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What is the pH, Fe and Cl_2 content of cosmetics we use? – a pilot study on safety of skin care products

Abstract

Introduction. The skin is one of the largest organs of the body protecting from external insults in order to maintain homeostasis. It plays many roles: in thermal, electrolyte, hormonal, metabolic, and immune regulation. Proper pH of skin plays a role in creation of skin barrier and resistance to external agents. Cl_2 and Fe may irritate skin. If noxious factors are strong, they damage the tissues under the skin. When the insult is severe enough to overwhelm the protective function of the skin, it may manifest itself with acute or chronic skin injury. Therefore, it is important to know if the used skin products are safe.

Aim. The objective of the study was to determine pH, Cl_2 and Fe content in selected cosmetics.

Material and methods. A total of 62 skin product samples were collected and divided into 4 groups: I soaps and gels, II hair cosmetics, III creams and balms, IV facial cosmetics. The pH, Cl_2 and Fe content in each sample was determined three times and means were calculated. Data were analyzed with one way ANOVA followed by Tukey test. $P<0.05$ was considered significant.

Results. The pH in group III was significantly higher than in the other groups. Fe content was significantly higher in hair cosmetics as well as in creams and balms. Cl_2 content was high in soaps and hair cosmetics.

Conclusions. The majority of the analyzed samples had pH within the healthy range. Traces of Cl_2 and Fe present in cosmetics are unlikely to cause skin irritation.

Keywords: pH, iron, chlorine, skin, cosmetics.

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INTRODUCTION

The skin is one of the largest organs of human body with surface area of 1.5-2 m^2 and weight up to 20 kg [1]. The skin consists of the outer epidermis and the underlying dermis. They are separated by a basement membrane. The junction has an undulating appearance – there are rete ridges. The epidermal appendages (hair follicles, sebaceous glands, and ecrine glands) span the epidermis and are embedded in the dermis. The dermis makes up to 90 percent of the skin thickness. It has mainly a supportive function. The subcutaneous tissue separates the skin from underlying tissues and has a cushioning action.

The skin protects the body against external insults in order to maintain body homeostasis. It plays many physiological roles: in thermal, electrolyte, hormonal, metabolic, and immune regulation. The pH of skin is slightly acidic and its values range from 4.0 to 6.0 (for correct and optimal physiological function it is considered that the skin surface pH should be about 5.0 or even below), while inside the human body pH is close to neutral (7.35-7.45). Between the stratum corneum of epidermis and dermis appears to be a difference in pH up to 2-3 units [2]. The proper pH of skin and stratum corneum participates in creation of skin barrier and skin resistance to the external physical and chemical agents. Cl_2 and Fe may irritate the skin. If the noxious chemical and/or physical factors are strong enough, they can cause damage to the tissues located under the skin. If the insult is severe enough to overwhelm the protective function of the skin, it may manifest itself with an acute or chronic skin injury. The maintenance of acidic pH depends on the creation of free fatty acids, mainly lactic acid and amino acids, hydrogen and ammonium compounds, as well as on the composition of sebum lipids and the proteins of the corneal layer of the epidermis. Proper pH of skin and stratum corneum plays an important role in antimicrobial resistance and maintaining healthy flora of skin. It is also the optimum environment for enzymes involved in the synthesis of lipids, for the process of their isolation the intercellular spaces and forming bilayer structures. Indirectly, this contributes to the creation of proper skin barrier and skin resistance to physical and chemical agents [3].

The pH can be defined as a numeric scale used to specify the acidity or basicity of an aqueous solution. It is approximately the negative of the logarithm to base 10 of the molar concentration, measured in units of moles per liter, of hydrogen ions.

A cosmetic is any substance or preparation intended for external contact with the human body: skin, hair, lips, nails, external genital organs, teeth and mucous membranes oral, and its sole or primary purpose is to maintain cleanliness of these body parts, to improve appearance of the body or improve its smell [4].

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As the skin is the main barrier protecting human body from external factors, therefore it is of key importance to know if the used skin products have proper pH, Cl_2 and Fe content and if they are safe.

AIM

The objective of the study was to determine the pH, Cl_2 and Fe content in commonly used cosmetics.

