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STABILITY AND CHARACTERIZATION OF *ANANA COMUSUS* BIOSURFACTANT EXTRACT AND POTENTIAL FOR APPLICATION IN COSMETICS

Keila I. Costa[1,3*], Isabelle R. Souza[2], Káren G. O. Bezerra[1,3] & Leonie A. Sarubbo[1,3]

[1] *Chemical Engineering, ICAM-TECH, Catholic University of Pernambuco, Recife, Brazil.*
[2] *University of Pernambuco, Department of Health and Life Sciences, Recife, Brazil.*
[3] *Advanced Institute of Technology and Information, Recife, Brazil*
** keila131215@outlook.com*

ABSTRACT

The study highlighted the importance of vegetable surfactants for the cosmetic industry, and evaluated the extract obtained from *Ananas comosus* regarding the stability of its surfactant and emulsifying properties. Furthermore, tests were carried out to define the ionic charge and the type of surfactant present in the extract. The results showed that the extract did not lose its properties when exposed to the pH used in cosmetic formulations. Furthermore, the presence of saponins in the extract composition and anionic nature was confirmed. These results point to the potential of this extract as a sustainable alternative in the formulation of cosmetic products, in line with the search for more natural ingredients with a lower environmental impact.

Keywords: Biosurfactants. Cosmetics. Stability.

1 INTRODUCTION

Natural beauty represents a movement that advocates for a gentler and more conscious approach to aesthetic care, linked to well-being and based on sustainability values and clean formulas. The development of cosmetics and cosmeceuticals with less harmful ingredients, non-detrimental to human health and the environment, and without animal cruelty, emerges as a response to this approach. These "green" products have influenced the beauty and personal hygiene industry to reduce and possibly replace the use of components that do not meet these criteria [1].

Surfactants are among the most employed components in beauty and personal hygiene products. These substances are responsible for the formation of emulsions, foams, moisturizing capacity, cleaning dispersion, and even antioxidant and antimicrobial activity, playing a crucial role in formulations [2]. However, the majority of surfactants in these products are derived from petroleum, toxic, and non-renewable. Residues from synthetic surfactants in soils and groundwater are harmful to the environment and have toxic effects on human health [3,4]. Therefore, there is an urgent need to replace and/or reduce the use of these synthetic surfactants with biodegradable, low-toxicity, or non-toxic and sustainable surfactants. Natural surfactants, derived from microorganisms and plants, represent an extensively studied alternative and have even been commercially adopted by some companies worldwide [5].

Vegetal-origin surfactants are widely distributed in nature and can be classified as phospholipids, proteins, or protein hydrolysates, and saponins. Among these, saponins are highly dispersed in the plant kingdom and are characterized by their structure containing a steroidal or triterpenoid aglycone linked to one or more sugar molecules [6]. Saponins or saponin-rich extracts have potential for various biotechnological applications due to their physicochemical and biological properties [7]. Furthermore, saponins have shown great potential for use in cosmetics, such as shampoos, conditioners, and skincare products [8,9]. Several patents have been issued employing saponins in shampoo formulations, both for cleansing purposes and for anti-dandruff, anti-itch, and anti-inflammatory actions, highlighting the broad spectrum of action of these molecules [10].

Considering the growing demand for environmentally friendly cosmetics and cosmeceuticals, along with the need for surfactants to meet this trend, this study aimed to evaluate the stability of the surfactant and emulsifying properties of the biosurfactant-rich extract of *Anana comosus* exposed to different pH ranges used in cosmetic formulations, as well as to characterize, in a preliminary way, the type of biosurfactant present in this extract and its ionic charge, aiming for its potential application in the cosmetic industry.

2 MATERIAL & METHODS

Obtaining extract

The dry pulp of the fruit of *Ananas comosus* will be used for hydroalcoholic extraction of biosurfactants using the Soxhlet apparatus [11].

Extract Stability

The stability of the extract at a concentration of 10% (m/v) was evaluated at different pH values (4, 6, 8, 10 and 12). The response variables were surface tension (ST) and emulsification index (E24) [12].

2.1 Liebermann-Burchard Test

Two milliliters of the extract were evaporated to dryness and then redissolved with 2 drops of acetic anhydride and one drop of concentrated sulfuric acid. Steroidal saponins produce a bluish-green color, while triterpenic saponins produce a purplish-red color[13].

2.2. Ionic Charge Determination

The ionic charge of the extract was determined based on the principle of the double agar diffusion technique, adapted from Luna et al. (2016).[14] Test tubes were filled with 2 mL of the 1% extract and with 2 mL of a pure compound with a known ionic charge. The anionic substance used was sodium dodecyl sulfate (SDS) at 20 mM, and the cationic substance was barium chloride at 50 mM. The appearance of precipitation in the tubes (indicative of the ionic nature of the extract) was monitored for a period of 48 hours at room temperature. A tube containing the combination of SDS and barium chloride was used as a standard.

