ENHANCING HAIR HEALTH: UTILIZING SPIRULINA BIOMASS AS AN ACTIVE INGREDIENT IN COSMETIC FORMULATIONS

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ABSTRACT

Biocosmetics have occupied a significant place in consumers' choices in the beauty market. In recent years, the demand for natural cosmetic products has increased considerably, leading cosmetic industries to innovate regarding their active ingredients. This growing demand is directly related to a shift in consumer thinking and behavior, which is more oriented toward seeking sustainable products. For years, synthetic actives have been added to cosmetics and have triggered a series of short and long-term harmful effects. Considering this, natural actives emerge as an alternative to synthetic actives. Spirulina (*Arthrospira*) is a cyanobacterium with health benefits due to its rich composition of proteins, vitamins, essential fatty acids, and bioactive compounds. In this context, the present study aims to develop two vegan cosmetic formulations, shampoo and hair mask, using Spirulina biomass as a natural active ingredient. Three different concentrations were prepared for each formulation: shampoo with 1%, 3%, and 5% and mask with 5%, 7%, and 10% of Spirulina biomass. The formulations underwent characterization tests, such as scanning electron microscopy (SEM-FEG) and spectrophotometry of Fourier Transform Infrared (FTIR). The results demonstrate that it is possible to incorporate dry Spirulina biomass into both hair formulations.

Keywords: Spirulina. Bioactive compounds. Biocosmetics. Hair cosmetic.

1 INTRODUCTION

The global consumption of cosmetic products has increased over the years, and according to the Brazilian Association of the Personal Hygiene, Perfumery, and Cosmetics Industry (ABIHPEC), in the first semester of 2023, there was a 14.1% increase in international trade flow in the category compared to the same period in 2022, amounting to approximately $249 million[1].

Simultaneously, synthetic actives used in cosmetic formulations have been associated with developing various health issues for humans and the environment. The presence of toxic elements in daily-use cosmetics can cause multiple types of allergies and irritation, and, due to recurrent exposure and absorption caused by continuous use, can result in dysfunction of vital organs and cancer[2,3]. As a result, the search for natural solutions in cosmetics has significantly increased. Not only consumers but also producers have been opting for natural ingredients and additives, showing a greater commitment to the health of their users and the environment[4]. Representing this new trend, biocosmetics are produced from 100% natural ingredients, free from pesticides and chemical fertilizers, using techniques related to green chemistry in extraction and production processes. Regardless of the naming, these products are less harmful to health and the environment when compared to conventional cosmetics, primarily due to the presence of substances considered non-toxic and safe[5].

Spirulina is a phototrophic microalga classified as a natural ingredient, widely known for its high nutritional value, and has been used as food or a dietary supplement for decades. Its chemical composition, in addition to containing vitamins and minerals, is rich in proteins (55% to 70%), carbohydrates (15% to 25%), essential fatty acids (5% to 8%), and pigments (carotenoids, phycocyanin's, and chlorophyll)[6,7]. Despite the considerable amount of research related to the application of Spirulina in food, little has been published about its application in the cosmetic field. Much of the cosmetic action of Spirulina is directed towards its use in dermocosmetics, exploring properties such as anti-aging, anti-acne, and wound healing effects[8,9,10]. However, studies specifically focused on proving the compound's efficacy in hair formulations are scarce, with products available in the market being supported by marketing claims about natural actives. In view of the above described, this work aims to develop two vegan hair cosmetic formulations, shampoo and mask, using Spirulina biomass as a cosmetic active to evaluate the feasibility of successfully incorporating dry Spirulina biomass.

2 MATERIAL & METHODS

Spirulina dry biomass was standardized with a particle size of 100 mesh and incorporated at 1%, 3%, and 5% (w/v) concentrations in the shampoo and 5%, 7%, and 10% (w/v) in the mask. The samples were inserted into a carbon fiber support and analyzed via resolution Scanning Electron Microscopy (SEM-FEG) (FEG-SEM Supra 35 VP, Carl Zeiss, Germany) to check the homogenization of the active ingredient in the formulations and analyzed via spectrophotometry Fourier Transform Infrared (FTIR) (Bruker Alpha-P, in the range between 4000 - 400 cm^{-1}) to evaluate the presence of Spirulina in the formulations and possible unwanted interactions. For FTIR, the samples were crushed with potassium bromide (KBr), and the powder obtained was pressed to form tablets for reading.

3 RESULTS & DISCUSSION

Spirulina crushed and sifted dry biomass was incorporated into the shampoo base formulation and the hair mask. The hair mask showed easy homogenization, while the shampoo formulation remained homogeneous after 24 hours.

From the images obtained by scanning electron microscopy (SEM-FEG), it was possible to evaluate the surface of the formulations. The shampoo samples maintained a homogeneous surface, guaranteeing complete solubilization of the active ingredient in the formulation (Figure 1). The hair mask samples had a surface with holes because it is an emulsion, and therefore, the irregularities are due to the aqueous and oily phase that makes up the base. Due to the nature of the base used, the Spirulina biomass was not completely solubilized in the solutions, which can be seen in the SEM-FEG images of samples M5, M7, and M10 in Figure 2.

