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Shampoos: Ingredients, efficacy and adverse effects

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- shampoo technology
- Surfactants
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- dandruff
- *Malassezia*
- anti-dandruff shampoo

Summary
Shampoos are the most frequently prescribed treatment for the hair and scalp. The different qualities demanded from a shampoo go beyond cleansing. A cosmetic benefit is expected, and the shampoo has to be tailored to variations associated with hair quality, age, hair care habits, and specific problems related to the condition of the scalp. The reciprocal relationship between cosmetic technology and medical therapy is reflected in the advances of shampoo formulation that has made applications possible that combine benefits of cosmetic hair care products with efficacy of medicinal products. A shampoo is composed of 10 to 30 ingredients: cleansing agents (surfactants), conditioning agents, special care ingredients, and additives. Since the cleansing activity depends on the type and amount of surfactants utilized, shampoos are composed of a blend of different surfactants, depending on the requirements of the individual hair type. Development time from the concept to the commercial shampoo may take longer than a year. Much effort is invested in the development of conditioning agents, which impart luster, smoothness, volume and buoyancy. Another prerequisite is a scalp free of scaling. Current anti-dandruff agents primarily have an antimicrobial mode of action, and inhibit growth of *Malassezia spp*. Recent developments in shampoo technology have led to increased efficacy of anti-dandruff agents, allowing shorter contact time, and reducing irritation.

Introduction

Shampoo treatments are the most commonly used means of managing hair and scalp conditions. Until the introduction of the first non-alkaline shampoos in 1933, soap was the only available cleanser for the hair [1]. Modern shampoos are expected to be much more than mere cleansing agents. They are expected to not dry out the hair; to produce lather in hard and soft water and when applied to oily hair; to be non-irritating to skin and mucous membranes; to be chemically and physically stable; to possess conditioning benefits; to be biodegradable; and affordable. A shampoo is expected to improve the hair cosmetically while being tailored to the needs of various hair types as well as age and individual habits; at the same time it should have a positive effect on specific problems involving the hair and scalp [2]. Shampoos have thus evolved into high-tech products consisting of 10 to 30 ingredients [3–5] (Figure 1) that are combined in precise formulations to meet consumer demands. Ingredients include:

- Detergents, i.e., surfactants
- Conditioning and active ingredients for hair manageability
- Additives that modify the surfactant effect (viscosity control agents, foam stabilizers), stabilize the product (preservatives), and increase its appeal (fragrances, dyes, and ingredients for consistency and a pearlescent appearance).

It can take more than a year from the initial planning phase to a saleable product. More effort is being invested in conditioners which are designed to give the hair a more healthy appearance, making it shiny and smooth while increasing volume and resilience. Scalp condition is another important factor in individual health and well-being; the scalp should neither be oily nor should dandruff develop.

