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Biobased polymers for cosmetic formulation: an alternative to silicones

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PURPOSE OF THE ABSTRACT

Since the 1950s, silicone polymers can be found in nearly every branch of personal care and cosmetic products [1] for their unique properties: silkiness and shine enhancer, non-greasy feeling on skin, chemical stability, etc. [2]. However, these ingredients cause many problems regarding their impact on the environment, and potentially on the human health.

Silicones are inorganic materials made out of silica, which is extracted from quartz, and methyl chloride. It requires harsh chemistry (high temperatures, petroleum-based solvents and reagents, organometallic-catalysis, etc.) to produce polysiloxanes out of those materials, resulting in a negative impact on the environment [3]. Moreover, studies found that some silicones (especially cyclic ones, i.e. Cyclomethicone D4 or D5) can be harmful to human health [4]. The use of these ingredients in personal care products has been banned by some legislations, and consumers tend to avoid cosmetics that contain any kind of silicones. Although some alternatives exist today, they do not meet the sensory properties associated with silicones and some are still petroleum-based [5].

This research project aims to synthesize bio-based alternatives to silicones and to characterize them in cosmetic formulations.

To deal with this challenge, renewable ferulic acid, a component of lignin, valorised from agri-food industry co-products (beetroot pulp, wheat bran, or rice oil), is dimerized through a Candida Antarctica Lipase B-mediated enzymatic reaction and different diols [6]. Selected diols, acting as linkers between the acidic moiety of the ferulic acid, are expected to provide silicone-like properties from to the final product. In order to improve the naturality of the synthesized silicone alternatives, bio-based diols will be used as much as possible. To obtain macromolecules, the dimers will then be oligomerized through a biocatalytic step in the presence of laccase [7]. The new oligomers obtained will exhibit multifunctional properties: antioxidant and antimicrobial properties, provided by their phenolic moieties [8], as well as texture and sensory properties brought by the linkers.

The properties of the synthesized alternative to silicone will then be assessed through physico-chemical and sensory characterizations, in comparison with commercial silicones, such as Dimethicone or Cyclometicone, which are widely used as cosmetic ingredients [9]. If the properties of the synthesized oligomers successfully mimic silicones properties in solutions, they will be incorporated into cosmetic emulsions for further characterizations.

First, an in vitro approach will help to study the spreading behaviour of new bio-based alternative ingredients alone and in emulsion compared to the references using a texturometer. The analysis is carried out on artificial non-biological surfaces, with a very good correlation with sensory analysis [10]). Other in-vivo approaches to

characterize the products will be performed such as (i) extended sensory profile evaluation by expert assessors, after ensuring the safe use of the new ingredients on human skin [11] ; and (ii) biometrological measurements: frictiometry, corneometry, tewametry or skin pH-metry, to assess the skin friction coefficient, the stratum corneum hydration, transepidermal water loss and the pH on the forearm of subjects before and after application of the cosmetic samples [10], [12].

This research project focuses on two aspects: (i) the synthesis of bio-based alternatives to silicones, and their characterization in cosmetic formulations in comparison with commercial silicones, (ii) an adjustment of the syntheses in accordance with the characterization results in order to reach the expected sensory properties. To efficiently address both aspects, a collaboration between two complementary research teams has been set up between URD ABI by AgroParisTech for the syntheses and URCOM from the University of Le Havre Normandie for the characterizations.

FIGURES

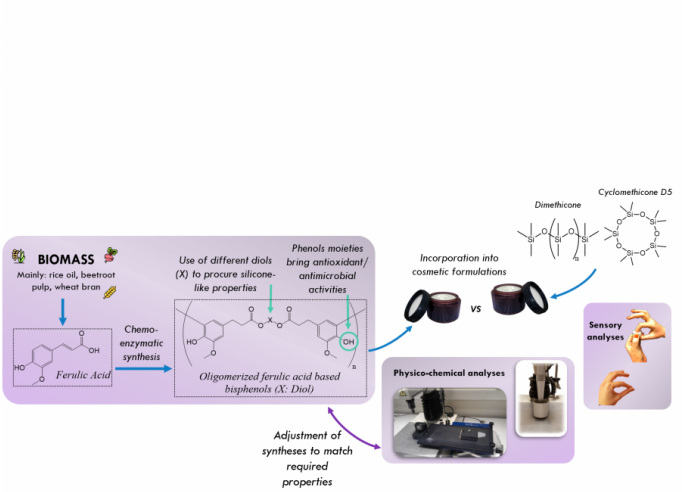

FIGURE 1
Graphical Abstract
Schematic overview of the research project

FIGURE 2

KEYWORDS
Biobased polymers | Silicone alternative | Cosmetics | Clean reactions

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