



Development and efficacy evaluation of hair care formulations containing vegetable oils and silicone

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Abstract

Introduction: Several active ingredients have been used for hair cosmetics, such as proteins, vitamins, plant extracts and mainly silicones, due to its low cost and easy application. Thus, the use of silicone promotes a superficial treatment of the fiber. This way, vegetable oils have been explored as an alternative to be applied in more effective hair care cosmetic products. The Brazil nut oil, composed of polyunsaturated fatty acids, proteins, minerals and complex B vitamins, presents potential to act in the hydration, nutrition and strengthening the hair fiber. Olive oil consists of monounsaturated fatty acids, triglycerides, tocopherol, carotenoids and squalene, presenting antioxidant activity and, potential to hydrate and prevent hair damage. The aim of this study was to evaluate comparatively the efficacy of hair care formulations containing Brazilian nut, olive oil or silicone - cyclomethicone.

Methods: It was developed three hair care formulations, a shampoo, a conditioner and a leave in. To the efficacy evaluation test, brown virgin hair tresses (without any type of treatment) were obtained and divided in 4 groups, a control (without application of formulations), tresses with application of the formulations containing silicone, olive oil or Brazil nut oil. The tresses were submitted to hair strength and combability test in the equipment Texturometer TAXT Plus® and shine analysis using Skin Glossymeter GL200®.

Results: The results showed that the tresses with application of olive oil and Brazil nut oil presented an increase of break force, reduction in the combing force and increase of shine, when compared to the silicone formulation. This result suggests that the silicone promotes a superficial treatment of the hair fiber. Thus, vegetable oils can be considered a good alternative for the treatment of hair damage as it promotes an improvement of hair conditions.

Conclusion: The developed formulations added with the vegetable oil were effective in the improvement of hair cuticles, increasing the hair softness, hydration and its strength, which was not observed for the formulation with silicone. This way, the vegetable oils can be a good choice to application in the development of hair care cosmetic formulations, in order to improve of hair gloss and softness as well increase the hair resistance to breakage.

Keywords: Brazil nut oil, Olive oil, Silicone, Hair care formulations, Efficacy evaluation.



Introduction

The use of cosmetics and the influence of these products on the well-being have been reported to be related to skin and hair care, since capillary changes (fall, appearance of white hair) can affect the quality of life.¹

Considering the growing interest and consumption of hair care products, given that Brazil is the third world market for personal hygiene, perfumery and cosmetics and the second world market for hair cosmetics,² the Research and Development of innovative and effective products is of fundamental importance.

Thus, there is a growing interest in researches that evaluates the hair damage caused by environment and chemical treatments, as well as the development of formulations that meets the consumer's needs.^{3,4}

Previous studies of our research group have shown that

hair care is of prime importance for the quality of life and well-being of women, since hair plays a significant role in women's body image.¹

Several ingredients have been used for hair cosmetics, such as proteins, amino acids, vitamins, conditioning agents, sunscreens, plant extracts and mainly silicones, due to their low cost. Silicones are used for hair treatment due to its properties, which allows it to deposit on the surface, forming a uniform film,⁵ giving the feeling of conditioning in the fiber. However, the use of silicones promotes only a superficial treatment of the fiber. Thus, substances of natural origin such as vegetable oils are now being explored by the cosmetic market.

Vegetable oils are natural compounds, derived from oleaginous plants, which presents several benefits to the human body, skin and hair. The vegetable oils are



composed mainly of triglycerides, the combination of glycerol with 3 fatty acids, these being monounsaturated or polyunsaturated.⁶

Their composition allows it to form a film on the surface of the fibers, promoting a protection of the cuticles, that will consequently act to protect the cortex region. In addition, they act in the improvement of sensorial characteristics of the hair fiber.⁷

Brazilian nut oil has 60% to 70% lipids, polyunsaturated fatty acids, 15 to 20% proteins, selenium, calcium, iron, magnesium and B-complex vitamins.⁸ Due to the amount of selenium in its composition, presents properties in the reduction of the formation of free radicals (antioxidant activity), preventing the natural destruction of the cells, as well as the protective effect of ultraviolet (UV) rays.⁹ Thus, the Brazilian nut oil, can act in the hydration, nutrition and strengthening of the fiber, aiding in the repair of damages to which the hair is exposed daily.