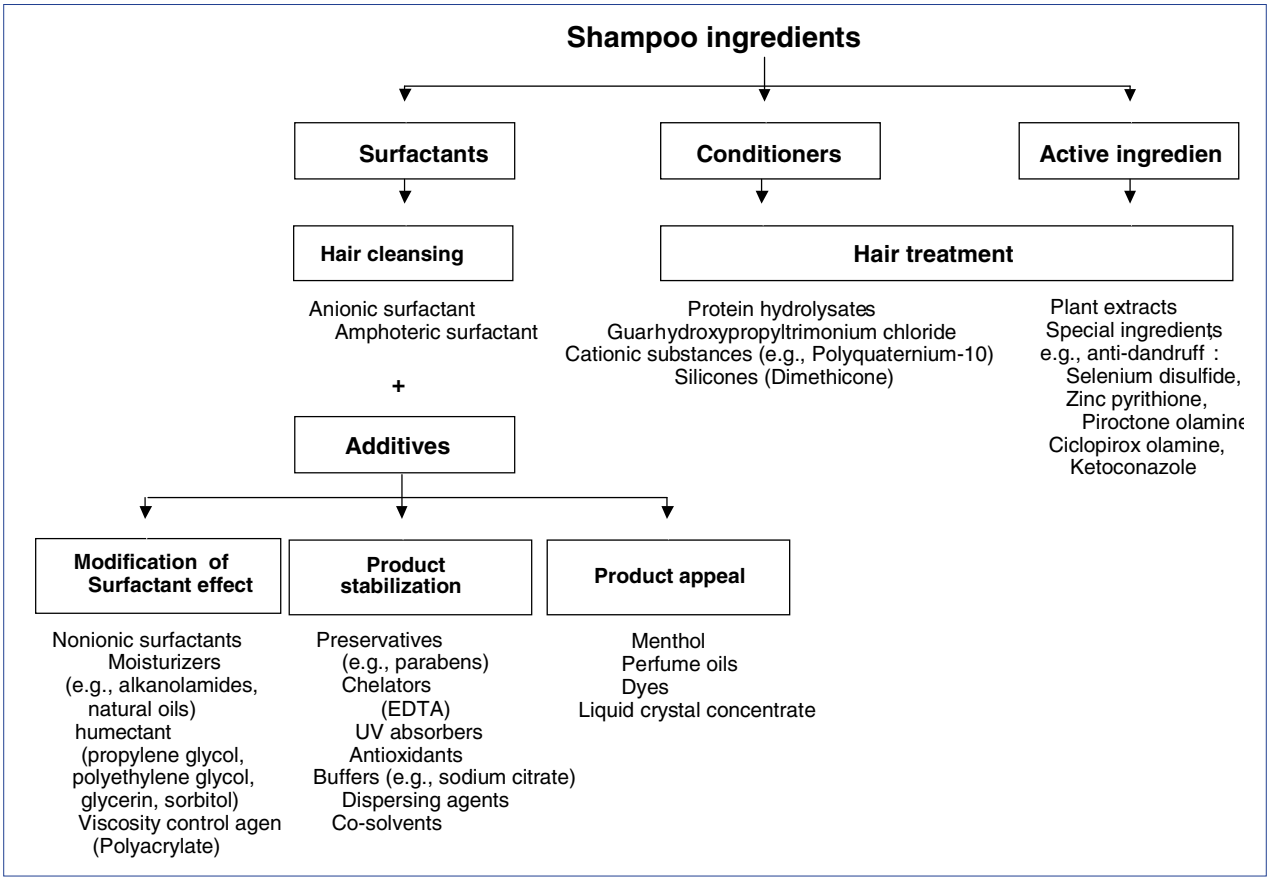

Figure 1: Shampoo ingredients.

The most important effects of shampoo on the hair are:

- moisturizing
- adsorption and/or penetration of the hair
- cleansing, removal of oils, lipid regeneration.

The following effects of shampoo influence scalp condition:

- restoration of alkali neutralization ability (pH)
- dryness
- seborrhea
- scalp bacteria (*Malassezia spp., Propionibacterium spp.*)
- enzyme activity of the scalp
- scalp circulation

Shampoo surfactants

The cleansing ability of a shampoo depends on the surface activity of its detergents. Surface-active ingredients, or surfactants, facilitate the removal of environmental dirt by reducing surface tension between water and dirt; dirt is suspended in the water phase and adsorption prevented. This is achieved by a special molecular structure consisting of a hydrophilic and a lipophilic group. Sebum and dirt are bound and surrounded at the center of a micelle structure with the hydrophilic molecule ends pointing outward. Dirt particles become water-soluble and can be removed from the hair shaft [3].

Surfactants are classified according to hydrophilic polar group as anionic, cationic, amphoteric (zwitterionic) and nonionic [3].

The cleansing ability of a shampoo depends on how well it removes grease as well as the type and amount of surfactants used. Various surfactants are used in shampoos in order to accommodate different hair types. In most products, the shampoo base consists of anionic and amphoteric surfactants. Depending on individual product requirements, nonionic and cationic surfactants are added to modify the effects of the surfactants or as conditioning agents for hair with surface damage [3].

Anionic surfactants

Anionic surfactants are characterized by a negatively-charged hydrophilic polar group. Well into the 20th century, natural soaps were the most commonly used anionic hair cleansing substances. Soap consists of salts that are extracted from naturally-occurring animal or vegetable fatty acids. Synthetic surfactants have now replaced soap as a hair cleanser. Because soap is sensitive to hard water, it leaves insoluble salts on the hair, forming a film which causes a dull look. Soap's alkaline pH can make it irritating to the skin and mucous membranes.

The first shampoos introduced on the market in 1933 were alkyl sulfate surfactants [1]. These were still sensitive to hard water and were not adequately tolerated by the skin. They have since been replaced by sodium alkyl ether sulfates which are now the leading surfactants. These are superior with regard to sensitivity to water hardness as well as skin and mucous membrane tolerability and are virtually the only surfactants that are can also be used alone in a shampoo as raw ingredients.

The best known anionic surfactants are sulfated fatty alcohols, alkyl sulfates, and their polyethoxylated analogues, alkyl

ether sulfates. They possess an outstanding cleansing ability and produce rich lather. A number of anionic surfactants such as alkyl ether carboxylate, acyl peptides, alkyl sulfosuccinate, and olefin sulfonate, which are well tolerated by the skin, and are used together with other anionic and amphoteric surfactants to optimize shampoo properties [3].

Amphoteric surfactants

Amphoteric (zwitterionic) surfactants contain both negatively and positively charged hydrophilic polar groups. At low pH values they behave as cationic agents and at higher pH values as anionic agents, and are thus classified between cationic and anionic surfactants. Amphoteric surfactants form complexes with anionic surfactants and reduce their tendency to attach to proteins. In combination with anionic surfactants, amphoteric surfactants are mainly used to optimize anionic-based shampoos: amphoteric acetates/diacetates in particular demonstrate excellent skin and mucous membrane tolerability, have a conditioning benefit on the hair, and are suitable for use in mild shampoos [3].

Examples include betaine, sulfonate betaine, amphoteric acetate/diacetate.

Nonionic surfactants

Nonionic surfactants differ from other surfactants in that they do not possess a charged polar group and are hence compatible with all other surfactants. They are also among the mildest form of surfactant; they make good cleansers with dispersion and emulsification properties, but lather poorly. In combination with alkyl ether sulfates or amphoteric surfactants, they serve to enhance tolerability in very mild cleansers such as baby shampoos [3].

