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Moisturizing and anti-sebum secretion effects of cosmetic application on human facial skin

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Synopsis

For human skin, high water content and low sebum secretion are considered to be main features of fair skin. To explore the proper personal care regimen for facial skin, we investigated the change of skin physiologic parameters after cosmetic application by measuring the skin water content, transepidermal water loss, and skin sebum secretion on facial skin before and after the cosmetic application using the Corneometer, Tewameter, and Sebumeter, respectively. The results indicated that the cosmetics application kept a higher water content and a lower transepidermal water loss, and at the same time, a lower sebum secretion 4 h and 8 h after the cosmetic application, compared with those before it. The situation was maintained in the succeeding three-week continuous use of the cosmetics. It could be concluded that the cosmetic application on human facial skin might provide some moisturizing effect and at the same time an anti-sebum effect, which favors the maintenance of good skin physiological function after applying skin care products. Our results might provide a scientific personal care regimen for human facial skin to prompt the balance for the hydrolipid film on skin.

INTRODUCTION

The hydration in the surface layer of the skin, stratum corneum (SC), gives important information on the biophysical properties and function of the skin barrier (1). With an adequate amount of water in the SC, the skin maintains its intact barrier function, feels soft and flexible, and looks smooth and healthy.

Additionally, the human face is covered by a lipid film. Sebum excreted from the seborrheic glands keeps the skin surface supple and moist, and is known to control moisture

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and to protect skin from microbiological infections. However, too much sebum secretion could make the skin surface very oily and might promote acne for some people (2,3). Thus, sebum control is an important factor for facial skin care, especially for young adults with excess sebum secretion.

It is generally accepted that the water content of the SC and skin sebum secretion are coordinative and important factors in the appearance and function of skin. A high water content, low transepidermal water loss (TEWL), and low sebum secretion are considered to be main features of fair skin. Thus, optimized facial care cosmetics should be developed that can supply a proper moisturizing effect and at the same time remove excessive amounts of sebum in facial skin (4).

To substantiate the efficacy claimed for cosmetic products, non-invasive bioengineering instruments have been introduced into cosmetology (5). The Corneometer has gained worldwide acceptance as an efficient instrument to detect water content variation in the SC, based on electrical capacitance measurement (6,7). The Tewameter is the device commonly used to determine TEWL, which measures the water vapor pressure gradient according to Fick's law, to evaluate skin barrier function integrity (8,9). The Sebumeter has become an acceptable method for detecting sebum secretion levels, which is determined by the photometric transparency of absorbed sebum onto a plastic film (10,11).

To explore the proper personal care regimen for facial skin, we have investigated the protection effect of some cosmetics on human skin under a simulated rigorous environment (12). Here, we investigated moisturizing and anti-sebum secretion effects by measuring skin water content, TEWL, and skin sebum secretion before and after cosmetic application on human facial skin.

MATERIALS AND METHODS

TEST PRODUCTS

The test products, including product 1, product 2, and product 3, were mainly composed of glycosyl trehalose, *Laminaria ochroleuca* extract, sodium hyaluronate, niacinamide, glycerin, panthenol, and tocopherol, and were provided by Procter & Gamble (China) Ltd. Some of the ingredients were newly researched actives claimed by P&G. For example, *Laminaria ochroleuca* extract was extracted from a plant that grew in a desert environment and could survive the rigorous droughty climate. Product 1 was colorless, nonaromatic, and water-like; product 2 was a white and faintly scented cream; and product 3 was a white sun protection cream with 2-ethylhexyl salicylate and titanium dioxide as the sunscreen actives, and labeled as SPF18, PA++. Product 1 was applied first and then followed by product 2. While product 3 was required to be used according to a test protocol, it was applied following the application of product 2.

SUBJECTS

Thirty healthy female subjects, with normal or slight oily types of facial skin, participated in this study. Their ages ranged between 25 and 34 years, and the average age was 29 ± 3 years. The criteria for non-inclusion were the presence of any dermatitis and/or

other skin diseases and allergy, or participation in any other study. An informed consent form was obtained and signed by each subject.

