



Cosmeceutical: Hair Cosmeceuticals

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Abstract- The traditional and widespread hair care procedures that transiently or permanently affect these hair fiber features are then described in detail. When hair is often exposed to some particularly aggressive cosmetic treatments, hair fibers become damaged. The future of hair cosmetics, which are continuously evolving based on ongoing research, will be the development of more efficient and safer procedures according to consumers' needs and concerns. Hair cosmetics are an important tool that helps to increase patient's adherence to alopecia and scalp treatments. This article reviews the formulations and the mode of action of hair cosmetics: Shampoos, conditioners, hair straightening products, hair dyes and henna; regarding their prescription and safetiness. The dermatologist's knowledge of hair care products, their use, and their possible side effects can extend to an understanding of cosmetic resources and help dermatologists to better treat hair and scalp conditions according to the diversity of hair types and ethnicity.

Keywords- hair cosmeceuticals: introduction, hair care, hair structure, hair damage, Hair Cosmetic Treatments: Hair Cleansing and Hair Shape Modulation, shampoo, conditioner, herbal oil, Health and Hair Hazards of Hair Cleansing Procedures, Hair Strength.

Introduction- In healthy hair, the layers of the cuticle lie flat, overlap tightly and reflect light. The inner layers are then well protected from heat, sun, chlorine and other environmental stressors. When hair is damaged, the cuticles can be separated and hair may be dry. As the cuticles don't protect the two inner layers, hair can break and look dull.

Humans have direct control on their hair in terms of length, colour and style. Hair plays a significant role in people's physical appearance and self-perception. Problems with hair include oily hair, dandruff and hair loss (alopecia). Hair care includes caring for hair quality and scalp care. Hair cosmetics can be categorized into two, which are those that work on the exocuticle (shampoo, conditioners, serums, hair sprays, waxes, gels and mousses) and those that work on the cortex (hair colour, bleaching agents, straightening

and perming agents) and those that work on the cortex (hair colour, bleaching agents, straightening and perming agents)¹. Shampooing is the most frequent form of hair treatment. Current shampoo formulations contain ingredients that can treat specific problems. Extract of yarrow (*Azhyllum millefolium L*), has been used to treat oily hair. The extract contains less than 0.5% by weight of polyphenolic derivatives². New method or technology has been developed for improving the texture and softness of the hair. The use of glycine³, silicon oil in microemulsion preparation, and use of silicon oil-in-water nanoemulsion has been used to improve the texture, stability and strength of individual hair shaft. New hair cosmetic products have been developed to cleanse hair of detritus, improve cuticular and cortical function, reduce detangling and improve hair shine⁴. Recently, argan oil has been incorporated in hair cosmetics and become very popular in the market. Some oils can penetrate the hair and fill the gap between the cuticle cells and the oils can enhance lubrication of the shaft and protect hair from breakage⁴. In particular, Rhassoul clay has been discussed for hair care. A brief discussion has also been centered on the safety of these products with the related toxicological evaluation⁵.

Hair Care-

The cosmetic does not come under the preview of drug license. The herbal cosmetics are the preparations containing phytochemical from a variety of botanical sources, which influences the functions of skin and provide nutrients necessary for the healthy skin or hair⁶. For this purpose, hair products that improve the structural integrity of hair fibers and increase tensile strength are available, along with products that increase hair volume, reduce frizz, improve hair manageability, and stimulate new hair growth. Interestingly, modern cosmetic products are formulated to clean hair from detritus, and to restore and improve hair physiology. For example, intensive conditioning agents can temporarily “replace” the f-layer, improving the moisture retention in the cortex and rebuilding some of the reduced physical properties of hair. Therefore, the boost in hair shine is a key benefit of modern products⁷.

