

Phosphatidylserine in skin care

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Phospholipids are essential components of the cell structures of living organisms and important components of physiologically compatible skin care in lamellar creams, liposomes and nanodispersions. Among phospholipids, phosphatidylserine is predestined for special applications in skin care.

Phospholipids are found in cell membranes and the intracellular matrix, where they perform a variety of metabolic functions. The human organism contains the following proportions:¹

- Phosphatidylcholine (PC): 45-55%
- Phosphatidylethanolamine (PE): 15-25%
- Phosphatidylinositol (PI): 10-15%
- Phosphatidylserine (PS): 5-10%
- Phosphatidic acid (PA): 1-2%

Plant lecithin

The phospholipids used in cosmetics are isolated from lecithin, which is produced during the manufacture of soybean, sunflower or other vegetable oils. Due to its relatively high proportion of anionic components, lecithin is an effective food emulsifier used for a wide variety of purposes.

Phosphatidylcholine (PC), also being the most abundant component in plant lecithin, is frequently used in skin care. It forms the typical lipid bilayer structures, which are planar in lamellar creams (PC with saturated fatty acid composition) and cell-shaped in liposomes (PC with essential fatty acid composition).

Nanodispersions

While phosphatidylcholine carries balanced positive and negative charges and is thus electrically neutral, phosphatidylserine (PS) is an anionic phospholipid with a net negative charge. This has a practical consequence: when PS is used in higher concentrations, W/O emulsions are preferentially formed.

The production of liposome preparations such as PC is therefore not possible. The formation of nanodispersions, i.e. vesicles of the same size as liposomes that contain a lipid body instead of an aqueous interior, also proves difficult.

Since nanodispersions offer many practical advantages in terms of application technology, such as their water-like consistency despite high oil content and their easy fusion with the lipid bilayers of the skin barrier, mixtures of phosphatidylcholine and phosphatidylserine are used for this purpose. They guarantee high availability of these and other active ingredients.

Oleogels

As an alternative to aqueous nanodispersions, anhydrous oleogels are suitable for preparations containing phosphatidylserine. This is because the anionic character of phosphatidylserine plays no role in anhydrous oleogels.

Physiological, biodegradable oleogels can also contain structure-forming components, such as those found in the skin barrier. These include long-chain fatty acids and their triglycerides, as well as phytosterols (plant analogues of human cholesterol). Phosphatidylcholine can be added as a penetration enhancer.

The absence of a water phase eliminates the need for preservatives, emulsifiers (surfactants), complexing agents and solvents, which are counterproductive in terms of physiology and microbiome compatibility. Oleogels with PS and PC even allow polar and hydrophilic active ingredients, such as urea, to a certain extent. Higher concentrations are achieved in pharmaceutical preparations through micronised active ingredients.

Skin smoothing

Since the lipid concentrations in oleogels are 3-4 times higher than in O/W emulsions, consumption is extremely low with oleogels. PS oleogels are well-suited for massages due to their smoothing properties.

Skin smoothing can also be felt when using PS nanodispersions. This is because, unlike pure PC nanodispersions, strong adhesion already occurs on the skin surface. This results from the high affinity of phosphatidylserine to keratino-

¹ P. van Hoogevest, Phospholipids – Properties, manufacturing and use, 5th International Symposium on Phospholipids in Pharmaceutical Research, Heidelberg 2017

cyte surfaces. Phosphatidylserine behaves similarly on artificial skin.²

Signal transmitter

Nanodispersions are particularly suitable for the care of erythematous, eczematous and atopic skin. These corneotherapeutic adjuvant applications are obvious when considering the behaviour of phosphatidylserine during apoptosis, the programmed cell death of keratinocytes.

