

Mucopolysaccharides for cosmetics

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The skin is composed of two distinct areas — the epidermis and the dermis. The epidermis consists of many layers of dead skin that are supported by the dermis. The dermis is a three-dimensional network of collagen fibers and elastin fibers surrounded by gel-like material called the ground substance.¹ This determines the stability of the skin.²

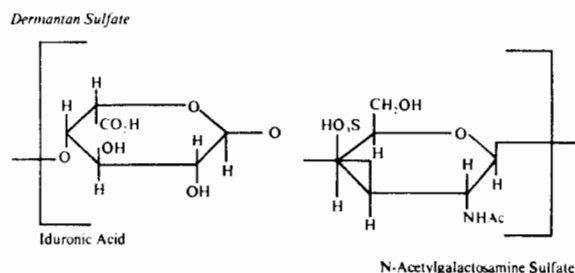
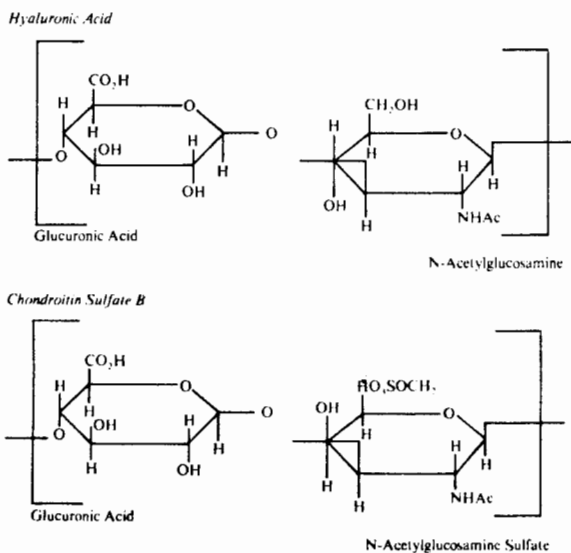
The dermis accounts for most qualities we consider cosmetic, i.e., the appearance of the skin. These include a moist, plump appearance and tautness. The aging process is therefore considered skin that is less taut, less moist, less plump, and in some areas, sagging along lines that are flexed (also known as wrinkles).² If a preparation could increase the turgor and firmness of the dermis, it would be a real "treatment" cosmetic.

We know that the ground substance is composed of mucopolysaccharides, noncollagen proteins, and water. Mucopolysaccharides are also known as glycosaminoglycans.

The purpose of this paper is to review the structure, formation, and role of these mucopolysaccharides as well as the benefits of applying hydrolyzed mucopolysaccharides to the skin.

Structure of Mucopolysaccharides

Mucopolysaccharides found in the dermis consist of hyaluronic acid, chondroitin sulfates, and dermatan sulfate. Their structures are as follows:³



Mucopolysaccharides are composed of hexosamines (on the right) and hexuronic acids (on the left). The molecular weight of hyaluronic acid is several million while that of chondroitin sulfate B and dermatan sulfate is about 40,000.⁴

The half life of hyaluronic acid is 2–4 days; that of chondroitin sulfate and dermatan sulfate is 7–10 days.⁵ This indicates that mucopolysaccharides turn over in the body very rapidly compared to collagen or elastin.

Production

Mucopolysaccharides are produced in the body by the well-known route from glucose (see Figure 1).⁵

During dermis aging, the amount of hyaluronic acid decreases from 70% to 30%, while chondroitin sulfate decreases from 20% to about 3%. This results in a parallel decrease in the water content as well as turgor of the dermis.⁵

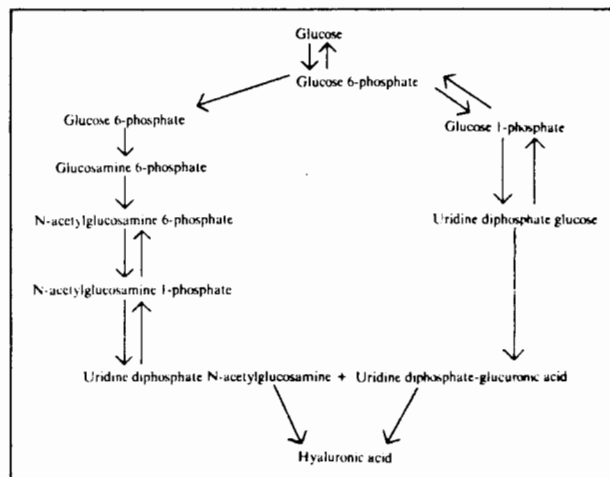


Figure 1: Production of mucopolysaccharides.

