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SUSTAINABILITY AND EFFICIENCY: VEGETABLE BIOSURFACTANTES AS CLEANING AGENTS IN SHAMPOO FORMULATIONS.

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ABSTRACT

Hair has cultural, social, and economic significance, influencing self-esteem and social integration. Hair care products, especially shampoos, are widely used, and their formulations are continuously innovated to cater to different hair types. Shampoos contain surfactants that clean the hair and scalp, but synthetic surfactants can cause allergies, hair loss, and irritations, and negatively impact the environment. In response, the cosmetic industry seeks to replace synthetic ingredients with natural, renewable, and biodegradable options. This study aims to formulate shampoos using extracts rich in biosurfactants from *Chenopodium quinoa* (quinoa) and *Ananas comosus* (pineapple), evaluating their cleaning potential. Plant-based biosurfactants are promising due to their surfactant and biological properties, as well as being more sustainable. The formulation with these extracts showed a sebum removal rate of 50%, significantly higher than the formulation with chemical surfactants alone, indicating that plant-based biosurfactants can act as effective primary surfactants. This approach aligns with market trends towards more natural and sustainable ingredients, reducing environmental impacts and the risks of irritation.

Keywords: Shampoo. Biosurfactants. Cleaning.

1 INTRODUCTION

. Hair holds significant cultural, social, and economic importance, being associated with improved self-esteem and integration into social, cultural, or ethnic groups. It is not surprising that hair care products are among the most widely used, especially shampoos, which feature innovative formulations tailored to different hair types [1].

Shampoos are essentially a solution composed of surfactants, the main components responsible for cleaning the hair and scalp, along with other ingredients and additives that provide benefits to the hair and enhance the shampoo's appearance and consistency. [2,3] One of the challenges faced by the cosmetic industry in shampoo formulations relates to allergies, hair loss, and skin and eye irritations caused by synthetic surfactants, which, in addition to harming humans, also affect soil and groundwater, causing environmental damage[4].

Thus, the cosmetic market has prioritized natural, renewable, biodegradable, and less toxic ingredients/actives that can reduce or replace synthetic raw materials in formulations. According to Cosmetics Europe (2019) [5], major companies in the sector reformulate 25 to 30% of their products annually, and about 10% of these reformulations depend on new actives/ingredients.

In this context, natural surfactants derived from plants present themselves as one of the alternatives to meet this demand. With great biotechnological potential, plant biosurfactants stand out for their surfactant and biological properties, in addition to offering higher yields in extraction processes compared to microbial biosurfactants.[6] The development of cosmetic formulations using plant biosurfactants is a promising possibility and presents itself as an alternative to cosmetics formulated exclusively with synthetic surfactants.

Therefore, this study aimed to formulate shampoos using extracts rich in biosurfactants from two plants: *Chenopodium quinoa* (quinoa) and *Ananas comosus* (pineapple), evaluating their cleaning potential.

2 MATERIAL & METHODS

Obtaining extract and producing prototypes

The dry pulp of the fruit of *Ananas comosus* and *Chenopodium Quinoa* will be used for hydroalcoholic extraction of biosurfactants using the Soxhlet apparatus, in the formulation, compounds described in Table 1 were used, prioritizing ingredients of natural origin. For instance, synthetic thickeners, humectants, and moisturizers were replaced with xanthan gum, vegetable glycerin, and coconut oil, respectively. Moreover, there was a reduction in the amount of synthetic surfactants, highlighting the natural surfactants present in the extracts, which were the focus of this study.

Table 1. Surfactant Agents Used

Code	Surfactant Agents
F1	*A. comosus* + *C. quinoa* + CGD
F2	CGD
F3	No surfactant

Cleaning Potential

The cleaning action of the formulations was evaluated based on the methodologies used by Thompson et al. (1985) [6] and Azadbakht et al. (2018).[7] The composition of the artificial sebum, used to simulate the presence of fat material, was adapted from Thompson et al. (1985)[8], with the following composition: 20% olive oil, 15% coconut oil, 30% oleic acid, 15% paraffin and 20% jojoba oil. The percentage of sebum removal was determined according to the following equation:

$$\text{Sebum removal (\%)} = (W1-W2)/(W1-W3) \times 100 \quad (1)$$

Where W1 is the mass of the strand with tallow, W2 is the mass of the strand after washing and W3 is the initial mass of the strand.

