The use of urea and its derivatives in the cosmetics industry

Alicja KAPUŚCIŃSKA*, Izabela NOWAK – Faculty of Chemistry, Adam Mickiewicz University, Poznań, Poland

Please cite as: CHEMIK 2014, **68**, 2, 91–96

Introduction

One of the most important cosmetic activities of chemical substances are moisturizing properties. Well-hydrated skin is elastic, looks young, and the softened layer of keratinocytes improves the penetration of active substances into the skin. One of the most effective moisturizing ingredients used in cosmetology is urea.

Urea as chemical substance

Urea is a natural chemical compound, produced in human organism as a metabolite of proteins and other nitrogen- containing compounds [4]. It is released in urine and sweat in amount 20–30 mg per day. Urea is a carbonic acid diamide (carbamide, CAS number: 57–13–6). It occurs in the form of odourless, colourless crystals whose melting point is 133°C, highly soluble in water and ethanol. It was for the first time synthesised in 1828 by a German chemist Friedrich Wöhler [4].

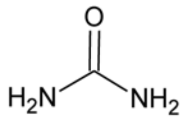

Fig. 1. Urea

Urea and its derivatives in cosmetic industry

The structure of the skin, or actually its outer layer – epidermis, consists of the stratum corneum, built of corneocytes and a special binder, called intercellular cement (Fig. 1). The intercellular cement has very high resistance to many different chemical agents and it is the main constituent preventing water loss from dermis to epidermis surface. Inside corneocytes there is the natural moisturizing factor (NMF), which is a mixture of many substances comprising about 10% of corneocytes dry matter that is responsible for regulation of the level of epidermis moisture by binding water molecules [1]. The amount of urea in NMF is about 7 %wt [5] and it decreases with age [6]. Thus the process of skin moisturizing involves the reduction in transepidermal water loss and enhanced water binding by corneocytes, so is based on maintaining correct water tightness of epidermis.

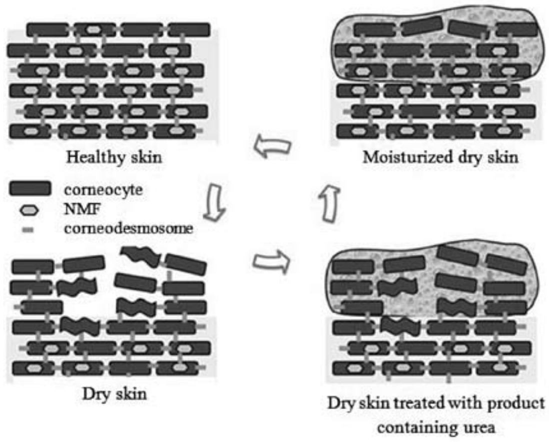

Fig. 2. Scheme of urea cosmetic activity

Corresponding author:
Alicja KAPUŚCIŃSKA – M. Sc., email: kapuscinska.alicja@gmail.com

Cosmetic activity of urea applied on the skin depends on its concentration and features of the cosmetic medium in which urea is contained [7]. In low concentrations (3–10%), urea shows indirect moisturizing activity. It is not hygroscopic, but modifies the chemical structure of proteins shielding the site of water binding, which leads to an increased water content in *stratum corneum* [8]. In this way urea reduces the transepidermal water loss as a result of decreasing the water gradient in epidermis in comparison with that in the dermis cells. In higher concentrations (10–30%) urea breaks hydrogen bonds in keratin leading to its denaturation and solubilization [9]. The keratolytic properties of urea are also used in cosmetology and dermatology. It is used as a component of cosmetic formulas reducing skin roughness and discolorations. In particular, urea is commonly used in foot skin care products, in which its concentration is 2–10 %wt [10]. Dermatological products containing carbamide in higher concentrations are recommended to patients suffering from psoriasis and other skin conditions with excessive and abnormal skin keratinization [2].

Urea cosmetic synonyms: Carbamide; Carbamide resin; Carbamimidic acid; Carbonyl diamide; Carbonyldiamine; Isourea; 75 Urea; Pseudourea; Ureaphil; Ureophil; Urevert [11].