MATERIAL AND METHODS

A total of 62 skin product samples were collected. All the investigated products were bought in the supermarket or in the chemists'. They were divided into 4 groups: I soaps and gels (10 samples), II hair cosmetics (13 samples), III creams and balms (24 samples), IV facial cosmetics (15 samples). For determination of pH in the range 1-10 the indicator papers were used (purchased from manufacturer: Polskie Odczynniki Chemiczne, 44-101 Gliwice, Sowińskiego St. 11, Poland). Cl_2 content in the investigated products was measured with MColortest ™, Chlorine Test 0.1-2.0mg/l Cl_2. Fe content in the samples was measured with MColortest ™ Iron test 0.05-1.0mg/l Fe. Both were purchased from the manufacturer Merck KGa, 64271 Darmstadt, Germany.

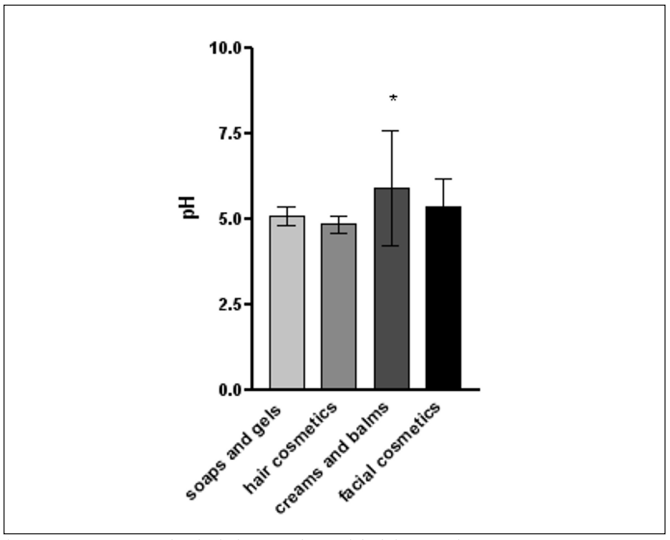
The pH, Cl_2 and Fe content in each sample was determined three times and means were calculated. The results were expressed as group mean +/- standard deviation (SD). Data were analyzed with one way ANOVA followed by Tukey test. $P<0.05$ was considered statistically significant.

RESULTS

Of the 62 samples of products tested, only 5 had pH out of the skin pH range. The majority of the tested samples (57) were in the range of skin pH (Table 1, Fig.1). The mean (±SD) pH in group I was 5.1±0.8, II 4.8±0.8, III 5.9±1.6, IV 5.3±0.8. The p value was <0.05 in group III vs. group I, II and IV. The Cl_2 content (mean ±SD) was in group I 0.08±0.03 mg/l, II 0.03±0.02 mg/l, III 0.00 mg/l, IV 0.00 mg/l, $p<0.05$ in group I and II vs. III and IV (Fig.2). The Fe level (mean ±SD) in group I was 0.03±0.008 mg/l, II 0.14±0.08 mg/l, III 0.1±0.14 mg/l, IV 0.00 mg/l, respectively; $p>0.05$ (Fig.3).

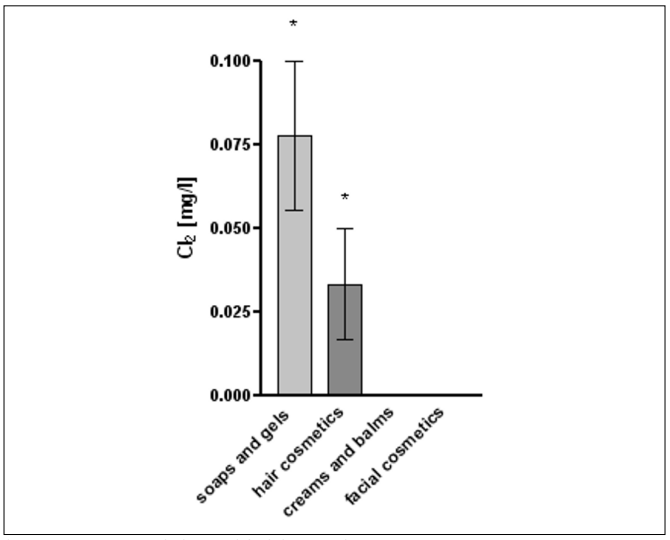
TABLE 1. The pH (pH – potential of hydrogen) of the investigated products.

pH range	group I	group II	group III	group IV
4.00-4.50	3	6	1	4
4.51-5.00	2	2	7	1
5.01-5.50	1	0	3	3
5.51-6.00	4	5	10	5
6.01-6.50	0	0	1	2
more than 6.51	0	0	2	0



*p < 0.05 vs soaps and gels, haircosmetics and facial cosmetics

FIGURE 1. The mean pH values ± SD of the investigated products, Anova, Tukey test.



