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Impact of Emulsifiers on the Performance of Sunscreen-loaded Nanosuspensions from Beeswax and Jojoba Oil

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Organic and natural ingredients have become a major trend in cosmetics due to the consumers' wish for ingredients friendly to both skin and environment. This is especially true for sunscreens in natural care cosmetics used for photo protection and thus skin cancer prevention.

A nanosuspension composed of titanium dioxide as inorganic sunscreen within a matrix of carnauba wax and decyl oleate in a 2:1 ratio and stabilized by the surfactant polysorbate 80 (polyoxyethylene (20) sorbitan monooleate) has previously been reported to yield a high sun protection factor (SPF) of about 60 (in vitro) [1]. The replacement of carnauba wax and decyl oleate by beeswax and jojoba oil also proved to result in high SPF values and small particle sizes in the nanometer range [2]. With regard to natural care cosmetics polysorbate 80 should be replaced by eudermic surfactants such as sugar esters and polyglyceryl esters. In this study, the impact of different surfactants on SPF and particle size distribution was investigated. Information about the morphology of the wax particles was obtained from transmission electron microscopy (TEM) and scanning electron microscopy (SEM), respectively.

Methods: Nanosuspensions were manufactured by dispersing a molten lipid phase into an aqueous phase by using high-pressure homogenization. Particle size distribution was determined by laser light diffraction and PIDS. SPFs were taken in vitro with an SPF analyzer. The visualization of the nanoscale particles was made using SEM and TEM after negative staining with a 2 % (w/w) solution of uranyl acetate, respectively.

Results: Sucrose laurate as sugar ester and polyglyceryl-4-laurate/succinate proved to be appropriate candidates for nanosuspensions with eudermic surfactants. From macroscopical evaluation nanosuspensions containing sucrose laurate seemed to be more viscous compared with corresponding formulations containing polyglyceryl-4-laurate/succinate. In terms of SPF, nanosuspensions with 6 % of titanium dioxide and 5 % of surfactant (both (w/w)) showed SPFs higher than 50 (polyglyceryl-4-laurate/succinate: 58.9, sucrose laurate: 51.6), whereas the plain formulations without titanium dioxide showed SPFs around 1.1 (polyglyceryl-4-laurate/succinate) and 1.5 (sucrose laurate), respectively.

In the case of polyglyceryl-4-laurate/succinate, increasing surfactant concentrations from 1 % up to 5 % led to a rise in SPFs from 13.2 up to 58.9. In contrast, nanosuspensions containing sucrose laurate showed lower SPFs with increasing surfactant concentration. While formulations containing 1 % of sucrose laurate yielded SPFs of about 70, those with 5 % sucrose laurate showed an SPF of about 50. This coincided with a reduction in particle size distribution upon

increasing surfactant concentration.

Furthermore, for the nanosuspensions containing polyglyceryl-4-laurate/succinate, no variation in particle size distribution occurred during a three-month storage at 20 °C. By using sucrose laurate a quick increase in particle size up to the micrometer range was observed after one week. Plain formulations without titanium dioxide showed a narrower particle size distribution than the corresponding nanosuspensions with titanium dioxide. Particularly with polyglyceryl-4-laurate/succinate a clear difference in particle sizes with regard to plain and titanium dioxide-loaded nanosuspensions could be observed.

Concerning morphology a close contact between beeswax and titanium dioxide crystals was confirmed. Nanosuspensions containing polyglyceryl-4-laurate/succinate showed plate-like particles of ellipsoidal to spherical shape with smooth edges. Particles of 400 nm and above showed furled or bent edges as well as an agglomeration of titanium dioxide in the middle of the particle. In the case of sucrose laurate as surfactant, the particles also seemed to have a plate-like shape with a central agglomeration of titanium dioxide, but showed rather irregular anisometric particles.

[1] J.R. Villalobos-Hernández, C.C. Müller-Goymann, Novel nanoparticulate carrier systems based on carnauba wax an decyl oleate for the dispersion of inorganic sunscreens in aqueous media, Eur. J. Pharm. Biopharm. (2005) 60:113–122.
[2] K. Dahl, C.C. Müller-Goymann, TiO2-loaded nanosuspensions - Influence of jojoba oil and surfactants on SPF and particle size distribution, Compendium on Sun care - Household and Personal Care Today (2012) 7(3):12-15.