



Development of hair care formulations containing *Spirulina platensis* and *Ascophyllum nodosum* extracts

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Abstract

Introduction: Considering that oily skin and hair is a constant concern, the search for active substances that helps skin and hair oiliness control it is a challenge in the Research & Development of cosmetics. Seaweeds are much known for its use as foods and microalgae are a type of seaweeds that convert solar light in bioactive compounds attractive for commercial interest. *Spirulina platensis* and *Ascophyllum nodosum* are microalgae present potential to be applied in cosmetic formulations, due to its properties, such as antioxidant activity, skin hydration and skin and hair oiliness control. Thus, the aim of this study was to develop and evaluate the efficacy of hair care formulations containing *Spirulina platensis* and *Ascophyllum nodosum* extract.

Methods: Shampoo and conditioner formulations supplement or not (vehicle) with *Spirulina platensis* and *Ascophyllum nodosum* extract were developed. Two hair samples of virgin brown hair with 10 g each were selected to perform the hair characterization tests and were evaluated in terms of Break force, combability and shine. After, 26 study participants were recruited for the clinical efficacy study and the sebum content were evaluated before and after 28 days of use.

Results: After 28 days of application of the conditioner containing *Spirulina platensis* and *Ascophyllum nodosum*, a decrease of the combability force for the wet and dry hair sample and an increase of hair shine were observed.

Conclusion: The formulation containing microalgae in combination presented benefits to the hair fiber, once the obtained results showed an improvement of hair mechanical properties and fibers surface.

Keywords: Hair care formulations, Hair characterization, *Spirulina platensis*, *Ascophyllum nodosum*



Introduction

Hair appearance and hair care are related with self-esteem and quality of life. The way hair looks it is important for women and men and can impact in self-image.^{1,2}

At the same time, oiliness is a condition that also affects negatively the image and self-esteem. Caused by the excessive oil production in enlarged sebaceous glands, oiliness gives skin and hair scalp a greasy appearance.³ This way, as oiliness is a constant concern, the search for active substances that helps in oiliness control it's a challenge for Research & Development area.

Seaweeds are much known for its use as foods, mainly in East Asian countries as Japan, China and Korea. Despite its use as food, seaweeds have potential to be applied in nutrition, pharmaceutical and cosmetic industries due to its rich composition. Microalgae are a type of seaweeds that convert solar light in bioactive compounds attractive for commercial interest.^{4,5} In this context, *Spirulina platensis*

and *Ascophyllum nodosum* are microalgae have potential to be used in cosmetics, due to its countless properties.

The *Spirulina platensis* used in our research is obtained by biotechnological process and is rich in pro-vitamin A, vitamins of the B complex, pigments, minerals, proteins, fatty acids, amino acids and polysaccharides as glucose, galactose, mannose and ribose.⁶ *Ascophyllum nodosum* is rich in vitamins A, B and C, minerals, proteins, fatty acids, pigment, amino acids and aspartic and glutamic acids.^{7,8}

Considering *Spirulina platensis* and *Ascophyllum nodosum* composition, they have anti-bacterial, anti-oxidant and anti-inflammatory properties.^{4,6,7}

Considering the rich composition and properties of *Spirulina platensis* and *Ascophyllum nodosum*, previous studies of our research group^{9,10} showed that microalgae have potential to act in skin and hair oiliness control and in the improvement of hair fiber conditions providing better nutrition, hydration and strengthening.



In this context, the development of cosmetic formulations containing microalgae in association is an innovation in cosmetic field and can help in the oiliness control as well as treat hair fiber.

Objective

The aim of this study was to develop and evaluate the efficacy of hair care formulations containing *Spirulina platensis* and *Ascophyllum nodosum* extract.

Materials and Methods

Developed Formulations

A Shampoo and conditioner formulations containing stable ingredients were developed.

The shampoo was prepared with the following ingredients: sodium laureth-2 sulfate, disodium laureth-sulfosuccinate, cocamide DEA, cocamidopropyl betaine, propylene glycol, BHT, disodium EDTA, sodium chloride, phenoxyethanol, methylparaben, ethylparaben, propylparaben, butylparaben, isobutylparaben and aqua (water).

The conditioner was prepared with the following ingredients: cetearyl alcohol, behentrimonium methosulfate, cetyl alcohol, ethylhexyl stearate, BHT, disodium EDTA, propylene glycol, glycerin, phenoxyethanol, methylparaben, ethylparaben, propylparaben, butylparaben, isobutylparaben, *Spirulina maxima* extract, *Ascophyllum nodosum* (L.) extract and aqua (water).

Conditioner was added or not (vehicle) with 0.1% *Spirulina platensis* dry extract and 2% *Ascophyllum nodosum* extract. The extracts were completely soluble in the conditioner, which was verified by centrifugation used to evaluate formulation stability. The shampoo was kept without active substances due to extracts instability also verified by centrifugation.