Hair Structure-

As described by Naizet, the hair is mainly constituted by three parts: the bulb, the root and the stem, and it is implanted in the pilosebaceous follicle in the dermis. The bulb is the deepest end of the hair and is also the portion that makes it grow. It is connected to the richly innervated and vascularized dermal papillae, which allow the contribution of nutrients necessary for hair growth. The root is firmly fixed in the hair follicle, the part of the hair located between the bulb and the surface of the epidermis where hair takes the form of the stem. The root and stem are made of the same three concentric layers: the medulla, the cortex and the cuticle on the outside (Figure 1). The medulla is the central core. The next stratum, the cortex, represents the largest and thickest part of the hair determining many of their mechanical properties⁸. Normal cuticles have a smooth appearance, allowing light reflection

and limiting friction between the hair shafts. Indeed, it is responsible for the hair luster and texture.

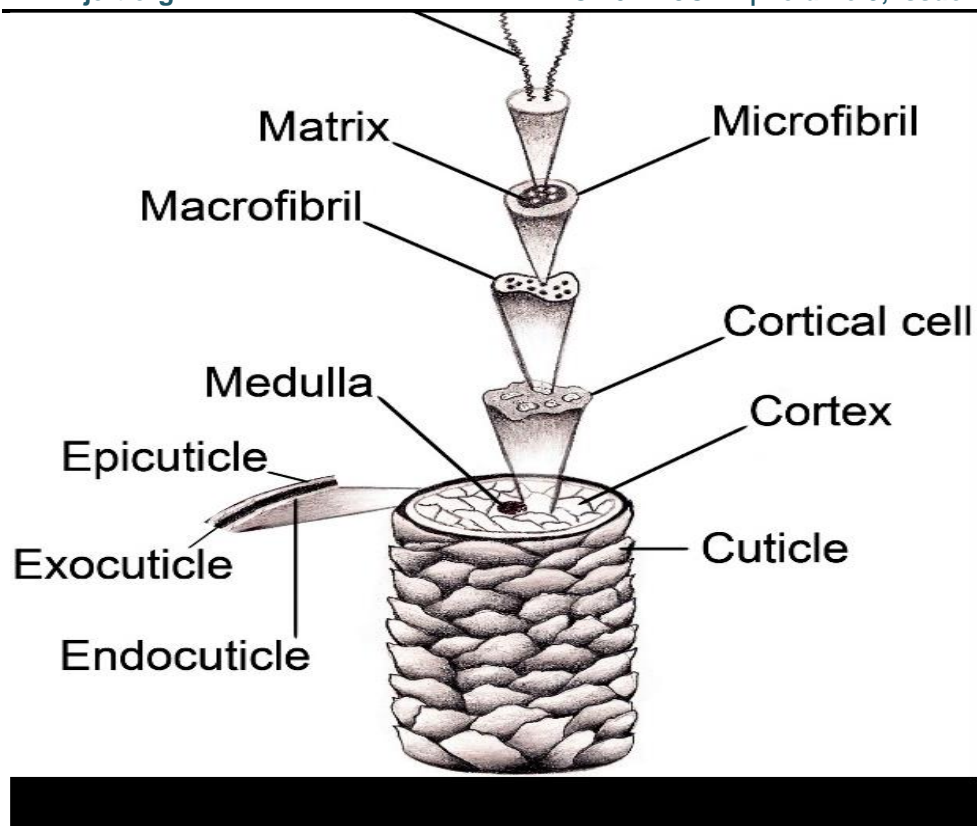


Figure 1. The hierarchical structure of hair

The combination of the outer hydrophobic layer with the cortex gives the physical properties of shine and volume (body), essential for the appearance of “healthy hair”. Indeed, if hair is damaged by frictional or chemical forces with the subsequent removal of the flayer, the first hydrophobic defense, the hair fiber becomes much more fragile [9]. It is useful to remember that hair fibers contain sulfur-rich proteins, lipids, water, melanin, and trace elements [9]. Keratin is the main component of the hair. It is a fibrous and resistant protein, whose aminoacidic chains are organized in an α helix and contains mainly tyrosine, glycine and cysteine. It is usually present as acidic, neutral and basic.

