# THE EFFECT OF COSMETIC EMULSIONS ON THE STRATUM CORNEUM

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IN DEVELOPING cosmetic creams and lotions the cosmetic chemist is faced with the task of preparing not only a stable product but one that will have good consumer acceptance.

Preparing a new emulsion for the application to the skin with acceptable shelf life may be a difficult task especially when one attempts to incorporate the promotional "plusses" that marketing must have; but this could very well be child's play compared to the decision as to what characteristics the consumer would like to see in the product and how to evaluate the efficacy of the product.

What is still more of a challenge is the fact that many emulsion properties are discussed daily among cosmetic chemists with no means at hand for measuring these characteristics. For example, experts in cosmetic product development will agree that an outstanding product should (1) possess a certain degree of "slip," (2) dry quickly, (3) leave just the merest trace of oiliness, (4) leave a velvety "feel," (5) leave a smooth finish, etc. But all these characteristics are purely subjective—the end result desired, of course, is a soft, smooth skin.

In trying to arrive at what properties the consumer looks for, one may resort to panel testings but the authors have found them of little value in arriving at an answer. True, panel tests are effective in detecting serious flaws in the product, such as evidence of irritation, but they are of little help in actually determining the efficacy of the product. Many of you have, undoubtedly, experienced the situation where two creams identical in every respect except for odor are panel tested. Yet, the results obtained would indicate that the products are poles apart as regards "feel," "finish," "slip," "stickiness," "skin smoothness," or "greasiness."

What is more disturbing is the case where the identical product is tested by a panel of cosmetic chemists on the one hand and by a panel of advertising and marketing personnel on the other with opinions as to "feel,"

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"slip," "finish," "smoothness," and efficacy ranging from good to poor and usually in wide disagreement. In this case, is performance or promotion more important for lasting sales?

A more reliable opinion can be obtained by increasing the size of the panel from a few dozen to a few thousand people and still better results can be obtained by clinical evaluation by experts, but these methods are costly and are usually reserved for the product when it is complete.

But how can the cosmetic chemist know if his formulations are on the "right track?" It would help tremendously to be able to measure those properties that are desirable and assign a value to these parameters in place of the subjective terminology used in the present state of the art. When this happens cosmetics will come a step closer to being a science rather than an art.

One of the functions of the majority of creams and lotions prepared for the skin is to soften the stratum corneum. For many years it was felt that the oils and waxes contained in creams and lotions softened the skin per se(1).

However, recent studies by Blank (2) and Peck (3) show that oils and waxes, as such, do not soften callus tissue but that the water content of the callus tissue is the prime factor responsible for its softness and flexibility.

Since ancient times oils, fats and waxes of one sort or another have been applied to the stratum corneum to obtain a soft, smooth, supple finish. How is this compatible with the data obtained by Blank (2) and Peck (3)? The answer now appears to be that a layer of an oily, water-insoluble material applied to the stratum corneum reduces the moisture loss from the surface of the skin (4). Figure 1 illustrates the mechanism involved.

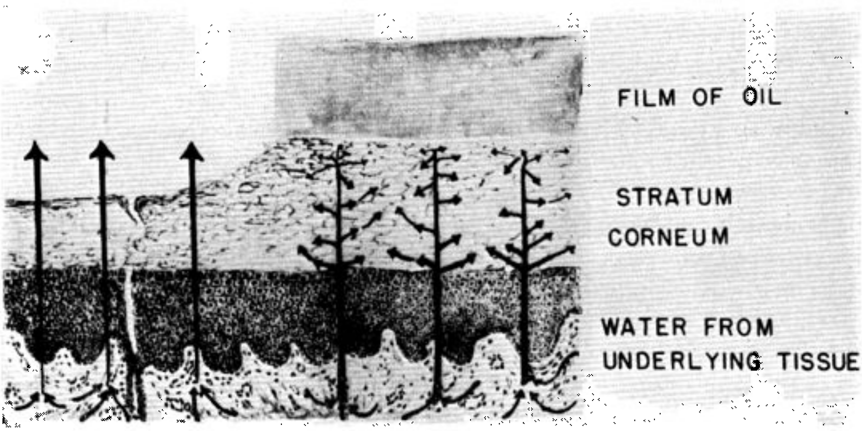


Figure 1.—Schematic representation of the retention of water of diffusion by the stratum corneum of an area of skin covered with a film of occlusive oil (4).

