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Skin Cleansing: An Update on Formula-pH for the German Market

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abstract

The slightly acidic pH of the human skin surface ranges between 4.1 and 5.8 and is essential for the skin's barrier function (*Segger et al.* 2007). Recommendations for pH-neutral or pH-friendly products take this pH range into account. Skin cleansers can cause a shift in the skin's pH of up to 3 units, followed by pH restoration within a few hours. Both the pH shift and the pH restoration are linked to the pH of the skin cleanser and the combination of surfactants used (*Aßmus et al.* 2013).

Given the relevance of pH to the epidermal barrier, the DGK's Skin Cleansing Expert Group builds on previous studies and projects in the present work. The working group analysed and classified 80 skin cleansers available in Germany with respect to pH, composition and claims. Particular attention was paid to ensuring a neutral selection and a broad range of skin cleansers included in the study. The products examined were classified and analysed according to product type, target groups, pH-related claims and various formulation characteristics.

An explicit pH-related claim was identified for 52.5 % (n=42) of the products.
The pH ranged from 3.47 to 6.53, with a mean of 4.85 (±0.6 SD; median: 4.74).
A total of 67 products (83.75 %) had a pH within the physiological range of 4.1–5.8 and thus complied with current recommendations.

Introduction

The human skin forms an interface with the external environment. In this role, the epidermal barrier plays a vital part in protecting the body from external influences, such as microbiological and chemical irritants, as well as during interaction with cosmetic care and cleansing products. Furthermore, the epidermal barrier prevents the loss of important physiological components such as electrolytes, water, stratum corneum lipids and proteins. Structurally, the epidermal barrier is located in the outermost layer of the skin, the stratum corneum (SC). Here, cohesion, resistance and regenerative capacity are largely regulated by pH. The role of pH as a central regulator of transcorneal processes is now undisputed. In short, the mildly acidic physiological pH controls the skin's own processes involved in antimicrobial defense, as well as the structural integrity and function of the epidermal barrier. Endogenous or exogenous disruption of the skin´s acidification processes may increase pH and consequently impair barrier function *(Blaak* 2025).

The slightly acidic pH of the skin surface was first demonstrated over 100 years ago (*Heuss* 1892) and was later termed the 'acid mantle' (*Schade* and *Marchionini* 1928). Subsequent measurements reported an average skin surface pH of 4.7 (*Lambers et al.* 2006). During this period, the Skin Cleansing Working Group of the DGK (*German Society for Scientific and Applied Cosmetics*) examined 222 male and female subjects aged between 18 and 69 in a multicentre study and was able to demonstrate that the skin surface pH on the forearm ranges between 4.1 and 5.8 (mean: 4.9; 95 % CI) (*Segger et al.* 2007). Based on these research findings, a German guideline was established for advertising claims related to pH (e.g. "pH skin-neutral", "pH skin-friendly") in cosmetic products, setting it at pH 4.1–5.8 (*German Chemical Society, n.d.*).

Building on this, a literature review was carried out by the aforementioned expert group in 2013, which noted that the influence of skin cleansing on the pH of the skin surface has been studied extensively, particularly over the last four decades (*Aßmus et al.* 2013). In particular, data on short- and long-term cleansing-induced pH shifts were analysed. However, the authors point out that comparisons between these studies are difficult due to significant differences in experimental conditions, used measuring instruments, timing of measurements, statistics and used product quantities. Therefore, the results should be interpreted with caution. Overall, cleansing-induced pH shift can range from ±0.0 (*Bechor et al.* 1988) to +3.0 (*Mücke et al.* 1993) units, depending on the product formulation and application scenario. The publication also summarises that the pH recovery time can range from 45 minutes (*Bechor et al.* 1988) to 8 hours (*Post et al.* 1992) after

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single cleansing, and up to 12 hours (*Grunewald et al.* 1995) after repeated cleansing. Consequently, it is generally accepted that pH shift and recovery are closely related to the pH of the cleansing product used (*Blaak* and *Staib* 2018).

In addition to the literature survey, the review paper also included original research on the topic, which revealed that the influence of a product's pH on the pH of the skin's surface is also affected by the product's ingredients, particularly the composition of the surfactant system. Notably, two products with pH 4.5 showed significant differences (p=0.014) in their effects on skin pH. This suggests that both the product pH and the combination of surfactants are relevant factors (*Aßmus et al.* 2013).