The stability of the formulations was evaluated after 24 hours of preparation in 3 cycles of 30 minutes each at 3000 rpm centrifugation. Also, the pH was evaluated for 90 days.

Hair Characterization

Hair Samples

Two hair samples of virgin brown hair with 10 g each were selected to perform the characterization tests. The samples were washed with the vehicle shampoo developed and then the conditioner without active substances - vehicle was applied in one sample and, the other sample received the conditioner with *Spirulina platensis* and *Ascophyllum nodosum*. Measurements of break force, combability force and shine were made before the application of any treatment in the control sample and after application of shampoo and conditioners.

Tensile Test

Tensile test was performed using a TA.XT Plus Texture

Analyzer (Stable Microsystems, Surrey U.K.). Were selected 20 fibers and then submitted individually to the rupture test in Texturometer equipment at 55 mm distance, 10 N load and constant rate of 300 mm min⁻¹.¹¹

Hair Combing Analysis

The combing analysis was performed using a TA.XT Plus Texture Analyzer (Stable Microsystems, Surrey U.K.). The hair sample was placed in the upper jaw of the equipment and the force required to pass the comb through the hair sample was measured. The test was made with the samples before washing the control sample (dry condition) and after washing (wet and dry condition).

Hair Gloss Analysis

Gloss analysis was performed using a Skin Glossometer GL200® (Courage & Khazaka, Cologne, Germany) which measures the gloss in hair surface. The test was performed in absence of light to avoid interferences. In total, 9 measures were performed divided in 3 regions of the hair samples.¹¹

Clinical Efficacy

Clinical efficacy was evaluated through quantification of sebum content in hair scalp using a Sebumeter® SM810 (Courage & Khazaka, Cologne, Germany). For this, after stability tests and Ethical Committee approval (CEP/FCFRP n°. 440 – CAAE n° 65154017.8.0000.5403) 26 participants aged between 18 and 35 years old with oily hair were recruited.^{12,13} The participants were divided into two groups, one group used the shampoo and conditioner without the algae in association (vehicle) and the other one used the formulation containing both active substances. Both groups used the shampoo without active substances (vehicle).

Results and Discussion

Formulations

The aim was to develop a shampoo and conditioner containing *Spirulina platensis* and *Ascophyllum nodosum* extract. However, the final shampoo formulation didn't contain any extract due to the difficulty in stabilizing the extracts in this type of formulation.

The final conditioner formulation presented stable with both extracts.

Tensile Test

According to the obtained results (Figure 1), there was not significant difference between control and the treatments. An increase in break force for the formulation containing microalgae can be observed though it was not statistically significant when compared to the control and vehicle formulation. The break force analyses provide data about hair fiber's cortex condition and diameter of the fiber.¹⁴ This way, an increase shows that the microalgae rich

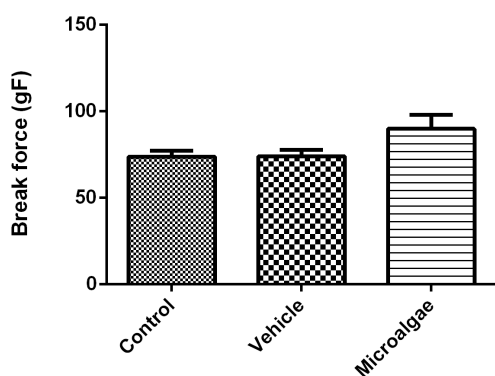


Figure 1. Break stress of control versus vehicle and microalgae formulations.

composition in vitamins, minerals, proteins and amino acids may have improved the hair fiber conditions by increasing its strength.⁶⁻⁸

Hair Combing Analysis

The results obtained in the combability test shows that after the application of the formulations there was a decrease in the combability force in the analysis of dry hair samples (Figure 2). It is possible to observe a significant decrease in the required force to comb comparing control and vehicle formulations and, also control and microalgae formulations.

For the wet hair sample, the results show also a decrease in the required force to comb comparing the formulations with the control sample and, also comparing the vehicle and microalgae (Figure 3).

