

# Efficacy of cosmetic products used to increase skin hydration feet

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**Abstract** — The work deals with influence of available hydration cosmetics on the human skin. Specifically it is focused on the findings of their declared hydration effects. Thirteen commercially available foot creams were tested. For examination, the creams were divided to the two groups: creams containing glycerol and creams with the addition of urea. Hydration effects were evaluated using corneometry, the method based on the measurement of electrical capacity. Skin hydration measurements were performed on a group of volunteers in three different application conditions: 4 hour application, application overnight and month-long application. It was found that only one of the thirteen tested creams provided adequate moisturizing effect. On the other hand it was also found that one of the tested creams had zero moisturizing effect.

**Keywords**— *Creams, Glycerol, Moisture, Skin hydration, Urea*

## I. INTRODUCTION

The skin is composed of three primary layers: epidermis, dermis and subcutis. Each layer possesses specific characteristics and functions [1]. Skin as a whole secures many functions; the most important of them are protection from harmful influences of environment, thermal regulation and

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respiration [2 - 6]. The epidermis is the most superficial layer of the skin. It is very important from a cosmetic standpoint, as this layer gives the skin its texture and moisture, and contributes to skin colour. If the surface of the epidermis is dry or rough, the skin appears aged [1].

Dry skin is more prone to skin infections, both bacterial and fungal [1, 7]. Usage of the moisturizing creams can help the skin in several ways: preventing damage caused by dryness, providing protection and improving skin appearance [8 - 11]. The best moisturizing cosmetics are creams that contain emollients, which refine epidermis, humectants designed to soften the skin, and occlusive substances, which hinder transpiration [13, 14]. Procedure for the hydration of the skin is simple, however to achieve and to keep the optimally hydrated skin is difficult [12, 15]. Many recent studies have been focused just on usage of ointment base with humectants as hydration agents, namely hyaluronic acid, lactic acid were applied [12, 13]. However, commercially available products (moisturizing creams) contain other types of hydration substances. Therefore, the current study is designed to evaluate the hydration effect of commonly applied combinations of humectants, glycerol and urea, using the corneometric measurement for the detection of hydration changes [15, 16, 18].

## II. METHODS

For the evaluation of the moisturizing effects, the Skin Diagnostic SD 27 (Courage and Kazaka, Germany) was chosen. Skin hydration was measured using the corneometry which is based on changes of dielectric constant depending on the amount of water contained in the *stratum corneum*.

The values of hydration after cream application were expressed in corneometric units (c. u.), relatively to hydration values of skin irritated with 0.5% sodium lauryl solution (SLS). The results are given as the average values of the measurements in the group of volunteers. Skin conditions prior and after application of moisturizing creams were evaluated according to the criteria shown in the table I.

**Table I. Value scale for Skin Diagnostic SD 27.**

Skin condition	Corneometric units
Very dry skin	0 - 30
Tendency to dryness	31 - 60
Normal skin	61 - 99

The target group consisted of women from 20 to 41 years of age. Number of participating subjects was dependent on the testing procedure (see Procedures A to C). Measurements were performed in accordance with ethical principles as set for this type of biomedical tests in [17]. Informed consent was obtained from all volunteers entering the test. The measurement was conducted at laboratory temperature of  $24 \pm 2^\circ \text{C}$  and relative humidity of  $61 \pm 2\%$ .

Thirteen commercially available cosmetics moisturizing products were tested (8 with glycerol and 5 with urea). Tables II and III show composition of cosmetics creams according to International Nomenclature of Cosmetic Ingredients (INCI). The creams are daily-use products intended for dry and hardened feet skin, hydration and restoration of the barrier function of the skin. Tested moisturizing cosmetics were divided into two groups and each of these groups was tested in 3 application modes: A, B and C.

For documentation of appearance the foot skin, Visioscope (Courage a Kazaka, Germany) was used.



