

# The composition of waterproof barrier creams' ingredients and their barrier properties

Joanna KURPIEWSKA, Jolanta LIWKOWICZ – Central Institute for Labour Protection, National Research Institute, Warsaw; Kamila PADLEWSKA – Academy of Cosmetics and Health Care, Warsaw.

Please cite as: CHEMIK 2012, **66**, 9, 991-996

## Introduction

The skin of hands contacts with many harmful or only irritating substances - as detergents, washing agents and cleaning, solutions of acids, bases, salts and other products of the chemical industry, wet soil, and etc. Even water can be harmful because frequent contact or so-called "wet work" is followed by maceration and degrease the skin. Professions the most exposed on the skin irritation of hands is being ranked of health service employees, mechanics, hairdressers, beauticians, printers, employees of the construction and a lot of other. The skin irritation is manifested at first with dryness, next turning red, roast, shelling, then cracking of epidermis and at last with the inflammation of the skin. Inflammations of the skin - allergic contact dermatitis (ACD) or irritant contact dermatitis (ICD), they often require long dermatological treatment. In some professions as nurses, orderlies, midwives, vanity cases, hairdressers, cleaning ladies, the problems associated with the skin of hands they concern even a 30% of examined persons [1, 2].

Occupational skin diseases of hands are in the European Union on the leading place on the list of occupational diseases, but medical costs, disability pensions, compensations, indemnifications reach half-billion euro [3].

Gloves (usually made of natural or synthetic rubber, PCV etc.) are generally used to protect the workers' skin against exposure to substances hazardous to health. Sometimes the application of gloves is forbidden, for example at workplaces where milling machines, metal-working machines and other machines with rotating parts which can hit the glove and injure the hand. Also during performing such works as mechanists, maintenance technicians, hairdressers, etc. gloves, as protective equipment, make it very difficult and inconvenient. At the same time about 6.4% of populations suffer from an allergy to natural rubber, so it is sometimes impossible to use the rubber gloves [4]. For persons who don't use gloves but are exposed to contact with low-grade irritants skin protection measures were elaborated.

## Skin prevention measures

Barrier creams are designed to prevent or reduce the penetration and absorption of various hazardous substances into the skin, preventing skin lesions and/or other toxic effects from dermal exposure [3].

These semi-liquid or about consistency of cream preparations, create on surface of skin of hand thin, elastic membrane, presenting barrier for harmful factors.

To reduce the risk of developing ICD and ACD in nature hand care and industry, mentioned preventive measures are recommended. They improve natural protective barrier against irritating and harmful substances at workplaces and households and should be applied before the work [5].

Skin protection measures can be divided into [6]:

**Hydrophilic creams, ointments and gels** spread on human skin create elastic barrier layer impermeable to organic substances and are a good protection against insoluble in water substances, for example: organic solvents, liquid fuel, oils, lubricants, varnishes, paints/lacquers, resins etc.

## Hydrophobic (water – repellent) creams and ointments

are made of waxes, silicones, vegetable or mineral oils, insoluble in water esters of cellulose, stearic acid, fats etc. The mixture of these substances create on the skin surface the membrane, which is impermeable to water and aqueous solutions up to 5% of acids and bases, salts, detergents. These preparations cannot be used as skin protection used before the work with solvents and other organic substances which can wash off the protective layer. Oils and greases dissolve in creams and penetrate human skin more easily.

**UV-protecting creams** of high level of Sun Protection Factor (as defined by COLIPA – Standard) have an extensive protective function because of the use UVA and UVB filters combination.

As no barrier cream to date offers universal protection, barrier creams should be tested against a variety of substances, and should be marked for protection against those specific substances. Selection of a proper protectant (oil-based, water based, UV radiation exposure) is determined by the nature of substances present at the workplace.

Unfortunately skin protection measures aren't subject to a certification or no evaluation of their quality is conducted by the so-called "third side", therefore at their selection it is possible to be pointed with exclusively information given by producers - usually on package of the preparation. However, from our practice result, sometimes barrier properties do not cover declarations of producers. In that case an attempt to make an estimation of the barrier properties of protective waterproof - hydrophobic preparations was made basing on their ingredients given usually on the package.

## Composition of hydrophobic barrier creams

We analyzed ingredients of eight preparations (coming from Germany, Great Britain and Poland) available on the market, declared as skin protecting. The composition declared in International Nomenclature of Cosmetic Ingredients (INCI) is presented below. Such declaration must be on the product package or on the leaflet attached, when the package is too small.

