

# The Influence of a Single Application of Different Moisturizers on the Skin Capacitance

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Moisturizers are believed to improve the skin condition by increasing the water content of the stratum corneum. A variety of techniques for assessing skin hydration has been developed. In the present study the capacitance following a single application of different moisturizers to normal skin on 12 volunteers was measured with the commercial available Corneometer 420. The moisturizers were pure petrolatum and three oil-in-water creams. The latter contained either glycerine, glycerine and pyrrolidone carboxylic acid, or urea as humectant agents.

The first measurement of the change in the capacitance was done 2 h after application of the products. All tested products increased the capacitance in the same order of magnitude. For the creams the values were significantly enhanced during the experimental period (6 h).

Excess product were removed from some skin areas after the 2 h measurement. This caused immediately a significant decrease in the capacitance of the cream treated sites, whereas a tendency towards higher values were noted on the petrolatum-treated sites. These findings indicate that the non-absorbed components influences the capacitance values. Hence, the interpretation of electrical measurements with respect to skin moisture should be made with caution.

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One primary claim for the efficacy of skin care products is moisturization. This originates from the classic work of Blank (1) in which he showed that the dehydrated stratum corneum is hard and brittle. Since then, investigators have attempted to define the mechanism of water binding in the stratum corneum and to objectively measure the hydration effects of moisturizers.

There are two major principles to alleviate dry skin. The first implies a simple reduction of the loss of water from the skin, and the second the use of humectant materials. Common occlusive substances used include petrolatum, beeswax and lanolin. There are many reports on the reduction of transepidermal water loss, TEWL, by application of pet-

rolatum (2-4). Humectant agents that are claimed to be effective include glycerine, sodium lactate, pyrrolidone carboxylic acid (PCA) and urea. Urea is used in commercial preparations designed for pathological dry skin conditions (5). Whether glycerine also acts as an occlusive agent is controversial. Some has found a reduction in TEWL following application of glycerine (6-8), whereas others found glycerine to increase TEWL (9,10).

A variety of techniques for assessing skin hydration have been developed and reviewed (11-14). Most in vivo techniques are based on electrical measurements, such as resistance, capacitance and impedance. Experimentally induced dry skin (15), dry atopic skin (16), and normal looking skin of patients with atopic eczema (17, 18) exhibit lower values of the skin capacitance. There seem to exist a relationship between electrical properties and degree of clinical dryness (19). Unfortunately, these techniques do only give qualitative information on changes in the water content at poorly defined locations within skin. Another drawback with these techniques are that agents other than water (e.g. urea and salts) can produce dramatic changes in the electrical properties (12).

The aim of the present study was to measure the capacitance of the normal skin surface after a single exposure to moisturizers containing different "active" ingredients. In order to study the influence of non-absorbed test material on the capacitance, excess product was removed from some skin areas 2 h after the application. The study was completed after 6 h.

## MATERIAL AND METHODS

### Subjects and treatment

Twelve female subjects (mean age 39, range 19-54 year) with normal skin participated in the study. By micropipette 20  $\mu$ l of the 3 different creams and 10  $\mu$ l of the petrolatum was applied to four areas (4 cm<sup>2</sup>) on the volar surface of the left and right forearm. A fifth area on each arm served as control and was left untreated. The test-substances were randomly allocated to the five sites. The allocation of the substances was the same on both arms in each person. Before application of the products, surface lipids were removed from all skin areas by rapidly cleaning the skin with soft paper impregnated with diethylether.

The electrical capacitance was recorded before application of the products to the skin and 2 and 6 h thereafter using a Corneometer CM 420 (Schwartzhaupt Medizintechnik GmbH 5000, West Germany). The instrument is considered to reflect the degree of hydration not only in the superficial layers of stratum corneum but also in the deeper

part of the skin surface (20,21). Immediately after the 2 h measurement non-absorbed product on the right arm was removed by cleaning the surface of the 5 skin areas as above, and additional measurements were done on the right arm. The probe was applied to the skin with a standard pressure of 3.5 N, and the recording time was 3 s. The capacitance is expressed digitally in arbitrary units. The study was performed during the month of August. The room temperature was 24°C.

### Products

Pure petrolatum and three oil-in-water creams were tested. The creams contained different humectants; glycerine, glycerine and PCA, or urea. Other principal ingredients in decreasing order of concentration were: Glycerine cream: water, PEG-9 stearate, mineral oil, cetylalcohol, isopropyl myristate.

Glycerine and PCA cream: water, isopropyl myristate, stearic acid, cetyl alcohol, cetyl phosphate & DEA-cetyl phosphate.

Urea cream: water, lactic acid, betaine, glyceryl monostearate.

### Statistics

Wilcoxon's rank sum test was used to compare the treatments. The level of significance was chosen at 5 % ( $p < 0.05$ ).