Water is continuously evaporating from the surface of the skin (5). This moisture stems from the tiny orifices of the eccrine glands and from the underlying tissues. The rate at which this moisture supply reaches the stratum corneum is controlled in a large measure by a thin layer of tissue lying just beneath the stratum corneum called the barrier layer (6). The stratum corneum has a mesh-like structure made up of a mixture of 60 to 70 per cent of keratin and 30 to 40 per cent of water-soluble compounds (7). Normal stratum corneum contains 10 to 25 per cent water. This water-holding ability of the stratum corneum is probably due primarily to these nonkeratinous, water-soluble, nitrogen-containing compounds (7, 8).

Figure 2.—Desiccator fabricated from a glass cylinder, covered with polyethylene snap cap.

Thus, a certain amount of the moisture reaching the stratum corneum is retained by it and accounts for its flexibility and softness. However, it is entirely possible for the stratum corneum to be deficient in the water binding components (9), in which case a dry scaly skin will result. And, of course, perfectly normal skin will lose moisture and become dry under conditions of low relative humidity (10).

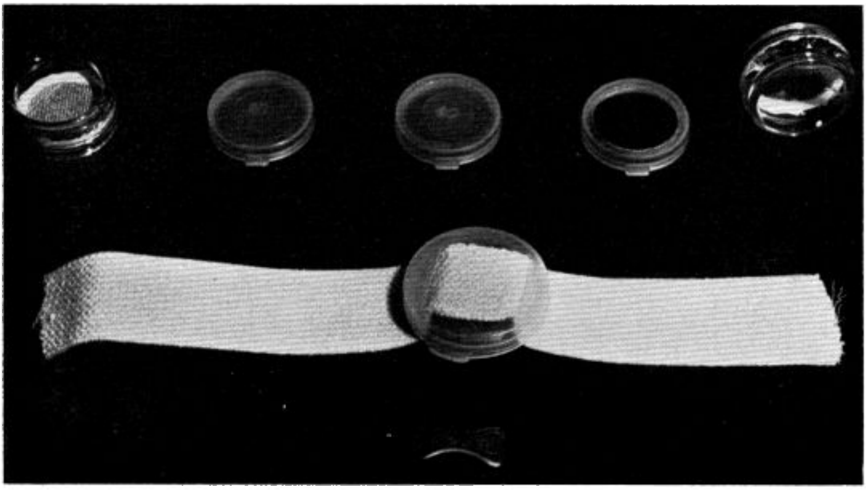

Figure 3.—Desiccator assembly showing cylinder, snap caps, gasket, elastic band and bandage clip.

By applying a layer of oil onto the stratum corneum, the rate of water evaporation from the surface of the skin may be reduced. This moisture, which normally would have been lost, is then deflected back into and increases the moisture content of the stratum corneum, resulting in a softer skin.

In an effort to study the effect of lotions on the water content of the skin, Powers and Fox (11) developed a method, using small desiccators, whereby the rate of moisture loss from the skin could be measured. The desiccator and assembly are shown in Figs. 2 and 3.

In this test, the desiccators containing silica gel* are placed on the inner portion of the forearm and held in place by a strip of elastic pajama belting fastened with a bandage clip (see Fig. 4).

Using this test method, it was shown that water-insoluble oily materials definitely retard the percentage of moisture loss from the skin and that certain emulsifiers and humectants may actually accelerate this moisture loss. Data obtained with the ingredients tested are shown in Table 1.

Further studies have revealed that the accuracy of the method may be improved by "calibrating" each subject. When the subject is quiescent,

* "Tell-Tale" silica gel, 6-16 Mesh, Davison Chemical Co.