*p < 0.05 vs creams, balms and facial cosmetics

FIGURE 2. The mean ± SD Cl_2 content in the investigated products, Anova, Tukey test.

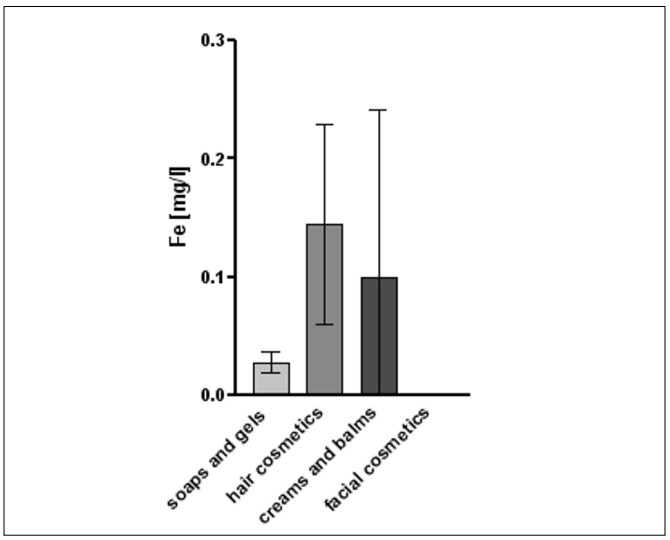


FIGURE 3. The mean ± SD Fe content in the investigated products, Anova.

DISCUSSION

In the present study it was shown that creams and body balms have higher pH than other groups of cosmetics.

Many factors, both endogenous and exogenous, influence the pH of our skin. To endogenous factors belong: age, anatomic site, genetic predisposition, ethnic differences, sebum, skin moisture, sweat. The exogenous factors include: detergents, cosmetics, soaps, occlusive dressings, skin irritants, topical antibacterials [4]. Face is especially frequently exposed to chemicals. Its surface lipid layer interacts with many hydrophobic substances from cosmetics, water and from the air. It is worth underlining that potentially irritating chemicals are frequently transferred from hands to face and eyelids, which have poor barrier function due to thin epidermis which makes them more sensitive to irritants than other parts of the skin [5].

There is evidence that many cosmetics are contaminated with bacteria and toxic substances. In the study of Rubini et al. 78 products for hair dyeing and body painting were analyzed. The samples were bought in ethnic shops, local markets and on-line shops and compared with products from specialized shops. As many as 58 samples have shown an aerobic microbial load. The ochratoxinogenic Aspergillus niger was the most frequently isolated. The number of 30% of the samples turned out to be contaminated by at least one class of mycotoxins. While 17 samples (23%) had p-phenylenediamine or sodium picramate and in only 8 out of 17 (59%) their presence were stated on the label. The cosmetics purchased in ethnic shops have shown worse chemical and micro-biological qualities than cosmetics purchased in specialized shops, which showed adequate microbiological and chemical properties [6]. Probably that was because they did not contain any preservatives.

In the present study only products bought in the supermarket or and in the chemists' were investigated. However, high pH of creams and body balms could enhance bacterial and fungal growth in some cosmetics.

Improper skin pH contributes to the onset of various diseases. Alkalization of the epidermis surface has been reported as a phenomenon associated with aggravated symptoms of different skin disorders, either acquired (atopic dermatitis) or inborn (psoriasis). Pruritis and peeling in the course of skin diseases may be very troublesome for patients impairing their quality of life [7].

According to some researchers, evaluation of pH can be used to predict risk of development of irritant contact dermatitis. It is further believed that the long-increase in skin pH (e.g. as a result of repeated exposure to alkaline cosmetics products) can be associated with treatment resistance and bad prognosis in work associate dermatoses and with increased susceptibility to skin irritation [8].