FACIAL SKIN WATER CONTENT, TEWL, AND SEBUM SECRETION MEASUREMENTS

Skin water content was estimated with a CM 825 Corneometer (Courage + Khazaka Company, Cologne, Germany), and the results were expressed in arbitrary units (a.u). TEWL was measured using a TM 300 Tewameter (Courage + Khazaka) and expressed in $g/h.m^2$. Facial sebum secretion was measured using an SM 815 Sebumeter (Courage + Khazaka) and expressed in $\mu g/cm^2$.

TEST PROCEDURE

Before each test, the subjects cleaned their faces with a standard lotion according to a standard procedure and rested for 30 min in the air-conditioned laboratory with a constant $22° \pm 1°C$ room temperature and $50 \pm 5\%$ relative humidity. The subject's cheeks were used as test areas.

For the kinetics test, one 3-cm × 3-cm area on one cheek was treated with product 1, product 2, and then with product 3, and the corresponding area on the other cheek was left untreated as a control according to permuting order. Measurements were taken 0, 2, 4, and 8 h after product application, with an amount equaling 2 $\mu l/cm^2$ or 2 mg/cm^2 on the first day.

For the three-week test, the cheeks were treated with product 1, product 2, and then with product 3, with no control area. Measurements were taken once a week over a period of three weeks, and the subjects were instructed to use the products twice a day at home.

At the end of the last test, the 8-h kinetics test was performed again, as on the first day, and the subjects filled out a questionnaire to present their feelings about the products after using them for three weeks.

STATISTICAL ANALYSIS

The difference between the measurements was statistically evaluated with analysis of variance (ANOVA) and the Student's *t*-test. The p value of 0.05 was considered significant. STATISTICA 7.1 (Statsoft Company, Tulsa, OK) software was used.

RESULTS

KINETICS TESTS ON THE FIRST DAY

For the areas treated with products on the first day, the Corneometer measurements gave an increased level, with the highest value measured 4 h after application (Figure 1). All the differences from baseline were significant in the statistical analysis ($p < 0.05$), whereas for the untreated area almost constant levels were found during the 8-h test period.