Figure 4.—The desiccators in position on the inner surface of the forearm.

TABLE 1—MOISTURE LOSS FROM THE INNER SURFACE OF THE FOREARM, AFTER THE APPLICATION OF SELECTED COSMETIC RAW MATERIALS (11)

| Test Material | Average Moisture Loss in mg. for 2-Hour Test: Test Material | Control | No. of Determinations | Average Effect on Moisture Loss |
|---|---|---|---|---|
| Petrolatum, U.S.P. | 7.80 | 14.92 | 8 | 48% reduction |
| Lanolin, anhydrous | 9.12 | 13.39 | 5 | 32% reduction |
| Mineral oil, light tech. | 7.94 | 11.00 | 4 | 28% reduction |
| Lanolin alcohols (25% sol. in mineral oil) | 7.46 | 10.40 | 3 | 28% reduction |
| Isopropyl palmitate | 14.65 | 20.45 | 3 | 28% reduction |
| Silicone oil | 7.94 | 10.72 | 5 | 26% reduction |
| Squalene | 9.04 | 11.70 | 3 | 23% reduction |
| Glyceryl trioleate | 8.72 | 11.30 | 5 | 23% reduction |
| Dewaxed lanolin oil | 9.80 | 12.50 | 5 | 22% reduction |
| Sorbitan sesquioleate | 14.50 | 17.40 | 3 | 17% reduction |
| Polyoxyethylene glycol 200 monoöleate | 15.75 | 15.62 | 5 | Nil |
| Polyoxyethylene glycol 600 monoöleate | 12.14 | 12.12 | 3 | Nil |
| Glyceryl monoöleate (90% mono ester content) | 9.70 | 9.73 | 4 | Nil |
| Safflower Monoglyceride (40% mono ester content) | 15.95 | 16.32 | 4 | Nil |
| Oleyl sarcosine | 10.68 | 10.95 | 5 | Nil |
| Polyoxyethylene glycol 400 mono stearate | 12.10 | 11.60 | 3 | Nil |
| Polyoxyethylene sorbitan mono laurate | 12.04 | 11.48 | 4 | 5% increase |
| Diethylene glycol monoöleate | 11.19 | 10.28 | 5 | 9% increase |
| Polyoxyethylene sorbitan monoöleate | 12.91 | 11.26 | 4 | 13% increase |
| Polyoxyethylene oleyl ether (15–20 Eto) | 14.42 | 11.98 | 3 | 22% increase |
| Polyoxyethylene oleyl ether (5–10 Eto) | 17.75 | 14.15 | 5 | 25% increase |
| Propylene glycol, anhydrous | 11.55 | 8.56 | 5 | 25% increase |
| Glycerine, anhydrous | 12.55 | 8.83 | 5 | 43% increase |

similar moisture loss readings are obtained from the adjacent test sites. However, when the subject is moving about, the moisture loss in one site may differ from the adjacent site. This difference is probably due to the varying number of eccrine glands at the different test sites. It is advisable, therefore, to use at least ten control readings for each subject and the results averaged. From these data one can calculate more accurately the percentage difference in moisture loss of the adjacent sites. Calibrating

TABLE 2—AVERAGE MOISTURE LOSS FROM ADJACENT SITES OF THE INNER PORTION OF THE FOREARM

| Subject | Number of Readings | Average Moisture Loss, mg.*: Upper Arm | Lower Arm | $D_c$, %† |
|---|---|---|---|---|
| CK | 17 | 11.0 | 12.9 | 18 |
| GB | 10 | 22.5 | 28.0 | 25 |
| CF | 20 | 16.6 | 19.4 | 17 |
| FM | 17 | 13.3 | 16.8 | 26 |
| LF | 10 | 11.0 | 12.9 | 17 |

* Moisture loss is the milligrams of water vapor picked up by the desiccator in a two hour period.

