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Short communication

Pickering emulsions: Development of an all-in-one dermocosmetic formulation

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Introduction

Classical emulsions have been recognized as the most widely used vehicle for topical drug delivery as well as cosmetic purposes. In general, an emulsion can be defined as a mixture of two or more immiscible liquids, one of which is finely and uniformly dispersed as globules throughout the second phase. However, since emulsions are thermodynamically unstable systems, a third component, surfactants should be used to stabilize the system by forming a thin film around the globules of the dispersed phase. On the other hand, Pickering emulsion is a relatively new concept and is a type of surfactant-free emulsion stabilized only by fine solid organic or inorganic particles (Albert et al., 2019). Pickering emulsions are a promising alternative as they eliminate surfactant-induced toxicity, improve formulation appearance, provide good viscosity, and promote long-term stability. With these features, Pickering emulsions appear as a satisfactory solution for daily cosmetic/dermocosmetic products as well as for drug delivery to the skin. Depending on the consistency, Pickering emulsions can range from liquid formulations such as lotions to semi-solid formulations such as creams. So, they are promising formulations for the treatment of skin disorders such as atopic dermatitis or eczema as well as skin care product such as anti-aging, moisturizer, or sunscreen (de Carvalho-Guimarães et al., 2022). For the formation of Pickering emulsion, the solid particles adsorbed at the oil-water interface must be fractionally wetted by two phases and the emulsion type (O/W or W/O) can be determined by the wettability of the particles. Hence, organic or inorganic solid particles such as silica, clay minerals, chitin/chitosan, hydroxyapatite, cyclodextrins, cellulose, starch, or minerals like titanium dioxide and zinc oxide, as well as metallic, polymeric, or lipidic nanoparticles can be utilized for creating stable Pickering emulsions. However, the type and morphology of the solid particles can modulate the properties of Pickering emulsions. Hence, choosing the right kind of solid is the essential parameter for the stability of the emulsion. Herein, it is aimed to effectively improve the changes such as fine lines and wrinkles, dryness, and loss of elasticity which are the main signs of skin aging with a single dermocosmetic product. Therefore, in this study, Pickering emulsion formulations were developed by combining different components known to be effective for skin appearance and in vitro characterizations of the formulations were studied.

Materials and methods

A high shear homogenizer was operated in the emulsification process of the Pickering emulsions. α-lipoic acid (ALA), which is a powerful antioxidant, was chosen as a cosmetic active substance to fight signs of skin aging and each formulation contains 2% of ALA. Beta Cyclodextrin (BCD), titanium dioxide (TiO_2) and zinc stearate (Zn) were used as solid particles to provide emulsion formation and also to benefit from their sunscreen effects as a physical sun filter. On the other hand, olive oil (OO), squalene (SQ) or argan oil (AO) are added to the formulations in order to obtain a moisturizing effect on the skin while forming the oil phase of the system. After the formulations were produced, their homogeneity was evaluated by organoleptic tests. Morphological and microscopic features of the formulations were depicted using optical microscopy (Leica DM 4000, USA). The viscosity of the Pickering emulsions was determined by using Brookfield DVII Digital Viscometer (Scintech Ins., VA, USA) at room temperature with a TE spindle. TA-XT Plus Texture Analyzer (Stable Micro Systems, Ltd., UK) was employed to determine the hardness, compressibility,

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adhesiveness, cohesiveness and elasticity of the formulations (Amasya et al., 2020).

Results and discussion

First, organoleptic and microscopic characterizations were carried out and emulsion formations were investigated. The organoleptic properties of the formulations were examined by evaluating their spreadability and visual homogeneity. When TiO_2 is used as solid particles, Pickering emulsions obtained in the presence of 3 different oils are not suitable for applying on the skin in terms of consistency. Hence, they were eliminated before microscopic characterization. Microscope images of formulations with the same magnification (x40) are shown in Figure 1. When BCD and Zn are used as solid particles in Pickering emulsions, emulsion formation with spherical globules in a continuous structure is observed.

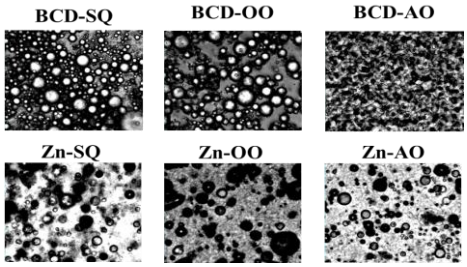

Fig. 1. The morphologic structure of the formulations

Viscosities of the formulations were investigated by a rotational viscosimeter at 20 rpm. As seen in Table 1, the viscosity values of Pickering emulsions were ranged between 16.5x1000 to 73.5x1000 cP at 25 °C. It was concluded that the differences in the viscosity of the formulations were related to the oil phase of the formulations. Determination of mechanical properties with texture analyzer for semi-solid products is important in order to have an idea about the homogeneity from batch to batch, as well as the quality and stability of the products. Hence, two-cycle compression test was performed to determine the mechanical behavior of Pickering emulsion formulations by means of hardness, compressibility, cohesiveness, adhesiveness, and elasticity. The results are presented in Table 1. The hardness and compressibility parameters evaluated together can explain the skin spreadability of the formulations as well as the ease of removal from the container and these values must be relatively low to meet the requirements. While all formulations have relatively low hardness values, it can be emphasized that the oil phase of the formulation has an effect on the compressibility. Also, it was observed that the formulation components had no effect on both elasticity and cohesiveness. On the other hand, the adhesion values give information about the contact time on the application surface and high values are advantageous (Amasya et al., 2020). In this case, it can be stated that the formulations show better adhesiveness in the presence of olive oil.

Table 1. Viscosity and texture properties of the formulations

	Viscosity ($cP.10^3$)	Hardness (N ± SD)	Compressibility (N.s ± SD)
BCD-AO	61.0	22.6±2.06	80.6±2.18
BCD-SQ	28.7	23.8±1.16	91.5±2.69
BCD-OO	28.7	32.4±3.16	118.6±15.37
Zn-AO	73.5	27.7±0.62	98.8±0.26
Zn-SQ	16.5	30.5±2.03	98.1±39.35
Zn-OO	25.2	35.5±2.03	131.5±12.85
	Adhesiveness (N.s ± SD)	Cohesiveness	Elasticity
BCD-AO	-31.0±0.62	0.73±2.05	0.98±4.25
BCD-SQ	-42.8±3.78	0.70±0.57	0.99±1.25
BCD-OO	-60.6±5.26	0.70±0.67	0.96±1.53
Zn-AO	-61.8±2.18	0.80±2.77	0.98±1.22
Zn-SQ	-62.7±28.62	0.75±0.87	0.98±0.98
Zn-OO	-90.3±5.01	0.81±0.60	0.97±1.02

Conclusion

It was concluded that Pickering emulsions prepared with both BCD and Zn are a promising alternative for topical application as a dermocosmetic formulation. It can also be said that emulsions have better texture and organoleptic properties in the presence of Zn.

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