The Practical Evaluation of Shampoos

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Synopsis—Appearance, performance during use, and effect on hair after use are the three major criteria by which shampoos should be evaluated. Within these three broad categories, 25 separate characteristics are enumerated. The importance of each of these and laboratory and beauty salon test procedures for evaluating shampoos are discussed.

Introduction

The development of a shampoo that can win a significant share of a highly competitive market is not a simple task. Even though a shampoo is more or less a rather prosaic toiletry, many of its qualities, or lack of these qualities, can affect the consumer either favorably or adversely. The chances of developing a utility shampoo with a significant innovation are rather remote. The term utility shampoo is used to differentiate between the general use shampoo and those which are more specifically defined, such as antidandruff shampoos, color shampoos, etc. In order to produce a successful shampoo of the utility type, it must have a quality of excellence built into it. This quality of excellence is almost always a total combination of many factors, some of which are immediately obvious to the consumer and many of which are not.

The consumer reacts to a shampoo at three different times. The consumer will be considered to be female, since almost all of the general use family shampoo is purchased by a feminine member of the family.

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It is true that her decision is influenced by advertising, packaging, brand name, and reputation of the manufacturer—and, perhaps a great deal more than one would like to admit, by price. Her first real impressions are established when she picks the package off the shelf. If she is favorably impressed at that time she may buy and use the shampoo. Her decision whether to purchase the product again is influenced twice more. How did the shampoo perform, and how did it leave her hair?

Most discussions of shampoo performance found in the literature are limited to evaluation of foaming qualities, manageability, and detergency. There are many other factors that contribute to a quality shampoo, which have been delineated in 25 distinct categories. Every shampoo under development and all competitive shampoos are evaluated against this check list. Many of the qualities can be measured by well-established laboratory procedures. Others must be evaluated by specially devised techniques. And still other qualities can only be determined subjectively, and here experience and a thorough understanding of shampoos are invaluable.

Details of the formulation or composition of shampoos will not be considered. Instead, the major objective is a discussion of the practical evaluation of the 25 characteristics or qualities which enable the chemist to determine whether or not a shampoo has that certain “quality of excellence,” as measured by the consumer. These qualities are reviewed not necessarily in order of importance; nor are they studied in the order shown; and many of them are interrelated.

The methods of evaluation as described in this paper apply to a clear liquid shampoo although similar criteria may be applied to a liquid lotion or a cream shampoo.

The 25 shampoo qualities can be divided into three broad groups. This is primarily a check list designed for the fairly rapid evaluation of large numbers of shampoos on a routine basis. The first group concerns the appearance of the product itself in the bottle and includes the following nine qualities for evaluation:

1. Clarity
2. Viscosity
3. Color
4. Color stability
5. Cloud point
6. Clear point
7. pH
8. Fragrance
9. Sterility

The second group of qualities relates to or is directly concerned with the actual performance on the hair and includes:
10. Foam production—hard water
11. Foam production—soft water
12. Foam production—hard water plus soil
13. Foam stability
14. Foam texture
15. Speed of foam production
16. Rinseability
17. Fragrance of lather

The third group of characteristics concerns the effect of the shampoo on both the hair and skin. Here the following qualities are evaluated:
18. Combability of wet hair
19. Combability of dry hair
20. Static electricity of the hair
21. Fragrance of the hair
22. Hair gloss
23. Effect on artificial hair color
24. Staining of bleached or permanent waved hair
25. Feel on hands

**Shampoo Evaluation**

*Clarity*

From a consumer point of view, the general outward appearance of the shampoo is the first contact with the product itself, stripped of its outer covering of label and package. For this reason it is most important that a clear shampoo be manufactured with maximum care. A shampoo with sparkling clarity has obviously greater consumer appeal than one that is hazy.

The danger in formulating clear shampoos is loss of clarity with aging, a fairly common defect. Only thorough stability testing of the shampoo will reveal this problem so that measures can be taken to solve it. Among the factors contributing to loss of clarity are temperature, perfume, water hardness, contamination by microorganisms, and water-insoluble fatty compounds used as hair conditioning agents.

Cloud point and clear point evaluations are important in order to maintain clarity under a range of colder-than-normal temperatures.
The cloud point is the highest temperature at which the shampoo will cloud or haze when cooled. The clear point is the lowest temperature at which the product will clear when warmed from a chilled opaque condition. They are not always the same. Clarity, insofar as cloud and clear points are concerned, should be maintained at about a maximum of 10°C. This should insure clarity in stores and homes under average conditions of temperature.

