



Skin Surface pH: A Protective Acid Mantle

An acidic skin-surface pH promotes barrier function and fights infection

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The skin's surface is acidic; its pH ranges between 4 and 6. On the other hand, the body's internal environment maintains near-neutral pH, ranging between 7.35 and 7.46. The pH change of more than 2 units over a short distance in the skin is a dramatic event in biology.¹

Factors Affecting pH

Skin pH varies between different body areas. Researchers believe skin pH depends on the production of amino acids and lactic acid, the ammonium and hydrogen content of sweat secretion, and sebum and protein substances of the stratum corneum. Skin pH also depends on skin moisture; areas with higher moisture have a higher pH. Thus, intertriginous areas (the axilla, inguinal regions and fin-

A Dermatologic View

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ger webs) have a slightly higher pH.²

However, we do not know the exact factors regulating skin surface pH. For instance, no obvious relationship exists between skin pH and internal body pH. A study in hemodialysis patients with end-stage renal disease found that their skin was significantly less acidic than that of healthy controls in most areas of the

body. This was despite the fact that these patients have decreased blood pH. Hemodialysis had no effect on skin pH, nor did skin pH correlate with blood bicarbonate or serum electrolyte levels.¹¹

Skin pH seems to be related to race and genetic background; the skin of non-Caucasians is more alkaline than Caucasians' skin. Sex-related differences seem not to exist. The skin's surface pH remains

Table 1-1. Factors affecting skin pH

Endogenous factors	Irritant dermatitis
Skin moisture	Diaper dermatitis
Sweat	Diabetes
Sebum	Uremia
Anatomic site (higher pH in intertriginous areas)	Exogenous factors
Genetic predisposition	Soaps, detergents, cosmetic products
Race	Occlusive dressings
Age ?	Skin irritants
Atopic skin disease	Topical antibiotics

Les auteurs passent en revue les études montrant qu'un pH cutané acide stimule la fonction barrière de la peau et aide la peau à se protéger contre les infections microbiennes et fongiques.

Die Autoren berichten über Studien, die belegt haben, daß ein saurer pH-Wert die Barrierefunktion der Haut verstärkt und sie gegen Mikroben- und Pilzinfektionen schützt.

Los autores pasan revista a estudios que demuestran que una superficie cutánea de pH ácido favorece la función barrera y ayuda a proteger la piel de las infecciones microbianas y micóticas.

constant from childhood until approximately age 80, then it increases slightly. Table 1-1 summarizes the various factors affecting skin pH.

The Acid Mantle

Schade and Marchionini in 1928 were the first to describe the importance of skin acidity in preventing infections.^{3,4} They referred to the skin as an "acid mantle" protecting against microbial and fungal infections. It took more than a decade to demonstrate that skin acidity has a protective role and discourages growth of many environmental bacteria and fungi. Moreover, chronic alkalization was found to be damaging to the skin's barrier function.

Studies have shown that washing with synthetic detergents of pH 7 increases the *Propionibacteria acne* count significantly compared to using a synthetic detergent with a pH of 5.5. Another study indicated that patients with fungal infections in the toe webs had a higher skin-surface pH. A study in diabetics found that, in intertriginous areas, skin pH was significantly higher than in normal control subjects. It is widely accepted that candidal skin infections, especially intertrigo, are more prevalent in diabetic patients. Moreover, the hyphae form of candida, which is the initial invader to the skin, grows optimally at a pH above 6.5.¹⁰

These findings suggest the significance of skin pH as a possible factor promoting host susceptibility to candidal skin infection. Researchers have shown that skin alkalization has negative effects, such as irritant dermatitis and atopic skin disease. Other researchers have claimed that an increase in skin pH is an important contributing factor in diaper dermatitis. A recent study correlated skin pH with the severity of experimentally induced irritant dermatitis. High skin pH coincides with a high transepidermal water loss, one of the more sensitive parameters used to quantify an irritant response in the skin.⁹

It is reasonable to assume that the skin's acid pH affects many pH-dependent processes within the upper epidermis. For example, the hydrolases important in the formation of a competent permeability barrier of the skin can be activated by acidic pH.

Product Forecast

The pH of soaps, detergents, cosmetic products and skin-cleansing products seems to be important for maintaining skin integrity. Developing new acidifying skin products,

soaps and cosmetics is of prime importance for the skin as a barrier and its function as an acid mantle.⁵

In spite of decades of concise and relevant investigations of skin pH, far more remains to be learned.⁶ We hope that what we learn will lead to the development of even more appropriate techniques and products for skin care.

References

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The authors recommend the following readings:

1. S Dikstein and A Zlotogorski, Measurement of skin pH, *Acta Dermato-Venereologica (Stockh)* Suppl **185** 18-20 (1994)
2. S Dikstein and A Zlotogorski, Skin surface hydrogen ion concentration (pH), in *Cutaneous Investigation in Health and Disease*, J-L Leveque, ed, New York: Marcel Dekker Inc (1989) pp 59-77
3. HC Korting, K Hubner and K Greiner, Differences in the skin surface pH and bacterial microflora due to the long term application of synthetic detergent preparations of pH 5.5 and pH 7.0. Results of a crossover trial in healthy volunteers, *Acta Dermato-Venereologica (Stockh)* **70** 429-431 (1990)
4. HC Korting, M Kerscher, M Schafer-Korting and U Berchtenbreiter, Influence of topical erythromycin preparations for acne vulgaris on skin surface pH, *Clinical Investigator*, **71** 644-648 (1993)
5. JS Lo, HA Oriba, HI Maibach and PL Bailin, Transepidermal potassium ion, chloride ion, and water flux across delipidized and cellophane tape stripped skin, *Dermatologica* **180** 66-68 (1990)
6. H Ohman and A Vahlquist, In vivo studies concerning a pH gradient in human stratum corneum and upper epidermis, *Acta Dermato-Venereologica (Stockh)* **74** 375-379 (1994)
7. H Schade and A Marchionini, Der Sauremantel der Haut, *Klin Wochenschr* **7** 12-15 (1928)
8. KP Wilhelm KP, AB Cua and HI Maibach, Skin aging. Effect on transepidermal water loss, stratum corneum hydration, skin surface pH, and casual sebum content, *Archives of Dermatology* **127** 1806-1809 (1991)
9. KP Wilhelm and HI Maibach, Factors predisposing to cutaneous irritation, *Dermatologic Clinics* **8** 17-22 (1990)
10. G Yosipovitch, E Tur, O Cohen and Y Rusecki, Skin surface pH in intertriginous areas in NIDDM patients, possible correlation to candidal intertrigo, *Diabetes Care* **16** 560-563 (1993)
11. G Yosipovitch, E Tur, G Morduchowicz and G Boner, Skin surface pH, moisture, and pruritus in hemodialysis patients, *Nephrology Dialysis Transplantation* **8** 1129-1132 (1993)

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