The olive oil presents in its composition monounsaturated fatty acids, triglycerides, tocopherol, squalene and carotenoids. It presents, due to the large amount squalene, potent antioxidant activity,¹⁰ acting on capillary hydration, besides the prevention of damage caused by UV radiation.¹¹ According to Fernandez et al,¹² solar radiation promotes changes in the structure of keratin, with the photo oxidation of amino acids, leading to a weakening of the sulfide bridges. In this way, the solar radiation can lead to the weakening of the fiber. Therefore, it is important prevent the daily damages to the fiber, not only to repair them.

The comparative sensory and texture profile analysis of cosmetic products for skin care containing vegetable oils and silicones, showed a significant better result for formulations containing vegetable oils.^{13,14} Considering the importance of the development of formulations based on vegetable oils as an alternative to the use of silicones, the research and development of hair care products containing vegetable oils and/or silicones and subsequent comparative analysis is of great value for evaluation of the effects of these compounds in the prevention and treatment of hair damage.

Considering that the Cosmetic Research and Development protocol includes studies of the stability and efficacy of the formulations under development, some methods have been described for the evaluation of the effectiveness of hair products, such as the tensile test by the evaluation of the mechanical properties, the Break stress, break extension and young modulus of the hair fiber, and evaluation of the combability,¹⁵⁻¹⁷ using Texture Analyzer. Physical properties, as the evaluation of the gloss and analysis of the fiber structure using laser confocal microscopy are also great parameters to evaluate the efficacy of hair care formulations.^{17,18} These methods are of great value to obtain products with proven effectiveness, including in subjective tests and objectives of use.

In this context, the development of formulations containing vegetable oils and/or silicones, for the prevention and treatment of the physical and chemical damages that the hair undergoes daily and comparative evaluation of the performance, aims to clarify the real benefits of its applications in cosmetic products.

Objective

The aim of this study was to evaluate comparatively the efficacy of hair care formulations containing Brazilian nut, olive oil or silicone - cyclomethicone.

Materials and Methods

Developed Formulations

The study protocol to the formulation's development was made to obtain a shampoo, conditioner and leave in formulations for hair care.

The hair care products were prepared with the following ingredients:

Shampoo formulation: Sodium laureth-2 sulfate, disodium laureth sulfosuccinate, cocamide DEA, cocamidopropyl betaine, PEG-40 hydrogenated castor oil, polyquaternium 7, PEG-8, panthenol, hydrolyzed keratin, BHT, EDTA, Aqua (water).

Conditioner and Leave in formulation: Behentrimonium methosulfate, cetyl alcohol, butylene glycol, PEG-40 hydrogenated castor oil, cetrimonium chloride, glycerin, propylene glycol, PEG-75 LANOLIN, BHT, EDTA, Aqua (water).

These formulations were added or not (vehicle) with Brazil nut oil, olive oil or cyclomethicone.

Hair Characterization

Tensile Test

The tensile test was performed using the Texturometer Analyzer TXA XT Plus[®]. The analysis was done at 20-22°C temperature, 50%-60% relative humidity (RH). The wire diameters were measured with a dynamometer and 20 fibers of similar diameter with at least 10 cm long were selected. The 20 wires were submitted individually to the rupture test in the Texturometer at 55 mm distance, 10N load and constant rate of 300 mm/min.¹⁷

Hair Combing Analysis

The hair combing analysis was carried out using the Texturometer Analyzer TXA XT Plus[®]. The analysis was done at 20-22°C temperature, 50%-60% RH. The hair sample of 5g is placed in the upper jaw of the equipment (load cell between 5.0 and 25.0 kg). The force required to pass the comb through the strands is measured by the equipment through its software, which makes the combing resistance calculations.¹⁹⁻²¹ The results are given in gF and each test is done in 10 cycles.

