S., Nieveler, S. and Förster, T. (2000)- Infrared Spectroscopy of The Skin: Influencing The Stratum Corneum With Cosmetic Products. International Journal of Cosmetic Science, 22: 371–383.
- Thornfeldt, C (2000)- Critical and Optimal Molar Ratios of Key Lipids. In Loden, M. and Maibach, H. (eds.) Dry Skin and Moisturizers: Chemistry and Function 2nd Edition. Boca Raton: CRC Press.

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