Examples of nonionic surfactants are fatty alcohol ethoxylates, sorbitan ether esters, and alkyl polyglucosides.

Cationic surfactants

Cationic surfactants are quaternary ammonium compounds which are characterized by a positively-charged hydrophilic polar group.

Given its amino acid structure, the keratin found in human hair has an excess of negatively-charged acid groups. The positively-charged quaternary ammonium compounds of cationic surfactants thus attach by salt bonds to the negatively-charged hair and remain after rinsing. Due to its high level of cysteine, damaged hair contains a higher number of negatively-charged acid groups and thus absorbs more quaternary ammonium compounds than intact hair [3]. Because of this quality, quaternary ammonium compounds are used as conditioning agents for damaged hair. Although they make hair easier to comb and manage, and they have anti-static properties, they are poor cleansers and do not lather well. They are also potentially strong irritants, and are thus only used with less irritating nonionic surfactants in shampoos designed for chemically-treated or very dry hair. Their incompatibility with anionic surfactants limits their use in other shampoo formulations [3].

Additives

Shampoo products are also expected to possess stability and to have an appealing quality, making the use of a number of additives necessary.

Modification of surfactant effects

In addition to selection and combination of surfactants, additives also help reduce skin irritation. Moisturizers and humectant, for instance, are added to make the hair silkier. Moisturizers include natural oils, fatty acid esters, and alkanolamides; humectant include propylene glycol, polyethylene glycol, glycerin, sorbitol, and lactate [3].

Shampoo stabilization

Ensuring shampoo stability requires the use of preservatives to protect against bacterial contamination (organic acids and their derivatives, e.g., parahydroxybenzoic acid ester, salicylic and sorbic acid; methylparaben; formaldehyde releasers, e.g., DMDM hydantoin); UV absorbers to stabilize dyes against light (benzophenone derivatives); antioxidants to protect oxidation-sensitive substances (ascorbic acid, α-tocopherol, butyl hydroxyanisole); buffers to ensure pH stability (citrate, lactate, and phosphate buffers); co-solvents to keep conditioning oils and fragrances clear in solution; and dispersing agents to keep otherwise insoluble agents, such as silicone oils and anti-dandruff agents, in suspension (polyvinylpyrrolidone) [3].

Enhancement of product appeal

The attractiveness of a shampoo is enhanced by fragrances, dyes, and special ingredients that give it a pearlescent appearance. Fragrance oils cover up the typically fatty odor of the shampoo base and lend the product and individual, pleasant-smelling scent. An appealing fragrance also helps promote regular use of the product. Dyes and liquid crystal concentrates give the shampoo a pearlescent and more "concentrated" appearance. Liquid crystal concentrates also contribute to its moisturizing effect. They usually consist of insoluble crystal particles made up of fatty acid esters of polyols and alkanolamide derivatives of fatty acids that reflect light [3].

Conditioners

Depending on hair length and exogenous factors, the distal end of the continually growing hair shaft exhibits increasing signs of damage that can involve cuticle damage and secondary destruction of the cortex (Figure 2a–c) [6]. Damage is mainly due to mechanical stresses caused by combing, brushing and teasing as well as the effects of UV rays and unavoidable structural alterations arising from chemical treatments such as permanent hair waving and coloring [6].

Along with ultrastructural changes to the hair shaft, there are measurable changes in biophysical parameters of the hair fibers, e.g., tensile-stretch properties and durability, as well as depletion of specific amino acids in the hair shaft, specifically, methionine (–50 %), tryptophan (–50 %), cystine (–20 %), histidine (–20 %), tyrosine (–10 %) and lysine (–10 %) [7].

The aim of conditioning agents in a shampoo is to maintain the natural condition of newly grown hairs for as long as possible. Virtually all standard shampoos used today contain conditioning agents. Damaged hair can, of course, not be restored to the condition of healthy, newly growing hair, and more than a reparative effect cannot be expected. Nonetheless, it is possible to increase shine and make hair more manageable and easier to comb by using a shampoo with a high proportion of conditioning agents, i.e., the "conditioner effect" [3, 4].

Conditioning agents include fatty substances such as vegetable oils, wax, lecithin and lanolin derivatives, protein hydrolysates (collagen, silk, animal proteins), quaternary ammonium compounds and silicones. There is increasing use of cationic polymers in place of