No adverse effects of urea on human skin have been known so far [11]. Urea, as a natural compound of human body, does not show allergic properties. Possible irritating effect of urea may be a result of applying urea-containing products on an open wound or improper selection of cosmetic vehicle to a particular stage of skin disorder [12].

It has been proved that cosmetic products containing 5% of urea, 0.1% of ceramid III and a mixture of physiological lipids are effective for dry skin care and treatment. With reference to the effect of placebo emulsion containing only the cosmetic vehicle, the effect of using the above preparation for one week has brought about a reduction in the transepidermal water loss (TEWL) and intercellular cement density increase [13, 14]. Moreover, on the basis of research and TEWL measurement results, urea has been shown to have better moisturizing effect on neurodermitis than glycerin. The moisturising properties of urea can be intensified by adding a small amount of sodium chloride to the cosmetic medium, as has been evidenced by measurements of TEWL and skin electric capacity and impedance [2]. The latter method used for determination of the degree of moisturization of stratum corneum by a corneometer, was applied to check 106 different cosmetic products containing 41 components representing the following categories: oils (6 classes, in total 15 different types); waxes (8), humectants (8 different, including urea), combination of surfactants such as Tween 60 ((Polyoxyethylene (20) sorbitan monostearate) /Arlacel 60 (sorbitan monostearate)), that differ in their hydrophilic-hydrophobic properties expresses in terms of Hydrophile-Lipophile Balance (HLB). It has been proved in [15] that urea and glycerin can lead to an increase in the skin moisture level better than other humectants. In the event of urea deficit in elder people and patients suffering from allergic eczema, the symptoms of dry skin can be alleviated by using cosmetics containing urea or its precursor- arginine [16]. On the basis of the hitherto performed research work, the recommended concentration of urea in cosmetic products is from 1 to 15 %wt [17, 18].

According to the recent research results, the loss of urea following from the impossibility of transporting this substance deep into the skin has an impact on the moisture level. To describe this phenomenon a new parameter called the transepidermal urea loss (TEUL) has been introduced. Salicornia herbacea reduces TEUL as well as TEWL (Transepidermal Water Loss). It stimulates the synthesis of aquaporin 8 (integral transmembrane protein, that consist of 6 transmembrane alpha-helical segments) that forms channels for urea transportation, increases lipids production and filaggrin (protein joining keratin fibres) excretion. Owing to this fact, it ensures urea transportation deep into the skin reduces TEUL and improves epidermis impermeability [19, 20]. It is supposed that the substances stimulating the activity of aquaporins are the cosmetic products of the future [21].

Stability of cosmetic emulsions containing urea depends on pH of the system and type of cosmetic vehicle. To improve the stability of urea-containing products, the use of hydrophilic medium and acid conditions is recommended. To acidify the medium, lactic (4–10%) or salicylic acid (1%) can be used [1].

The type of cosmetic formulation containing urea also has impact on the effectiveness of its activity. In oil- in-water emulsion, the cosmetic activity of urea does not last for more than several dozen minutes. In contrast, in water-in-oil emulsion, this time is longer reaching from a few to nearly twenty hours after application [22].

Urea derivatives used in cosmetics. One of the most popular urea derivative used in cosmetic industry is allantoin (5-ureidohydantoin) (Fig. 3). This heterocyclic derivative of urea is produced from ureic acid by tissues of *Leguminosae* roots that are in symbiosis with nodule bacteria. In cosmetic industry synthetic allantoin is used as keratolytic ingredient applied for stimulation of epidermis regeneration and assistance in wound healing process. Allantoin- containing products are used for the treatment of psoriasis, decubitus and other skin disorders [3].

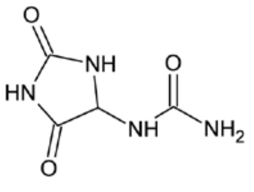

Fig. 3. Allantoin (5-ureidohydantoin)

Other urea derivatives are popular cosmetic preservatives, such as imidazlidynyl urea (1,1'-methylenebis{3-[1-(hydroxymethyl)-2,5-dioxoimidazolidin-4-yl]urea}) available under the trade names Germall 115, Euxyl K 200, Biopure 100 or Hydroconserv COS [9].

