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LIPEX® SheaSolve™ as a dispersant of mineral UV filters

Abstract

There is rising demand for mineral-based sunscreens, driven by environmental concerns regarding specific organic UV filters, requiring for the market the exploration of sustainable emollient alternatives that easy the formulation with such materials. This study investigates the influence of various emollients on the wettability and dispersion stability of triethoxycaprylyl silane-coated zinc oxide, a common inorganic UV filter. Four emollient esters were selected alongside LIPEX® SheaSolve™ to assess their effectiveness in formulating stable 40% zinc oxide dispersions.

Dispersions were prepared using a sawtooth disperser and homogenized with an Ultra-Turrax, followed by rheological characterization using Anton Paar RheoCompass and light microscopy. Results revealed that traditional synthetic esters, such as caprylic/capric triglycerides and C12-15 alkyl benzoate, resulted in high-viscosity dispersions with significant particle agglomeration. In contrast, LIPEX® SheaSolve™ and dicaprylyl carbonate exhibited lower viscosities and minimal agglomeration, indicating superior wettability.

Interestingly, while LIPEX® SheaSolve™ displayed a higher viscosity as a pure emollient, it produced the lowest viscosity in dispersions, suggesting that factors beyond intrinsic viscosity are critical in assessing emollient performance. These findings highlight the importance of emollient selection in optimizing mineral sunscreen formulations, balancing product efficacy with sustainability objectives.

Background

The market for sunscreens based on mineral UV filters is growing due to potential environmental concerns with some organic UV filters. Traditionally, synthetic esters like C12-15 Alkyl benzoate have been used to disperse the mineral filters prior to emulsification. As the cosmetic industry is moving towards using more sustainable alternatives, the introduction of natural esters in sun care is gaining traction. To optimize the use of the mineral filters and create cosmetically appreciated products without whitening of the skin, the dispersing emollient need to act as an efficient wetting agent of the primary mineral filter particles. A low viscosity of a dispersion indicates that the emollient provides good wetting of the mineral filer particles.[1)]

Study objective

The purpose if this study is to understand how the choice of emollients impacts the wetting properties of a triethoxycaprylyl silane coated zinc oxide.

Methodology

- The most common emollients in commercial sun care products were mapped using Mintel.
- Four emollient esters where selected to be studied along with LIPEX® SheaSolveTM
- Dispersions of the 40% zinc oxide in the carrier emollient was prepared using a sawtooth disperser blade. The zinc oxide filter was added in portions to the emollient during stirring. Ones the zinc oxide was fully dispersed into the emollient, the mixture was transferred to an Ultra-Turrax and homogenized for 2 minutes at 10 000 rpm.
- Both the dispersions and the pure emollient were characterized using an Anton Paar RheoCompass. The viscosity was measured a couple of days after preparation and after two months. The results presented in Figure 2 are from the data generated at the measurement after two months.

[1)] Lim Henry W and Draelos Zoe Diana (editors), 2009, Clinical Guide to Sunscreens and Photoprotection, New York: Informa Healthcare USA Inc.

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- The dispersions where also studied using light microscopy. The dispersions where manually stirred, and 0.003 grams of sample was weighed in directly on the microscopic slide. The dispersion was then diluted with one drop from a 3 ml plastic pipette of the same emollient. The sample was gently mixed before the cover glass was applied. The samples were studied in the microscope and pictures taken using the x40 objective.

Results

Microscopy images using the x40 objective highlight the impact of emollient choice on the dispersibility of zinc oxide particles. Dispersions using LIPEX® SheaSolve™ show significantly fewer agglomerates and smaller particle clusters compared to those with caprylic/capric triglycerides (MCT) and other emollients such as C12-15 Alkyl Benzoate and Coco-Caprylate/Caprate. LIPEX® SheaSolve™ provides superior pigment wetting, evenly coating zinc oxide particles, resulting in enhanced dispersion and reduced particle aggregation.

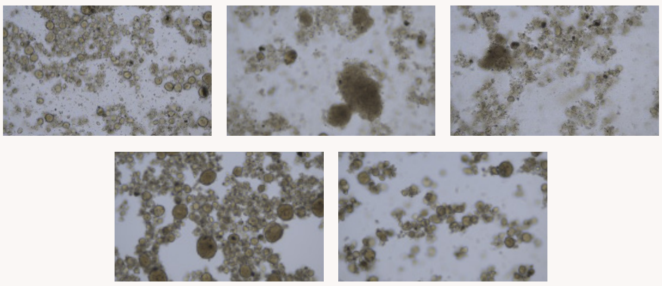

Figure 1. Microscopy pictures of the dispersions using x40 objective shows the impact of the choice of emollient on the dispersibility of the zinc oxide particles. From top left: LIPEX® SheaSolve™, Caprylic/capric triglyceride, C12-15 Alkyl benzoate, Coco-Caprylate/caprate, Dicaprylyl carbonate.