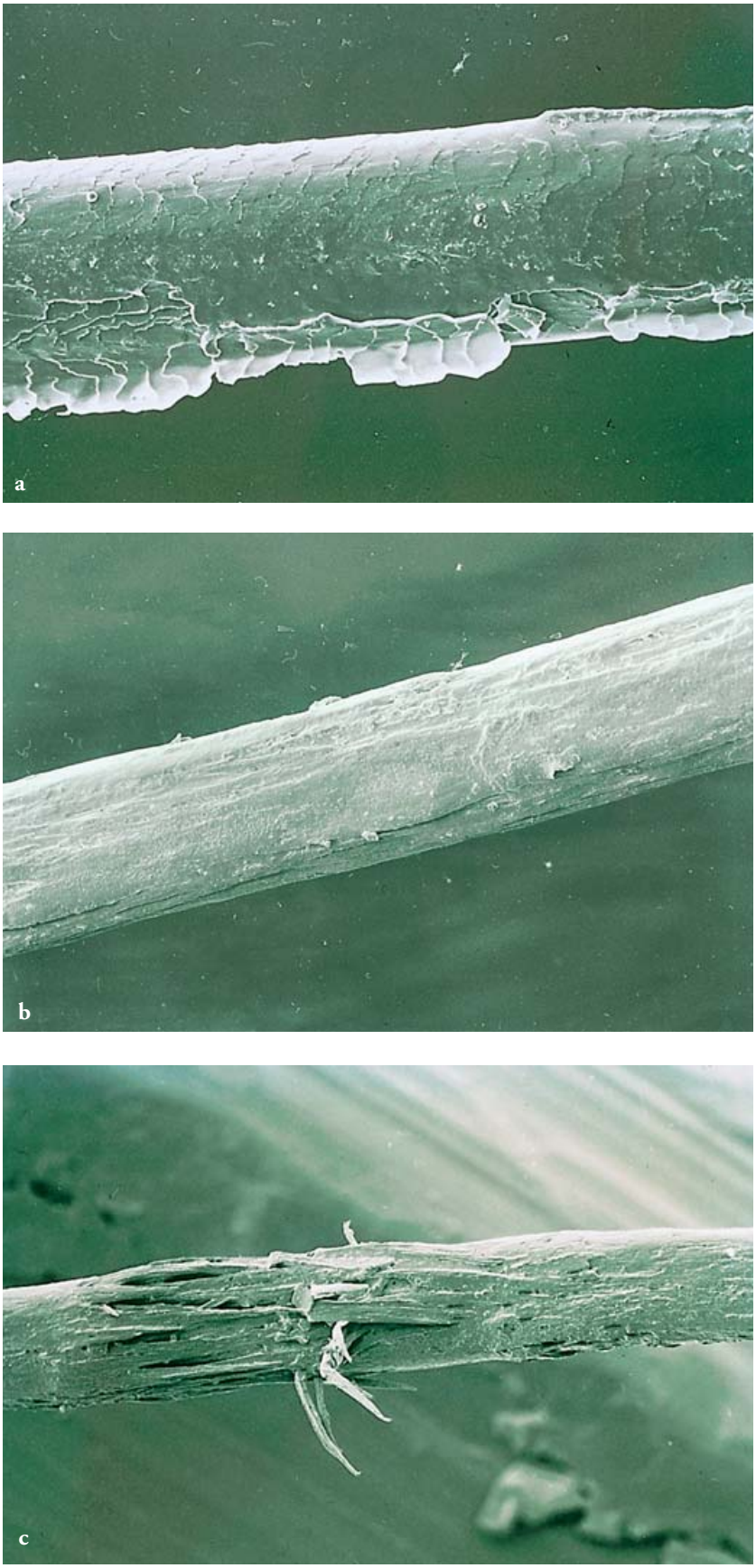

Figure 2: Raised hair cuticle (a), complete loss of hair cuticle (b), loosening of intercellular cement with initial transverse fracture in the fiber (c). From: Trüeb R M. Haare. Praxis der Trichologie. Steinkopff, Darmstadt, 2003.

monomer quaternary ammonium compounds, in which the cationic groups are integrated in a polymer structure, e.g., polyquaternium-10 and polyquaternium-16 as well as guar hydroxypropyltrimonium chloride [3]. These adhere more firmly to the hair than monomer bonds and leave a film that coats the surface of the hair fiber, making it appear to be soft and smooth while improving shine and color by altering the refractive index. In addition to their use in conditioners, these cationic polymer finishing agents have become a main component of 2-in-1 shampoos which combine cleansing and conditioning [8]. The amount used must correspond to the condition of the hair since these agents have a high affinity for the hair and with repeated use can build up on the hair shaft. Excessive conditioning can make hair less manageable and appear oily [3, 4]. In addition to cationic polymer finishing agents, silicones are also used, especially dimethicone, which is added along with special dispersing agents to a shampoo base containing a relatively high proportion of surfactants [4]. The strong conditioning effect occurs as a result of extremely fine dimethicone droplets being deposited on the hair as the shampoo is diluted during washing. Silicone has a similar effect to that of fats and oils, but without weighing the hair down. Silicones add lubricity and reduce friction that arises from combing, making the hair easier to comb and style, and thus also preventing damage. They also give the hair anti-static properties that prevent it from becoming frizzy.

Active ingredients

Active ingredients are added to shampoos for the management of specific problems affecting the scalp such as mild dandruff, seborrhea, seborrheic dermatitis, and psoriasis [5]. The spectrum of active ingredients is broad and encompasses various classes of substances, depending on indications for use; newer, scientifically proven anti-dandruff ingredients including selenium disulfide, zinc pyrithione [9], piroctone olamine [10], ketoconazole [11, 12], and ciclopirox olamine [13, 14] are used alongside traditionally-used substances derived from natural sources, e.g., plant extracts.