Barrier creams should be used with careful consideration of the types of substances they are designed to protect against based on specific exposure conditions. Protective preparations contain different substances and each plays specific role [7]:

**Barrier substances** which protect skin against harmful substances as water, salting water solutions, acids, bases (up to the 5% of the concentration), detergents, soaps, etc. ranking among them:

- beeswax - natural substance, not going rancid, big wetting angle, is strongly water-repellent, giving on the skin the long continuing film
- lanolin - fat acquired from the wool of sheep, has a complex and variable composition. For example, a typical high purity grade of lanolin is composed predominantly of long chain waxy esters waxy (ca. 97% by weight) the remainder being lanolin alcohols, lanolin acids and lanolin hydrocarbons. Lanolin possesses a number of important chemical and physical similarities to human stratum corneum lipids; the lipids which help regulate the rate of trans-

epidermal water loss and govern the hydration state of the skin. Its softness is a defect what affects fast wiping off the surface of the skin and the possibility of going rancid

- vaseline – mixture of hydrocarbons obtained from petroleum; creates on the cuticle the hydrophobic film protecting from the permeation of water and her solutions. It isn't fat, so isn't going rancid. A softness, facilitating wiping off and a quite great viscosity are disadvantages
- ozokerite - natural substance called the mineral wax, comprising of the combination of hydrocarbons, mainly paraffin. is acquired from petroleum; constitutes the substitute for beeswax
- stearin - triglyceride derived from three units of stearic acid. Most triglycerides are derived from at least two and more commonly three different fatty acids. Very big wetting angle indicate the high water resistance. It don't become rancid, so is a perfect basis for waterproof preparations
- dimetikon - silicone preparation, applied in barrier creams but has weak protective properties, leaves difficult to remove tracks on touched objects.

Apart from basic barrier compounds, skin protection measures are produced from different substances: emollients, soothing substances, lubricants, vitamins, substances improving the consistency, pH regulators, emulsifiers and preservatives.

The task of some substances is to soften barrier means like - wax, stearin, ozokerite and other. Vegetable oils are usually applicable, mineral oils, e.g. paraffin - liquid paraffin, or mineral oil, is a mixture of heavier alkanes. Paraffin seems to be a perfect medium, because isn't growing old so quickly and creates a protective layer. A possibility of going rancid is a disadvantage of vegetable oils.

Emollients [8] are complex mixtures of chemical agents specially designed to increase the skin's hydration, moisturizing the skin of the hand. In cosmetology date emolient is possible practically to take back to many, of natural or synthetic raw materials differing in the polarity, of which providing for the skin proper moistening is a common characteristic, being an effect of their occlusive action for example: sorbitol, propylene glycol, glycerine, mirystyl myristate, isopropyl myristate. They have a positive effect on the state of the epidermis.

Substances which calm the skin irritation - zinc oxide and panthenol are only in two preparations.

Vitamins in barrier creams are applied in small volume. An improvement in the state of the skin, rather than a protection are setting them. They applied: tocopherol, ascorbic acid, retinol.

Consistency - creative substances are added to grant the right cohesion of preparations for example: magnesium sulfate, glyceryl stearate, magnesium stearate, isopropyl myristate, cetyl and stearyl alcohol were used.

pH regulators are supposed to adapt adjusters' reaction of preparation up to the pH of the skin. Potassium hydroxide, lactic acid, citric acid were applied in five preparations.

Emulsifiers support the formation of the emulsion of the type water in oil or oil in water. Water is contained in all preparations, except from the Polish one, so they must contain emulsifiers like are most often applied: lecithin, lanolin and glycerin monostearate.

To protect the preparations against quickly growth of micro-organisms almost to everyone, apart from domestic, preservatives like phenoxyethanol, metylparaben, propylparaben, sorbic acid are added.

Results from the review of the composition of skin protective measures, show that seven to eight tested products try to combine protective and cosmetic functions. Results of laboratory tests show on the example of three preparations how diversified and weak barrier properties can be, depending on the content of barrier substances. It can be caused by these ingredients of preparation which "make holes" in occlusive layer created on the skin of hands by barrier substances.

Emollients, or water, largely applied in preparations, evaporating from the surface of the skin of the hand can leave micro ducts, facilitating the search of irritant substances.