Role in the Dermis

Research into the role of mucopolysaccharides in the dermis is a relatively new field. In 1955, "the mention of mucopolysaccharides to collagen biochemists was likely to evoke a hurt or scornful reaction."⁶ We now know that the functions of mucopolysaccharides are very important.

The most important function of mucopolysaccharides is as a binding agent for water. Hyaluronic acid can bind from 5 ml/g up to 4 L/g.⁷ The gel-like structure of water with mucopolysaccharides fills the space between collagen fibers. This is essential for maintaining the proper degree of turgor pressure and plasticity of the tissue.⁸

The structure of mucopolysaccharides also allows them to regulate the water content of connective tissues, restrict other solutes, and act as a sieve for passage of large molecules.⁸ The anionic nature of these polymers also enables them to function as ion-exchange regulators.

Hyaluronic acid seems to be most often located in the inter-fibrous collagen network.⁴ Dermatan sulfate is more often associated with collagen fibers.⁴

The other major function of mucopolysaccharides involves their relation to collagen. Mucopolysaccharides restrict the conversion of soluble collagen to insoluble collagen.⁴ On aging, the ratio of mucopolysaccharides to collagen decreases.⁸ Mucopolysaccharides also function as lubricants for collagen fibers.⁹

We know that the collagen fibers have a sheath of mucopolysaccharides surrounding them. When we reconstitute these fibers free of mucopolysaccharides, they are much more rigid.¹⁰ Dermatan sulfate has not been isolated from the dermis without causing collagen degradation. Finally, dermatan sulfate has been found to inhibit maturation of collagen into its insoluble form,⁸ thus increasing the amount of insoluble collagen degraded by "collagenase."

Studies of Cosmetic Applications

It is obvious from examining the role mucopolysaccharides play in the dermis that increasing or replacing the diminishing amounts present will yield skin with more moisture and more soluble collagen, and the collagen fibers will be more flexible. That is the goal of treatment cosmetics.

In one study, two groups of rats were treated with a solution of mucopolysaccharides and a blank saline solution. The results indicated that mucopolysaccharides had no effect on the skin of the rats.¹¹ This result was scientifically expected, since the molecular weight is high and penetration was not expected.

In the early 1960s, Laboratori Vevy, Inc., Genoa, Italy made commercially available a hydrolyzed mucopolysaccharide called Ialuramina (CTFA-adopted name: Hydrolyzed Mucopolysaccharide, abbreviated HMP). This precursor (the smallest mucopolysaccharide molecule) was developed for the purpose of permitting absorption of the metabolic precursor of mucopolysaccharides through the skin. Ialuramina is a 100% active white crystalline powder that is readily soluble in water. A 5% solution has a pH of 3.5-4.5 and a rotation after 1 hr of +86° (±0.5). It is nontoxic and nonsensitizing.

When HMPs were tested in a manner similar to the test run

for mucopolysaccharides, the results indicated rapid repair of induced ulcers.¹¹

A second study was performed with HMPs to see if they would stimulate the biosynthesis of mucopolysaccharides. This was done by radioactive tracing of HMPs in a cosmetic cream. The results showed the increase of mucopolysaccharides in the dermis, increased hydration of the dermis, and greater elasticity of the skin.¹²

Rialdi reported on a controlled study of the application to rats of a cosmetic cream containing HMPs.¹³ The study measured the following properties:

- Skin moisturization — measuring the water content of the skin
- Skin tropism — measuring the rapidity of cicatrization of a standard trauma
- Skin elasticity — measuring the tensile strength of the scar tissue of a standard trauma.

