Lecithin and Phospholipids – the optimal choice for natural cosmetics

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Cosmetic products are required to be safe and effective. Hence, increasing emphasis is placed on the origin of raw materials, their nature, their degradability and their impact on the environment. Owing to this, cosmetics of natural origin have gained increasing importance. In recent years their share of the market has steadily risen.

In Germany there is no mandatory definition of what is natural cosmetics. The BDHI established some criteria for the choice of raw materials for natural cosmetics[1]. They contain the abdication of numerous synthetic raw materials. Lecithins and phospholipids of natural origin or modified ones are a substitute of synthetic emulsifiers, functional additives and fulfil the criteria of the BDHI for natural cosmetics.

What is lecithin and what are phospholipids?

Lecithin represents a mixture of polar and non-polar lipids whereby the content of polar lipids (= acetone insoluble matter) should be at least 60 % (according to the EU standardised description of lecithin). Lecithin can be isolated e. g. from egg yolk, brain, carp eggs, and plant seeds.
For cosmetic applications lecithin from soybean source is used.

The phosphorus containing lipids found in lecithin were summarised under the term "phospholipids". Together with glycolipids and sphingolipids, they represent the fraction of the polar lipids present in lecithin which are essential components of all cell membranes.

Glycerophospholipids are the predominant group of substances found in commercially available lecithin. They can be derived from sn-glycero-3-phosphate. The non-polar region is formed by two fatty acid molecules esterified to the positions 1 and 2 of the glycerol backbone. The polar region consists of a phosphate ester at position 3 (Fig. 1). The various phospholipids differ mainly in the nature of the polar headgroup:

- in phosphatidylcholine the phosphate group is esterified to choline
- in phosphatidylethanolamine the phosphate group is esterified to ethanolamine
- in phosphatidylinositol the phosphate group is esterified to inositol

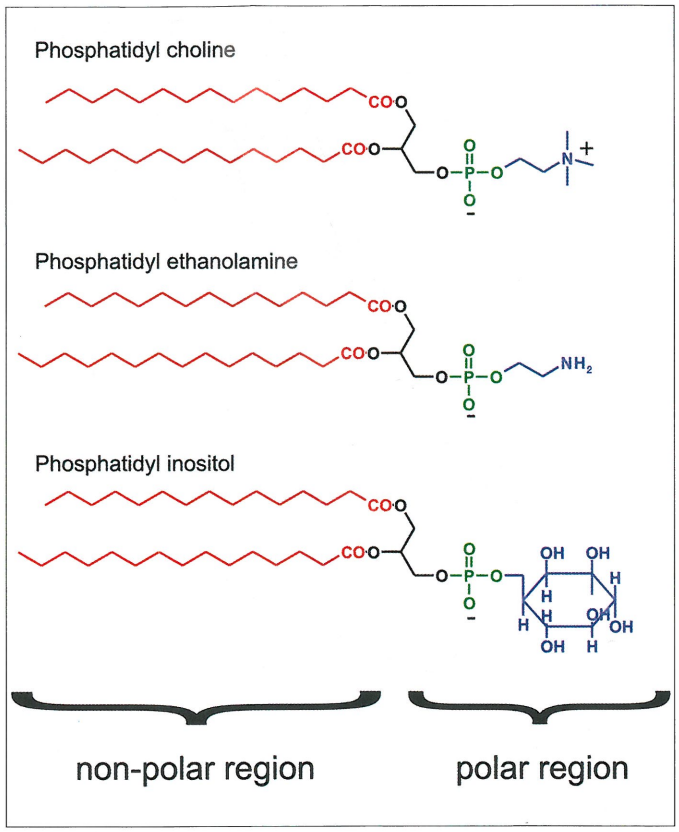

Fig. 1: Chemical structures of the most common phospholipids.

In terms of technological as well as physiological properties, phospholipids are the essential active ingredients of lecithin. While the notation "lecithin" describes non-specifically the mixtures of polar and non-polar lipids, the term "phospholipid" refers to clearly characterised substances with reproducible properties.