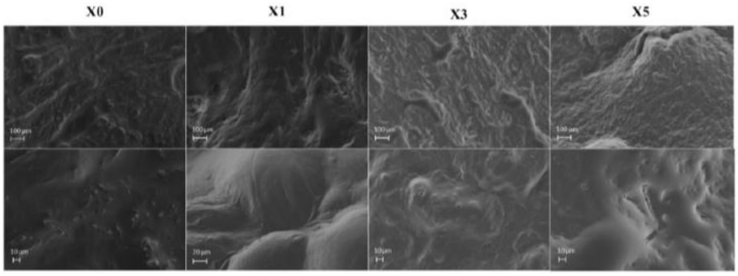

Figure 1 Images obtained by high resolution Scanning Electron Microscopy (SEM-FEG) of samples of base shampoo (X0), 1% Spirulina biomass shampoo (X1), 3% Spirulina biomass shampoo (X3), 5% Spirulina biomass shampoo (X5).

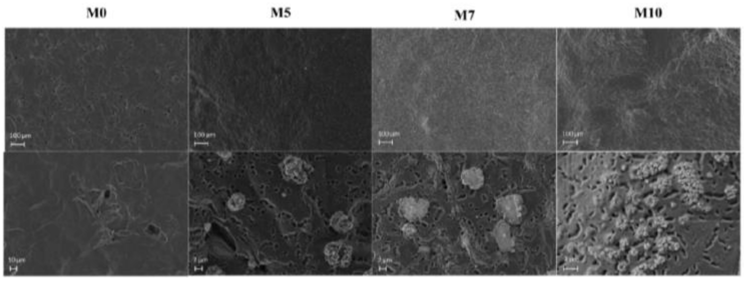

Figure 2 Images obtained by High Resolution Scanning Electron Microscopy (SEM-FEG) of samples of base hair mask (M0), base hair mask 5% Spirulina biomass (M5), base hair mask 7% Spirulina biomass (M7), base hair mask 10% Spirulina biomass (M10).

FTIR analysis was carried out to confirm the presence of Spirulina biomass in the formulations and analyze whether there was any type of interaction that could impact the product. Initially, the shampoo and mask formulations were compared with the bioactive active ingredient to verify the composition profile (Figure 3), and, for both the shampoo and the mask, there was no variation in the FTIR spectrum of the formulations.

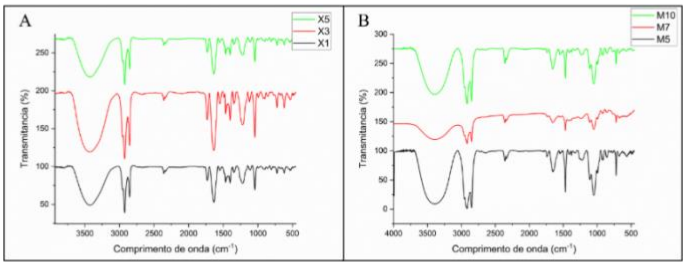

Figure 3 FTIR spectrum for shampoo (A) and mask (B) formulations with Spirulina biomass at different concentrations.

Since the composition profile did not vary, a sample of each formulation was selected for comparison with the FTIR spectrum of Spirulina biomass and the bases without incorporating the active ingredient (Figure 3). In all samples, it is possible to identify a peak in the region of 3416 cm^{-1}, referring to the presence of the -OH radical in the water molecule[11]. Furthermore, in the Spirulina biomass spectrum, peaks in the region of 2950 cm^{-1} correspond to C-H stretching. Carboxylic acids can be identified due to peaks in the region of 1650 cm^{-1}. The peak corresponding to the region of 1655 and 1540 cm^{-1} can be related to the presence of proteins in the sample[12].

As the base formulations contain a series of organic ingredients and Spirulina is a microalgae rich in several compounds, it is natural that several peaks relating to stretching and elongation in organic molecules are identified in both spectra. However, it is possible to observe differentiated peaks, either by presence or intensity. In Figure 4 (A and B), it is possible to observe two peaks, at 2362 cm^{-1} and 1656 cm^{-1}, present with greater intensity in the Spirulina sample, and when compared to samples X0 and M0, the peak is less pronounced but returns to form in samples X3 and M7. This result infers that Spirulina remained present in the formulations. In Figure 4A, a peak at 2924 cm^{-1} is observed, present in the shampoo formulations, but it becomes less evident in the Spirulina sample.

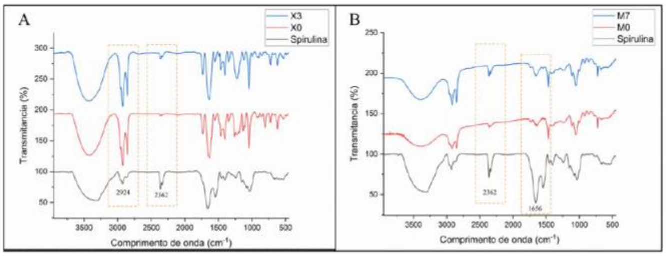

Figure 4 FTIR spectrum for samples (A) base shampoo, 3% Spirulina biomass shampoo and Spirulina biomass and (B) base mask, 7% Spirulina biomass mask and Spirulina biomass.

4 CONCLUSION

The need to replace synthetic active ingredients with natural compounds is a reality. Spirulina is a rich source of potential substances for hair cosmetic formulations, as well as for the use of its biomass. A possible difficulty in incorporating active ingredients into cosmetic formulations lies in homogenization since these solutions may present instability after adding certain compounds or even phase separation, as in the case of emulsions. However, the results presented demonstrate that it is possible to incorporate dry Spirulina biomass into both hair formulations, shampoo, and mask in a satisfactory way without affecting the structure of the substances that form the solutions and maintaining the integrity of the vegan bases used. In this way, Spirulina biomass presents itself as an active potential for hair cosmetic formulations.

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