Based on an evaluation of international publications from the past 20 years, a review article published in 2018 noted that the majority of skin cleansing products on the market have a pH of at least 5.0, ranging from neutral to alkaline pH values. In general, the data available on the pH of current skin cleansing products was found to be very limited and out of date (*Blaak* and *Staib* 2018).

Given the described relevance of pH for the epidermal barrier and its interaction with the use of skin cleansing products, this study aims to describe and classify relevant data on skin cleansing products commercially available in Germany.

Materials and Methods

Selection of the Test Products

The selection of the test products was carried out impartially and independently by the DGK's Skin Cleansing Expert Group, with explicit attention paid to ensuring a wide variety in terms of product category, target audience positioning, brand, product type, price segment and distribution channel, all with the aim of providing a broad overview of the market. In total, the working group selected and analysed 80 skin cleansing products.

Analysis of the Test Products

In the first step, the selected products were photographed, dated, and the relevant product data was derived from the product labelling and claims, as well as from the ingredient lists (INCI, International Nomenclature of Cosmetic Ingredients). The test products were stored at room temperature.

Subsequently, the pH of all 80 skin cleansing products was determined electrochemically on a daily basis using a pH meter (MP125, Mettler-Toledo LLC, Columbus, OH, USA) in accordance with the relevant instructions by trained laboratory staff (including weekly calibration; electrolyte solution: potassium chloride 3 mol/l with AgCl).

Three consecutive measurements were taken for each product, and the arithmetic mean was calculated. The time of measurement was recorded, and the temperature conditions were standardised (laboratory conditions, 21.0 ±1 °C).

Results

Product Data

In order to classify the test products purchased from retailers, various product data and information, as well as labelling elements, were documented and analysed. **Tabs. 1** and **2** present the product types, target groups and visible claims regarding pH. Among other things, it is clear that 52.5 % of the test products (n=42) include a statement regarding the pH of the formulation.

No. of Products	Body Wash & Shower	Face Cleansing	Hand Cleansing	Intimate Cleansing	
80 (100 %)	54 (67.5 %)	10 (12.5 %)	15 (18.8 %)	1 (1.3 %)	
No. of Products	**Women**	**Men**	**Unisex**	**Kids**	**Baby**
80 (100 %)	12 (15.0 %)	10 (12.5 %)	42 (52.5 %)	6 (7.5 %)	10 (12.5 %)

Tab. 1 Type of test product and target group

No. of Products	no pH claim	pH-skin-friendly	pH-skin-neutral	pH value regulating	distinct pH value
80 (100 %)	38 (47.5 %)	2 (2.5 %)	34 (42.5 %)	1 (1.3 %)	5 (6.3 %) [between pH 3.5 and pH 5.5]

Tab. 2 pH claims of the test products

Formulation Characteristics [based on INCI]	Number
Type of Preservatives	
Classic [Preservatives according to EU-KVO Nr. 1223/2009]	58 (72.5 %)
Alternative	22 (27.5 %)
Natural Cosmetics	
certified	19 (23.8 %)
not certified	61 (76.3 %)
Surfactant System	
with SLES and CAPB	37 (46.3 %)
Different Surfactant Combinations	43 (53.8 %)
Synthetic Polymers	
with [Ax, PPG, PEG, PQ, PS]	27 (33.8 %)
without	53 (66.3 %)

SLES=Sodium Laureth Sulfate, CAPB=Cocamidopropyl Betaine
Ax=Acrylates, PPG=Polypropylene Glycol, PEG=Polyethylene Glycol, PQ=Polyquaternium, PS=Polysorbate

Tab. 3 Formulation characteristics

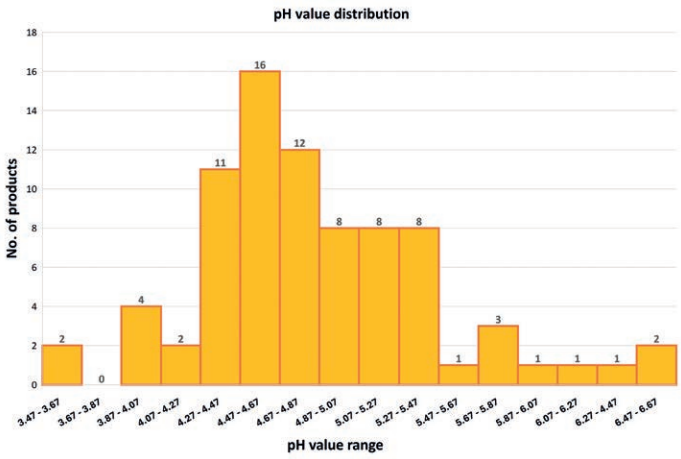

Fig. 1 Classification of pH measurements into ranges in relation to the corresponding number of test products.