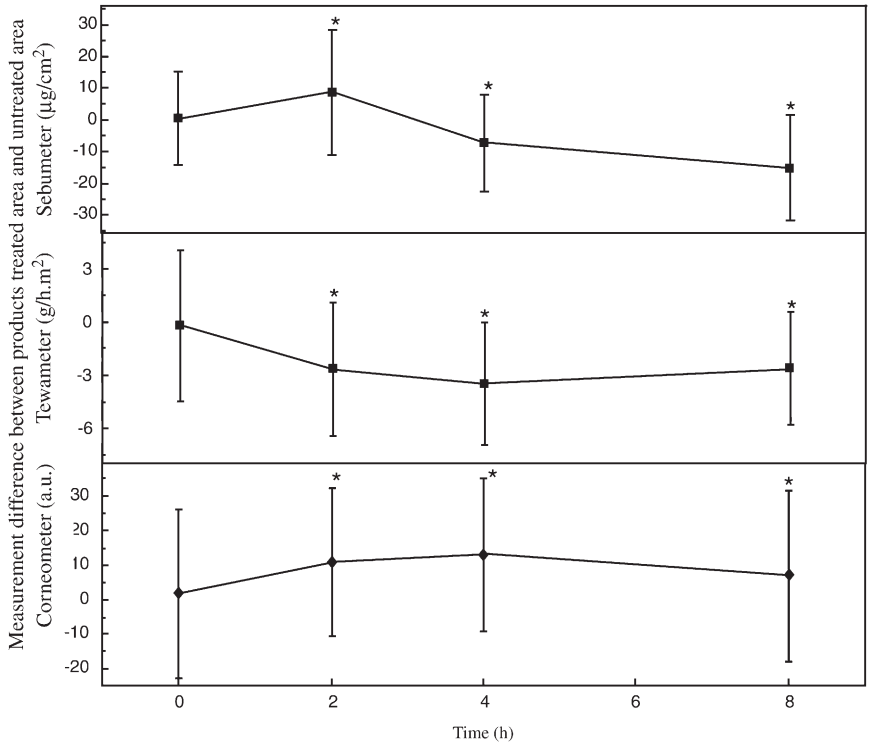

Figure 1. Measurement difference between product-treated area and untreated area after 0, 2, 4, and 8 h of treatment on the first day. Data are shown as mean ± SD and the asterisk (*) indicates a statistically significant difference from the baseline ($p < 0.05$).

In contrast, the Tewameter measurements showed a decreased level, with the lowest value measured 4 h after application to the product-treated area (Figure 1). In addition, all the differences from baseline were significant in the statistical analysis ($p < 0.05$), and for the untreated area, no significant changes were found during the 8-h test period.

For the Sebumeter measurements on the untreated area, an increased level was found during the 8-h time, which may have resulted from the spontaneous physiological secretion of sebum on the facial skin after washing. On the area treated with products, the Sebumeter measurements indicated a decreased level 4 h and 8 h after product application (Figure 1), and the differences to baseline were significant in the statistical analysis ($p < 0.05$).

KINETICS TESTS ON THE LAST DAY

Similarly, for the areas treated with products on the last day, the Corneometer measurements gave an increased level (Figure 2), whereas both the Tewameter and the Sebumeter measurements exhibited a decreased level, except for the Sebumeter measurement after 2 h of treatment. The differences from baseline were significant in the statistical analysis ($p < 0.05$), except for the Sebumeter measurement after 4 h of treatment. Additionally, the measurements exhibited plateau characteristics, with no typically peak values after 2, 4, and 8 h of treatment, except for the Sebumeter measurement after 2 h of treatment.

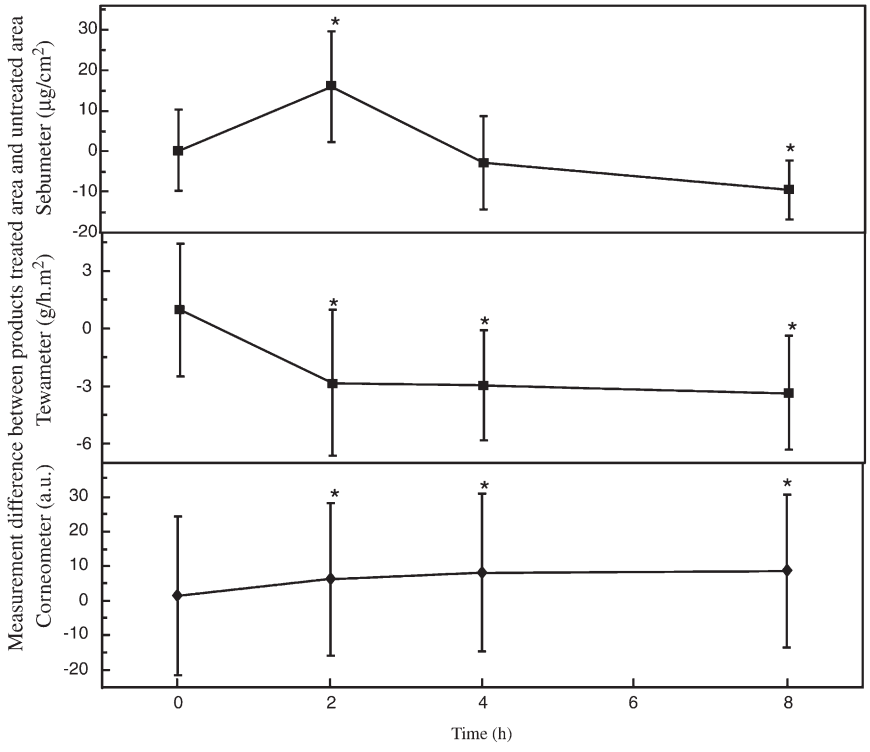

Figure 2. Measurement difference between product-treated area and untreated area after 0, 2, 4, and 8 h of treatment on the last day. Data are shown as mean ± SD and the asterisk (*) indicates statistically significant difference from the baseline ($p < 0.05$).