The viscosity profiles of various emollients in their neat form, excluding Zinc Oxide, were systematically measured to establish baseline viscosity values. The same standardized methodology previously applied for assessing the viscosity of Zinc Oxide dispersions in these emollients was utilized. This process was conducted to isolate and quantify the intrinsic viscosity contributions of the individual emollients, independent of Zinc Oxide particles. The resulting baseline data serves as a critical reference point for accurately interpreting viscosity changes when Zinc Oxide is introduced into the formulations. Additionally, this approach provides insight into the interaction dynamics between the emollients and Zinc Oxide, facilitating the optimization of dispersion stability and overall rheological performance in the final formulation. (See Table 1).

Table 1. Viscosity of the different carriers evaluates without Zin Oxide

Rotational speed [1/min]	1 rpm	5 rpm	10 rpm
Caprylic/Capruic triglycerides	29.5	29.5	29.4
Dicaprylyl Carbonate	5.9	5.9	6.0
Coco-Caprylate/Caprate	10.0	9.9	10.0
LIPEX® SheaSolve™	10.0	10.2	10.2
C12-15 Alkyl Benzoate	15.3	15.2	15.2

The viscosity measurements (see Figure 2) correlate strongly with these findings. Dispersions prepared with LIPEX® SheaSolve™ exhibit a significantly lower viscosity compared to those with MCT, which tend to produce thicker dispersions with higher agglomeration. The lower viscosity of LIPEX® SheaSolve™ enables better mobility and even distribution of particles, which contributes to improved product spreadability and a more uniform film formation on the skin.

Figure 2. Viscosity of 40% coated zinc oxide dispersions in the selected emollients

Rotational speed [1/min]	1.5	2.0	5.0	10
Caprylic/capric triglycerides	38,844	26,742	6,009	1,066
C12-15 Alkyl benzoate	17,630	5,907	2,277	829
Coco-Caprylate/Caprate	4,360	2,910	1,324	568
DicaprylylCarbonate	2,094	1,696	1,037	489
LIPEX® SheaSolve™	2,350	1,584	851	425

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Viscosity of 40% zinc oxide dispersions

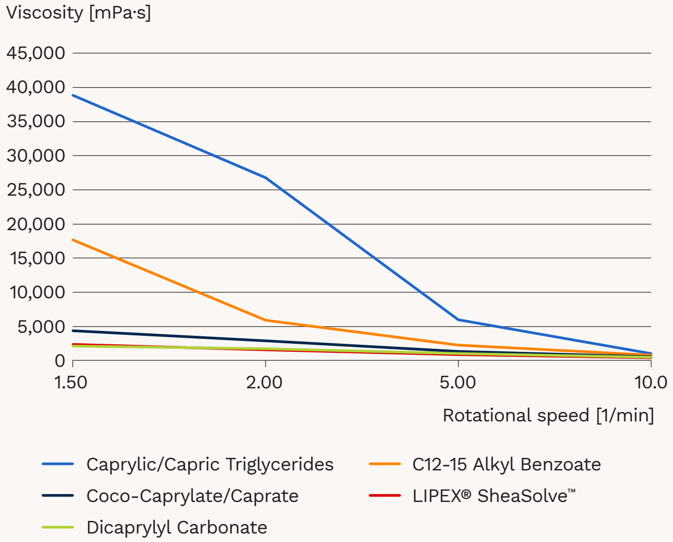

Figure 3. Viscosity of 40% coated zinc oxide dispersions in the selected emollients.

These observations confirm that LIPEX® SheaSolve™ is a more effective emollient for dispersing zinc oxide in sun care formulations, compared to MCT, due to its superior pigment wetting and lower viscosity. This results in enhanced stability, fewer particle agglomerates, and a lighter, more elegant skin feel.

The choice of emollient does impact the viscosity of a 40% triethoxycaprylyl silane coated zinc oxide. Traditional emollients like caprylic/capric triglycerides and C12-15 Alkyl Benzoate generates dispersions with high viscosities. Microscopy reveals that agglomerates of primary zinc oxide particles are also more common in dispersions using these two emollients.

LIPEX® SheaSolve™ and dicaprylyl carbonate generate dispersions with the lowest viscosities. Microscopy also shows that agglomeration is less common in dispersions using these emollients. LIPEX® SheaSolve™ does not have the lowest viscosity as the pure emollient but still generates dispersion with the lowest viscosity.

Very small changes were observed in the viscosity on the fresh samples versus two months later.

Conclusions

- The study confirms that the choice of emollient in sun care formulations impacts the dispersibility of a triethoxycaprylyl silane coated zinc oxide.
- Viscosity in combination with microscopy provide a great tool for understanding the wetting properties of an emollient and confirms that LIPEX® SheaSolve™ is a good choice as the dispersions show low viscosity and few agglomerates of the triethoxycaprylyl silane coated zinc oxide.
- LIPEX® SheaSolve™ does not have the lowest viscosity as a pure emollient but still generates the lowest viscosity in a dispersion. This concludes that there are other characteristics of relevance than viscosity of the pure emollient when assessing how well the emollient works as a dispersant.

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