Lecithin and phospholipids in cosmetics

Phospholipids succeed in combining a series of desirable properties of cosmetic products. They are ideal raw materials for modern cosmetics for three reasons:

1. For their **technological properties**

Thanks to their amphiphilic molecular structure, phospholipids are excellent:

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- *Emulsifiers*
  They have the ability to emulsify fat soluble active ingredients. Homogenisation by means of high shear forces leads to finely dispersed nanoemulsions.
- *Stabilisers*
  They prevent the aggregation of suspensions, especially in the field of aerosols, by coating the cosmetic pigments. By coating, they also improve the adhesion of pigments to the skin (lipsticks, make up).
  They prevent or retard fat recrystallization of formulation ingredients and thus provide improved storage stability and solidity of the formulation, especially in the field of lipsticks.
- *Liposome forming materials*
  Liposomes represent the ideal transport vehicle for water soluble active ingredients.
  In recent years, liposomes have strongly influenced the development of cosmetics by their use as a carrier system for water soluble active agents. This is due to the liposomes' capacity of enclosing an aqueous volume.
  Liposomes are vesicles built up of one or several lipid double layers (membranes). Liposomes with only one membrane are called unilamellar liposomes; with several membranes they are called multilamellar liposomes (Fig. 2). The size of liposomes ranges from 0.02 µm to many micrometers.

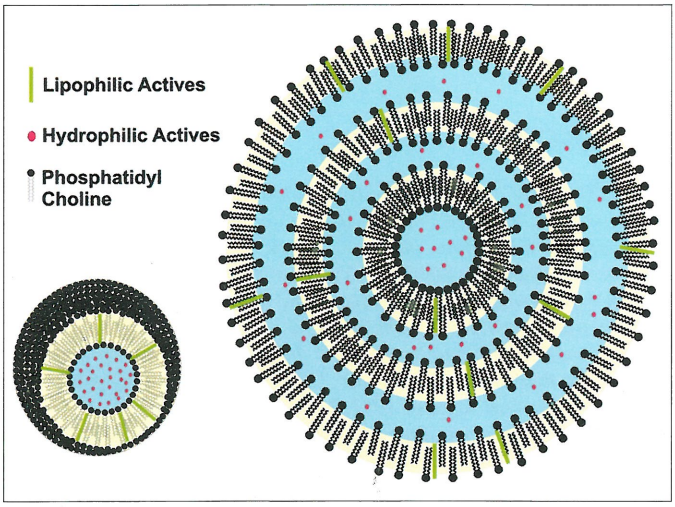

Fig 2: Encapsulation of water- and lipid-soluble actives.
Left: unilamellar liposome, right: multilamellar liposome.

Numerous studies have shown that the topical application of liposomally encapsulated active agents leads to clearly higher concentrations of active agents in the upper layers of the epidermis than with non-encapsulated actives [2-5]. Thus, liposomes may serve as carrier for hydrophilic active agents.

2. For their **properties as an active ingredients**

Phospholipids enhance the efficacy of skin and hair care products by providing the following positive effects:

- A better smoothness and suppleness of the skin, without the skin feeling greasy.
- A certain protection against strong degreasing of the skin.
- Improved moisture balance of the skin by the strong water binding ability of phospholipids.

Phospholipids also adhere to the hair surface giving a pleasant non-sticky effect. They improve the combing quality and reduce the electrostatic charge of the hair.

Customers can feel these differences; they favour the prolonged protection and hence prefer phospholipid products over others.

3. For their **advertising arguments**

- Phospholipids are *of natural origin.*
  Phospholipids for cosmetics are usually obtained from soybeans or egg yolk through extraction processes.
- Phospholipids are *biodegradable* and therefore are *ecologically sound.* They are produced from renewable raw materials.
- Phospholipids are *safe raw materials*, because they do not *cause dermatological or toxicological problems.*
- Lecithins/Phospholipids enjoy the *GRAS-status* (generally recognized as safe) and are even used as emulsifiers for intravenous pharmaceutical preparations.

Different types of Phospholipids for natural cosmetics

Unsaturated Phospholipids

Unsaturated phospholipids are the natural ingredients of lecithin and therefore are ideal raw materials for natural cosmetics. They are neither toxic nor skin-irritant.

For years, unsaturated phospholipids have been used as emulsifiers for the production of fat emulsions in the pharmaceutical field. However, up to now, little attention has been paid to unsaturated phospholipids as natural emulsifiers in the cosmetic field. Nevertheless, simple types as well as highly purified ones are nowadays well accepted; as active ingredients, a source of highly unsaturated fatty acids in hair care and skin care and as valuable raw materials for the production of liposomes.

Hydrogenated Phospholipids

Hydrogenated phospholipids are gained by catalytic hydrogenation of natural phospholipids and are appropriate raw materials for natural cosmetics according to the criteria of the BDHI.

The technology of transforming unsaturated phospholipids into saturated (or hydrogenated) ones (Fig. 3) offers a completely new perspective into possibilities for the use of this valuable raw material. In this context it is advantageous that hydrogenated phospholipids are odourless, stable against oxidation and of white to beige colour.

They come on the market as powders or porous agglomerates.