Anti-dandruff shampoos

One study with 1 000 men reported that 18 % of respondents had mild dandruff

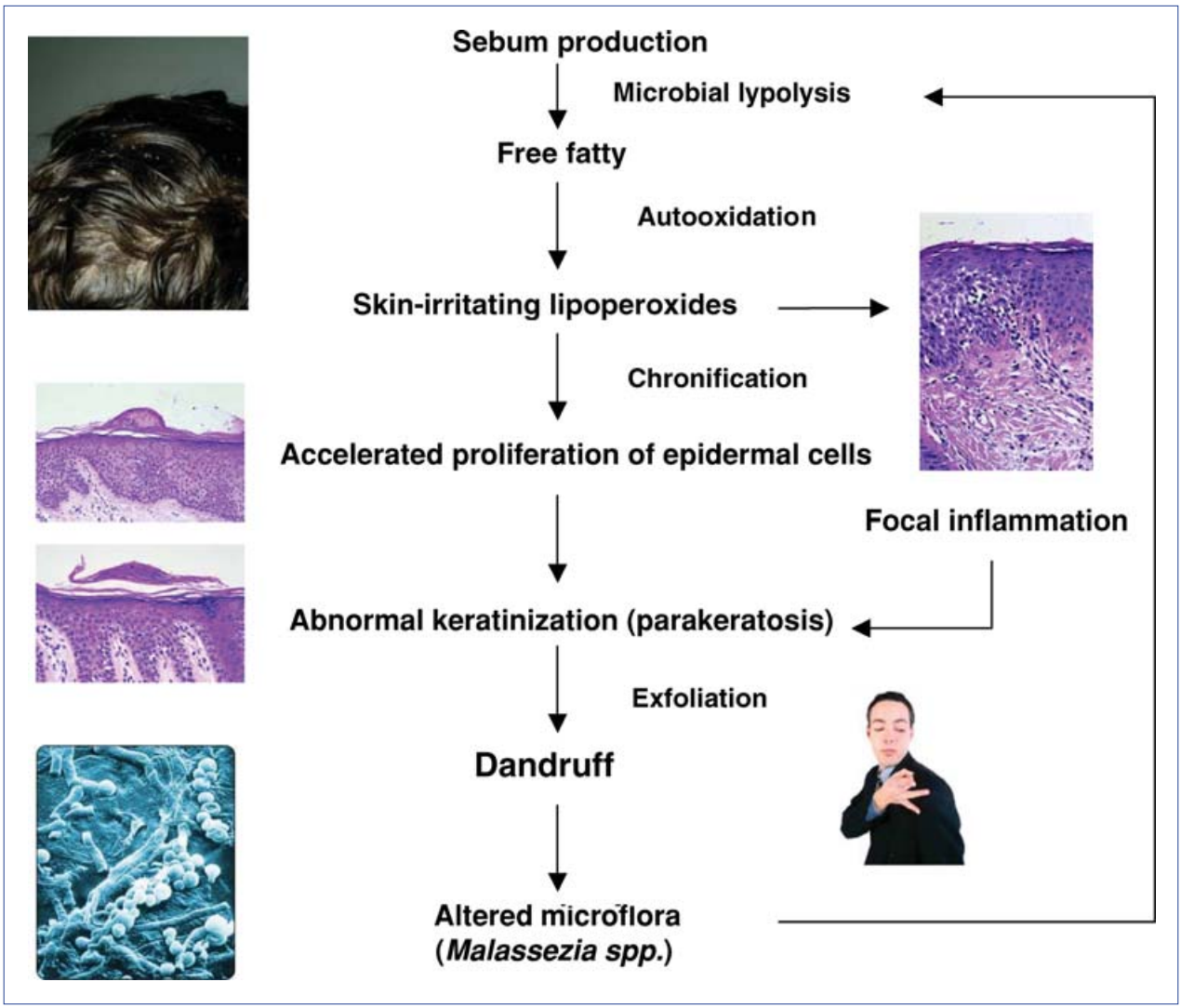

Figure 3: Pathogenesis of dandruff.

and 4.5 % severe dandruff [15]. In a smaller study with 500 students, 70 % reported having dandruff [16]. Specific anatomic features of the scalp skin, such as the large number of terminal hair follicles and the enlarged epidermal surface due to numerous hair canals, contribute to a higher rate of exfoliation; even a healthy scalp will develop dandruff within one or two weeks if the hair is not washed. Pathological dandruff results from accelerated proliferation of epidermal cells and thus increased exfoliation of variously large collections of abnormally keratinizing epidermal cells [17]. This leads to breakdown of the normal columnar structure of the stratum corneum [18] and increased formation of cell aggregates which determine the size of the flakes. The process results from focal inflammation of the scalp with parakeratosis which causes abnormal exfoliation and an altered light refractive index of the keratinized cell aggregates (Figure 3). The clinical appearance of dandruff is determined by the size, adherence, and light refractive characteristics of the flakes. Among the factors that lead to inflamed patches on the scalp are physical/chemical stimuli, microbial colonization, and sebum production and composition. The lipophilic yeast *Malassezia spp.* normally inhabits the scalp, making up about 45 % of its resident microflora. In patients with dandruff, it is the predominant yeast type with about 75 % and in patients with seborrheic eczema 83 % [19]. Modern classification and nomenclature of *Malassezia spp.* is based on DNA typing. The most common types found on the scalp are *M. restricta* and *M. globosa*, the latter of which in particular has a major role in the development of dandruff given its high level of lipase activity.