Due to the fact that the pH of skin is so important, cosmetic products that have been approved for use must comply with the relevant standards:

- value of pH between 3.0 and 8.0 for cosmetics permanently applied on the skin such as creams and lotions;
- value of pH between 2.0 and 10.5 for cosmetics used for short periods such as soaps, shampoos, baths products;
- value of pH between 3.0 and 8.0 for products to make-up removal [9].

According to the law regulations, all cosmetics should comply with the relevant requirements concerning their composition and proper labeling to provide consumers necessary information [9].

In the present study only 5 investigated products had pH out of skin normal pH (4-6) but none had pH out of the legal range [9].

Improper pH of skin and content of potentially irritating ingredients of hand hygiene products may impair immunity and contribute to skin infection [10]. Among healthcare workers there is high incidence of adverse skin reactions to products dedicated to skin hygiene procedures. The first and most common type includes symptoms that can vary from quite mild to debilitating, including dryness, irritation, itching, and even cracking and bleeding. This array of symptoms is referred to as irritant contact dermatitis. The second type of skin reaction, allergic contact dermatitis, is rare and represents an allergy to some ingredients in hand hygiene products. Symptoms of allergic contact dermatitis can also range from mild and localized to severe and generalized. In its most serious form, allergic contact dermatitis may be associated with respiratory distress and other symptoms of anaphylaxis. Therefore, it is sometimes difficult to differentiate between the two conditions [10].

Allergic contact dermatitis is a delayed (type IV) hypersensitivity reaction. Even very small quantities of xenobiotic are enough to induce overt reactions. The difference between allergic contact dermatitis and irritant contact dermatitis is that in the latter case the intensity of the reaction is proportional to the dose applied. It is estimated that 20% of all contact dermatitis cases is allergic in nature. For allergic contact dermatitis, one must be sensitized to the allergen first and subsequently repeated contact elicits the classic clinical and pathologic findings. Among common contact allergens there are many hygiene products, dyes, fragrances and antiseptics added to antiseptic soaps. Systemic contact dermatitis can produce delayed-type hypersensitivity or/and deposition of immunoglobulins and complement in the skin. Such deposits induce secondary inflammatory response and may initiate many blistering and connective tissue diseases of the skin [5].

The p-Phenylenediamine is used as an ingredient in hair dyes and is occasionally used as a substitute for henna [11]. It often produces cross-reaction with parabens, which are used as preservatives in cosmetics. The cross-reactions between chemicals occur if they share similar groups critical to the formation of complete allergens. These reactions cause difficulties in controlling contact dermatitis because, in order to achieve improvement, one has to avoid not only the known allergens but also all potentially cross-reacting substances [5].

Other dyes (disperse blue 35, eosin and acridine orange) often produce photosensitivity and phototoxic reactions [5].

Many young people suffer from acne. Acne is a pleomorphic disease. Its etiology is multifactorial. The skin pH sebum production, hormones, skin bacterial flora, genetics and environmental factors all play a role [12]. Sometimes, especially in the young people, its symptoms aggravate when sebaceous glands on the face are occluded by large amounts of skin powder used.

Chloracne is caused by exposure to polyhalogenated aromatic hydrocarbons and it is considered to be an occupation-related disease [5]. Choracne is located mainly on face (behind the ears, around the eyes) and on the trunk (on shoulders, back, genitalia). In addition, hypertrichosis, hyperpigmentation, brown discoloration of the nail, conjunctivitis and eye discharge may be present [12].

Chlorine, being a strong oxidant, is widely used to disinfect water in the water supply systems. The highest allowed

concentration of chlorine in tap water is 0.3 mg/l [13]. In the investigated cosmetics, chlorine content was much lower than its upper limit in tap water so it is not likely to produce adverse skin reactions.

Traces of Cl_2 in soaps and gels detected in the present study are unlikely to cause skin irritation.

Fe ions add an unpleasant taste to tap water, therefore, according to the law regulations, its content in drinking water should be below 0.200 mg/dm3 [14]. In the preset study Fe content in hair cosmetics, creams and balms was low and was unlikely to cause skin irritation.

All the cosmetics investigated in the present study fulfilled the requirements of the European law [15].

CONCLUSIONS

The investigated products had pH within the healthy range. Traces of Cl_2 and Fe present in the examined cosmetics are unlikely to cause skin irritation. However, people aware of allergy should always read the labels and buy cosmetics only from legitimate sources.

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