Phospholipids with saturated fatty acids are also found in nature (e.g. in lung surfactants and milk phospholipids[6-8]). Hydrogenated phospholipids, which are obtained from unsaturated ones by catalytic hydrogenation, are identical to these natural substances.

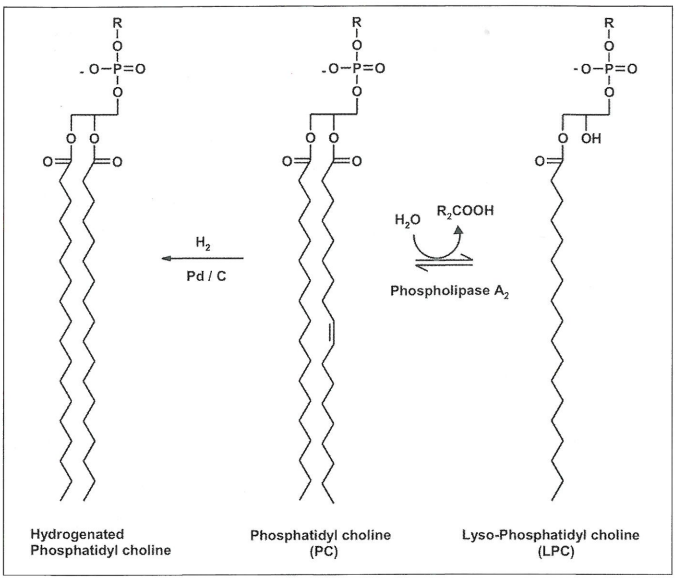

Fig 3: Modification of natural phospholipids
Left hand side: hydrogenation to obtain saturated phospholipids
Right hand side: hydrolysis to obtain lysophospholipids.

Hydrogenated phospholipids can be considered as emulsifiers of natural origin[9], nature-identical emulsifiers[10] or natural emulsifiers[11].

Hydrogenated phospholipids are a new generation of efficient phospholipids that meet the high standards of modern cosmetics. With this type of phospholipid it is possible to produce stable o/w-emulsions that are well accepted by the cosmetic industry.

Depending on the ingredients of a formulation, a concentration of 1 - 3 % is sufficient.

Hydrogenated phospholipids show an excellent compatibility with the human skin, and they have no irritation potential. In a comprehensive study, hydrogenated phospholipids were tested against different emulsifiers[12]. By means of the Duhring-Chamber-Test irritations were assessed according to the occurrence of the formation of erythemas and scales. All test substances were studied in a 20 % dilution in cosmetic alcohol, suspended or dissolved. The reference substance was a solution of 1 % sodium laureth sulfate besides the carrier alcohol. This study demonstrated in a very impressive way that the hydrogenated phospholipids were the only test substances tolerated by all test persons without any negative findings. Even under these extreme conditions, hydrogenated phospholipids can be considered as highly compatible even with sensitive skin.

Lysophospholipids

The emulsification efficacy of phospholipids in the field of o/w - emulsions can be improved by specific enzymatic hydrolysis under the formation of so-called Lysophospholipids. Lysophospholipids are also appropriate raw materials for natural cosmetics according to the criteria of the BDHI.

Partly hydrolysed phospholipids are already used widely as emulsifiers and wetting agents for the manufacturing of food and feed.

The hydrolysis of phospholipids with phospholipase A2 results in defined products consisting of lysophospholipids and free fatty acids[13].

During this process (Fig. 3) the ester bond at C-2 of the glycerol backbone is cleaved. The fatty acid is released and replaced by an OH-group. This hydroxyl group enhances the polarity of the molecule, which results in an increase of the HLB value.

As reported in the literature, lysolecithin has an effect on the basement membrane. This is because lysolecithin stimulates the synthesis of laminin 5, a factor supporting the regeneration of an aging basement membrane[14].

For application in cosmetics, mixtures of hydrogenated phospholipids with about 20 % lysophosphatidylcholine have provided good results. The calculated HLB value ranges from about 7.5 to 8.5. This material is soluble in ethanol, excellently dispersible in water and combines the advantages of the hydrogenated phospholipids (neutral in smell and colour, oxidatively stable) with that of the more polar lysophospholipids (higher HLB-value).

Conclusion

Phospholipids are ideal emulsifiers for the field of natural cosmetics. They are of natural origin, combine different desirable properties, offer a known safety profile and are compatible with existing formulations. Even modified phospholipids fulfil the criteria for raw materials for natural cosmetics in the sense of the BDHI and offer a broad technological basis for innovative cosmetics that meet the consumers´ demand.

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