Innovative topical emulsions with enhanced antioxidant and photoprotective properties containing anthocyanins and derived pigments

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Introduction: Exposure to ultraviolet radiation (UV) can induce several deleterious effects on human skin, including erythema, photoaging and photocarcinogenesis [1]. Given the UV absorptive and other skin-heath beneficial properties of numerous plant-derived molecules, there has been a growing interest in using these natural compounds in formulations to prevent skin damage. The popularity of these ingredients has also been driven by the controversy regarding the potential negative effects of some commercial synthetic UV filters used in sunscreen formulations [2]. Among the different classes of phytochemicals with reported protective effects against UV-induced skin damage, anthocyanins represent one of the most attractive, owing to their simultaneous acknowledged bioactivity repertoire and visually attractive colors [3].

Objectives: Prepare and characterize topical formulations enriched with natural antioxidants (cyanidin-3-glucoside and its derivative carboxypyranocyanidin-3-glucoside) with sun protection factor (SPF). Different types of emulsions were developed: oil/water and gel-in-oil emulsions, containing the natural dyes alone or in combination with a commercial chemical UV filter (disodium phenyl dibenzimidazole tetrasulfonate).

Methods: Cyanidin-3-glucoside was obtained by fractionation of an extract of blackberries. Further reaction with pyruvic acid resulted in the formation of the derivative. Both molecules were incorporated in two types of emulsions: oil-in-water (prepared by hot emulsification process) and gel-in-oil emulsions (prepared by low shear cold emulsification process). Formulations containing both anthocyanins and the chemical UV filter were also developed. UV-vis spectrophotometry analysis was used for SPF estimation and interaction studies. All samples were characterized, regarding their rheological behavior (Kinexus Lab+ Rheometer, Malvern), pH, droplet size distribution and microscopic appearance. Samples were subjected to different storage conditions and color variation monitored at several timepoints by colorimetry.

Results and Discussion: Both compounds were successfully dissolved and incorporated in the topical emulsions, yielding formulations with different and appealing colors. No significant changes were observed after adding the anthocyanins to the base formulations (macroscopic appearance, rheology, droplet size distribution and microscopy appearance). Colorimetric results showed slight color variations in dark storage conditions, while exposure to light and high temperatures induced significant changes. Interestingly, formulations containing both natural compounds and the chemical UV filter revealed an interaction between both molecules, which resulted in a strong increase of absorbance with notorious

color intensification of the formulations and also a slight deviation from the original color hue. Combination of both agents did not impair the absorptive capacity of the filter, in fact, a good complementarity between the absorbance spectrum of both agents and the filter was obtained.

Conclusions: Exploitation of blackberries surplus production (e.g., non-conforming, out-of-size, over-ripened products) represents a rich source of natural ingredients with appreciable preventing properties of UV-induced damages properties, which can be extracted with a good purity, using relatively simple procedures and conditions, requiring mostly just water. Despite their susceptibility to light and temperature, when kept at dark conditions at room temperature, formulations exhibited good color retention. The new uncovered interaction between the natural dyes and the chemical filter shall be studied with greater detail in upcoming studies, both from the possibility of natural color diversification and the potential promotion of photostability of these molecules.

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