Hair Gloss Analysis

The evaluation of the hair tresses gloss was performed with the Skin Glossometer GL200[®] equipment, which

measures gloss of the hair surface. The analyses were done in hair samples of 5 g, one sample per group, at 20-22°C temperature, 50-60% RH and in the absence of light to avoid interference. Nine measurements were performed, 3 in each region of the with the tress split into 3 regions, i.e., roof, middle and tip.^{17,22-24}

Results and Discussion

Tensile Test

The obtained results in the tensile test, showed that the use of the formulations with the vegetable oils promoted an increase of the hair fiber strength, which was not observed in the hair fiber with the application of the formulation with silicone (Figure 1). This increase was significantly higher for the formulation with Brazil nut oil, which shows the benefits of the application of this oil in the mechanical properties of the fiber. As this analysis evaluates the internal structure of the hair, the strength of cortex region, with this increase, it can be concluded that the composition of the vegetable oils presented in the formulations, such as proteins, selenium, calcium, iron, magnesium and B-complex vitamins presented in the Brazil nut oil and tocopherol, squalene and carotenoids present in the Olive oil, promoted a treatment of the internal region (cortex) of the hair fiber, increasing its strength.^{8,9,16,25}

According to Yu et al,^{26,27} the majority of the hair composition is of proteins, 65% to 95% depending on the humidity, up to 32% of water and the rest of the composition is of lipids and other compounds. The α -keratin is the protein most present in the hair composition, presented in its majority on the cortex region, which is the responsible region for the tensile properties of the hair.^{28,29} Thus, the obtained results showed a higher increase in the hair strength when treated with the formulation with Brazil nut oil, due to its composition, rich in proteins and selenium, once the increase of hair proteins in the hair fiber can promote this effect on the hair fiber.

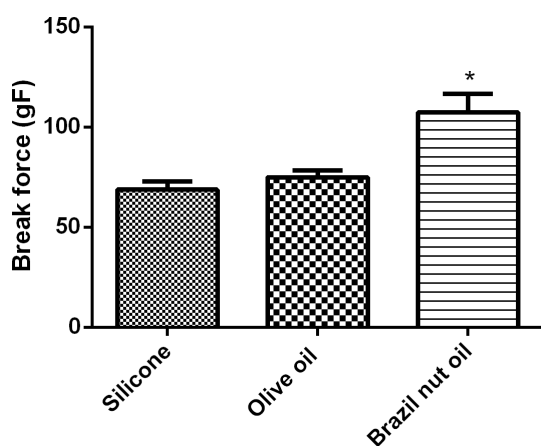


Figure 1. Break Stress of The Silicone Versus Olive Oil and Brazil Nut Oil (* Indicates significant difference $P < 0.005$).

Compatibility Test

The results obtained in the compatibility test (Figure 2) shows that after the first application, a significant reduction was observed in the values of the strength required to comb the hair, representing an increase of the softness of the hair tress and less resistance to comb the hair. After 15 applications, a significant change was observed and the tress with application of the Olive oil extract presented better results.

At the same time, the control tress (without application of any formulation) showed a high strength required to comb, consequence of the absence of treatment. This means that the lipid content of the vegetable oils and also the silicone promoted a lubrication of the hair surface, promoting an increase in hair softness. At the same time, the control tress required greater combing force.

This show the importance of the adequate conditioner treatment to the hair, in order to maintain the integrity of the hair fiber, since the higher the force required to comb the hair, higher the risk of mechanical damage to the hair fiber.^{17,26}

This means that the vitamins and silicones promoted a lubrication of the hair surface, promoting an increase in hair softness. In contrast, the control tress required greater combing force, showing the importance of the conditioning treatment in order to maintain the integrity of the hair fiber, since, the greater the combing force, the greater the damage to the fiber.¹⁷

Gloss Analysis

As it is possible to observe in the analysis of the results (Figure 3) the tresses with application of the formulations with the Brazil nut and olive oil, presented a significant improve in the hair gloss, when compared to the with application of the silicone formulation.