**Figure 1 Skin diagnostic SD 27.**

**Table II. Composition of cosmetics creams with glycerol (according to INCI).**

Name	Composition
Balea Fuss, Hirschtalg Creme	Aqua, Caprylic/Capric Triglyceride, Adeps Cervidae, Diisostearoyl Polyglyceryl-3 Dimer Dilinoleate, Cera Flava, Glycerin, Magnesium Sulfate, Chamomilla Recutita Extract, Alcohol, Phenoxyethanol, Dehydroacetic Acid, Benzoic Acid, Aloe Barbadosis, Rosmarinus Officinalis Oil, Bisabolol, Parfum, Limonene, Linalool
Freeman – barefoot	Aqua, Carthamus Tinctorius Seed Oil, Stearic Acid, Glycerin, Glyceryl Stearate, Melissa Officinalis Extract, Melaleuca Alternifolia Leaf Oil, Butyrospermum Parkii, Theobroma Cacao Seed Butter, Camellia Oleifera Leaf Extract, Tocopheryl Acetate, Panthenol, Dimethicone, Carbomer, Glycol Stearate, Cetyl Alcohol, Sodium Hydroxide, DMDM Hydantoin, Disodium EDTA, Propylene Glycol, Butylene Glycol, Methylparaben, Ethylparaben, Propylparaben, Benzyl Benzoate, Cinnamyl Alcohol, Citronellol, Coumarin, Eugenol, Geraniol, Hexyl Cinnamal, Limonene, Mentha Piperita Oil, Mentha Viridis Leaf Oil, Myristica Fragrans Kernel Oil, Salva Sclarea, Fragrance, Yellow 6 (CI 15985), Red 40 (CI 16035), Blue 1 (CI 42090)
Hirschtalg Creme	Aqua, Petrolatum, Cera Alba, Sorbitan Sesquioleate, Adeps Cervidae, Isopropyl Palmitate, Paraffinum Liquidum, Glycerin, Dimethicone, Cetyl Alcohol, PEG – 7 Hydrogenated Castor Oil, Magnesium Sulfate, Parfum, Rosmarinus Officinalis, Aloe Barbadensis Gel, Propylene Glycol, Bisabolol, Limonene, Linalool, Matricaria (Chamomilla Recutita), Extract, Benzyl Alcohol, Geraniol, Hexyl Cinnamal,

	Coumarin, Benzyl Benzoate, Cinnamyl Alcohol, Citronellol, Alpha – Isomethyl Ionone, Hydroxycitronellal, Eugenol, Methylchloroisothiazolinone, Sodium Benzoate, Potassium Sorbate, Methylisothiazolinone
Garnier – regenerative care	Aqua, Glycerin, PEG-2 Stearate, Cetearyl Alcohol, Elaeis Guineensis Oil / Palm Oil, Oleth-12, Stearyl Alcohol, Dimethicone, PEG-40 Glyceryl Cocoate, Allantoin, Sodium Coceth Sulfate, Sodium Hydroxide, Acer Saccharinum Extract / Sugar Maple Extract, Sorbic Acid, Phenoxyethanol, Parfum / Fragrance (F.I.L B35110/1)
Neutrogena - Norwegian formula-nourishing foot cream	Aqua, Glycerin, Cetearyl Alcohol, Paraffinum Liquidum, Cyclopentasiloxane, Dimethicone, Cera Microcristallina, Panthenol, Bisabolol, Allantoin, Tocopheryl Linoleate, Dilauryl Thiodipropionate, Paraffin, Palmitic Acid, Stearic Acid, Sodium Cetearyl Sulfate, Sodium Sulfate, Menthol, Methylparaben, Propylparaben, Parfum
Vichy Laboratoires Podexine	Aqua, Glycerin, Cyclohexasiloxane, Isopropyl Myristate, Polyethylene, PEG-2 Stearate, Cetearyl Alcohol, Triethanolamine, Salicylic Acid, Acrylamide/Sodium Acryloyldimethyltaurate Copolymer, PEG-100 Stearate, Stearyl Alcohol, Glyceryl Stearate, Isohexadecane, Methylparaben, Phenoxyethanol, Disodium EDTA, Oleth-12, Polysorbate 80, Parfum / Fragrance, CODE F.I.L. B10642/1
Dermacol sweet feet cream	Aqua, C12-15 Alkyl Benzoate, Glyceryl Stearate, Cetyl Alcohol, Butyrospermum Parkii Butter, Cetearyl Isononanoate, Octyldodecanol, Paraffinum Liquidum, Ceteareth-25, Dimethicone, Simmondsia Chinensis Oil, Glycine Soja Oil, Calendula officinalis Extract, Tocopherol, Sodium Polyacrylate, Trideceth-6, Propylene Glycol, BHT, Ascorbyl Palmitate, Citrid Acid, Disodium EDTA, Triethanolamine, Diazolinidyl Urea, Sodium Benzoate, Potassium Sorbate, 1,2-Hexanediol, 1,2-Octanediol, Tropolone, Linalool, Limonene, Geraniol, Citronellol, Parfum.
Peogel	Aqua, Alcohol Denat., Glycerin, Parfum / Menthol, PEG-40 Hydrogenated Castor Oil, Acrylates / C <sub>10-30</sub> , Alkyl Acrylate Crosspolymer, Triethanolamine, Melaleuca Alternifolia Oil, Allantoin, Linalool, Limonene, Triclosan, Disodium EDTA, Diazolinidyl Urea

