Chapter 2

Shampoos

Tony O'Lenick and Robert Y. Lochhead

A modern shampoo comprises the following components:

- water
- primary surfactant(s) whose principal function is to remove sebum and soil from the hair
- co-surfactants that assist in structuring the composition and help boost the lather during the shampooing process
- functional ingredients to confer benefits other than cleaning, such as bodying, conditioning, conferring mildness to skin, or anti-dandruff properties
- rheology modifiers to confer desirable flow properties and also to stabilize suspensions of insoluble particulate components
- preservative or preservative system
- pH adjuster
- colors
- fragrance

It is appropriate to begin this chapter by considering the requirements and function of shampoos.

Detergency and Foam

Two of the most basic properties that consumers demand from shampoos are detergency and foam. Before one can adequate-

ly address detergency, which is the removal of soil one must first define soil as it applies to hair.

Soils

A determination of what is removed during cleaning of hair is critical to the understanding of detergency and any potential scale of detergency. The ability to pick a detergent from the virtual cornucopia of compounds available should be determined by the efficiency of the detergent to remove the specific oils found commonly on hair.

Hair in its native state is made up of protein. Protein in turn is composed of amino acids which are assembled into what is referred to as primary structure. The peptide bond as it is referred to by biochemists is referred to as polyamides by organic chemists. The amino acid structure has a secondary structure which relates to hydrogen bonding, giving each protein a three dimensional structure. There are also disulfide bonds between sulfur bearing amino acids. For the most part, unless you are relaxing or perming hair you do not want to do anything to alter the protein structure.

The hair also contains oils that come from the scalp. The build up of which constitutes the major portion of what is commonly called “soils”. Some of these materials are superficial on the hair and can be easily removed while others soils are located deeply within the hair and this cannot be easily removed. An understanding of these materials and how they function is critical to understanding what is removed in cleaning hair.

A key article related to this analysis is entitled Hair Lipids and their contribution to perception of hair oiliness.[1] The Koch article defines two types of oils, the first referred to as “external oiliness” and the second as “internal oiliness”. The article points out that some of the oil that designated external oil is

superficial and is removed by shampooing. The remainder of the oil remains strongly absorbed onto the hair and in the cuticle and can only be removed by strong extraction.[2] It has been shown by consumer testing that the internal oil does not contribute to the consumer perception of oiliness. It does however function as what Koch calls a "storage capacity" for oil. This is important because the internal oil works its way to the hair's surface. This replenishing mechanism explains why hair becomes oily quite regularly even with regular washing. It likewise explains why some hair types require application of more oil, while others require more oil removal.

Koch also points out that the nature of the oil and not only its concentration has a major effect upon the consumer perception of oiliness both on hair and on skin. Others point out that the chemistry of the oil on the hair has effects upon such variables as the velocity of oil spreading from the internal oil storage, the feel of the oil as it is received by the consumer. The oil's physical properties including its melt point, stickiness and viscosity all contribute to the consumer's perception of oiliness.[3,4]

The oils observed on the hair vary considerably in terms of polarity. If only some of the oils are extracted based upon polarity, the extract oils will not be the same as those removed by shampooing. Koch developed extraction methodologies that both showed the composition of internal and external oils and related directly to those extracted by shampooing. This outstanding analytical work has allowed for both structure elucidation and quantification of the components of both internal and external oils. The methodology finds both non-polar oils like triglycerides, and far more polar components like mono acyl glycerides commonly found on the hair and skin. Since these classes of compounds differ appreciably in polarity, an extraction of external oils must pick the polar and non-polar

oils from the hair and leave the internal oils intact. It was determined in the Koch reference that the best extraction solvent for the polar and non-polar oils on the hair as external oils is a mixture of water and chloroform. The presence of water has a profound effect upon cleaning hair. Water swells the hair during shampooing, which is thought to have an impact on the availability of the internal oiliness especially just under the cuticle. The object of the experiment of Koch et al was to identify the external oils extracted from the hair during shampooing. The fact that shampooing almost always used water, an extraction with a partial water containing system seems appropriate.

It was determined that the "average commercial shampoo" removes only 40–60% of the total oils in the hair.[5] This quantity matches up well with the extraction method of Koch. The internal oils are extracted using extreme methods, specifically by Soxhlet extractions with boiling ether and water for 16 hours.

Table 2.1 details the composition of the oils called "external oils". These are the oils removed by shampooing. A good detergent will remove these materials efficiently.

Table 2.1. Composition of External Oils (Hair)

External	mg extracted	% Comp
Squalene	0.26	9.4
Cholesterol Esters	0.56	20.3
Triglycerides	0.51	18.5
Free Fatty Acid	1.27	46.0
Cholesterol	0.05	1.8
Monoglycerides	0.11	4.0
Total	2.76	100.0