Proteins Used in Cosmetics

Polymers represent a significant share of raw materials used in cosmetics. Both natural and synthetic polymers are used as thickening agents, film formers, resinous powders, and humectants. Polymers are molecules consisting of a large number of identical units. If only one unit forms the base unit (e.g. ---A-A-A-A-A---), then the polymer is called homopoylmer. If more than one unit form the base units (e.g. ---A-B-A-B-A---), then the polymer is called copolymer. The number of the repeat A-units is called the degree of polymerisation. Polymers are usually classified by their structure (see table below).

Classification of Polymers

Natural Polymers (Biopolymers)

A. Proteins (base unit = amino acids):
e.g. collagen, elastin, keratin, silk, casein

B. Polysaccharides (base unit = simple sugars):
e.g. cellulose, chitin, pectin, xanthan gum, hyaluronic acid, chondroitin sulfate, guar gum

Synthetic Polymers

A. Petroleum-based polymers
- Acryl-polymers (e.g. acrylic ester)
- Vinyl-polymers (e.g. propylene)
- Allyl-polymers (e.g. allylamine)
- Oxide-polymers (e.g. ethylene oxide)

B. Biologically-derived polymers
- Polycaprolactones
- Silicone polymers
- Polyamides

Protein Polymers

Sources

Both animals and plants give suitable proteinaceous materials for the preparation of cosmetic ingredients. Proteins from inferior organisms as fungi and algae, however, are also increasingly being used as protein sources. Proteins typically obtained from animals include collagen, elastin, keratin, milk, reticulin, fibronectin and silk (from silkworm). Moreover, raw extracts from animal tissues like thymus, placenta, heart and bone marrow have also been of use in cosmetics. Since animal protein preparations are treated with several inactivation procedures to remove any viral and bacterial contaminants, the risk of the transmission of infectious diseases with the use of animal-derived proteins in cosmetics is regarded low. However, authorities (e.g. the European Community) has banned the use of cosmetic ingredients derived from brain, spinal cord, and eye from cattle, sheep, and goats due to the risk of BSE (bovine spongiform encephalopathy).

Proteins from vegetable sources have become increasingly popular. High-protein plants most commonly used as starting material for producing vegetable proteins are wheat and corn gluten, soy, rice and oat protein concentrates, and defatted oilseeds (peanuts, almond, sunflower). Among the large variety of vegetable proteins wheat gluten and soy globulins are by far of the widest use and interest. Wheat gluten (often just called wheat protein) is a unique cereal protein of high elasticity when hydrated. Soy proteins are useful due to their gelling and emulsifying effects.

Hydrolysation

Because of their very poor water solubility, most proteins are unsuitable for the use in cosmetics. Only very few native proteins (e.g. albumin, enzymes) are native soluble proteins. To make proteins suitable to be incorporated into water-based cosmetic products, they need to be converted into soluble form. This is usually done by hydrolysation, a process where the protein is cut into smaller pieces. This cleavage is done chemically by hydrogen ions or biologically by enzymes.

Derivatisation

To add or enhance a specific function of a protein specific chemical groups are attached (derivative). For example, by adding a quaternary ammonium group to keratin or collagen these proteins become effective conditioners in that they bind easier to the damaged hair, reduce static electricity (fly away hair) and are not so easy rinsed off. To give a protein additional emulsifying and cleansing properties similar to a surfactant, various fatty acids are attached in a process called condensation. Used in cleansers such protein-fatty acid condensates have a high skin and eye tolerability, mild washing and foaming activity and are thus widely used to reduce the irritability of harsh surfactants. Proteins can also be complexed with surfactant molecules. The main purpose is to achieve water solubility of high-molecular weight, otherwise water-insoluble proteins. In addition, such surfactant-protein complexes can be used as vehicle to obtain high-concentrated solutions of low-soluble proteins like collagen or wheat protein.

Formulating with Proteins

Soluble proteins are suitable to be incorporated in almost all common forms as emulsions, lotions, gels, and powders. The table below gives a brief overview about the use of proteins and their derivatives in skin and hair care preparations.

Proteins in Skin Care Products

Protein Hydrolysates
Example: hydrolyzed collagen/elastin/silk/wheat
Function: humectant, film former, conditioner
Use: 0.2 - 5% in creams, lotions

Highly Water-Soluble Proteins
Example: desamido collagen, serum albumin
Function: humectant, protectant, conditioner
Use: 0.01 - 0.1% in creams, lotions

Gelatin
Function: thickener, film former, emulsion stabiliz.
Use: 1 - 2% in emulsions

Protein Condensates
Example: potassium cocoyl hydrolyzed collagen
Function: co-emulsifier
Use: 0.5 - 2% in O/W emulsions

Insoluble Proteins
Example: silk powder, insoluble keratin/elastin
Function: oil absorbent, cohesive agent
Use: 1 - 5% in powder makeup preparations

Proteins in Hair Care Products

Protein Hydrolysates
Example: hydrolyzed collagen/keratin/silk/wheat
Function: conditioner, buffering agent
Use: 0.2 - 2% in shampoos, conditioners, rinses

Protein Condensates
Example: hydrolyzed wheat protein polysiloxane copolymer, AMP-isostearoyl hydrolyzed collagen, alkyldimonium hydroxypropyl hydrolyzed elastin
Function: conditioner
Use: 0.05 - 3% in conditioners, relaxers, rinses

Soluble Proteins
Example: soluble keratin, soluble wheat protein
Function: permanent conditioner
Use: 0.5 - 5% in conditioning perms

Special Protein Condensates
Example: potassium undecylenoyl hydrolyzed collagen, potassium abietoyl hydrolyzed collagen
Function: anti-dandruff
Use: 0.5 - 2% in shampoos

Sources:
Goddard ED, Gruber JV. Principles of polymer science and technology in cosmetics and personal care. M. Dekker, New York, P391-464

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