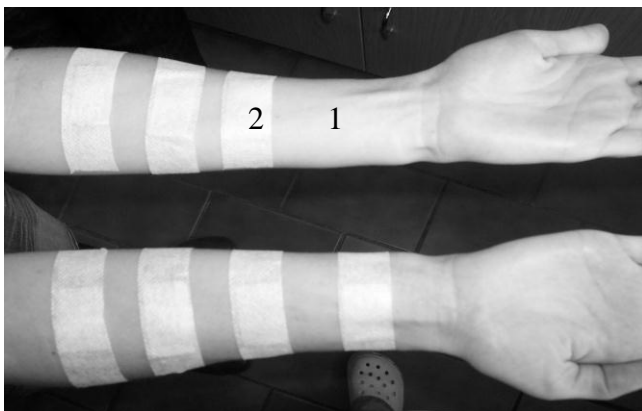
**Table III. Composition of cosmetics creams with urea (according to INCI).**

Name	Composition
Balea, Urea Fusscreme, mit 10% Urea	Aqua, Urea, Caprylic/Capric Triglyceride, Cetearyl Alcohol, Alcohol denat., Niacinamide, Phenoxyethanol, Polyacrylic Acid, Cetearyl Glucoside, Glyceryl Caprylate, Lactic Acid, Acrylates/C10-30 Alkylacrylate Crosspolymer, Sodium Hydroxide, Parfum, Coumarin
Burgit footcare	Aqua, Caprylic/Capric Triglyceride, Glycerin, Cetearyl Alcohol, Dimethicone, Simmondsia Chinensis Oil, Urea, Hydrogenated Vegetable Oil, Cetearyl Glucoside, Panthenol, Tocopheryl Acetate, Phenoxyethanol, Propylene Glycol, Parfum, Benzoic Acid, Acrylates/C10-30 Alkyl Acrylate Crosspolymer, Xanthan Gum, Bisabolol, Sorbic Acid, Hydrogenated Palm Glycerides Citrate, Tocopherol, Benzyl Salicylate, Limonene, Citronellol, Linalool, Coumarin, Citral, Citric Acid
Scholl, Foot&Nail Cream	Aqua, Glycerin, Paraffinum Liquidum, Urea, Cyclopentasiloxane, Polyglyceryl-3 Methylglucose Distearate, Glyceryl Stearate, Myristyl Alcohol, Panthenol, Dimethicone, Paraffin, Phenoxyethanol, Bisabolol, Tocopheryl Acetate, Allantoin, Methylparaben, Butylparaben, Ethylparaben, Propylparaben, Isobutylparaben, Parfum.
Ozalin	Aqua, Stearic Acid (and) Palmitic Acid, Glycine Soja, Glycerin, Urea, Lanoline, Petrolatum, Dimethicone, Glyceryl Stearate SE, Lecithin, Laureth-30, Lactid Acid, Lavandula, Cetyl Alcohol (and) Stearyl Alcohol, Salicyl Acid, Sodium Hydroxide, Methylparaben (and) Ethylparaben (and) Propylparaben (and) Butylparaben (and) Phenoxyethanol, Disodium EDTA, BHT.
Norwegische formel-Fußcreme	Aqua, Urea, Paraffinum Liquidum, Glycerin, Glyceryl Stearate SE, Cera Microcristallina, PEG-8, Vitis Vinifera, Paraffin, Glycine, Dimethicone, Stearic Acid, Palmitic Acid, Carbomer, Lecithin, Ascorbyl Palmitate, Tocopherol, Sodium Hydroxide, Phenoxyethanol, Methylparaben, Propylparaben

