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A REVIEW ARTICLE ON EVALUATION OF PH OF SHAMPOOS

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INTRODUCTION

- Dermatologists most frequently prescribe shampoos for the treatment hair and scalp disorders.
- Prescriptions hair products are often focused on improving scalp hair density, while only the over-the-counter products seem to focus on hair damage prevention.
- Little is taught in medical school about the hair cosmetics so that the prescriptions are based only on the active substance for the treatment of the scalp and usually disregards the hair fibre structure.
- It is important that dermatologists prescribe shampoos that minimize the risk of frizz and interrfiber friction augmentation.
- Choosing the right shampoo will help dermatologists to increase the patient'sadhesion to any treatment involving shampoos.
- Shampoos are not only scalp cleaners, because they also act on the hair shaft.
- It is desirable that whatever may the disease or scalp condition be (dermatitis, seborrhoea, alopecia, psoriasis), the shampoo must preserve the softness, comparability and shine of the hair shaft.
- Friction the main cause of frizz, can be minimized by adequate formulation of cleaning products, which is particularly important for African hair and curly hair.
- The scalp pH is 5.5, and the hair fibre surface and, therefore, increase the negative electrical net charge of the hair fibre surface and, therefore, increase the friction between the fibres.
- In this work, we review the action of the surfactants and the influence of the pH on the hair fibre friction, regarding the electrical charges on the surface of the shaft and its consequences on the frizz effect.

- We also analyse the pH of commercially available shampoos of various brands to verify if the pH levels follow a constant pattern.

FIGURE 1:

SURFACTANTS

- Surfactants are cleaning agents that substituted soap.
- They act through the weakening of the physicochemical adherence forces that bind impurities and residues to the hair.
- Surfactants dissolve these impurities, preventing them from binding to shaft or the scalp.
- Residues are non-soluble fats (sebum) that do not dissolve with water. In order to be removed from the hair shaft, surfactants present a hydrophobic molecular portion and another hydrophilic.
- The former will chemically bond with the fat while the latter with the water.
- The surfactants are composed of a lipid chain of hydrocarbons with polar extremity and a non-polar one.
- The polar edge is capable of giving this portion of the molecule hydrophilic traits that allow it to dissolve in water and wash away the residues.
- The surfactants in contact with the water attain the structural formation of micelle.
- Their structure becomes spherical with a hydrophilic exterior, which can be rinsed with water, and a hydrophobic interior where the fats and residues are binded.
- Depending upon the electric charge of the polar extremity, the surfactants are classified in four groups: Anionic, cationic, amphoteric, non-ionic.

- The main cleansing agents are anionic.
- The soap, which is also an anionic detergent, in contact with water, leaves an alkaline residue that is very harmful to the hair and skin and that precipitates in the form of calcium salts, which accumulate in the hair strands, leaving them opaque and tangled.
- Such effects do not happen with the new anionic surfactants that are derived from the sulfation of fatty acids and analog polyoxyethylene (alkylsulphates, alkyl ether sulphates), which are smooth cleaners and cosmetically superior.
- Some examples are:

❖ Sodium lauryl sulphate,
❖ Ammonium lauryl sulphate,
❖ Ammonium laurethsulphate
❖ Alpha olefin sulfonate

- The current expression "sulphate less shampoo" refers to a preparation without the anionic surfactant.
- An example of a surfactant with sulphate is the sodium lauryl sulphate.
- Cationic, amphoteric and non-ionic surfactants are added to some shampoo formulas to reduce the static electricity generating effects caused by the anionic surfactants.
- Since they carry a positive charge, cationic surfactants bond quickly to the strands negatively charged due to the use of anionic surfactants and reduced the frizz effect.
- Besides, they optimize the formation of foam and the viscosity of the final
- The static electricity verified after the use of shampoo is exactly the result of abalancing out between electric charges during the removal of the sebum and residue.
- Negative charge of the hair fibrerepels the also negative charge of the micelle. The repulsion of charges allow rinsing with water.
- However, the result is an increase of the preexisting negativity of the strands and the formation of stable complexes that bond with the keratin, creating a repulsion between the strands due to excessive static electricity.
- Although the cationic agents try to neutralize the effect, there is the interference of the shampoo pH, which can increase the static electricity and reduce charge neutralization.

pH: DEFINITION AND IMPORTANCE

- The pH, or hydrogenionic potential indicates the acidity, alkalinity or neutrality of a given medium.