Thirty rats were treated twice daily with a cream containing HMPs, while thirty rats were treated using the same cream without HMPs. The rats were broken into three groups; and tests were run at 10-, 20-, and 30-day intervals. The results are listed below:

Moisturization:

$$\% \text{ increase H}_2\text{O} = \frac{\% \text{ H}_2\text{O treated} - \% \text{ H}_2\text{O control} \times 100}{\% \text{ H}_2\text{O control}}$$

- (1) after 10 days: +5%;
- (2) after 20 days: +7%;
- (3) after 30 days: +8%.

Tropism:

$$\% \text{ increase cicatrization} = \frac{\% \text{ cicat. treated} - \% \text{ cicat. control} \times 100}{\% \text{ cicat. control}}$$

- (1) 10 days: 23%;
- (2) 20 days: 30%;
- (3) 30 days: 35%.

Elasticity:

$$\% \text{ increase tensile strength} = \frac{F \text{ treated} - F \text{ control}}{F \text{ control}}$$

- (1) 10 days: 16%;
- (2) 20 days: 19.5%;
- (3) 30 days: 23%.

The second part of this study was done with 25 women. They applied the control cream once a day for 30 days, to the cheeks, backs of hands, and legs. They applied the control cream to one side and a blank to the other side. They were not aware of the contents of either cream.

After 30 days, the women were examined and evaluated by three dermatologists who also were unaware of the contents of the creams or which side was treated with which cream. They evaluated the women for four parameters: general appearance, moisturization, elasticity, and roughness. The results showed improvement from a minimum of 7.6% to a maximum of 41.2%, with the average being 25%. The dermatologists concluded that incorporating HMPs greatly improved overall appearance and moisturization and produced clearly positive results in improving elasticity and roughness.¹³

Recently, an independent testing company conducted another double-blind test to confirm these published results.¹⁴ Twenty women applied diluted solutions (0.375% and 1.0%

Table I: Moisturizing cream.

Ingredient	%	CTFA Name
A Xalifin 15	9.0	PEG-8 C ₁₂ -C ₁₈ alkyl ester
Nesatol	18.0	Glycerol Tri-C ₁₀ -C ₁₈ acids
Lipocerite	8.0	Tristearin
Undebenzofene	1.5	Phenoxyethoxyparaben (and) undecylenoyl PEG-5 paraben
Efadermasterolo	0.02	Unsaponifiable soya oil
B Idroramnosan	1.0	Isocetheth-10 stearate (and) isosteareth-10 stearate
Propylene glycol	6.0	
Isoxal H	1.2	
Water	45.0	
C Fragrance	0.04	Hydrolyzed mucopolysaccharides Soluble collagen
Ialuramina	0.3	
Collagenon	2.0	
Water	6.14	

Heat A and B to 65°C-70°C. Mix A into B with stirring. Homogenize 10 min, cool to 40°C. Dissolve in water, mix with Collagenon and fragrance. Add C to A and B at 40°C. Stir and cool.

Table II: Moisturizing tonic.

Ingredient	%	CTFA Name
Propylene glycol	12.5	Rose oil
Hydroessential rose	0.015	
Water	87.185	Glucamine Hydrolyzed mucopolysaccharides
Desomina	0.05	
Ialuramina	0.2	
Color	0.05	

Mix the hydroessential rose with the water using turboemulsifier until completion of solubility. Mix the remaining ingredients.

Table III: Moisturizing gel.

Ingredient	%	CTFA Name
Ialuramina	0.25	Hydrolyzed mucopolysaccharides
Hydroessential chamomile	0.01	Chamomile oil
Methyl paraben	0.1	Gelling agent
Liporamnosan	3.0	
Water	96.64	

Dissolve the hydroessential chamomile in the water with a turboemulsifier. Add the Ialuramina and methyl paraben and dissolve. Finally, add the Liporamnosan with stirring. Once the gel has formed, remove the air bubbles using a vacuum.

HMPs in combination with soluble collagen) twice daily for one- and two-week periods. The results showed HMPs "to be a very effective and indeed superior treatment for the skin."¹⁴

Formulations

Tables I-III are suggested formulations for using HMPs in cosmetics.

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