† $D_c$ is the percentage difference of the lower reading compared to the upper reading.

$$D_c = \frac{L - U}{U} \times 100$$

data obtained with the five subjects involved in this test series are shown in Table 2. These values represent the average of 10 to 20 readings, as indicated. It is interesting to note that the lower test site (farthest from elbow) consistently gave the higher readings.

Table 3—Moisture Loss from Adjacent Sites of the Inner Portion of the Forearm (Subject CK), in a Two-Hour Test Period

| Date | Time | R. H. | T., °C. | Moisture Loss, mg. Upper Arm | Moisture Loss, mg. Lower Arm | $D_c$, %* |
|---|---|---|---|---|---|---|
| 6/9 | a.m. | 55 | 30 | 9.2 | 9.7 | 5.4 |
| 6/6 | p.m. | 52 | 24 | 11.9 | 12.3 | 3.4 |
| 6/10 | p.m. | 68 | 26 | 8.9 | 10.6 | 19.1 |
| 6/11 | a.m. | 65 | 27 | 6.9 | 8.5 | 23.2 |
| 6/12 | p.m. | 60 | 25 | 8.0 | 8.8 | 10.0 |
| 6/17 | a.m. | 55 | 24 | 6.3 | 8.8 | 39.7 |
| 6/19 | p.m. | 57 | 23 | 8.9 | 13.0 | 46.0 |
| 6/24 | p.m. | 58 | 23 | 10.7 | 13.5 | 26.2 |
| 6/26 | p.m. | 59 | 26.5 | 15.4 | 16.4 | 6.5 |
| 7/7 | a.m. | 55 | 26 | 11.8 | 14.4 | 22.0 |
| 7/8 | p.m. | 60 | 25 | 25.5 | 33.0 | 29.4 |
| 7/9 | a.m. | 62 | 24 | 7.7 | 9.4 | 22.1 |
| 7/14 | p.m. | 69 | 22 | 14.1 | 14.1 | 0 |
| 7/16 | p.m. | 69 | 22 | 12.6 | 17.3 | 37.3 |
| 7/17 | a.m. | 65 | 22 | 8.5 | 9.5 | 10.8 |
| 7/21 | p.m. | 62 | 22 | 11.5 | 11.7 | 1.7 |
| 7/23 | a.m. | 68 | 21 | 9.1 | 9.4 | 3.2 |
| | | | | | Av. $D_c$ = | 18.0 |

* $D_c$ = Percentage difference in moisture loss between the upper and lower sites.

$$D_c = \frac{L - U}{U} \times 100$$

In Table 3 data are shown for the individual readings obtained with a representative subject.

Twenty-one cosmetic creams and lotions manufactured by leading companies were then tested for their ability to retard the moisture loss from the skin. A three-quarter gram portion of the test cream or lotion was rubbed into the lower, inner portion of the forearm. The test product was allowed to dry on the skin for fifteen minutes at room temperature and the application repeated followed by a thirty minute drying period. A desiccator was then placed over the test site and a control desiccator was placed directly above and adjacent to it on the untreated portion of the arm.

Moisture pick-up readings were taken after the desiccators had been in place for two hours. Ten determinations were made for each product. By calculating the percentage difference in moisture loss between the treated and untreated areas and applying the calibration factor for the subject involved, one can calculate the effect of the test product on moisture loss.

The results obtained are presented in Table 4.

## Discussion

It is interesting to note that of the preparations tested, cold cream E retarded moisture loss to the greatest degree (−27 per cent), while hand cream C, with a high humectant content, accelerated moisture loss to the greatest degree (56 per cent).

Eleven of the twenty-one products tested accelerated moisture loss to an appreciable degree (over 5 per cent). Four products had very little effect on moisture loss and only six emulsions retarded moisture loss to any extent. Thus, of these 21 emulsions sold to the public as skin softening preparations, only six could be expected to lead to an increase in moisture content of the stratum corneum with attendant increase in softness and flexibility.