**Viscosity**

Liquid shampoos comprise the largest share of the shampoo market, with clear liquid shampoos accounting for better than 50% of the market. Among the most important characteristics of these products is viscosity which may range from water-thin products to viscous liquids. There are both psychological and practical advantages to relatively high viscosity liquid shampoos. They often imply a high concentration of shampoo ingredients plus a richness that is usually associated with hair conditioning and management. There is also a practical value. High viscosity liquid shampoos can be poured into the palm of the hand for application to the hair, thus eliminating dripping through the fingers or down the face and neck.

A desirable viscosity range will vary between 500 and 1500 cps. Shampoos having viscosities below this level tend to be runny; and if the viscosity is over 2000 cps., they may not pour too well. Maintaining viscosity within a close range over a long period of time can sometimes be a problem. Here again, stability testing is of utmost importance.

**Color**

A shampoo may be uncolored, or it may have certified color added. The color of a shampoo is dictated by esthetic considerations, packaging, and subtle psychological factors. The market to which it is directed is also a factor. A shampoo for men may be blue, green, amber, or gold, or it may be colorless, but pink would be a doubtful choice. There has been a transition over the years in the colors which the consumer prefers. Until recent years liquid shampoos were usually amber, yellow, or orange. More recently, green and blue shampoos have become popular. Clear, colorless shampoos are also on the market. Such shades as lavender and red and deep colors are particularly unacceptable.
In selecting the color to be used, color stability or instability can become a problem. Many of the certified dyes used are sensitive to light, pH, and other chemical factors. It should be unnecessary to state that every shampoo should be thoroughly tested for light stability. Since it is not always convenient to set the product in the sun and since the results are not reproducible, a commercial "fadeometer" may be used to determine color stability. In such equipment the shampoo is exposed to high intensity ultraviolet light under controlled conditions. A minimum exposure of six hours with negligible or no color change is usually considered acceptable.

Incidentally, one of the pitfalls to be avoided in light exposure studies is to test the shampoo in a container made from the same material as the ultimate package. It is not unusual to find a color that may fade in glass but is stable in a given plastic and vice versa. With the de-listing of many certified colors, the problem of finding a suitable color that is stable to light has increased. The use of ultraviolet absorbents in the shampoo can be extremely helpful in improving the light stability of fugitive colors. Some container manufacturers are coating their glass or plastic bottles with ultraviolet absorbents which serve the same purpose.

A third area where the color of a shampoo should be evaluated is one that is frequently overlooked. Some hair, and this is especially true of bleached and permanently waved hair, is quite porous and may absorb the color from the shampoo. Here again, pH and chemical composition of the product may be contributing factors. Only thorough testing on laboratory hair swatches and subsequent application to subjects with bleached or permanently waved hair will determine whether this problem exists.

**pH**

The pH of a shampoo may have definite effects upon its properties. Most liquid shampoos today are formulated to have a pH between 6.5 and 8.5. Within this range a suitable viscosity and clarity can usually be achieved, as well as good stability and lathering properties. A few generalizations can be made concerning the effects of pH on a typical clear shampoo formulation:

1. Shampoos formulated on the high side of the pH range will exhibit a greater degree of foaming and cleansing as well as a greater ability to strip the natural oils from the hair.
2. Conversely, shampoos on the low side of the range will generally leave the hair in better condition with a greater degree of manageability and combability.

3. Shampoos with pH's above and beyond the high side of the range can cause eye irritation more readily than those within the range.

4. It is easier to maintain clarity on the high side of the pH range.

5. Viscosity generally increases as the pH is lowered. This is especially true of alkylolamide-lauryl sulfate shampoos.

pH can, therefore, be considered as a key factor in formulating a product to suit the consumer's desires. Although she may never have heard of the term, pH can affect the appearance, efficacy, and residual performance of a shampoo.

**Fragrance**

The fragrance of a shampoo is a most important quality. It can add a touch of cosmetic elegance to the product plus an air of distinction. It can significantly influence the consumer whether or not to purchase the product initially or to repurchase it. It is the authors' opinion that a shampoo fragrance should be a light and clean bouquet; but the perfume type will be dictated by whether the shampoo is marketed primarily to women, men, children, or for family use.

The shampoo fragrance should be evaluated critically at three different stages. First, the product itself in the bottle. A buyer will often remove the cap and sniff the product at the shelf or counter. Does it have a light refreshing scent with high appeal? Is the shampoo free of a chemical or detergent odor; is it effectively masked? Does the fragrance appeal to the consumer group to whom the shampoo is directed? The fragrance at point of purchase can often make or prevent a sale.

The second time that the fragrance may elicit a response from the consumer is during application to the hair. The use of hot water plus the fact that shampoos are often applied to the hair in a confined area, such as the bathroom or shower, can result in a fragrance change noticeable in the lather and in the atmosphere. The fragrance should retain its basic characteristics without becoming overpowering.