- The pH scale assumes the neutrality at 7.0, and varies from 1 to 14.
- A substance is considered acid below 7, alkaline above 7.
- At the 7.0 pH, there is an equilibrium between H^+ and OH^- at the centre.
- The isoelectric point is defined as the moment of charge neutrality in determined pH.
- The hair is extremely sensitive to the pH variation of the products applied in its surface.
- The pH of which a protein or a particle has an equivalent number of total positive and negative charges is called the isoionic point.
- The pH at which a protein or particle does not migrate in an electric field is the isoelectric point.
- Its isoelectric point is around a 3.67 pH. The isoionic point is around 5.6.
- The hair reaches neutrality of charges when the pH is around the isoelectric point.
- In lightened hair, the isoelectric point is reached at an even more acidic pH.
- It occurs because the A-layer and the epicuticle are rich in cysteine and therefore there is the formulation of cysteic acid.
- Free lipid which contains fatty acids is an important and essential component of the surface of animal hairs.
- The free lipid that is present in this surface layers the lower the isoelectric point of the keratin fibres.
- Free lipid is important to the absorption of surfactants and the other ingredients onto human hair.
- The longer the interval between shampoos, the morefree lipid and the lower the isoelectric point of the hair.
- Any product that applied on hair that has pH higher than 3.67 cause an increase in the negativity of the electric network of the hair, that is, an increase of static electricity and repulsion between strands.
- The fibresurface bears a net negative charge because of its low isoelectric point.
- Positively charged ions are attracted to the negatively charged surface, thus helping to overcome the electrical barrier for anions.
- When the hair is rinsed, the water pH is 7.0.Thereforean increase in negativity occurs and the micelle is repelled by negatively charged strands.
- The negative electrical net charge generated will tangle the hair and make it hard to comb, thus causing frizz effect.
- Besides, in alkaline pH, hair has increased capacity to observe water.

- Water penetrates the scales that open, hydrating the strand and breaking the hydrogen bonds of the keratin molecule.
- The keratin is a spiral, helical molecule that keeps itself in that shape due to chemical bonds between its atoms: Hydrogen disulfide and the ionic bonds and Van der Waals forces.
- Water causes hydrolysis, that is, temporarily breaks the hydrogen bonds and makes the molecule malleable and consequently, fragile to the hair due to lowering in elasticity and increase in elasticity, which means that the wet hair, if deformed, does not regain its original shape.
- When that hair is wet, cuticle scales lift, leading to increased cuticle removal, cuticle fragmentation, and cracks to the fibre axis.
- The pH of the scalp, however, is around 5.5 like the rest of the skin, which is more alkaline than the hair shaft.
- Although there is not a standard definition for the concept of low pH shampoo, in this work we consider a low pH shampoo one with a pH of 5.5 and lower.

MATERIALS AND METHODS

- This is a transverse and descriptive study, in which shampoos (commercial, dermatological, paediatric) were chosen at random, and in enough quantity from popular pharmacies and major national retailers.
- At least, one shampoo was analysedfrom each brand.
- The pH of all products was evaluated with the portable paper pH indicator, ranging from 0 to 14.
- The pH of the products was enumerated in tables according to the category:

❖ Commercial/popular
❖ Dermatological
❖ Antidandruff
❖ Professional

RESULTS

➢ A total of 123 shampoos were analysed. The pH values ranged from 3.5 to 9.0. About 38.27% of all analysed shampoos presented a pH ≤ 5.5 and 61.78 % presented a pH >5.5
➢ 100% of the children's shampoos presented a pH > 5.5
➢ 26 antidandruff shampoos were analysed. 19.23% presented pH ≤ 5.5.

- 80.37% of all antidandruff shampoos presented a pH>5.5.
- The 19 dermatological shampoo group presented 42.10 % with pH ≤ 5.5 and 57.90 % presented pH >5.5.
- Among the commercial products,96 shampoos, 34.37% presented pH ≤ 5.5 and 65.62% presented pH > 5.5.

TABLE 1:

Level of pH of all analysed shampoos=123

pH	Frequency	Percentile
3.5	1	0.8
4.0	1	0.8
5.0	6	4.9
5.5	39	31.7
6.0	14	11.4
6.5	29	23.6
7.0	26	21.1
7.5	5	4.1
8.0	1	0.8
9.0	1	0.8
Total	123	100.0

- 123 shampoos were analysed. 47(38.21%) shampoos have a pH 5.5 or lower.
- 76 (61.78%) shampoos have a pH level higher than 5.5.

TABLE 2:

Adults and children's shampoos pH.

pH	Adult	Children	Total
3.5	1	0	1
4.0	1	0	1
5.0	6	0	6
5.5	39	0	39
6.0	14	0	14
6.5	27	2	29
7.0	23	3	26
7.5	5	0	5
8.0	0	1	1
9.0	1	0	1
Total	117	6	123

TABLE 3:

Regular and antidandruff shampoo pH.

pH	Antidandruff	Regular	Total
3.0	0	1	1

4.0	1	0	1
5.0	0	6	6
5.5	4	35	39
6.0	3	11	14
6.5	6	23	29
7.0	11	15	26
7.5	0	5	5
8.0	0	1	1
9.0	1	0	1
Total	26	97	123

- (21.13%) shampoos were antidandruff;
- 97 (78.86%) shampoos were regular.
- 5(19.23%) antidandruff shampoos have the pH level 5.5 or lower.
- 21(80.77%) of all antidandruff shampoos have a pH level higher than 5.5.
- 42(43.29%) regular shampoos have a pH 5.5 or lower.
- 55(56.70%) regular shampoos have a pH higher than 5.5.

