SAFETY NANOCOSMETICS: TRIBLOCK COPOLYMER NANOSTRUCTURED LIPID CARRIERS

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INTRODUCTION

Human hair is mainly composed by keratin, a protein with sulfur components, which forms a network of disulfide bonds giving some mechanical and chemical resistance to the hair. The hair fibers vary from 50 to 100 µm of diameter and are protected by the cuticle layer, which is built by the overlap of cells from 45-60 µm long and 0.5 µm thick[1,2]. Shampoos composed of anionic surfactants are the most common products for hair cleaning. On the other hand, cationic surfactants are widely used as conditioning agents due to the ability to neutralize negative surface charges of hair, promoting a reduction of coulombic repulsion between the cuticles.[2] Cupuaçu butter has an absorption capacity of 240% higher than lanolin, acting as a vegetable substitute. The phytosterols (present in this material) act regulating the water balance and lipid activity at the cellular level.[3] The oil of *Mauritia flexuosa* (buriti) has a composition rich of unsaturated fatty acids. This component increases elasticity and decreases dryness of the skin exposed to solar radiation, being indicated for dyed and damaged hair [4,5] Nanostructured lipid carriers (NLC) are drug delivery systems derived from solid lipid nanoparticles (SLN) that have been extensively studied to maintain the effect of the active on the target tissue, improve physical stability, solubilize actives, minimize side effects and reduce toxicity.[6]In this study, we are reporting the use of nanostructured lipid carriers with cupuaçu and buriti oil as a cosmetic product for hair protection.

METHODOLOGY

Preparation of Nanostructured Lipid Carriers (NLC):

Solid lipids: Cupuaçu butter and Lanolin, Liquid lipid: Buriti oil. The solid lipids were heated 10°C above melting point, then liquid lipid was added. This blend was added to an aqueous solution containing Pluronic F68 at the same temperature of the melted lipids (10.000 rpm at Ultra-Turrax). This pre-emulsion was homogenized at high pressure homogenizer: 600 bar (1st stage) and 60 bar (2nd stage) for up to 4 cycles. After homogenization, the emulsion was cooled in ice bath to the temperature of 15°C, obtaining the nanostructured lipid carriers.[7]

Average size, distribution of particle size and zeta potential:

The mean diameter of the nanoparticles was determined by the dynamic light scattering technique (DLS) using the ZetaSizer Malvern apparatus.

Preparation of the Conditioner Base with and without NLC:

The conditioner prepared without NLC has a composition of 3.5% keto-stearyl alcohol; 4% cetyl trimethyl ammonium chloride (25%); 1% cocoamidopropyl betaine; 0.5% mineral oil; 0.15% methylparaben; 0.05% propylparaben and 100% water (qsp). Conditioner with NLC: Solvent was divided into 50% distilled water and 50% nanoparticle formulation. The oily part was heated to 80°C and mixed in Ultra-Turrax (10,000 rpm; 2 min). The water at the same temperature was added to lipid mixture under stirring. The preparation was cooled to 30°C. The pH was corrected to 5.0-6.0 with citric acid. For the NLC preparations, the nanoparticle formulation was only added when the preparation had reached 30°C.

Cleaning the hair tresses and applying the conditioner with and without nanoparticles:

The tresses were cleaned with distilled water/1 min and washed with aqueous solution of Sodium Lauryl Sulphate (27%) in 1:10 ratio and rinsed again with distilled water and dried (Control). Another proportion of the tresses had the conditioner without NLC applied and were left to act for 2 min, then they were rinsed with water and dried. Another population of tresses was treated with NLC-containing conditioner, resting for 2 minutes and then washed and dried.

Frizz's experiment:

The treated and untreated 0.5 g weight tresses were placed under a millimeter A3 paper in a hood at 27°C and 55% RH photographed by a Fujifilm Finepix T camera with 1.0 mm zoom with flash, in a period of 30 min for 6 h.

Scanning Electron Microscopy (SEM):

Hair tresses were characterized by SEM. The test was performed on a Jeol scanning electron microscope (JSM-6360LV), using an acceleration voltage of 20 kV.