The force required to comb the hair is related with the evaluation of hair conditioning, therefore the decrease in the combability force indicates a better conditioning treatment.¹⁴ The conditioning agent turns hair easier to comb due to the reduction of fiber static electricity.¹⁵ Also, the results show that the treatment is important to the hair fiber, once that the reduction of the strength required

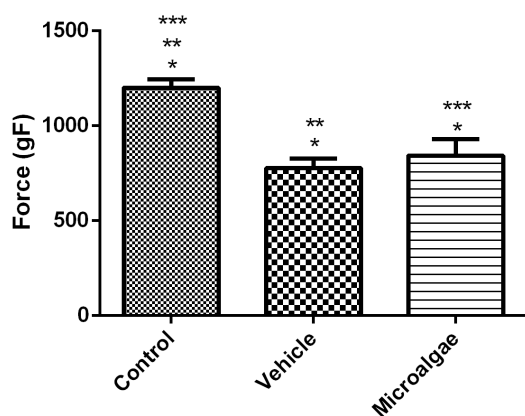


Figure 2. Combability of control versus vehicle and microalgae of dry hair sample (* indicates significant difference $P < 0.005$).

to comb reduces the damage caused by the combing process.¹⁶ It was possible to observe a reduction of the force required to comb the hair after the application of the vehicle formulation due to its conditioning agents in the composition. After the application of the formulation containing microalgae the decrease was even more evident (Figure 3), due to *Spirulina platensis* and *Ascophyllum nodosum* composition rich in vitamins A, B and C, minerals, proteins, fatty acids and amino acids.⁶⁻⁸

Hair Gloss Analysis

Hair tresses treated with the formulation containing algae in association showed a significant increase of hair shine when compared with the control sample, showing an improvement of the hair surface. Hair shine is how the hair surface reflects and diffuses the incident light (Figure 4). Hair surface comprises hair cuticle thus, alignment is related with hair shine. This way, the increase of hair shine indicates that there was an improvement of hair fibers surface conditions and cuticle alignment after the application of the formulation with microalgae.^{14,17}

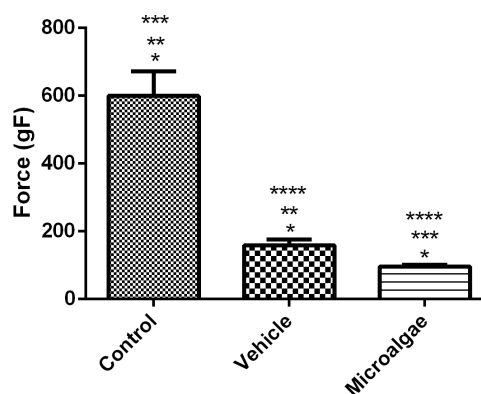


Figure 3. Combability of control versus vehicle and microalgae of wet hair sample (* indicates significant difference $P < 0.005$).

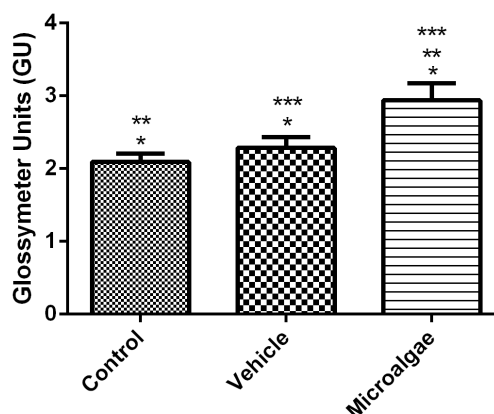


Figure 4. Gloss analysis of control versus vehicle and microalgae of hair sample (* indicates significant difference $P < 0.005$).

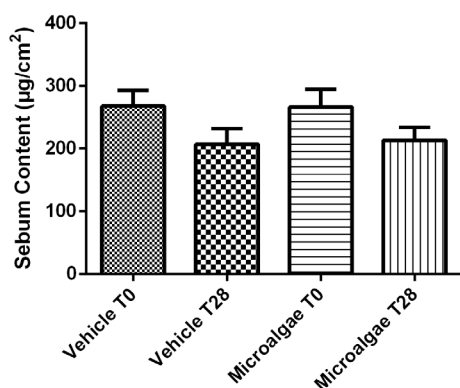


Figure 5. Sebum content after the use of vehicle and microalgae formulations for 28 days.

Clinical Efficacy

According to the obtained results, there was not significant difference between basal and after 28 days of treatment with vehicle and microalgae formulations. It is possible to observe a decrease in sebum content in both treatments, but there was not a statistical significance among them (Figure 5).

The reduction of sebum content is related to the shampoo surfactants composition, once their most important function is to clean the hair.¹⁸ The shampoo formulation vehicle and containing microalgae effectively cleaned the hair. Besides that sebum production can be altered by weather, diet and age, this way the sebum production of the participants during the test may have been modified by one of these factors.³

Conclusion

The formulation containing microalgae under study in combination presented benefits to the hair fiber, once the obtained results showed an improvement of hair mechanical properties and fibers surface. The increase in the hair shine and the decrease in combing force after the treatment with the formulation containing algae in association is an indicative of this improvement. The decrease in sebum content was observed in both treatments and for this reason can be related to shampoo surfactants, alterations in weather and diet and influence of age.

Finally, the obtained data scientifically proven the potential of microalgae as an active ingredient for the development of innovative hair conditioner formulation, once it showed benefits for hair fibers and improve its properties.

Competing Interests

None.

Founding Sources

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