Table I

Composition of hydrophobic barrier creams

Product/ Country	Declared properties	Ingredients INCI
Product A –Poland	Protecting the skin from water, of water solutions, detergents and the salt and acid solutions and bases up to the 5% of the concentration	Cera Alba, Stearic Acid, Paraffinum Liquidum, Zinc Oxide
Product B – Germany	Barrier cream with the vitamin E without mineral oil and silicone. Protecting from water-soluble substances and chemical substances.	Aqua, C12-15 Alkyl Benzoate, Isopropyl Palmitate, Zinc Stearate, Mirystyl Myristate, Cetearyl Alcohol, Cetearyl Glucoside, Cocoglycerides, Shorea Stenoptera Butter, Cera Alba, Methyl Hydroxyethylcellulose, Stearic Acid, Carrageenan, Helianthus Annus Seed Oil, Butyrospermum Parkii Butter, Phenoxyethanol, Triethylene Glycol, Imidazolidinyl Urea, Methylparaben, Propylparaben, Dehydroacetic Acid, Parfum, Potassium Hydroxide, Tocopheryl Acetate.
Product C – Germany	Protective lotion against water substances. To apply lotion regularly before and after work. The product should not be in contact with eyes.	Aqua, Mineral Oil, Glycerin, Ethylhexyl Stearate, Peg-7 Hydrogenated Castor Oil, Caprylic/Capric Triglycerides, Dibutyl Adipate, Peg-45/Dodecyl Glycol Copolymer, Cera Alba, Stearyl Alcohol, Panthenol, Magnesium Stearate, Alluminum Stearate, Tocopheryl Acetate, Parfum, Phenoxyethanol, Methylparaben, Ethylparaben, Propylparaben, Butylparaben.
Product D – Germany	Cream protecting the skin from water and water substances. Without silicone and perfume. Use during the work.	Aqua, Petrolatum (and ) Ozokerite (and) Hydrogenated Castor Oil (and) Glyceryl Isostearate (and) Polyglyceryl-Oleate, Isopropyl Myristate, Sorbitol, Sodium Lactate (and ) Lactic Acid, Lanolin, Magnesium Sulfate, Sorbic Acid, Lecithin, Propylene Glycol, BHT, Glyceryl Stearate, Ascorbyl Palmitate, Citric Acid.
Product E – Great Britain	Protective cream of blasted hands. He is acting as the invisible glove, protecting hands from the irritating effect of cleaning agents and water during everyday homeworks.	Aqua, Glyceryl Stearate Se, Dimethicone, Cetyl Alcohol, Paraffinum Liquidum, Imidazolidinyl Urea, Sodium Lauryl Sulfate, Parfum, Cera Alba, Disodium Edta, Methylparaben, Oryza Sativa Bran Oil, Tocopherol
Product F – Germany	Protecting against the effect of industrial water-soluble substances. Contains greasing substances. Water-insoluble. Without silicone.	Aqua, Paraffinum Liquidum, Petrolatum, Ozokerite, Sorbitol, Glyceryl Oleate, Lanolin Alcohol, Isopropyl Palmitate, Tocopheryl Acetate, Retinyl Palmitate, Stearyl Heptanoate, Stearyl Caprylate, Magnesium Sulfate, Citic Acid, Sunflower Seed Oil, Parfum.
Product G – Germany	Emulsion forming the barrier before water substances	Aqua, Octyl Octanoatepolyglyceryl-3-Copolyhydroxystearate, Dioctylcyclohexan, Glycerin, Buxus Chinesis, Cera Alba, Panthenol, Magnesium Sulfate, Hydrolyzed Wheat Protein, Allantion, Metylparaben, Propylparaben, Phenoxyethanol, Dextracetic Acid, Sorbit Acid, Benzoic Acid, Lactic Acid
Product H – Germany	Barrier cream to the skin exposed to the professional stress. Without silicone.	Aqua, Paraffinum Liquidum, Peg-7 Hydrogenated Castor Oil, Isopropyl Myristate, Petrolatum, Sorbitol, Orbitan Isostearate (and) Peg-2 Hydrogenated Castor Oil (and) Ozokerite (and) Hydrogenated Castor Oil, PEG-45/Dodecyl Glycol Copolymer, Sodium Lactate (and) Lactic Acid, Lanolin, Imidazolidinyl Urea, Magnesium Sulfate, Sorbic Acid, Lecithin, Propylene Glycol, BHT, Glyceryl Stearate, Ascorbyl Palmitate, Citric Acid, Parfum, Benzyl Salicylate, Citral, Citronellol, Geraniol, Hydroxycitronellal, Isoeugenol, Lomonene, Linalool, Alpha-Isomethyl Ionone, Cinnamyl Alcohol.

In case of seven of discussed preparations information given by the producers is declaring the protection only against water and before with “water substances”, not specifying, that substances. Only in case of polish preparation which contains mainly barrier substances, is specified, that it protects not only against water, but also against solutions of detergents, salt, acid and base (to 5 % concentrations).

### Laboratory tests

Some preparations were subjected to laboratory tests. An absorbability of cellulose membranes covered with layer of preparation and blank samples using water and the 1% - of that detergent solution was measured as well as permeation of the 5% - of t NaOH and the 5% - of HCl through samples covered with the layer of preparations. Results are shown in Table 2.