Statistical Analyzes

All tests were performed in triplicate and data are expressed as mean ± standard deviation. ANOVA analysis was used to determine significance. P values <0.05 were considered significant.

3 RESULTS & DISCUSSION

Development of prototype formulation

The components used in the basic formulations of the shampoo prototypes are listed in Table 2. Synthetic thickeners and humectants were replaced with natural ingredients, such as xanthan gum and vegetable-derived glycerin, respectively. Additionally, the amount of synthetic surfactants was reduced by incorporating natural surfactants present in the extracts.

Table 2. Basic Prototype Formulation.

Componente	INCI *	%	Função
Wafer	Aqua	qsp	Solvent
Extracts	*Chenopodium quinoa* e *Ananas comosus* fruit extract	10	Surfactant
Amisoft CCS 22	Disodium Cocoyl Gluatamate	4	Surfactant
Glycerin	Glycerin	3	Humectant
Xanthan Gum	Xanthan Gum	0,85	Thickener
Coconut Oil	Hidrogenated coconut oil	0,5	Moisturizer
Potassium Sorbate	Potassium Sorbate	0,2	Preservative
Oil Essential	Citrus Limon (Lemon) Peel Oil	0,2	Fragrance
Sodium Gluconate	Sodium Gluconate	0,1	Sequestrant
Citric Acid	Citric acid	qsp	pH Adjuster
Sodium Hydroxide	Sodium Hydroxide	qsp	pH Adjuster

Cleaning Action

When evaluating the cleaning potential of formulation F1, a sebum removal rate of 50% was observed, while formulation F2, containing only the chemical surfactant (CGD), showed a sebum removal rate of 1.5% (Figure 1). This result indicates that the addition of the extracts to the formulation provided a 48.5% increase in cleaning action, demonstrating effective application potential. The formulation without surfactant agents (F3) showed no cleaning potential.

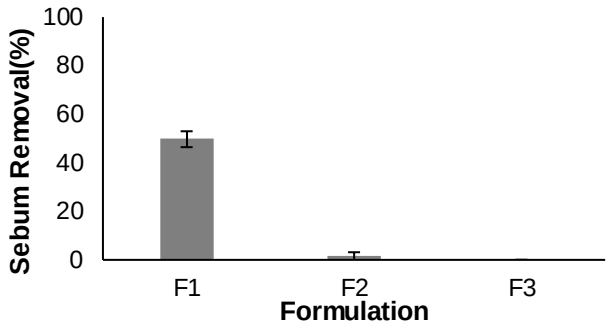

Figure 1. Cleaning Potential of the Formulations. F1: CGD + extract de *C. quinoa* + extract de *A. comosus*; F2: CGD; F3: No surfactants.

To achieve the desired results in shampoo formulations, it is common to combine at least two surfactant agents: the primary cleaner, in higher concentration, and the secondary, which compensates for the shortcomings of the first.[9,10] To reduce the number of synthetic surfactants in formulations and consider the cleaning potential of the extracts from *C. quinoa* and *A. comosus*, it is understood that they can be used as primary surfactants in shampoo formulations.

4 CONCLUSION

The results obtained in this study demonstrate that incorporating plant extracts rich in biosurfactants from *Chenopodium quinoa* and *Ananas comosus* into shampoo formulations is a promising strategy to reduce the number of synthetic surfactants without compromising cleaning efficacy, thus indicating that plant-based biosurfactants can act as efficient primary surfactants. This approach not only meets the demand for more natural and sustainable ingredients but also minimizes environmental impacts and the risks of irritation associated with synthetic surfactants, aligning with current trends in the cosmetic market.

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