3 RESULTS & DISCUSSION

Extract Stability

Stability is a fundamental factor in cosmetic products, and it is essential to check the chemical and physical attributes of actives/ingredients before their incorporation into cosmetics, to determine their susceptibility to instability and degradation, which can be caused by several factors, such as exposure to light, air and oxygen, as well as changes in pH [27]. Therefore, plant extracts with potential cosmetic applications need to maintain their desired functions in the presence of variations and consider the particularities of each formulation. The effects of pH variations on the surface tension (ST) and emulsification index (E24) on *A. comosus* extract are shown in Figure 1.

The surface tension did not change significantly when exposed to pH variations, considering that the surface tension of the extract is 35mN/m, in the pH ranges 4 and 6 this tension was maintained, and for the pH ranges 8, 10 and 12 the tension was 36mN/m. Regarding the emulsification index, the pH ranges 4 and 6 were suitable for maintaining emulsification at 72%±1,6. When the pH was 8, 10 and 12, there was a reduction to 63%±1,2. Even so, the index was above 50%, which indicates that the extract can act as a good emulsifier [15] (Lopes et al., 2014) in a wide range of pH.

In the cosmetics field, many emulsions, such as shampoos, creams and conditioners, are prepared by heating and their pH is generally between 4 and 7 to maintain compatibility with skin and hair[16].Therefore, the *A. comosus* extract had suitable characteristics for possible applications in various formulations.

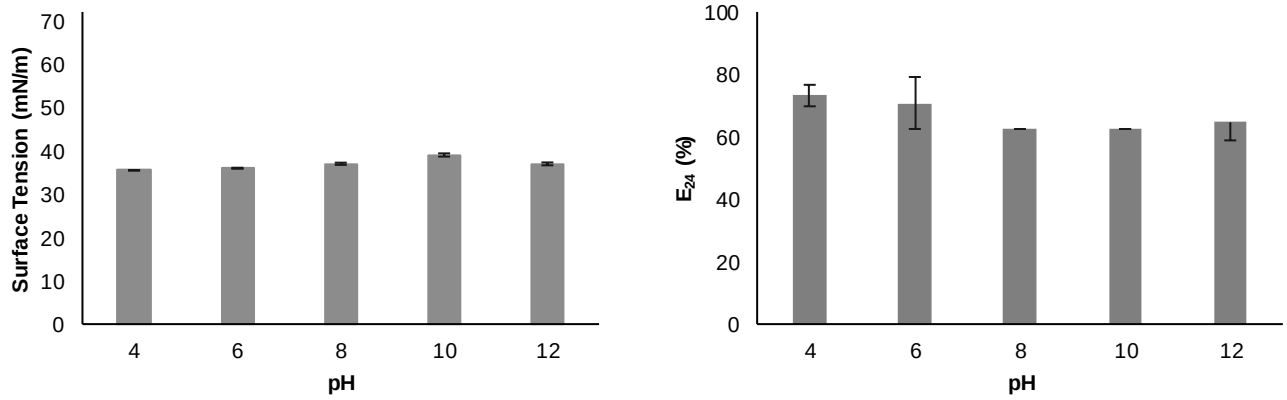

Figure 1. Influence of pH on *Anana comosus* surface tension (ST) and emulsification index (E_{24})

3.1 Liebermann-Burchard Test

The Liebermann-Burchard test is a chemical technique used to detect the presence of steroids in various samples, especially in organic compounds such as vegetable oils and biological materials. In the Liebermann-Burchard test, the *A. comosus* extract exhibited a reddish-purple color, indicating the presence of triterpene saponins [17].

Figure 2. Liebermann-Burchard indicators of *A. comosus* extract.

3.2 Ionic Charge Determination

The ionic charge assay revealed precipitation in the *A. comosus* extract when exposed to the cationic compound (barium chloride); conversely, no precipitate formation was observed when the extract was exposed to sodium dodecyl sulfate, indicating the extract's anionic nature (Figure 3).

Although saponins are non-ionic molecules in their pure state, in the extract of *A. comosus*, the presence of anionic constituents can be attributed to their ability to precipitate in the presence of barium chloride. Additionally, reports indicate that certain saponins have ionizable carboxylic groups, allowing them to acquire a negative charge.

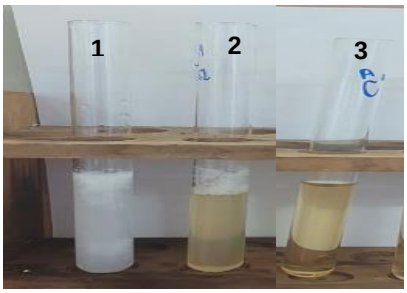

Figure 3 Control (1); *A. comosus* extract with barium chloride (2); *A. comosus* extract with sodium dodecyl sulfate (3).

4 CONCLUSION

The analysis of plant surfactants, especially the saponins present in *A. comosus* extract, reveals significant potential for applications in the cosmetic industry, aligned with the search for more natural and sustainable ingredients. The stability demonstrated by the extract at different pH levels, its ability to maintain surfactant and emulsifying properties, and the confirmation of saponin presence through Liebermann-Burchard test and ionic charge assay are promising aspects. These results reinforce the viability and interest in using plant-based surfactants as sustainable and practical alternatives in cosmetic product formulations, contributing to a more conscious and responsible approach to personal care and aesthetics, in line with current demands for products with lower environmental impact.

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