BIOSHAMPOO: CLEANING POTENTIAL AND STABILITY

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ABSTRACT

When developing new cosmetics, a series of steps must be followed to reach the final product. In general, the process goes through the initial idea, preliminary research, and development of the prototype, when analytical tests are carried out to prove the viability of the product. In the present work, three shampoo prototypes containing plant extracts, rich in biosurfactants, from *Chenopodium quinoa* (quinoa), *Glycine max* (soybean), and *Malpighia emarginata* (acerola cherry), as primary surfactants were formulated and analyzed for stability and cleaning potential. Accelerated stability was determined by subjecting the prototypes to heating and cooling cycles for 90 days, and the cleaning potential was evaluated by the percentage of sebum removal from strands of hair washed with the prototypes. The stability test showed that the prototypes maintained their stable organoleptic, chemical and physical characteristics during the evaluated days. Regarding cleaning potential, the F3 prototype showed the highest percentage of sebum removal (60%), even greater than the removal obtained after washing with a commercial shampoo (56%), thus confirming the surfactant activity of the extracts of *C. quinoa*, *G. max* and *M. emarginata* and their potential as primary surfactants in shampoo formulations.

Keywords: Plant-derived surfactants. Plant extracts. Innovative cosmetics. Cleaning agents.

1 INTRODUCTION

Personal hygiene products and cosmetics play an essential role in everyday life. A wide variety of products are used daily, such as soaps, shampoos, toothpaste, deodorants, skin creams, perfumes and makeup.[1] Among these, shampoos are among the most used, having the primary function of cleaning the hair and scalp.[2]

The main components of shampoos are surfactants, responsible for the cleaning action and formation of foams, emulsions, wetting and dispersion. Such properties mean that surfactants have a wide range of applications in the cosmetics and cleaning industry[3,4]. However, the majority of surfactants present in shampoos are derived from petroleum, and almost always cause toxic effects on human health and the environment, in addition to being non-renewable, making it necessary to search for non-toxic, biodegradable and renewable surfactants. In this sense, natural surfactants (biosurfactants) present themselves as an alternative to replace or reduce the use of synthetic surfactants in formulations.[5]

Biosurfactants can come from plants and microorganisms and have the same functional properties as synthetic surfactants. Biosurfactants from plants, however, have received attention, especially due to the potential for better yields in extraction processes, when compared to the yield of biosurfactants from microorganisms, making them more viable for industrial applications.[6]

Given the above, the development of cosmetic formulations using plant biosurfactants as active ingredients and/or ingredients is a promising possibility and investment in applied research into these biomolecules has a great chance of resulting in direct applicability in innovative and safe formulations on the market. Based on this, the present study proposed to produce three shampoo prototypes using plant extracts rich in biosurfactants as primary surfactants and to evaluate the stability of these prototypes following regulatory requirements of the National Health Surveillance Agency (ANVISA), as well as to investigate the effectiveness formulations by analyzing their cleaning potential.

2 MATERIAL & METHODS

Obtaining extracts and producing prototypes

The seeds of *Chenopodium quinoa* and *Glycine max* and the dry fruit of *Malpighia emarginata* were used for the hydroalcoholic extraction of biosurfactants. [7] The three shampoo prototypes used plant extracts of C. quinoa, G. max and M. emarginata as primary surfactants and disodium cocoyl glutamate (DCG) as a secondary surfactant. The combination of extracts in the prototypes is presented in Table 1. A formulation without the addition of surfactants, another containing only DCG, and a shampoo already commercialized were used as comparative standards.

Table 1 Surfactants used in prototypes.

Code	Combination of surfactants
F1	*C. quinoa* + *M. emarginata* + DCG
F2	*G. max* + *M. emarginata* + DCG
F3	*C. quinoa* + *G. max* + *M. emarginata* + DCG
F4	DCG
F5	No Surfactant

Accelerated Stability

The prototypes were placed in neutral, transparent glass bottles with lids and were subjected to heating in ovens and cooling in refrigerators. Standard samples were kept at room temperature, and protected from light. The temperature values adopted were:

Cycles of 24 hours at 37 ± 2°C, and 24 hours at 5 ± 2°C;
Cycles of 24 hours at 40 ± 2°C, and 24 hours at 5 ± 2°C;
Cycles of 24 hours at 45 ± 2°C, and 24 hours at 5 ± 2°C.

The organoleptic (appearance, color and odor) and physical-chemical (pH and density) characteristics of the prototypes were evaluated at times zero, 24 hours and 7th, 15th, 30th, 60th and 90th days.[8]

Cleaning Potential

The cleaning action of the formulations was evaluated based on the methodologies used by Thompson et al. (1985)[9] and Azadbakht et al. (2018).[10] The composition of the artificial sebum, used to simulate the presence of fatty material, was adapted from Thompson et al. (1985)[9], 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 base formulations of the shampoo prototypes are listed in Table 2. Synthetic thickeners and wetting agents were replaced by natural ingredients, i.e., xanthan gum and glycerin of vegetable origin, respectively, and the amount of synthetic surfactants was reduced by the use of natural surfactants in the extract.