The third important stage is the fragrance of the hair after shampooing. The hair should retain an almost imperceptible scent. Certain perfume types should be avoided, such as heavy, sweet types which tend to cling to the hair. Hair that has been bleached or permanently waved
tends to retain more of the fragrance than chemically untreated hair. Also, hair that has been shampooed with products containing amphoteric surfactants often retains more fragrance than when anionic surfactants are used.

Sterility

For some reason cosmetic chemists often disregard or minimize the potential problem of shampoo contamination by microorganisms. They would not consider marketing a cream or lotion that is inadequately preserved, but shampoos are often found without preservatives. There is a mistaken notion that, since sulfated lauryl alcohol and sulfated ethers are considered antagonistic to bacterial and fungal growth, no contamination problems exist in shampoos. Several investigators (1, 2) have shown that this is only partly true, and shampoos are often found that give high bacterial counts—particularly of gram-negative bacteria. This has been confirmed by the authors’ experience over the years. Contamination by microorganisms poses not only a health hazard but can cause changes in the shampoo, such as malodor, turbidity, and viscosity changes. On the other hand, it is also possible to find grossly contaminated products without visible signs of change.

All shampoos must be preserved not only for original freedom from contamination but also must be protected against the possibility of future contamination when the package is opened and reopened for use. Many preservatives are available for use in shampoos today, and their incorporation is fairly simple; however, their effect on certain organisms may either diminish in time or cause the generation of resistant strains. Thus, even after many years of preservation by specific agents have passed safely, a periodic investigation should be undertaken to determine whether the preservatives are still effective. Freedom from microorganisms not only depends on adequate preservation but also upon uncontaminated raw materials—particularly water. Vitaly essential are strict sanitary measures during manufacture. Constant diligence is required, and development production shampoos should be routinely subjected to bacteriological evaluation.

Foaming

To the consumer, foaming or lathering action is one of the most important aspects in determining the quality of a shampoo, and the measurement of foam has received much attention in the literature. The volume, foam structure, foam viscosity, and foam stability are also
important criteria by which the consumer judges the shampoo even though she may not realize it. Undoubtedly, techniques to measure and evaluate foaming qualities are important. Normally, such measurements are first performed in the laboratory and then in actual use on models. There have been many laboratory techniques developed over the years to measure foam, some of them highly sophisticated. The authors use a very simple technique which requires only a 500 ml glass stoppered cylinder and a device to revolve or agitate it. This very simple method has been widely criticized, and there are more precise procedures (3-5). For practical purposes and after thousands of foam tests, this technique has been found to meet the following conditions: It is fast, it is reproducible, and it reflects the performance of the shampoo on the hair.

First, 10% dilutions of the shampoo in either soft water or water of known hardness are prepared. Increasing increments of the diluted shampoo are pipetted into the cylinder, diluted with water of required hardness to a fixed level, and then rotated for a precise number of times. The foam volume is recorded, and the bubble structure and foam stability are examined. Three foam curves are plotted for every shampoo: A soft water dilution; a dilution with water of known hardness; and a dilution of water with known hardness plus the addition of 1 ml of olive oil. The foam determination in the presence of oil fairly accurately
reflects the performance of the shampoo on the first lathering. During the first lathering the foam is often depressed because of sebum, hair dressings, and other cosmetic products which may be on the hair. The hard and soft water curves represent the range of water hardness used by consumers throughout the country and can be a major factor in the type of foam developed. Figure 1 illustrates these three foam curves of a nationally advertised brand of shampoo. Figure 2 shows the foam curves in very hard water (310 p.p.m.) of two popular shampoos. This significant difference in foam production of shampoos A and B is also evident when the two shampoos are actually applied to the hair of a subject using a "half-head" technique.

Figure 2. Comparison of the foam volume of two shampoos in very hard water (310 ppm)

The most important test in evaluating shampoo performance is to shampoo a variety of hair types under controlled conditions and observe the results. The recommended method is the "half-head" technique which involves parting the hair down the center and shampooing each half simultaneously with two different shampoos. The "half-head" technique is commonly used with many hair preparations such as hair sprays, wave sets, hair dressings, etc. With these, "half-head" testing is simple and easy, but it is not quite so simple with a shampoo.

The reasons for "half-head" testing are quite obvious. No two heads of hair are the same. The hair varies in texture, length, condition, sebum and soil content, and presence of cosmetics. Therefore, compar-
ing Shampoo A on one head with Shampoo B on another head is rather meaningless, especially if only subtle differences exist. One must then rely on memory and, therefore, cannot compare the results of a head shampooed with product A and subsequently treated with shampoo B. A skilled beautician can apply two shampoos to the same head and, if done on a number of heads, obtain meaningful and reproducible results.