Additionally, the ingredient declarations (INCI) were assessed and categorised based on derivable formulation characteristics (**Tab. 3**): a) type of preservatives, b) natural cosmetics, c) surfactant system, and d) use of synthetic polymers.

With regard to preservation, the distinction was made on the basis of the use of preservatives in accordance with Annex V of the Cosmetics Regulation (EC) No 1223/2009. In the case of natural cosmetics, the differentiation in certification was indicated by a corresponding visible seal. The surfactant system was categorised into systems containing the combination of sodium laureth sulphate (SLES) and cocamidopropyl betaine (CAPB) versus systems in which this combination was not present. The classification regarding synthetic polymers was based on the presence of the following components: acrylates (Ax), polypropylene glycol (PPG), polyethylene glycol (PEG), polyquaternium (PQ) and polysorbate (PS).

Measurement: pH Value

The graphical representation of the measured pH values as frequencies reveals nearly a statistical normal distribution,with pH values ranging from 3.47 to 6.53 (**Fig. 1**). The arithmetic mean across all measured values was pH 4.85 (±0.6 SD; median: 4.74).

Tab. 4 clearly indicates that the statistical data on pH values, broken down by product type and target group, vary. Among the evaluated product types, the arithmetic mean reaches a maximum of 5.13 (Face Cleansing) and a minimum of 3.47 (Intimate Cleansing). In the analysis of the target groups, the mean is 5.19 (Men) and the mean is 4.75 (Unisex).

Type of Product	Body Wash & Shower	Face Cleansing	Hand Cleansing	Intimate Cleansing*
MIN	3.92	4.45	3.52	–
MAX	6.53	5.99	5.32	–
Mean	4.92	5.13	4.50	3.47
MEDIAN	4.80	5.25	4.60	–
SD	0.59	0.56	0.42	–

Target Group	Women	Men	Unisex	Kids	Baby
MIN	3.47	4.37	3.52	4.30	3.92
MAX	5.81	6.53	6.52	5.41	6.09
Mean	4.77	5.19	4.75	4.83	5.05
MEDIAN	4.79	4.79	4.66	4.80	5.14
SD	0.56	0.86	0.56	0.38	0.56

* One product of this type was analysed; mean = arithmetic mean; SD = standard deviation

Tab. 4 Statistical measures (pH) in relation to product type and target group

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Formulation Characteristics [based on INCI]	MIN	MAX	Mean	MEDIAN	SD
Type of Preservatives					
Classic	3.47	6.53	**4.81**	4.71	*0.56*
Alternative*	3.92	6.46	**4.97**	4.91	*0.70*
Natural Cosmetics					
certified	3.99	6.46	**4.98**	4.91	*0.70*
not certified	3.47	6.53	**4.81**	4.73	*0.57*
Surfactant System					
with SLES and CAPB	3.52	6.53	**4.73**	4.60	*0.58*
Different Surfactant Combinations	3.47	6.46	**4.95**	4.97	*0.61*
Synthetic Polymers					
with	3.47	6.53	**4.89**	4.80	*0.71*
without	3.92	6.46	**4.83**	4.72	*0.54*

*For products (n=9) that were microbiologically stabilised with organic acids and/or their salts, the arithmetic mean is pH 4.78; mean = arithmetic mean; SD = standard deviation

Tab. 5 Statistical measures (pH) in relation to the defined formulation characteristics

Tab. 5 correlates defined formulation characteristics and measured pH values.

According to *Segger et al.* (2007), a total of 67 (83.75 %) of the measured product pH values fall within the physiological pH range of 4.1–5.8 and could therefore be described as "pH skin-neutral" or "pH skin-friendly" (*German Chemical Society, n.d.*). Furthermore, 6 (7.5 %) of the measurements are below this defined pH range, while 7 (8.75 %) are above it (**Fig. 2**).

In summary, the averages for the overall portfolio (pH 4.85), as well as the averages broken down by product type, target group, and formulation characteristics, are fully within the pH range of 4.1–5.8.