Table 2 Base formulation of prototypes.

Component	INCI *	%	Function
Water	Water	q.s.*	Solvent
Extracts	*Chenopodium quinoa* seed extract and/or *Glycine max* seed extract and/or *Malpighia emarginata* fruit extract	10	Surfactant
Amisoft CCS 22	Disodium cocoyl glutamate	4	Surfactant
Glycerin	Glycerin	3	Wetting agent
Xanthan gum	Xanthan gum	0.85	Thickener
Sodium benzoate	Sodium benzoate	0.2	Preservative
Essential oil	Lavandula officinalis Flower Oil	0.2	Fragrance
Sodium gluconate	Sodium gluconate	0.1	Scavenger
Citric acid	Citric acid	qsp	pH corrector
Sodium hydroxide	Sodium hydroxide	qsp	pH corrector

Accelerated Stability Test

The accelerated stability test showed that the three prototypes maintained their organoleptic (appearance, color and odor), chemical (pH) and physical (density) characteristics stable in alternating heating and cooling cycles for 90 days. The appearance remained uniform, with the same macroscopic characteristics as the standard sample, as well as the initial reddish-brown color; the odor remained the fragrance of the essential oil. The pH remained stable, in the range of 5.00, 5.14 and 5.18 for F1, F2 and F3 respectively, and the density averaged 1.011 g/cm3 ± 0.07 for F1, 0.973 g/cm3 ± 0.007 for F2 and 1.027 g/cm3 ± 0.04 for F3, showing that there was no loss of volatile ingredients or incorporation of air in the prototypes during the cycles over the 90 days. Furthermore, the density value remained in the range of commercialized shampoos, which is around 0.950 g/cm3 to 1.100 g/cm^3.[11]

Cleaning Potential

The cleaning action was evaluated, and the prototypes F1 (CGD + C. quinoa + M. ermarginata), F2 (CGD + G. max + M. ermarginata) and F3 (CGD + C. quinoa + G. max + M. ermarginata) showed sebum removal potential of 34, 39 and 60%, respectively. The formulation containing only CGD as a cleaning agent promoted strand cleaning of only 9.26%, showing that the cleaning action of the prototypes was improved by the biosurfactants present in the plant extracts. The prototype without added surfactants did not show any cleaning action. The shampoo sold had lower cleaning potential than the F3 prototype, with 56% sebum removal (Figure 1), showing the effectiveness of the F3 formulation, and consequently, its viability to start production on a pilot scale and reach the market in the future and compete commercially with other products.

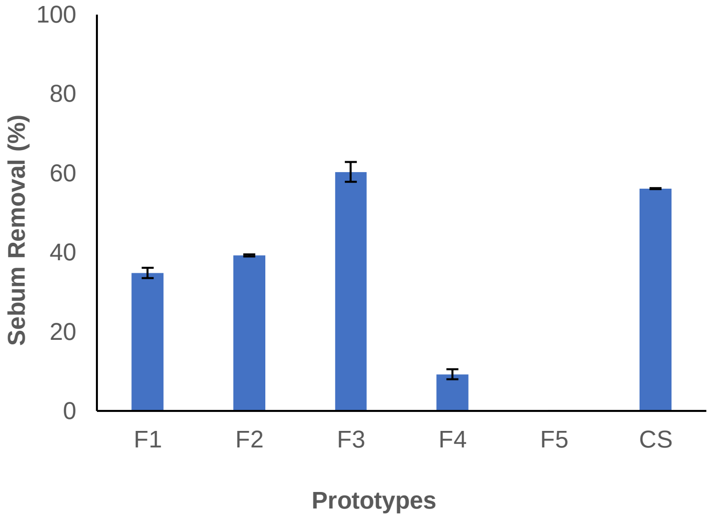

Figure 1 Cleaning potential of prototypes: F1: *C. quinoa* + *M. emarginata* + DCG; F2: *G. max* + *M. emarginata* + DCG, F3: *C. quinoa* + *G. max* + *M. emarginata* + DCG; F4: DCG; F5: no surfactant; CS: commercial shampoo

3 CONCLUSION

The present study shows that it is possible to formulate shampoos with a lower concentration of synthetic surfactants than current practice, and that surfactants extracted from plants have suitable properties for obtaining good alternative natural products. The evaluated parameters revealed that the prototypes are stable, and that among them, the F3 prototype is effective in cleaning action, thus showing the potential to compete commercially with shampoos present on the market, providing consumers with an innovative differentiator not presented to date in Brazil.

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