Hair damage-

The hydrophobicity of the hair is possible thanks to the 18-MEA lipid layer. Removal of this covalently linked fatty acid renders the fiber hydrophilic. When wet, virgin hair can be stretched by 30% of their original length without damage; however, irreversible changes occur when hair is stretched between 30% and 70%. Stretching to 80% causes fracture¹¹. Hair is porous and damaged hair is intensely so. Water absorption causes the hair shaft swelling. Excessive or repeated chemical treatment, grooming habits, and environmental exposure produce changes in hair texture and if extreme can result in hair breakage. These changes can be seen microscopically as “weathering” of the hair shaft and contribute to tangling, and frizzing. Weathering is the progressive degeneration from the root to the tip of the hair. Normal weathering is due to daily grooming practices. When the hair is extremely weathered and chemically treated, there may be scaling of the cuticle layers, removal of the 18-MEA and cuticle crack. If the cuticle is removed, the exposure of the cortex and further

cortex damage may lead to hair fiber fracture. The use of hair cosmetics may restore hair cuticle damage and prevent hair breakage by reducing friction and water pick up¹².

Hair Cosmetic Treatments: Hair Cleansing and Hair Shape Modulation-

Hair is one of the physical features easier to modify. Haircare industry has developed plenty products to provide beauty and modify some hair characteristics. In this review, we focus on hair cleansing products and cosmetic treatments that impact on hair shape (straightening and waving permanent procedures) and their influence on hair fiber health. Hair cleansing products were included in this review because, firstly, they are extensively used and they affect mainly the features of hair fiber surface (smoothness, shine, combability and hydrophobicity) and, secondly, they are also used in the finishing of hair shape chemical modifications to recover hair properties (pI, hydrophobicity besides the fiber surface features).

Shampoo-

The arrangement of the hair cuticles allows self-cleaning properties of the hair fibers, repelling by itself some dirt and greasy residues. However, with time accumulation of grease and dirt occurs and the hair needs to be cleaned. Shampoos' primary goal is to clean the hair and scalp of these residues. Nowadays, it is expected that shampoos have secondary benefits such as to prevent hair fiber damage, keep the hair aesthetically presentable, preserve its softness, combability and shine. These secondary functions are usually the reason to purchase a particular shampoo. Therefore, the most significant interactions for shampoos are the ones happening near the fiber surface and first few cuticle layers. Nonetheless, if the hair surface is damaged and the cortex exposed, shampoos interact also with the exposed cortex¹³.

A shampoo usually has an average of 80% water content and pH from 5 to 7. They are typically composed of 10 to 30 ingredients; that can be grouped into cleansing agents, conditioning agents, special care ingredients, additives, preservatives and aesthetic agents¹⁴.

Table 1. Shampoo formulation components [47,80,81,82].

Shampoo Components	Function	Example	
Cleaning agent (surfactant)	Anionic	Primary cleansing of the hair with improved removal of lipids	Soap
	Cationic	Provide softness to the hair and improves combability. Reduce hair static electricity	Quaternary ammonium salts
	Amphoteric	Mild cleansers, reduce the anionics tendency to adsorb onto proteins	Betaines, amphotacetates
	Non-ionic	Improves hair manageability. Provide dispersing, emulsifying and detergent properties	Ethoxylated fatty alcohols, tweens, alkyl polyglucosides,
Conditioning agent	Imparts softness and gloss, reduce flyaway and enhance disentangling facility	-	
Special Care ingredients	Treat specific hair or scalp conditions, such as dandruff and greasy hair, dermatitis, seborrhea, alopecia, psoriasis	-	
Additives	Contribute to the stability and comfort of the product, adjust pH and viscosity	Foam stabilizers, chelating agents, viscosity builders (gum, salt, amide)	
Preservatives	Reduce possible microbial contamination	-	
Aesthetic agents	Provide aesthetic to the shampoo, either color or fragrance	Fragrance, colorants, pearlescent or opacifiers agents	