### III. APPLICATION PROCEDURE

#### A. Testing procedure A

Moisturizing effects were measured during 4 hour application on the volar forearms of 26 persons. The samples were tested by single application on irritated skin. First, 0.5% SLS solution was prepared and used to degrease the skin. Then, patches of filtration papers were placed to the bowl with the SLS solution for 20 seconds and placed on the volunteer's volar forearms. Three of the patches were placed on the left forearm and four of them were located on the right forearm, as illustrated in Fig. 2. Irritation patches were fixed with plasters. Moisturizing cosmetics were put into syringes and placed into a desiccator to assure their constant humidity. The irritation patches were removed after 4 hours, the places were marked and hydration was measured by Skin Diagnostic SD 27. Samples of creams were applied on the marked places. The first place (1) served as a control; it was not irritated, natural skin hydration after degreasing was measured on the second place (2). On two places on the left forearm and four places to the right forearm samples of cosmetics were applied from the syringes in the volume of 0.1 ml as shown in Fig. 3. Corneometric measurement was carried out each hour within the 4 hour time interval. The creams were tested in two series: A1 – creams with glycerol and A2 – creams with urea.



**Fig. 2. Distribution of the irritation material.**



**Fig. 3. Tested areas with applied cream samples.**

#### B. Testing procedure B

The measurement of hydration effect corresponded to procedure A, the only difference was in the time intervals of hydration measurements. The hydration effect was measured to the first three hours after the cream application and then after nine and ten-hour exposure. This application mode has participated 10 volunteers.

#### C. Testing procedure C

In procedure C, the creams were applied on feet of the volunteers. The effects of five moisturizing cosmetics were measured regularly, once a week during one month period. Volunteers were asked to not mechanically treat their feet and anoint the feet daily after bath/shower. This application mode has participated 6 volunteers.

### IV. RESULTS AND DISCUSSION

The results of hydration measurements below are given in the corneometric units and are calculated from the hydrations recorded for the respective cream relative to the values of hydration recorded on irritated skin.

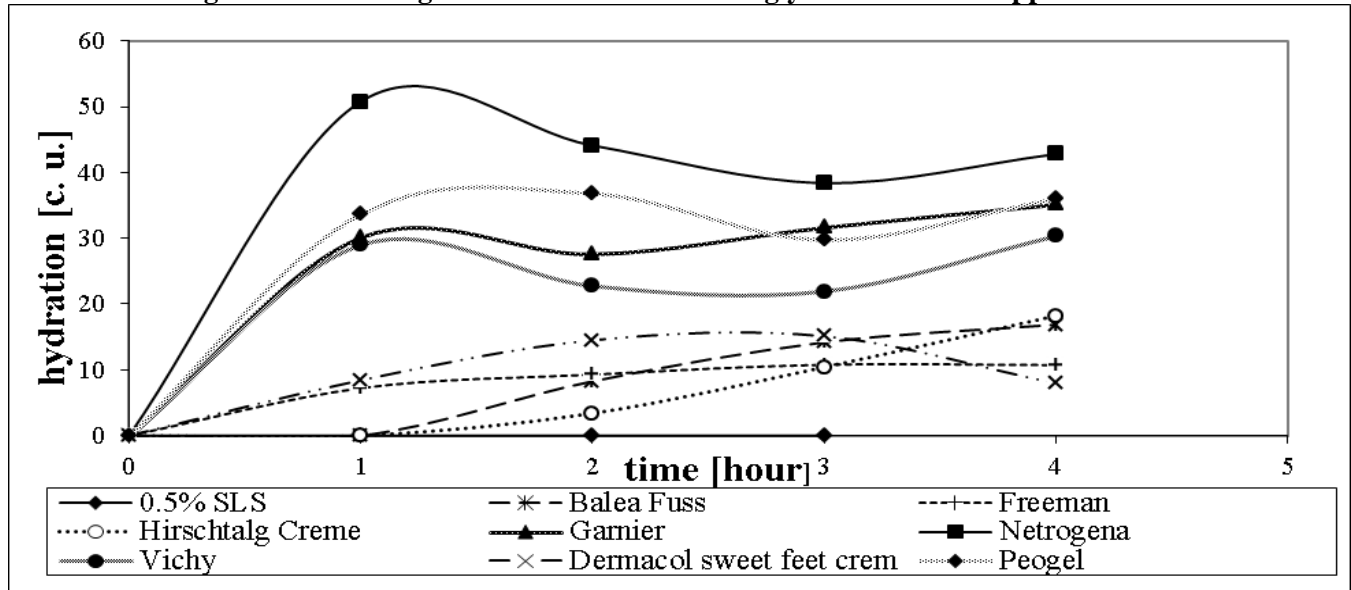
#### A Testing procedure A1 - Hydration creams with glycerol