The glossymeter equipment measures the gloss using the principle of the reflectance of the light, thus a more regular surface will have a higher reflectance and,

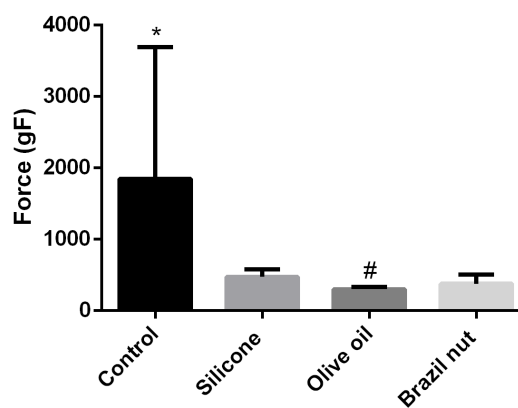


Figure 2. Compatibility of the Control Versus Olive Oil, Brazil Nut Oil and Silicone, After 7 Applications, t7 and after 15 Applications t15 (* indicates significant difference $P < 0.005$).

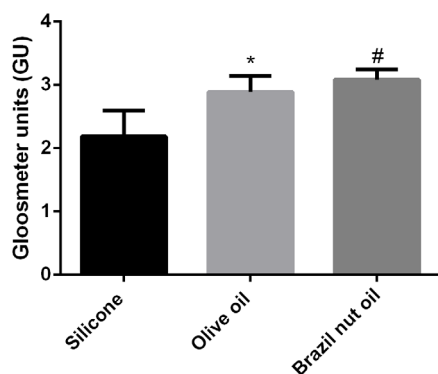


Figure 3. Gloss Analysis of the Silicone versus Olive oil, Brazil Nut Oil, After 7 Applications, t7 and After 15 Applications t15 (* indicates significant difference $P < 0.005$).

consequently more shine.^{23,28} This way, the equipment allows the evaluation of the improvement in the hair surface.

The hair surface, the outermost layer of the fiber, is composed of cuticles. The cuticles are 0.3–0.5 μm and are divided into exocuticle, epicuticle, endocuticle and the cell membrane complex that bind all the layers together. The cuticle has the principle function of protection of the internal structures of the hair fiber, as the cortex region, consequently being the region most exposed to damages.²⁷⁻²⁹ Thus, the protection and treatment of this region is very importance to maintain the integrity of the hair fiber.

The improvement of the hair fiber shine with the use of the formulations with the vegetable oils, allowed us to conclude that the formulations promoted a treatment of the hair fiber surface, which is not observed in the tress with application of the vehicle formulation. This can be related to the composition of the formulations, which are rich in monounsaturated fat acids and triglycerides (olive oil) and, polyunsaturated fat acids as well as proteins (Brazil nut) that can form a film on the surface region and also improve the hair hydration.

According to Belleti et al,³⁰ the hydration is directly related to the water content both in hair and skin. In her previous studies, it was shown that the increase of the water content can improve the hair strength, determined by DSC analysis and using the hair strength methods.³¹ Thus, since the formulation was able to promote a repair in the cuticle region as shown, it was also able to reduce the water loss of the hair fiber, consequently increasing its hydration.

In summary, the formulations supplemented with the vegetable oil were effective in the improvement of hair cuticles, increasing the hair softness, hydration and its strength, which was not observed for the formulation with silicone. This way, the vegetable oils can be a good choice to application in the development of hair care cosmetic formulations, in order to improve of hair gloss and softness as well increase the hair resistance to breakage.

Finally, the understanding of the effects of vegetable oils in the hair fiber is very important, in order to help the choice of effective active ingredients for the development of more effective hair care formulations with proven effectiveness.

Conclusion

The Research and Development protocol of hair care formulations resulted in stable formulations of shampoo and conditioner in order to add the active ingredients under study.

The application of the formulations added with the vegetable oils promoted an increase of the strength necessary to break the fiber (break stress), improvement of hair softness and a reduction of the strength to comb the tress. On the other hand, the use of silicones promoted only a superficial treatment of the fibers, though it presents a good acceptance in the market. In addition, the vegetable oils have also been showing a good acceptance and can promote an improvement of the hair fiber conditions, with a deeper effect in the cortex region, as observed in the tensile test.

Competing Interests

None.

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