RESULTS & DISCUSSION

Time-stability:

Table 1. Zeta Potential, PDI and Size average on 3 cycles of NLC prepared with 6g of solid lipid (4.2g of cupuaçu butter and 1.8g of lanolin) and 1% liquid lipid (LL) (buriti oil) at 600 bar of pressure.

Time (days)	*Zeta Potential (mV)*	*PDI*	*Size average (nm)*
0	-33.9±2.5	0.15 - 0.18	180 - 185
7-15	-42.1±2.7		
7-30	-47.7±4.9	0.17 - 0.20	178 - 180
62-75	-38.5±0.9		

Cytotoxicity:

In the case of NLC the IC50 value could not be calculated due to the fact that the test samples did not show any cytotoxicity up to the highest test concentrations in HaCaT cells. This result shows that NLC can be used in cosmetic formulations without toxic effects on HaCaT human keratinocyte cell lines.

Frizz measure of hair tresses:

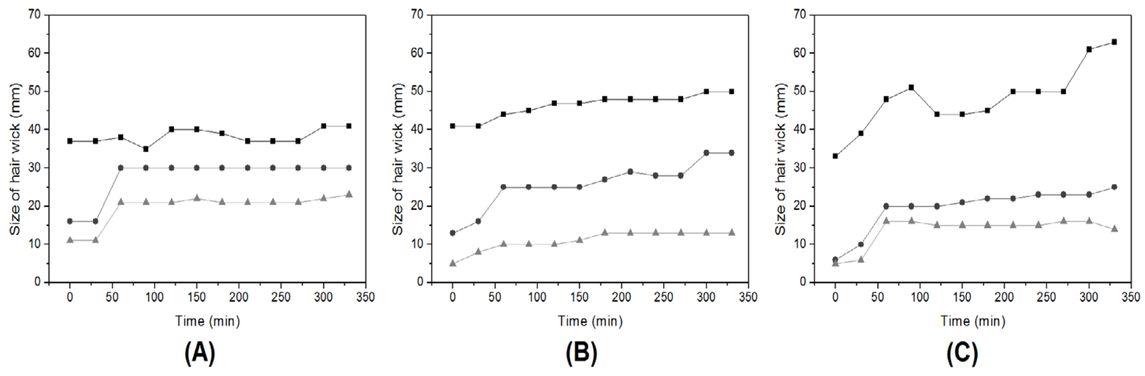

Figure 1. Frizz variation along 3 points of the hair tress: (A) closest to the root of the tress; (B) Measured 15 mm below the root of the tress; (C) Measured 40 mm the root of the tress; where the group Control (treated with solution of SLES 2.7%), group treated with base conditioner without NLC and group treated with NLC-containing conditioner are represented by: squares (■), circles (●) and triangles (▲), respectively (each point were measured three times with an average deviation of less of 1.5%).

Scanning Electron Microscopy (SEM):

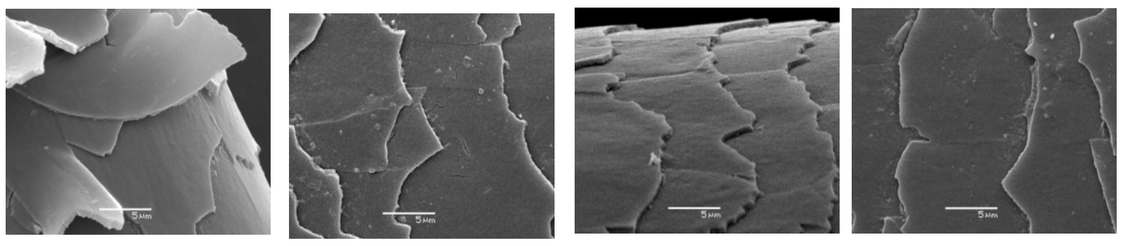

Figure 2. Images of untreated hair tresses (A), group treated with base conditioner without NLC (B), group treated with NLC-containing conditioner (C), and group Control (treated with solution of SLES 2.7%) (D), respectively.

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Acknowledgments

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