Conclusions

This study shows that 67 (83.75 %) of the 80 skin cleansers correspond to the 'physiological pH of human skin', which lies between 4.1 and 5.8.

First, the results regarding product types will be evaluated. One of the products was intended for intimate cleansing and had an application-specific and accordingly adjusted pH of 3.47, as described for the female intimate area (*Carr et al.* 1998). Hand cleansing products were found to have slightly lower median pH of 4.60 than facial or body cleansing products, which had values of 4.80 and 5.25 respectively. In terms of target groups, unisex products, with a median pH of 4.66, were slightly lower than the other categories. Unisex products and products for men also include items with relatively high pH of 6.52 and 6.53, whilst the maximum measured pH for products for women is 5.81. It is striking that pH values ranging from 3.92–6.09 were found in baby products. This range does not correlate with the recommendation to offer pH-neutral or pH-skin-friendly products for this target group: "Areas of application for pH-controlled care and cleansing" (*Blaak* 2025), although products that meet this criterion are not explicitly mentioned here.

With regard to the derivable formulation characteristics, the following was determined: regardless of whether the products were preserved using conventional preservatives or alternatives, the pH values are relatively similar, both at the extremes and in terms of the means. There is therefore no dependence on the preservation system. Only in products preserved with organic acids or their salts is the mean slightly lower at 4.78, because the preservative effect of organic acids is pH-dependent and products protected in this way must be formulated to be slightly more acidic.

Nor can a correlation be found between the ingredients used in certified or non-certified natural cosmetics and the pH set, as the range found was from pH 3.47–6.53.

With regard to surfactant combinations, the combination of SLES with CAPB was considered on the one hand, and other surfactant combinations on the other. Here, there is a slight trend towards slightly higher pH values for surfactant combinations other than the 'classic' mixture, in terms of the mean (+0.22 units) and median (+0.37 units). Nevertheless, all mean and median values for the various surfactant combinations (classic and alternative) remain within the physiological pH range.

Synthetic polymers such as polyacrylates require a minimum pH in order to effectively increase the viscosity of the products.

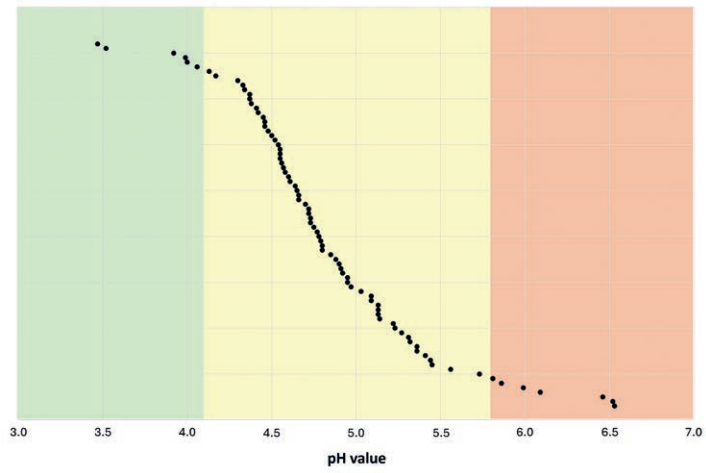

Fig. 2 Presentation of measurement values (pH) for all 80 test products (black spots). The range of pH 4.1–5.8, defined as the "physiological pH of human skin" (*Segger et al.* 2007), is highlighted in yellow. Green indicates values below pH 4.1; red indicates values above pH 5.8.

In the case of biopolymers, viscosity may also depend on pH to some extent, depending on the chemical structure of the polymers used. No anomalies were observed in the pH measurements or their classification according to polymer type.

Overall, it was found that the majority (83.75 %) of the analysed products had pH values within the range of pH 4.1–5.8 and thus comply with the recommendations for a 'skin-physiological' pH for skin cleansers. pH values as low as 3.47 can, for example, be attributed to the product type 'intimate wash', whilst higher pH values of up to 6.53 are still below the neutral point of 7.0.

With regard to product claims regarding pH, it was found that approximately half of the products included a pH claim, whilst the other half did not (52.5 % vs. 47.5 %), with the pH being specifically stated for 5 products (6.3 %).

This study of skin cleansers available in Germany shows that variations in pH values were found, but with good alignment with the expert recommendation for skin cleansing that protects the skin barrier (*Blaak* and *Staib* 2018).

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