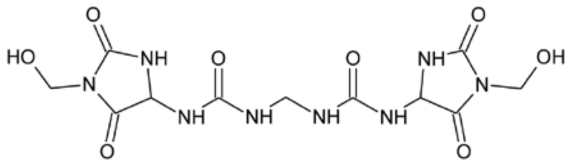

Fig. 4. Germall 115 (1,1'-methylenebis{3-[1-(hydroxymethyl)-2,5-dioxoimidazolidin-4-yl]urea})

Germall 115 (Fig. 4) is a heterocyclic compound showing antimicrobial activity against Gram- negative and Gram- positive bacteria that can be used in a wide range of pH. The admissible concentration of this compound in cosmetic formulation is 0.6 %wt [9]. Upon storage imidazolidinyl urea releases formaldehyde, which can cause contact allergies and skin irritation. Another cosmetic preservative that is an urea derivative is diazolidynyl urea (1,3-bis(hydroxymethyl)-1-(1,3,4-tris(hydroxymethyl)-2,5-dioxoimidazolidin-4-yl)urea). The trade name of this compound is Germall II (Fig. 5). The admissible concentration of this conservative in cosmetic product is 0.5%. Germal II is chemically related to diazolidinyl urea and also releases formaldehyde, which can cause undesirable skin reactions [23]. For this reason, Germall 115 and Germall II are mainly used to preserve washing gels, hair conditioners or shampoos because of these products have a short contact to the skin.

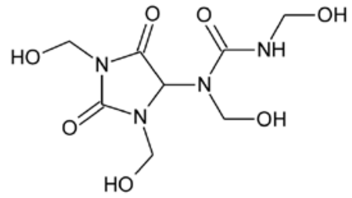

Fig. 5. Germall II (1,3-bis(hydroxymethyl)-1-(1,3,4-tris(hydroxymethyl)-2,5-dioxoimidazolidin-4-yl)urea)

Summary

Depending on the concentration in which it is used, urea has moisturizing or keratolytic properties. The effectiveness of urea activity has been experimentally confirmed in the studies on probes. Carbamide used in proper concentrations is safe for the skin as it naturally occurs in epidermis. Urea derivatives such as allantoin and cosmetic preservatives (Germall 115 and Germall II) are also used in cosmetic industry.

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Translation into English by the Author

* Alicja KAPUŚCIŃSKA – M. Sc., she is a Ph.D. student in the Faculty of Chemistry at Adam Mickiewicz University in Poznań. She obtained the Master's degree in 2013, specialty: Cosmetic Chemistry. Her scientific interests is focused on cosmetic chemistry, in particular on chemistry of jasmonates and peptides.

email: kapuscinska.alicja@gmail.com

Izabela NOWAK – (Sc.D), Associate Professor and Head of the Applied Chemistry Group. She was granted from TEMPUS a scientific fellowship at the University of Reading, U.K., in 1992–1993, where she wrote her M.Sc. thesis. She received her M. Sc. in chemistry in 1993 from Adam Mickiewicz University (AMU) in Poznań, Poland, where she also obtained her Ph.D. degree in chemistry in 1996. She received a postdoctoral training at the Leverhulme Centre for Catalysis in Liverpool. In 2006, she was awarded the degree of Sc.D (habilitation) for the research on synthesis, characterization and catalytic properties of nanoporous materials for the liquid-phase oxidation processes. American Chemical Society together with IUPAC recognized her in 2011 as "Distinguished Woman in Chemistry/ Chemical Engineering". Her current scientific interests are focused on synthesis and modification of novel ordered materials, textural/stryctural/surface/acid-base/redox properties of thereafter, heterogeneously catalyzed synthesis of fine and intermediate chemicals and modern synthesis strategies for cosmetics and cosmoceuticals. She has published more than 140 papers, 3 patents, and made more than 300 presentations at symposiums and conferences.

email: nowakiza@amu.edu.pl; phone: +48 61 829 1580

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Anton Paar Poland Sp. z o.o.