Dandruff can be divided by clinical appearance into simple dandruff (Pityriasis simplex), oily dandruff (Pityriasis steatoides), and asbestos-like scales (Pityriasis amiantacea) (Figure 4a–c).

Pityriasis simplex [20] typically occurs with dry skin as a result of atopic dermatitis or age-related dry skin. It can be caused by excessive hair-cleansing or the use of a shampoo designed for oily hair. Typical findings include dry, bran-like scales, and patients often complain of itching. Most authors cite the co-existence of overgrowth of *Malassezia spp.* in pityriasis simplex as evidence of its role in pathogenesis [21].

Pityriasis steatoides is associated with seborrhea of the scalp. It often occurs with inadequate personal hygiene and *Malassezia spp.* is widely believed to be involved in pathogenesis [22]. Firmly adherent, oily, bran-like scales are found,

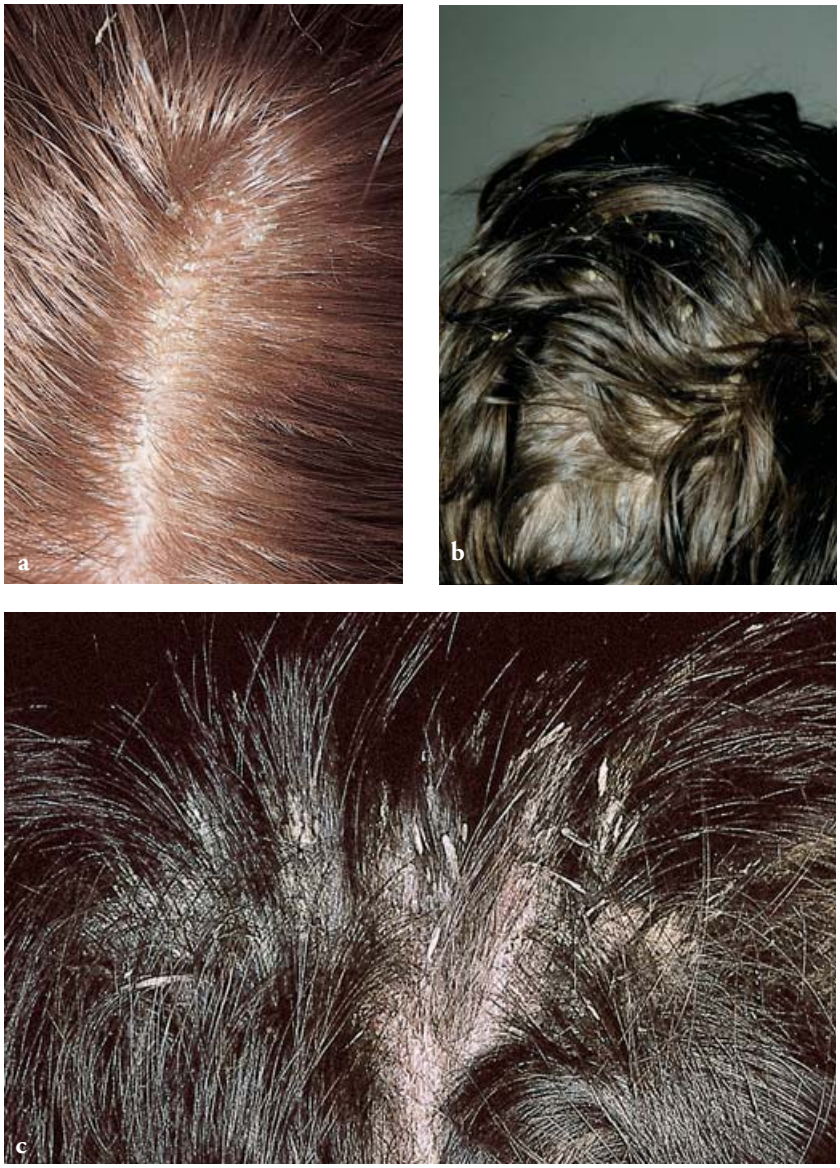

Figure 4: Pityriasis simplex (a), Pityriasis steatoides (b), Pityriasis amiantacea (c). From: Trüeb R M. Haare. Praxis der Trichologie. Steinkopff, Darmstadt, 2003.

often on the anterior hairline, external ear, preauricular area, and around the eyes.

Pityriasis amiantacea [23] frequently occurs as an idiopathic disorder in girls, but can also be related to lacking personal hygiene. It presents with well-circumscribed areas of thick, asbestos-like, firmly-attached scales with focal hair loss and no itching. Concomitant postauricular skin cracks are typical.

Specific dermatological disease such as eczema, psoriasis, tinea capitis, and pemphigus foliaceus should be excluded and other pathogenetic factors should be considered and appropriately addressed in the treatment plan. These include physical/chemical environmental influences, abnormal sebum production, microbial colonization, and psychological stress with lowered immune resistance.