Table 2

Results of laboratory tests

Tested parameter of efficacy	Without protecting measure	Product A	Product B	Product F
Absorbability of samples subjected to the action of water [%]	49.34	1.72	14.55	29.34
Absorbability of samples subjected to action of the 1% of detergent [%]	72.65	8.41	19.78	33.50
Penetration time 5% water solution of NaOH through thin layer of hydrophobic creams [min]	0	>60	3.60	2.10
Penetration time 5% water solution of HCl through thin layer of hydrophobic creams [min]	0	>60	6.30	3.10

The degree of reducing absorbabilities of samples as well as extending the permeation time for membranes covered with examined skin protection measures give the information about barrier properties of tested preparations. Creams A and B contain beeswax and stearic acid which have very good hydrophobic properties, however F cream contains ozokerite - weaker barrier properties. Also an amount and a type of remaining ingredients of creams not without meaning.

### Conclusions

Consideration of substrates applied for preparations' production confirm results of the laboratory tests. Preparation A has the best protective better properties and contains only barrier substances, without cosmetic additives. It fulfills the declaration of the producer regarding resistance against water and water solutions of detergents and acid/basis resistance.

There is one important note: even the most effective barrier cream will fail when it is used inadequately. Education is one of the most important measures in the prevention of irritant contact dermatitis. Appropriate information about requirement, selection, applying are included for example in an instructive brochure “Skin protection measures (barrier creams and gels)” [9].

Waterproof barrier preparations are efficient, simple in the application therefore should be widely applied in workplaces as well as at housekeeping.

Spreading the knowledge about skin protecting measures, in this case about water resistant barrier creams, will improve the comfort of the life of persons susceptible to contact dermatitis, will reduce the number of ICD cases, will reduce financial charges of employers and state.

### Literature

1. Kurpiewska J., Liwkowicz J., Benczek K., Padlewska K.: *A Survey of Work - Related Skin Diseases in Different Occupations in Poland*. International Journal of Occupational Safety and Ergonomics, JOSE 2011, **17** (2), 207 - 214.
2. Kręcisz B., Kieć-Świerczyńska M.: *Zagrożenia dermatologiczne wywołane środowiskiem pracy*. Praca i Zdrowie 2007, **4**, 4 - 7.
3. Chew A., Maibach H.I.: *Irritant Dermatitis*. Springer, 2006, 435.
4. Kamińska W.: *Alergia na lateks u pracowników służby zdrowia i możliwości jej ograniczania*. Bezpieczeństwo Pracy 2002, **3**, 4 - 7.
5. Elsner P.: *Skin Protection in the Prevention of Skin Diseases*. Schliemann S., Elsner P. (eds): *Skin Protection*. Curr. Probl. Dermatol. Basel, Karger, 2007, **34**, 1-10.
6. Liwkowicz J., Kurpiewska J., Benczek K.M., Łopacka B.: *Środki ochrony skóry*. Przegl Dermatol 2006, **93**, 259 - 263.
7. Malinka W.: *Zarys chemii kosmetycznej*, wyd. VOLUMED, Wrocław 1999.
8. Sikora M.: *Emolienty: ważne składniki preparatów kosmetycznych*. Chemical Reviews 2004, **10**, 28-35.
9. Kurpiewska J., Liwkowicz J.: *Środki Ochrony Skóry. Kremy/żele barierowe. Wymagania, dobór, stosowanie*. CIOP-PIB, Warszawa, 2010.

Joanna KURPIEWSKA - M.Sc., is a graduate of the Environment Protection Faculty at Warsaw Technical University. She started work at the Central Institute for Labour Protection - National Research Institute in Warsaw. She works in the Department of Chemical, Aerosol and Biological Hazards. Her recent years' research has been focused on testing the properties and efficacy of barrier creams. The aim of her occupational activity is to implement these preparation as skin protection measures. She is the author and co-author of 40 publications.

Tel.: (22) 623 46 94, e-mail: jokur@ciop.pl

Jolanta LIWKOWICZ - Ph.D., is a graduate of the Chemical Faculty at Warsaw Technical University. She received her Ph.D. degree in chemistry. She works in the Central Institute for Labour Protection - National Research Institute. For many years she was a vice head of Laboratory of Personal Protection Equipment - Gloves. For more than a decade she has been engaged in elaborating and testing skin protection measures. She is the author and co-author of 110 publications.

Kamila PADLEWSKA - Ph.D., is a graduate of Medical University of Warsaw. She received her Ph.D. degree in dermatology. At present she works as professor in Warsaw Academy of Cosmetics and Health Care.