Decyzją Zarządu PIPC z dnia 24 stycznia 2014 r. do grona członków stowarzyszonych w PIPC dołączyła firma Anton Paar Poland Sp. z o.o. Anton Paar Poland Sp. z o.o. oferuje najwyższej jakości urządzenia pomiarowe i badawcze służące do opisywania fizyko-chemicznych właściwości wyrobów. Swoją ofertę kieruje do przedsiębiorstw z branży chemicznej, farmaceutycznej, kosmetycznej, elektronicznej, przemysłu napojów bezalkoholowych oraz przemysłu spożywczego. Urządzenia Anton Paar można znaleźć w laboratoriach instytutów naukowych i uczelni wyższych. Wszystkie wyroby są wytwarzane przez spółkę macierzystą Anton Paar GmbH z siedzibą w Grazu, w Austrii. Spółka córka, Anton Paar Poland powstała w styczniu 2013 r. i ma swoją siedzibę w Warszawie. Oferuje Klientom najlepszą dostępną obsługę i wsparcie serwisowe w Polsce. Pakiet produktów i usług Anton Paar Poland obejmuje wyposażenie techniczne dla różnych gałęzi przemysłu (Spółka dostarcza gęstościomierze, lepkościomierze, refraktometry, polarymetry, precyzyjne mierniki temperatury oraz reometry); wsparcie w zakresie zastosowania produktów; wsparcie serwisowe; edukację i szkolenia

(inf. PIPC, 27 stycznia 2014 r.)

JUBILEUSZE

110-lecie Politechniki Gdańskiej

22 stycznia 2014 r. w Laboratorium Maszynowym na Wydziale Mechanicznym Politechniki Gdańskiej odbyło się uroczyste śniadanie, inaugurujące obchody 110-lecia istnienia uczelni. Wzięły w nim udział władze uczelni, zaproszeni goście i dziennikarze. *(kk)*

(pg.edu.pl, 3.02.2014)

20-lecie firmy AMARA

Rok 2014 jest jubileuszowym, dwudziestym rokiem działalności Zakładu Farmaceutycznego AMARA. Przez dwie minione dekady firma rozwijała się na wielu szczeblach swojej działalności: zwiększała porfolio produktów, zatrudniała coraz większą liczbę pracowników, rozszerzała pola współpracy z hurtowniami i aptekami. Na 2014 rok zaplanowała wdrożenie nowości, które otworzą zupełnie nowe drogi rozwoju i pozwolą rozwiązywać odmienne problemy zdrowotne pacjentów. *(kk)*

(http://www.amara.pl, 31.01.2014)

BADANIA I ROZWÓJ

Najnowocześniejsze w Polsce laboratorium badań przedklinicznych

15 stycznia 2014 r. w Narodowym Centrum Badań Jądrowych oddano do użytku najnowocześniejsze w Polsce laboratorium badań przedklinicznych do badania radiofarmaceutyków. Projekt o wartości 2,5 mln PLN wpłynie nie tylko na zwiększenie potencjału badawczego Ośrodka Radioizotopów POLATOM Narodowego Centrum Badań Jądrowych, ale pozwoli również na przyspieszenie prac nad nowymi lekami stosowanymi m.in. w radioterapii onkologicznej. Teraz polscy naukowcy będą mogli m.in. stosować modele ludzkich nowotworów u zwierząt o obniżonej odporności immunologicznej, przeprowadzać wielofunkcyjne obrazowanie rozmieszczenia fizjologicznego radiofarmaceutyków in vivo na doświadczalnych modelach zwierzęcych jak również badać specyficzność poszczególnych leków, np. gromadzenie znacznika na poziomie komórkowym i tkankowym. *(kk)*

(http://www.ncbj.gov.pl, 15.01.2014)

NOWE INWESTYCJE

Nowa inwestycja PGE

1 lutego 2014 r. PGE Polska Grup Energetyczna rozpoczęła budowę dwóch bloków energetycznych na węgiel kamienny o łącznej mocy 1800 MW w Elektrowni Opole (Opole II, bloki numer 5 i 6) o wartości 11,6 mld PLN brutto. *(kk)*

(http://www.gkpge.pl, 24.01.2014)

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