Medicated shampoos containing anti-dandruff ingredients are essential in treating dandruff and exfoliative scalp disorders such as seborrheic eczema and psoriasis. The choice and frequency of shampooing are determined by the underlying cause, i.e., dry skin or seborrhea. Patients with dry skin should be advised to wash their hair less frequently and avoid using oily hair shampoos; for pityriasis steatoides, on the contrary, daily hair cleansing alone can lead to improvement.

The following agents are used in the treatment of dandruff:

- agents that inhibit overproduction of keratinizing cells, e.g., coal tar [24] (now banned in Germany for use in cosmetic shampoos) and ammonium bituminosulfonate (pale sulfonated shale oil as a coal tar substitute);
- keratolytic agents that break down cell aggregations, e.g., colloidal sulfur and salicylic acids [25];
- antimicrobial agents that inhibit *Malassezia spp*. yeasts [26], e.g., selenium disulfide, zinc pyrithione, piroctone olamine, ketoconazole, and ciclopirox olamine;
- combinations of these substances.

Zinc pyrithione demonstrates a strong anti-dandruff effect with a low potential for irritation or sensitization. Clinical studies have shown it to be superior to coal tar, selenium disulfide, and piroctone olamine. In one study the effect of 2 % ketoconazole was better and longer-lasting than 1 % zinc pyrithione [27], but improving shampoo formulation can increase the effectiveness of anti-dandruff agents [28]. In particular, the effectiveness of zinc pyrithione could be significantly improved with the use of micronized ingredients, especially given the legal maximum of 1 %. The zinc pyrithione molecule is present as a crystalline suspension in glycol distearate and is not water soluble. The formulation allows even distribution of zinc pyrithione crystals in shampoo and the use of non-spherical crystals measuring only 2.5 μm allows better adsorption and more even distribution on the scalp. This is particularly effective in inhibiting *Malassezia spp*. yeasts, even with a short contact time and rinsing. The combination of zinc pyrithione with zinc carbonate leads to reduced dissociation of the active ingredients into zinc and pyrithione, which alone have a lower anti-dandruff effect [29–31].

In scalp disorders that involve scaling, especially scalp psoriasis, the use of a medicated shampoo is a valuable supplement to topical corticosteroid therapy. 0.05 % clobetasol propionate has recently become available in short-contact shampoo formulations for scalp psoriasis [32]. It presents a superior alternative to coal tar shampoo in terms of efficacy and product appeal [33] and results have shown that it does not produce unwanted corticosteroid effects on the skin, adrenal axis, or eyes [34].

Medicated shampoos for managing seborrhea dermatitis of the scalp

A significant improvement in seborrhea generally cannot be achieved with over-

the-counter shampoos. Coal tar, which reduces sebum production, is virtually the only effective active ingredient in medicated shampoos [35]. Ammonium bituminosulfonate (ichthammol) is comparatively ineffective. Other options include a reduction in lipids and microbial lipolysis. To maintain volume, the surface of the hair must be prevented from becoming too smooth and to avoid lipolytic or peroxidative transformation of scalp or hair lipids, antimicrobial substances are used. This is usually achieved with a mild, generally anionic surfactant base consisting of effective cleansing substances with low substantivity [3]. Inhibition of microbial lipolysis can also be achieved by the surfactants forming the shampoo base. Antimicrobial agents that are effective against *Malassezia spp.* are suited for use in seborrhea and dandruff. Selenium disulfide is contraindicated since it increases sebaceous gland excretion [36]. Additional conditioners, especially moisturizers and cationic polymers, should be avoided in hair that has a tendency to become oily, since they weigh it down. The use of plant extracts containing tannin, e.g., oak bark extract, can have a positive influence holding a style by roughening the surface of the hair.

Anti-aging shampoos

As hair ages changes affecting pigmentation and growth become evident. Preventive measures begin with early avoidance of factors that cause damage to the hair and scalp such as UV rays [37, 38], tobacco smoking [39, 40], poor diet, and stress. UV rays contribute significantly to the aging of the skin and presumably the hair as well. The effect of UV radiation on the hair follicles is attributed, among other things to the light activation of porphyrins produced by *Propionibacterium spp.* in the hair canal which triggers a follicular microinflammation [41]. For this reason, the use of an antimicrobial solution is recommended as a preventive measure [42]. Cinnamidopropyltrimonium chloride is a quaternized UV absorber that also has a conditioning effect in shampoo [43]. Solid nanoparticles as carriers of UV blockers are being developed for use in hair [44]. The effects of hair growth agents and anti-aging substances in shampoo are rather dubious given their dilution with water and short contact time, unless they can be absorbed in effective quantities. Antioxidants and UV absorbers primarily serve to protect oxidation-sensitive oils or dyes against the effects of light. Yet, they are often present in concentrations that are too low to protect the hair. Pantothenic acid is a strong humectant and is thus considered a conditioner. Shampoos are also currently being developed that are enriched with amino acids specifically depleted by wear and tear [7].