Although phosphatidylserine, like phosphatidylcholine, is a component of cell membranes, it is not found within the membranes, but exclusively on their inner surface. During apoptosis, PS migrates from the inner surface to the cell surface, where it serves as a signal for macrophages to dissolve and digest the cell in question.^{3,4}

Phosphatidylserine activates macrophages, suppresses inflammatory messengers such as cytokines during this process, and triggers the formation of TGF- β (transforming growth factor) and prostaglandin E₂.⁵ Phosphatidylserine also appears more frequently on cell surfaces in the event of external injuries, thereby activating coagulation and wound healing. The anti-inflammatory effect can be demonstrated in vivo using rat paw oedema.⁶ A recent publication suggests a similar effect on psoriasis.⁷

Serine

Like all phospholipids, phosphatidylserine contains long-chain fatty acids, most of which are essential, bound to glycerol in the form of esters. PS isolated from soy contains approximately 60% polyunsaturated fatty acids, about 20% monounsaturated fatty acids and approximately 20% saturated fatty acids.⁸ Among

these, linoleic acid (omega-6, double unsaturated), α -linolenic acid (omega-3, triple unsaturated), and their metabolites play an important role in organisms. When taken orally, they are used to form local hormones such as prostaglandins, thromboxanes, and leukotrienes, among other things.

The amino acid serine, which is also bound in phosphatidylserine, plays a central role in protein structures. Historically, the name serine is associated with silk production. During the processing of raw silk, the so-called sericin, which is rich in serine, is removed.

In addition to its presence in proteins such as collagen, serine is found in the catalytically active centre of special proteases, i.e. enzymes that break down proteins. These serine proteases include, for example, trypsin (digestion) and thrombin (blood clotting).

Nutrition

The total amount of phosphatidylserine in the body averages around 60 g, with about half located in the central nervous system alone. Studies suggest that oral intake can increase memory and learning ability^{9,10} – as a result, phosphatidylserine is also available as a dietary supplement. Higher concentrations are found in cold-water fish such as herring and mackerel.¹¹

Further information

Phosphatidylserine is a component in skin care that fits seamlessly into the biochemical conditions of the skin and microbiome. Further

² S Zellmer, D. Reissig and J. Lasch, Reconstructed human skin as model for liposome-skin interaction, *J Control Release* 55, 271-279 (1998)

³ R. B. Birge et al., Phosphatidylserine is a global immunosuppressive signal in efferocytosis, infectious disease, and cancer, *Cell Death and Differentiation* 23, 962-978 (2016)

⁴ V. A. Fadok, D. L. Bratton, S. C. Frasch, M. L. Warner, P. M. Henson, The role of phosphatidylserine in recognition of apoptotic cells by phagocytes, *Cell Death and Differentiation* 1998 (5), 551-562

⁵ P. M. Henson and D. L. Bratton, Antiinflammatory effects of apoptotic cells, *The Journal of Clinical Investigation* 123, 2773-2774 (2013)

⁶ K. Mäder, M. Klein, S. Mauch, G. Ramos, U. Hofmann and A. Meister, Phosphatidylserine enriched phospholipids as anti-inflammatory agents, 5th International Symposium on Phospholipids in Pharmaceutical Research, Heidelberg 2017

⁷ B. F. Far, P. M. Saffari, R. M. Jafari, R. Goudarzi, A. R. Dehpour, A. Partoazar, Phosphatidylserine topically attenuates imiquimod-induced psoriasis through inflammation inhibition in mice, *Drug Res*, 75 (1), 12-20 (2025)

⁸ Data sheet PS P 70 dated 17 August 2015, Lipoid GmbH, Frigenstr. 4, D-67065 Ludwigshafen

⁹ H-Y. Kim, B. X. Huang and A. A. Spector, Phosphatidylserine in the brain: metabolism and function, *progress in lipid research* 56, 1-18 (2014)

¹⁰ H. Dannert, Einfluss von Phosphatidylserin auf den durch Glycolipidtransferprotein katalysierten Gluco- und Galactocerebrosidtransfer zwischen Liposomen, Dissertation Eberhard-Karls-Universität Tübingen 2005

¹¹ S. W. Souci, E. Fachmann and H. Kraut, Food composition and nutrition tables, Medpharm Scientific Publishers Stuttgart 2008

details and a detailed portrait of the substance were recently published elsewhere.¹²

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¹² H. Lautenschläger, Trend zu physiologischen Inhaltsstoffen – Phosphatidylserin in der Hautpflege, Chemie in unserer Zeit 58 (2), 93-97 (2024)