THREE-WEEK TESTS

For the three-week Corneometer, Tewameter, and Sebumeter measurements, we did not determine an untreated area on the cheeks. However, the volunteers applied the products on both cheeks, upon considering that use of cosmetics on the untreated area was not permitted for three weeks, which has caused difficulties for some subjects, especially for those 25 to 34 years old. However, we had some results tested on the subjects' forearms used as the untreated areas, and there were no significant changes on the skin surface for the three measurements during the three-week period. In addition, we can expect that with no cosmetics applied on the facial skin, dry and uncomfortable feelings should appear on those young women's facial skin, especially in Beijing, a very dry and windy city in China.

On the cheek area treated with products, the Corneometer measurements gave an increased level during the three-week period (Figure 3). However, the Tewameter and the Sebumeter measurements showed a decreased level. All the differences from baseline were significant in the statistical analysis for the three measurements ($p < 0.05$).

SUBJECTS' FEELINGS ABOUT THE EFFECT OF THE PRODUCTS

Except for the instrument measurements, there were similar improvement results attained from the subjects' feelings reflected in a questionnaire (Table I). The subjective

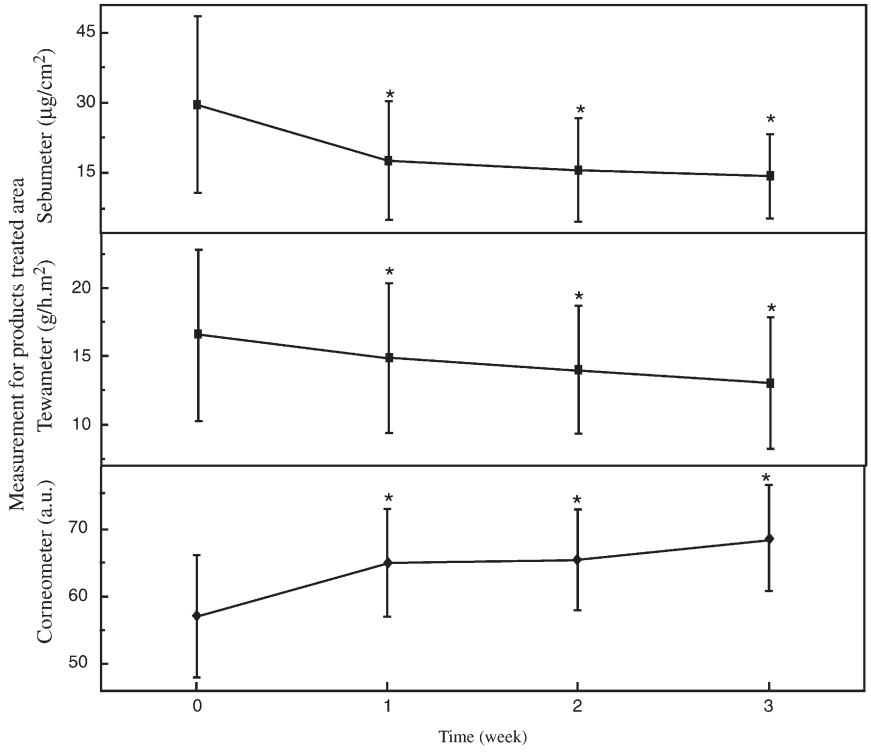

Figure 3. Measurement on cheeks after using products for one, two, and three weeks. Data are shown as mean ± SD and the asterisk (*) indicates statistically significant difference from the baseline ($p < 0.05$).

evaluation results for both the moisturizing and anti-sebum related aspects gave a mark of 2 to 3 (1, excellent; 2, fine; 3, popular; 4, normal; 5, bad), which showed that the subjects thought the product application could make the skin feel moist instantly, keep feeling moist, and control the skin oil for a whole day and the later three-week use time. The noninvasive instrument measurements showed coincidental results with the perceivable feelings of the subjects.