Table 1. Shampoo formulation components

Among commercial shampoos, besides “normal” cleaning and conditioning hair shampoo, there are “specific” shampoos that have additional functional ingredients considering some hair problems. Indeed, nowadays, shampoo is well beyond the stage of pure cleaning agents of the hair. In detail, these “specific” shampoos contain antibacterial agents, natural essential oils or extracts for treating dandruff, dermatitis and other hair diseases¹⁵. Since the scalp is considered as the most absorbent part of the body, the applied cosmetic products go directly into the blood. Therefore, it is very important to know the effects of ingredients used in shampoo formulations. In the work of Zhang et al., due to the multitude of purposes of these hair care products, ingredients with many effects on hair are listed. In particular, a typical shampoo usually contains a mix of primary and secondary surfactants for cleaning, viscosity builders, solvents, conditioning agents, pH adjusters and other components such as fragrance and, eventually, color for commercial appeal¹⁶.

- Cationic surfactants have a positively charged hydrophilic end are used mainly as conditioners, being able to balance hair negative charges after washing, reducing frizz. Indeed, they are efficient softeners and substantive for hair because of the hair's low isoelectric point (pH 2.1).
- Amphoteric surfactants, such as betaines and amphoteric acetates, reduce the anionic tendency to adsorb onto proteins. They are mild cleansers, leave the hair manageable but do not irritate the eyes. Hence, they are usually combined with other surfactants of mild shampoos to modulate cleansing efficiency.
- Nonionics, such as ethoxylated fatty alcohols, tweens and alkyl polyglucosides, are the mildest surfactants. They are not so effective at removing dirt and sebum but leave the hair more manageable. They have good dispersing, emulsifying and detergent properties but poor foaming capacity. Consequently, they are usually auxiliary cleansing agents¹⁷.

Conditioner-

The ideal conditioner is capable of restore the hydrophobicity of the fiber and neutralize the static electricity. Depending on the capacity of entering the fiber, the conditioner may reach the cuticle surface or the inner part of the cortex. Smaller molecules can reach the cortex. Larger ones act on the cuticle. Low molecular weight polypeptides (<10.000 Da) can diffuse into hair. Bigger molecules (500.000 Da) can diffuse into the cuticle, especially on bleached hair. The preferred route is intercellular diffusion or diffusion through the nonkeratin regions, although intracellular diffusion may also occur. Higher molecule weight polymers (<600.000 Da) may sorption on the surface of the hair shaft. Cationic ingredients such as cationic polymers are very popular in hair products. They can be so substantive to the hair that they can be difficult to remove. They are highly substantive to hair because of the hair's low isoelectric point (pH - 3.67). Any cosmetic with higher pH bears a net negative charge on the hair surface, and therefore cationic charges (positive) are attracted to it¹⁸.

Conditioners are usually emulsions of oil or wax in water, with a cationic charge. Conditioners usually contain polymers, oils or waxes, cationic agents, additives, preservatives and aesthetic agents. Some cationic molecules are also combined with bridging agents to enhance the adsorption of hydrophobic ingredients to the hair. Conditioners may include UV filters for color protection. The most frequently used hair conditioners are based primarily on cationic surfactants with additives like silicones or cationic polymers. The most

used conditioner agent is silicone. Silicones may be of different types, having different deposition, adherence and wash out capacities. They spread over the hair surface and form a uniform, thin, hydrophobic layer that increases luster and gloss and reduce the combing force¹⁹.

Functions of the conditioners are:

- Improve combability
- Mimetize the hair natural lipid outer layer: 18-MEA
- Restore hydrophobicity
- Seal the cuticle
- Avoid or minimize frizz, friction: Neutralize the negative charged net
- Enhance shine, smoothness and manageability.

Herbal Oil-

Amla: Amla is the name given to the fruit of a small leafy tree (*Emblica Officinalis*), which grows throughout India and yields an characteristics. There are mainly four species of roses for oil production. These are *Rosa damascena* Mill., *R. gallica* L., *R. moschata* Herrm. and *R. centifolia* L. Rose oil and rose water have many therapeutic effects. Rose oil helps soothe the mind and heals depression hair, minimize frizz and improve combability. It also helps to heal wound and skin health.