Table 4—The Effect of Cosmetic Emulsions on Moisture Loss from the Skin

| Product | | Subject | Average Moisture Loss* Upper Arm | Lower Arm | $D$, % | $D_c$, % | Net Effect |
|---|---|---|---|---|---|---|---|
| Nutritive cream | A | CF | 12.2 | 13.8 | 13 | 17 | 4% reduction |
| Moisturizing lotion | B | GB | 16.2 | 20.7 | 28 | 25 | 3% increase |
| Hand cream | C | CF | 6.7 | 11.6 | 73 | 17 | 56% increase |
| Foundation lotion | D | FM | 8.2 | 9.7 | 18.5 | 26 | 7.5% reduction |
| Cold cream | E | CK | 10.3 | 9.4 | −9 | 18 | 27% reduction |
| Night cream | F | GB | 22.3 | 31.3 | 40 | 25 | 15% increase |
| Night cream | G | FM | 24.4 | 26.9 | 10 | 26 | 16% reduction |
| Night cream | H | GB | 23.8 | 34.0 | 43 | 25 | 18% increase |
| Moisturizing lotion | I | CK | 13.1 | 14.7 | 12 | 18 | 6% reduction |
| Night cream | J | CF | 26.2 | 27.4 | 5 | 17 | 12% reduction |
| Moisturizing gel | K | CF | 15.4 | 20.1 | 30 | 17 | 13% increase |
| Night cream | L | CK | 11.2 | 13.9 | 24 | 18 | 6% increase |
| Night cream | M | LF | 9.7 | 11.8 | 22 | 17 | 5% increase |
| Hand cream | N | CF | 11.0 | 14.9 | 35 | 17 | 18% increase |
| Hand lotion | O | CK | 7.2 | 10.5 | 46 | 18 | 28% increase |
| Lubricating lotion | P | LF | 10.4 | 13.2 | 27 | 17 | 10% increase |
| Hand lotion | Q | FM | 8.7 | 11.6 | 34 | 26 | 8% increase |
| Hand lotion | R | FM | 11.3 | 15.9 | 41 | 26 | 15% increase |
| Hand lotion | S | CF | 13.8 | 17.7 | 28 | 17 | 11% increase |
| Moisturizing lotion | T | CK | 9.5 | 9.5 | 0 | 18 | 18% reduction |
| Moisturizing lotion | U | FM | 6.7 | 8.2 | 22 | 26 | 4% reduction |

* Average of 10 readings.

It is also of interest to note that six hand preparations—which are expressly sold to soften the skin—all accelerate the rate at which moisture is lost to the atmosphere.

Previous work has shown that many of the nonwater-soluble oils used in cosmetic emulsions reduce the rate of moisture loss from the skin. The present study illustrates, however, how the beneficial effects of an oil as regards its ability to regulate moisture loss can be negated by the addition of emulsifiers and humectants.

Further work is needed to study the results of different ratios of the various types of emulsifiers and oils to establish the manner in which they effect the moisture loss from the skin. When this is done perhaps we will be able to develop emulsions which act so as to build up moisture and soften the skin. Here, again, this study is designed as a laboratory test for accurately measuring one specific property of a cosmetic cream or lotion. A great deal of additional study and work will be needed before any clear-cut conclusions can be drawn. The work to date indicates that many humectants and hand lotions tend to increase the rate at which the skin dries out and suggests that they are not particularly effective in softening the skin


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# THE ROLE OF DETERGENTS IN SHAMPOOS

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The importance of detergents in shampoos is clearly indicated by the fact that they are used in the great majority of all important shampoos sold in the American market. It has been claimed that they alone are responsible for the growth and acceptance of shampoos to the point where their annual sales are over one hundred and twenty million dollars. It is particularly interesting to note that the formulation of these shampoos depends not only on the detergent as the active ingredient but the addition of conditioners, foam-builders, viscosity builders, delicate fragrances—all are most important in making them cosmetically acceptable.

In this paper a study of the detergents alone uncompounded is made to determine what role they play in producing a cosmetically acceptable shampoo. It must be re-emphasized that shampoos are not just cleansers;

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