Table I
Subjects' Feelings About the Moisturizing and Anti-Sebum Effects of the Products Reflected in the Questionnaire

No.	Item	Average score*
1.	Do you think the product application could make the skin feel moist instantly?	2.4
2.	Do you think the product application could keep the skin feeling moist for a whole day?	2.6
3.	Do you think the product application could keep the skin feeling moist for the later three-week period?	2.7
4.	Do you think the product application could control the skin oil for a whole day?	2.7
5.	Do you think the product application could control the skin oil for the later three-week period?	2.9

*1, excellent; 2, fine; 3, popular; 4, normal; 5, bad.

DISCUSSION

For human skin, water content is an important physiological factor for the skin condition, and moisturizing is the basic function for skin care. In our experiments, the product application showed increased Corneometer and decreased Tewameter measurements during the 8-h test period on the first and last days. The situation was maintained for the later three weeks, which indicated a favorable moisturizing effect provided by product application on human facial skin. After three weeks of application, the measurements for the 8-h kinetics test on the last day became uniform, with no typically peak values, which also indicated the amelioration effect on human skin after three weeks of treatment. The perceivable feelings of the subjects reflected in the questionnaire showed that the subjective evaluation of the moisturizing effect of product application was satisfying too, which coincided with the Corneometer and Tewameter measurement results.

One reason for the moisturizing effect might be hyaluronic acid, an important ingredient in product formulation accounting for the moisturizing effect. It is a glycosaminoglycan composed of alternating N-acetyl-D-glucosamine and D-glucuronic acid moieties. It is also a ubiquitous component of connective tissue where it forms a matrix and plays an important role in the maintenance of matrix structure and water balance (13,14). When included in the test products and applied directly to the subjects' skin surface, hyaluronic acid hydrates the skin as a humectant. It literally attracts airborne water vapor into the skin and retains water delivered to the skin by circulation. It also provides another key benefit by preventing the evaporation of water from the skin surface, which could decrease the TEWL of the skin on clinical research.

Just ameliorating the hydration state of the skin is not enough, and skin sebum secretion control is also an important factor for skin care. Cosmetics should be applied upon considering both the moisturizing and the anti-sebum effects on human facial skin, which is the scientific and advisable personal skin care method. In our experiments, product application showed a satisfying anti-sebum effect 4 and 8 h after application on the first and last days, and the situation was maintained for the following three weeks, indicated by decreased Sebumeter measurements. In the 8-h kinetics test on the first day, the anti-sebum effect was achieved 4 h after product application, which was coincident with the beginning time of the best moisturizing effect. Our results indicated the favorable anti-sebum effect provided by product application was concurrent with the moisturizing effect. In addition, the Sebumeter measurement results were coincident with the perceivable feelings of the subjects about the anti-sebum effect of product application reflected in the questionnaire.

One ingredient, possibly accounting for the anti-sebum effect, is nicotinamide (niacinamide, Vitamin B_3), a physiologically active form of niacin (nicotinic acid), which has been assessed in clinical studies and found effective for lowering the sebum secretion on the skin surface and in some inflammatory skin diseases such as acne vulgaris and bullous pemphigoid. It is theorized that the niacinamide possibly alters the movement of sebum to the skin surface by altering the reservoir in the duct connecting the sebaceous gland to the skin surface at the follicular ostia and encourages sebum to flow to the skin surface more quickly. This depletion of the reservoir eventually translates into decreased sebum excretion on the skin surface (15,16). It exhibits a satisfying anti-sebum effect when included as an active ingredient in the test products. Nevertheless, there may be other active ingredients that may contribute to skin benefits, especially integrated prescriptions and technologies.

It could be concluded that product application could provide some moisturizing effect and at the same time some anti-sebum secretion effect on human facial skin. Our results might provide a scientific personal care regimen for human facial skin to prompt the balance for the hydrolipid film on skin.

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