Figure 4 shows the hydration effect of the cream with glycerol in 4 hour application. As can be seen, the abilities of individual samples to hydrate skin are different. Neutrogena has the best moisturizing effect, it has the highest performance during the first hour after application. On the other hand, Hirschtalg Creme has the worse moisturizing effect;

hydration is five times lower than that of cream Neutrogena. Creams Vichy, Garnier and Peogel have similar moisturizing effects. Vichy shows twice as high moisturizing effect as cream Baleas Fuss. These results can be caused by poor absorption of some creams into the skin (Balea and

Hirschtalg). Cream Garnier has high contents of humectants and emollients (Cetearyl Alcohol, Elaeis Guineensis Oil, Dimethicone, PEG-40 Glycerol Cocoate, Allantoin), which most likely causes its high moisturizing effect.

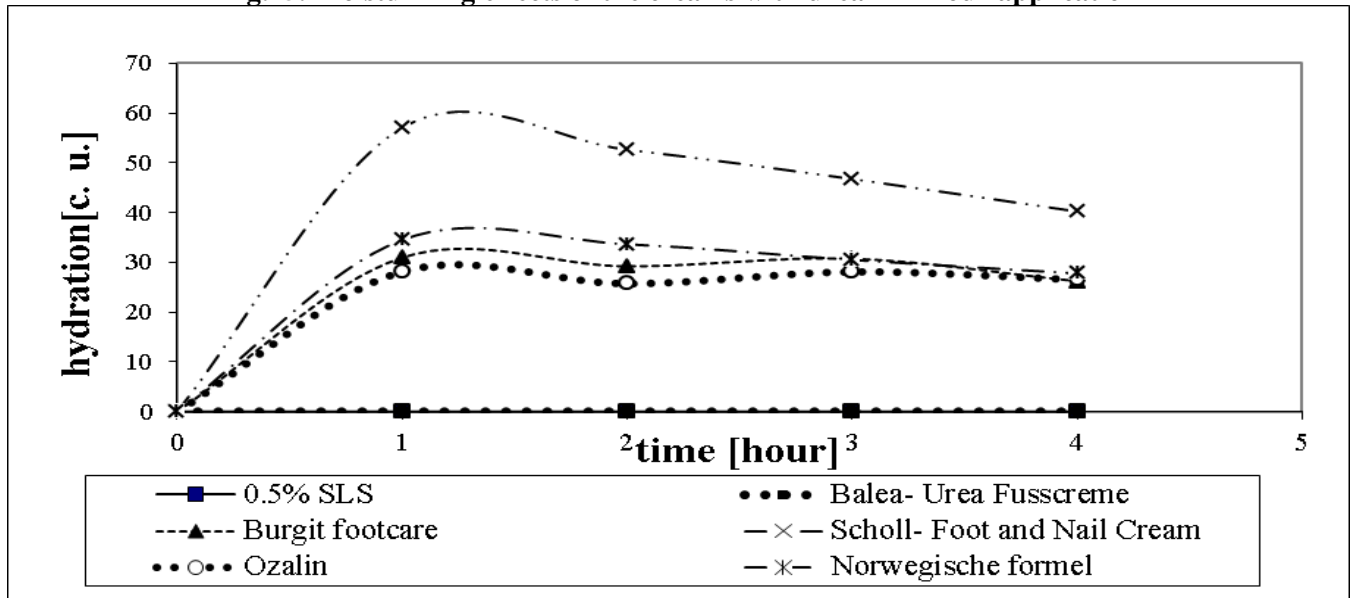
**Fig. 4. Moisturizing effects of the creams with glycerol in 4-hour application.**