Two shampoos are applied to dampened hair in equal amounts (from glass hypodermic syringes for accuracy and convenience) to both sides. The lather is worked up as uniformly as possible on both sides of the head and the various lathering and foaming qualities observed, including the speed at which the lather develops, the so-called "flash-foam" characteristics. A second lather is worked up, again using syringes for accurate dispensing of the shampoo, and the evaluation is repeated. Very often the second lather is allowed to remain on the hair for three to five minutes and foam collapse, if any, noted. The shampoos are rinsed from the hair and the rinsing characteristics observed. It has been found that some shampoos rinse very rapidly while others continue to produce foam for several minutes during the rinsing procedure.

The foam texture is also examined during these tests. Foam made up of large, thin bubbles is not desirable; neither is foam made up of very small bubbles, which tend to make the foam feel like a cream.

Incidentally, one observation made during these "half-head" tests is frequently overlooked. How does the shampoo feel on the hands during application? Does the shampoo impart the desirable soap-like lubricity, or does it impart a raspy harsh feel to the hands? The consumer has been conditioned to the feeling of lubricity or slip that is always characteristic of soap and most shampoos. With the current trend to shampoos of lower pH, this quality can be lost. A shampoo of pH 6.0 to 6.5 can lack this feeling of lubricity on the hands, but the problem can be resolved by skillful formulation.

**Manageability**

Perhaps one of the most abused words used in shampoo advertising is "manageability" or "conditioning." Such claims are frequently made for shampoos, even though they do not exist. However, they are meaningful to the consumer and are, therefore, important to the chemist. Just what do these words mean? A healthy, normal head of hair is one that is easily combed when either wet or dry. This is due to natural secretions which coat the hair with a lubricating film, eliminate
**Figure 3.** Beauty Clinic form

Static charges, and impart gloss or sheen. Many shampoos will completely strip the hair of sebum and other natural secretions, with the result that the wet hair snarls or tangles and is difficult to comb. The dry hair is often lustreless and also difficult to comb. A strong static charge results in "fly-away" or hair difficult to hold in place.

There are two solutions to this problem. One is to formulate a shampoo with reduced detergency. The shampoo will remove surface soil on the hair and most—but not all—of the sebum coating. The amount of natural oils remaining on the hair is sufficient to impart some
degree of "manageability." A second solution is to compound a shampoo that will cleanse the hair but still leave a film on it to serve temporarily as a conditioning agent until natural scalp secretions are replaced. The authors doubt that most so-called "conditioning agents" incorporated in shampoos are deposited on the hair. There are, however, substantive materials which are useful for this purpose.

After the hair has been thoroughly rinsed and towel dried, it is again parted down the center and combed (using two identical clean combs) by both the beautician and the chemist, and differences in combability are noted. No other cosmetic products are used on the hair when shampoos are evaluated. When dry, the hair is again checked for dry combability, gloss, and static charge. Excellent methods have been devised for the measurement of static charge on hair (6, 7) but for routine purposes visual observation is sufficient. All beauty clinic observations are recorded on the form shown in Fig. 3. A subjective rating system is used whereby many of the characteristics discussed above are scored from 0 to 5, with 0 being very poor and 5 very good. In a series of tests on a shampoo, using suitable controls, meaningful observations are readily made as to the performance characteristics.

Effect of Shampoo on Hair Color

In view of the tremendous growth of hair coloring, the possible effects of shampoos on artificially colored hair cannot be ignored. Specialty shampoos have been developed for use on color treated hair, but utility shampoos should also be checked. This is routinely performed in the laboratory and in the beauty clinic on hair that has been colored with oxidation dyes and with semi-permanent dyes. In the laboratory, the AATCC Launderometer as modified by Goldemberg (10) is used. Observations of loss of color during shampooing and of color changes are made. Here again the "half-head" technique is useful because color changes and attrition of color may be due primarily to the color and not to the shampoo.

Concluding Comments

There are additional shampoo qualities that require evaluation, and omission of these from the list of 25 characteristics does not necessarily minimize their importance. Safety to the consumer is of paramount importance, and certainly no shampoo should ever be marketed that is a sensitizer or an irritant to the eyes or skin. Factors that contribute to
such hazards are well known, and methods to detect them are in widespread use.

Detergency has not been listed as an important consideration for routine evaluation. Although excellent methods have been reported for the measurement of detergency (8, 9), some cosmetic chemists are of the opinion that a shampoo should not be so powerful a detergent as to strip all natural secretions from the hair and scalp. Modern shampoos are based on surface-active agents that perform this task adequately for all practical purposes. The latitude for degree of detergency is fairly wide. When one considers that most heads of hair are shampooed with two applications of shampoo, the factor of detergency becomes relatively unimportant.

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