Unwanted effects

Hair loss

Patients frequently complain of increased hair loss when they change shampoos. Patients being treated for dandruff should be told that increased loss of hair can result from exfoliation associated with the use of a medicated shampoo. This is due to loss of telogen hairs (Figure 5), which adhere to the crusts, and not due to increased pathological hair loss related to the shampoo. Patients with pityriasis amiantacea are especially affected [45]. The relationship between the complaint of hair loss and the use of various shampoos has been systematically studied with most findings pointing to other causes [46]. Some authors recommend that agents which suppress dandruff, such as selenium disulfide, be used for only a limited time since they may also inhibit mitosis of the follicle epithelium [47]. Paired comparison studies on zinc pyrithione versus placebo have not found zinc pyrithione to have a cytostatic effect on epidermal cells, the presumed mechanism of action of agents that suppress dandruff such as selenium disulfide.

Acute felting

Damaged hair, e.g., permanently waved hair, is particularly prone to sudden entanglement, which can occur with the use of viscous fluids such as undiluted shampoo. The raised cuticle cells of the damaged hair can interlock as a result excessive friction and static electricity and the hair become tangled. An irreversible knot, sometimes referred to as a "bird's nest" (Figure 6), forms over a limited area [48, 49]. Since the structure of the hair is significantly damaged, the only alternative is to cut off the tangled portion. The best means of prevention in damaged hair is to follow the instructions for using shampoo products and to regularly use conditioner, especially for permed hair [50].

Figure 5: Detachment of compact crusts with telogen hairs. From: Trüeb R M. Haare. Praxis der Trichologie. Steinkopff, Darmstadt, 2003.

Figure 6: Acute felting. From: Trüeb R M. Haare. Praxis der Trichologie. Steinkopff, Darmstadt, 2003.

Product safety

The public is keenly interested in knowing of any health risks potentially associated with everyday products such as shampoo. The effects of shampoo ingredients such as coal tar, halogenated organic compounds, formaldehyde releasers, and musk on personal health and/or the environment are only a few of the issues that have received media attention. The product safety rating of a shampoo is based on an evaluation of the

data for all ingredients with regard to skin and mucous membrane tolerability, sensitization potential, acute and chronic toxicity, mutagenicity, skin penetration and accumulation potential, biodegradability, and aquatic toxicity.

Carcinogenicity

Opponents of tar-based products, concerned with the risk of carcinogenicity, grew even more vocal with the first publications [51, 52] on percutaneous absorption of polycyclic aromatic hydrocarbons (PAH) from tar-based shampoo. In fact, in the roughly one hundred years since tar-based products have been used for dermatological indications, the incidence of related skin cancer is very rare and no relationship has been reported with the use of coal tar-based shampoos [53]. Containing up to 79 µg/g benzoapyrene, the main PAH in tar-based shampoos, only a fraction of 79 µg PAH per hair washing is absorbed [54]. By way of comparison, the benzoapyrene in a pound of grilled ground beef is about 10 µg.

Skin and mucous membrane irritation

Critical assessment of validated data on the frequency of contact allergies to shampoo demonstrates their low risk [55]. Given that shampoos are diluted by water, have a short contact time, and are rinsed off, the risk of sensitization is highly unlikely [56]. Nevertheless, in patients who are already sensitized, exposure could conceivably trigger eczema. Patients should therefore be advised of all ingredients contained in the shampoo; a complete allergy history can also help avoid contact with relevant allergens. Although in most cases testing individual ingredients is sufficient, testing the final formulation for skin and mucous membrane irritation is preferable. Such testing is not mandated by current directives on cosmetic products and is often not performed. Therefore, safety ratings of cosmetic shampoos used for therapeutic indications should be critically assessed on an individual patient basis.

Environmental safety

Environmental safety requirements for cosmetic products are derived from applicable environmental laws. Water protection regulations mainly address the effects of substances that end up in the water; for a given ingredient to be approved for use, it should not be expected to cause irreversible damage. Rapid and complete biodegradation of surfactants, which are used in large quantities, is required and has been the subject of careful scrutiny and confirmation. Most knowledge of ecological characteristics of surfactants has come from their use in laundry detergents and cleaners, which are used in far larger quantities, rather than from the comparatively smaller amounts used in shampoos which pose less of a threat to the environment.

Methods for measuring efficacy of hair care products

Modern hair care products must be safe and non-irritating, but they must also demonstrate efficacy. Cosmetics laboratories have developed objective methods for measuring efficacy. Measurements are made using individual hair fibers as well as strands of hair. Compared to measurements of individual hair fibers, those conducted on groups of hairs are more valuable, yet the degree of abstraction remains high given that consumers are not concerned with strands of hair, but with overall appearance. Nevertheless, they supply important information. Measurement methods encompass a large number of computerized and sometimes robot methods which are used to quantify cosmetic phenomena and effects such as build-up, bounce, body, manageability, entanglement, causes of damage, and conditioning benefits [57]. By using a carefully selected variety of methods, refining the method park, and conducting dialogues with experts on subjective tests with end consumers, hair care effects can be precisely described and optimized to suit practical considerations and economic targets. Testing of various hair types in climate chambers with different levels of humidity is aimed at developing global hair care product lines.

Conflict of interest

This paper was written with the kind support of Procter & Gamble. <<<

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