#### *B. Testing procedure A2 - Hydration creams with urea*

Figure 5 shows the hydration effect of creams containing urea in 4 hour application. As shown in figure, the highest effect was determined for cream Scholl, where the maximum hydration appears in the first hour after application on the irritated skin. These hydration values corresponded to those typical for normal skin. The Scholl cream was the

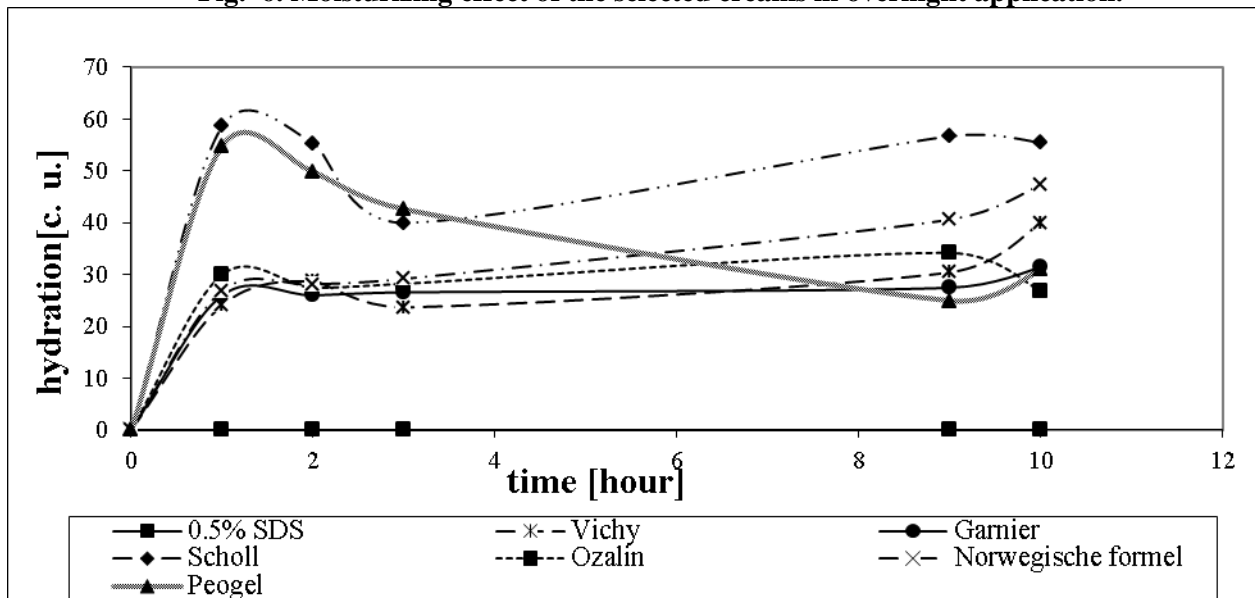
only that caused sufficient moisturizing of the skin so that the resulting hydration was above 61 c.u. The worst results, on the other hand, were measured for cream Balea - Urea Fusscreme. The hydration values recorded for this cream corresponded to conditions specified for very dry skin. Creams Norwegische formel, Burgit footcare and Ozalin have a similar effect during the whole testing time.