Eucalyptus oil: There are around 700 different species of Eucalyptus in the world, of which at least 500 produceatypoeffessential oil. It is produced by steam distillation from the leaves of Eucalyptus species (*E. cinerea* F. Muell., *E. baueriana* F. Muell., *E. smithii* R. T. Baker, *E. bridgesiana* R. T. Baker, *E. microtheca* F. Muell., *E. foecunda* Schau., *E. pulverulenta* Sims, *E. propinqua* Deane and Maiden, *E. erythrocorys* F. Muell.) etc. They are widely used in the preparation of liniments, inhalants, antimicrobial, antifungal, herbicidal properties and also as pharmaceutical flavors. The European Pharmacopoeia monograph for Eucalyptus oil sports a chromatographic profile: 1,8-cineole (eucalyptol; not less than70%), limonene (4- 12%), α -pinene (2-8%), α - phellandrene (less than 1.5%), β -pinene (less than 0.5%), camphor (less than 0.1%). Eucalyptus oil to apply to hair suggest that it: stimulates hair follicles & Improves hair health.

Almond Oil: The almond oil is obtained from *Prunus dulcis*. The almond oil basically contains about 78% of this fat. This oil contains very small amounts of super-unsaturated Omega-3 essential fatty acids. It proves to be very nourishing, and softens and strengthens the hair. The almond oil also proves to be a very good cleansing agent. Almond oil has been used for many centuries, even before it's spread as a commercial agro-product²⁰.

Health and Hair Hazards of Hair Cleansing Procedures

Shampoos and hair conditioners are usually perceived as products that do not damage hair. However, there is evidence indicating these products may contribute to hair damage through abrasive or erosive actions. They may result in the degradation of the non-keratinous components of the endocuticle and CMC. Regarding scalp, shampoos are not a frequent cause of irritant or allergic contact dermatitis due to their short contact time with the skin. Shampoo's components, such as anionic surfactants can still contribute to xerosis and eczematous dermatoses due to the ability to remove sebum. Common allergens in shampoos are: cocamidopropyl betaine, formaldehyde-releasing preservatives, methylchloroisothiazolinone, propylene glycol, vitamin E (tocopherol), parabens and benzophenones²¹.

Hair Strength-

Patients want their hair to be resistant to breakage with no split ends. Hair strength is a mix of hair body mass and resistance to breakage. A strong hair is a hair with its full capacity of growing healthy in both diameter and length and an intact cuticle and cortex. Also, highly oxidized cortex cell membrane by free radical chemistry is more susceptible to split. Hair treated with free radical cosmetics and exposed to sunlight is susceptible to splitting. Also, hair body is maybe defined as the structural strength and resiliency of a hair mass, sensed by patients as having a soft and firm touch and full volume. Full volume is meaning a scalp full covered with terminal hair fibers that grow to the desired length without breaking²².

Hair Dyes-

Epidemiologically and human monitoring studies have not detected any risk of carcinogenicity of the ingredients used nowadays. Contact dermatitis is the main reaction. Turati *et al.* meta-analysis definitively excluded any appreciable excess risk of bladder cancer among personal hair dye users²².

Conclusion-

Hair is a very distinctive personal feature playing a major role in self-perception. It is one of the physical features that can be easily changed in terms of length, color or shape. However, common chemical styling processes are also known to induce changes in hair cuticle and cortex, damaging the fiber and in some cases the health of the person or the hair care professional. The cosmetics industry has traditionally focused on the development of products or procedures for hair cleansing and to modulate the shape of hair fibers after their exit from the skin surface, as referred in this review. Due to the potential damage to the hair fiber caused by many traditional methods, mainly of hair shape modulation, there is increasing interest in understanding the genetic basis associated with hair shape, exploring whether hair appearance can be modified as the fiber is generated in the hair follicle. Studies on hair follicle biology and on the hair fiber, together with the development of improved formulation components, will be essential to develop new and safer hair cosmetics.

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