## RESULTS

Two hr following application of the products the capacitance on the treated sites was significantly higher than that on the control area (Fig. 1). On the control area the capacitance was slightly enhanced

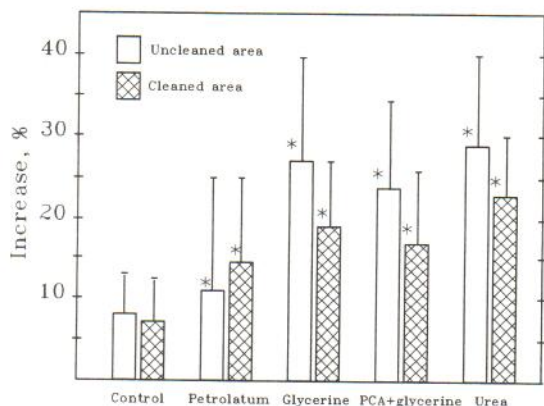


Fig. 1. The increase in capacitance in 12 subjects 2 h after application of different moisturizers. Comparison of the values from the right arm before and after cleaning with diethylether at 2 h. For details see text. Error bars represent standard deviation of the data.

\* =  $p < 0.05$ , n.s. = not significantly different from control sites.

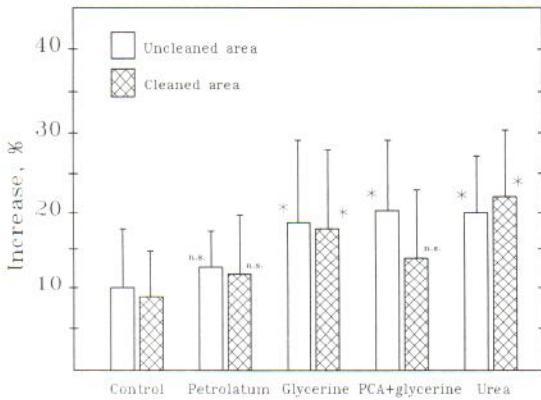


Fig. 2. The increase in capacitance in 12 subjects 6 hours after application of different moisturizers. Comparison of the values from the right arm (cleaned) and the left arm (uncleaned). For details see text. Error bars represent standard deviation of the data.

\* =  $p < 0.05$ , n.s. = not significantly different from control sites.

compared to the initial value. Removal of non-absorbed cream components resulted in a prompt and significant decrease in the capacitance. This was not seen in the petrolatum-treated sites, where instead a slight tendency towards higher values were seen after the cleaning (not statistically significant).

During the next 4 h the capacitance values on the cream-treated sites decreased and the difference between the cleaned and uncleaned sites became less pronounced (Fig. 2). In most of the cream-treated sites the significant increase in capacitance values still remained after 6 h.

## DISCUSSION

Dry skin has a low capacitance (15–19). Thus, an increase in capacitance is believed to reflect an improved skin condition. In the present study the applied moisturizers increased the capacitance significantly. On the cream-treated sites, but not on the petrolatum-treated sites, the values were significantly enhanced during the entire experimental period (6 h). Removal of the non-absorbed cream components after 2 h, caused a prompt decrease in the capacitance values. This indicates that the capacitance values do not only reflect the capacitance of the skin, but also that of non-absorbed cream components. A similar indication of influences of non-absorbed components on the measurements was obtained from the results from the petrolatum-treated sites. However, in contrast to the creams, removal of

petrolatum did not decrease the capacitance but appeared to induce a slight (not statistically significant) increase in the capacitance.

An increase in electrical response after cleaning a petrolatum covered skin area have been reported by others (8). Wepierre reported that after application of petrolatum to the skin the electrical measurements indicated that the skin became less hydrated (22). The reason for this is thought to be due to the high electrical resistivity of petrolatum, i.e. petrolatum that simply remains on the skin surface may well influence the measurements of the skin hydration so that the effect of petrolatum is underestimated. On the other hand, petrolatum has also been reported to increase the skin capacitance (23). The same was also reported for glycerine and NaPCA, but not for the well-known moisturizer urea (23).

During the study the capacitance on the control area increased. This might either be due to changes in the Corneometer or in the skin surface (e.g. temperature or content of sebum and sweat). Changes in the Corneometer values with time were also seen in a study by Frödin et al. (24). For instance, in the cited study the value decreased by 30 % on the untreated area during 4 days.

The present study shows that all tested creams increase the capacitance in the same order of magnitude, irrespective of their content of "active" ingredients. However, the most well-known moisturizer, pure petrolatum, was the least effective one. Removal of non-absorbed components causes immediately a significant change in the capacitance. These findings emphasize the importance of using different approaches to verify product performance, and that the interpretation of electrical measurements with respect to skin moisture should be made with caution.

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