**Fig. 5. Moisturizing effects of the creams with urea in 4-hour application**

### C. Testing procedure B

Six selected creams were tested overnight: Garnier, Vichy, Scholl, Ozalin, Norwegische formel and Peogel. Figure 6 illustrates the results of the hydration efficacy of these creams. As can be seen, the highest moisturizing effect was measured for cream Scholl, which assured hydration values

responding to the conditions for normal skin. Peogel shows the second highest hydration, but its effect continuously decreases after the first hour. Vichy, as well as other hydration creams shows a constant moisturizing effect on the skin during the whole period of application.

**Fig. 6. Moisturizing effect of the selected creams in overnight application.**

### D. Testing procedure C

The measured values of hydration were significantly lower on the feet compared to those determined on the forearms in the Procedures A and B. These differences are caused by the different

properties of skin on the application places. The hydration of feet is more complex because skin on the feet is harder and thicker than skin on the forearms. That is why moisturizing effects are so low. Hence, the benefits of these creams are

primary seen in the qualitative change of the look of the feet (Fig. 7, 8). These changes are caused by emollients, mainly Dimethicone, Palm Oil, Paraffin, Paraffinum Liquidum, contained in the creams. Thanks to creams, skin becomes softer and loses

noticeable grooves after monthly application. It is documented in Figure 7 and 8, taken with the Visioscope. The values for the moisturizing effect of tested creams are shown in the table IV.

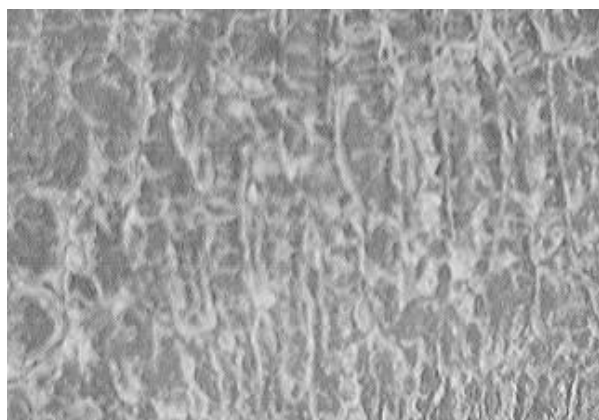
**Table IV. Moisturizing effects of the selected creams in month application.**

Time [week]	Moisturizing effect [c. u.]											
	Garnier		Vichy		Scholl		Ozalin		Norwegische		Peogel	
	RF*)	LF*)	RF	LF	RF	LF	RF	LF	RF	LF	RF	LF
0	1	0.4	0.2	0.2	0	0.2	0.4	1.4	0.2	0.6	0.4	0.2
1	3.4	3.6	0.6	0.6	0.4	0.2	0.6	1.8	1.4	1.6	0	0
2	9.6	14.2	2.8	2.8	3.8	2.8	1.2	2.6	2.2	1.6	1.2	2.6
3	6.2	10.8	5.6	3.6	8	6.6	3.2	5.6	3.4	2.4	2.6	0.8
4	7	6.2	11.6	5.8	13.6	14	4	9.4	6.4	6	3.4	6.4

\*) LF- left forearm RF - right forearm



**Fig. 7. Appearance before the application of the foot cream.**



**Fig. 8. Appearance after month application of the foot cream.**

#### IV CONCLUSION

The aim of this work was to verify the declared hydration effect of commercial cosmetic products. Creams with urea and glycerol were tested in

various testing applications (4 hour application, application overnight and a month application). The best moisturizing effect was found for cream Scholl containing urea; its hydration effect was the highest in all three testing applications. Only this cream assured moisturizing effect that corresponded to conditions for normal skin. The results indicate that urea has better moisturizing effect than glycerol. The worst effect, on the other hand, was detected for cream Balea - Urea Fusscreme. Surprisingly, this cream was also from group containing urea. The hydration values recorded after application of this cream corresponded to criteria set for very dry skin. From this finding follows that influence of other ingredients (not only hydrating substance) in creams formulation plays significant role in their performance. Most of the other tested creams showed moisturizing effect corresponding to criterion "tendency to dryness". In the next stage of this research the focus will be concentrated on measurement of transepidermal water lost (TEWL) after application of these creams on the skin.

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