Polymers: Proteins

Rice is one of the most commonly used vegetable proteins in cosmetics.

Classification of Polymers:

Natural Polymers (Biopolymers)

- Proteins (Base unit = amino acids)
  - o Collagen, elastin, keratin, silk, casein.
- Polysaccharides (base unit = simple sugars)
  - o Cellulose, chitin, pectin, xanthan gum, hyaluronic acid, chondroitin sulfate, and gaur gum

Synthetic Polymers

- Petroleum-based polymers
  - o Acryl-polymers (acrylic ester)
  - o Vinyl-polymers (propylene)
  - o Allyl-polymers (allylamine)
  - o Oxide Polymers (ethylene oxide)
- Biologically-derived polymers
  - o Polycaprolactones
  - o Silicones Polymers
  - o Polyamides

Polymers represent a significant portion 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) - then the polymer is called homopolymer. If more than one-unit forms - the base units (e.g., A-B-A-B) - then the polymer is called copolymer. The number of the repeat A-Units is called the degree of polymerization. Polymers are usually classified by their structure (see table).

Where do protein polymers come from?

Both animals and plants give suitable proteinaceous materials for the preparation of cosmetic ingredients. Proteins from inferior organisms such as fungus and algae, however, are also increasingly being used as protein sources.

Proteins that are typically obtained from animals include:

- Collagen
- Elastin
- Keratin
- Milk
- Reticulin
- fibronectin
- Silk (From Silkworms)

Raw extracts from animal tissues like the thymus, placenta, heart, and bone marrow have also been used in cosmetics. Since animal protein preparations are treated with several inactivation procedures to remove any viral and bacterial contaminants, the risk of transmission of infectious diseases in cosmetics is low. However, authorities (in the European community) have banned the use of cosmetic ingredients from the 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, almonds, sunflower). Among the large variety of vegetable proteins, wheat gluten and soy globulins are by far one of the widest used. Wheat gluten (often called wheat protein) is a unique cereal protein that has 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 use in cosmetics. Only a few native proteins (albumin and enzymes) are soluble proteins. To make proteins suitable enough to be incorporated in water-based cosmetic products, they need to be converted into a soluble form. This is usually done by hydrolyzation, a process where the protein is cut into smaller pieces. This is done chemically by hydrogen ions or biologically by enzymes.

Protein in Skin Care Products:

Protein Hydrolysates

- Ex) Hydrolyzed Collagen/elastin/silk/wheat
- Function: Humectant, film former, conditioner
- Use: 0.2-5% in creams and lotions

Highly Water - Soluble Proteins

- Ex) Desamido collagen, serum albumin
- Function: Humectant, protectant, conditioner
- Use: 0.01-0.1% in creams, lotions
  Gelatin
- Function: Thickener, film former, emulsions stabilizer
- Use: 1-2% in emulsions

Protein Condensates

- Ex) Potassium Cocolyl Hydrolyzed collagen
- Function: Co-emulsifier
- Use: 0.5-2% in O/W Emulsions

Insoluble Proteins

- Ex) Silk powder, insoluble keratin/elastin
- Function: Oil absorbent, cohesive agent
- Use: 1-5% in powder makeup preparations

Milk is one of the most common proteins obtained from animals.

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 because they bind easier to the damaged hair, reduce static electricity (fly away hair), and are not easy to rinse off. To give protein additional emulsifying and cleansing properties similar to surfactant, various fatty acids are attached in a process called condensation. Cleansers such a protein-fatty acid condensate has 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 a 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 and to the left gives a brief overview of the use of proteins and their derivatives in skin and hair preparations.

Protein in Hair Care Products

Protein Hydrolysates

- Ex) Hydrolyzed Collogen/keratin/wheat
- Function: Conditioner, buffering agent
- Use: 0.2-2% in shampoos, conditioners, rinses

Protein Condensates

- Ex) Hydrolyzed wheat protein polysilox ane copolymer, AMP-isostearoyl hydrolyzed collagen, alkylammonium 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