TABLE 4:

Commercial, Dermatological and Professional shampoos pH.

pH	Commercial	Dermatological	Professional	Total
3.0	1	0	0	1
4.0	0	1	0	1
5.0	1	2	3	6
5.5	31	5	3	39
6.0	9	3	2	14
6.5	25	4	0	29
7.0	23	3	0	26
7.5	5	0	0	5
8.0	1	0	0	1
9.0	0	1	0	1
Total	96	19	8	123

- 96 commercial (over the counter and popular) shampoos were analysed.
- 33(34.37%) have pH 5.5 or lower.
- 63(65.62%) commercial shampoos have pH higher than 5.5.
- 19 Dermatological(prescribed by doctors)shampoos were analysed.
- 8(42.10%) shampoos have pH 5.5 or lower.
- 11(57.90%) Dermatological shampoos have pH higher than 5.5.
- 8 Professionals (salons) shampoos were analysed.
- 6(75%) have pH 5.5 or lower.

❖ 2 (25%) shampoos have pH higher than 5.5.

DISCUSSIONS

- Most of the analysed products have a final pH higher than the hair shaft pH of 3.6 and even higher than scalp pH of 5.5.
- There are no standardized pH for any specific indication of hair shampoo, either commercial/popular, antidandruff or dermatologically prescribed products.
- The pH level is not a mandatory issue to be printed on the product labels or specified among the product formulation.
- Such scenario is not observed products for professional use in hair salons, in which it is seen 75% of the products, have a pH value within the optimal range of 5.5 or lower.
- According to the current literature, the usage of shampoo with higher pH than 5.5 may increase friction and cause frizz, hair breakage and enhance hair tangling.
- After using a shampoo of pH higher than 5.5, conditioner of low-pH should be applied so that besides lubricating, the electrostatic forces can be neutralized, the frizz effect eliminated and cuticle scales may be sealed.
- If the conditioner is not recommended by dermatologist, it is necessary to choose a shampoo with pH lower than.
- Regarding the paediatrics shampoos, one can attribute the higher pH (100% of the samples had a pH higher than 6.0) encountered in the samples, to the fact that they have a major concern “no tears” concept rather than conditioning the fibre or the hair scalp.
- That is why the shampoo pH is closer to the tear physiological pH.
- If the hair cosmetics are formulated above the pH 3.67, cationic ingredients must be added to the formula in order to be attracted by the negatively charged net.
- Therefore, the more negative the net is, the more attracted to it are the cationic ingredients added to the formulas of the sample.
- If a shampoo formula is above pH 3.67 and has no cationic ingredients added, the electrostatic forces will considerably increase the tangling and the attrition forces, increasing the damage to the A-layer and the epicuticle of the hair fibre.
- The prescription of a shampoo treatment formulated without the cationic ingredients will demand the use of conditioner after shampooing.
- This situation is commonly avoided by dermatologist, which do not encourage the use of hair conditioners due to the possibility of worsening seborrheic dermatitis.

- For commercial and popular available shampoos, the higher pH might impair the performance of the product regarding compatibility and manageability because of friction and frizz effect.
- For extremely greasy and thin straight hair it may have a positive effect, of adding volume to the hair.
- It is of notice that a pH higher than 5.5 may irritation of the scalp.

CONCLUSION

- There is no standardized value for shampoo final pH, and this is not mandatory issue.
- The pH value is not informed on the labels.
- As the fibre has a pH of 3.67, a pH closer to 3.67 has less possibility to increase the negative charge that normally involves the capillary fibre.
- To address the treatment of the scalp, shampoos must have a pH higher than 5.5.
- Most of the commercially available products, do not fulfil this requirement.
- Since there is no obligation in specifying this variable(pH) in the formula, it is the dermatologists'duty to demand the inclusion of antistatic agents in the formulas of shampoos and conditioners.
- Ideally, however, this rule should apply to any hair product since we know that it is important for the final result of using them.
- It is important that the dermatologist know that, besides inclusion of antistatic agents in the shampoo and conditioner formulas, the formula and ingredients must create a final pH no longer than 5.5 so not to damage the scalp.
- We consider that, to reduce aggression against the strands and allow adequate access to the treatment of the scalp issues, hair care cosmetic should not overcome the pH of 5.5, as to avoid a significant increase in static electricity and consequently, in the negativity of the hair fibre that causes frizz.
- Although the products were collected at pharmacies, the brands are international famous brands and may be found all over the world.
- Further works are needed to compare the performance of different levels of pH shampoo's formulas and their cationic ingredientspresent in the chassis as well as the type and percentage of the surfactants.

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