DEVELOPMENT AND CHARACTERIZATION OF COSMETIC NANOEMULSIONS CONTAINING AVOCADO OIL AND FERULIC ACID

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Introduction

Skin aging is a gradual process caused by natural and external environmental factors. One of the most popular methods for achieving healthy skin is using cosmetic products. The beauty industry has undergone significant transformations in recent years. Technological and sustainable innovations have been demanded by consumers, stimulating research into more ecological and value-added cosmetics. Natural ingredients such as vegetable oils and antioxidants can be incorporated, repurposing materials, reducing waste, and minimizing environmental impact [1].

Avocado oil (AO) is obtained from the mesocarp of *Persea americana* Mill. fruit. It is considered a rich source of fat acids, such as oleic, palmitic, and linoleic, which can enhance skin moisture and permeability [2]. In addition, the oil contains vitamin E, carotenoids, phenolic compounds, and chlorophylls, which contribute to rejuvenating skin [3].

Ferulic acid (FA) is a bioactive compound commonly found in fruits and vegetables, known for its potent antioxidant activity. It has been suggested as a new antioxidant drug with significant cytoprotective activity, attributed to its ability to scavenge free radicals and activate the cell stress response. Furthermore, FA presents a photoprotective effect when applied to the skin. Despite the therapeutic activities, it has poor aqueous solubility and can easily degrade, affecting its performance on skin permeation [4].

Nanotechnology is widely applied across multiple sectors, including cosmetics and cosmeceuticals. Moreover, nanomaterials have played a major role in enhancing and boosting the global market share of both pharmaceutical and beauty products. Nanoemulsions are described as a mixture of oil, water, and surfactants. They present high stability, low viscosity, transparent appearance, and droplet size below 200 nm, making them interesting for cosmetic purposes through skin protection, sensorial enhancement, and controlled delivery of active ingredients [5].

This study aimed to develop avocado oil and ferulic acid nanoemulsions, evaluating their stability and antioxidant properties for future use in natural cosmetic formulations.

Material and Methods

The formulation consisted of water, PEG-40 (MERCK) as the surfactant, Span© 80 (MERCK) as a co-surfactant, avocado oil (LAZLO) and ferulic acid (FRAGRON). Initially, the required HLB (hydrophilic-lipophilic balance) was evaluated. Eight formulations with different ratios of PEG-40 and Span© 80 were prepared to obtain HLB values between 7,51 to 12,56 (F1 to F8). The formulations were prepared using the phase inversion composition method, with water being added by titration to the oil phase under agitation. The samples were stored for 24 hours at room temperature and evaluated for visual aspects (color, consistency, and stability). The stable nanoemulsions were selected to produce a new batch, with four formulations (A1, A2, A3, and A4) containing different ratios of ferulic acid (0,5%, 0,4%, and 0,3%). Characterization tests included Particle Size (Z-Ave), Zeta Potential (ZP), and

Polydispersion Index (PDI) by use of Dynamic Light Scattering (DLS) (Malvern Zetasizer Pro-Blue). The ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging capacity was determined to evaluate the antioxidant potential of samples [6].

Results and Discussion

The samples F6 and F8 exhibited typical nanoemulsion characteristics (liquid, translucent, and bluish reflection). Two nanoemulsions from the second batch (A2 and A3, containing 0,5 and 0,4% of FA, respectively) showed ferulic acid precipitates and were excluded from further tests.

The selected samples were evaluated, and the results are presented in Table 1. The DLS analysis showed a small particle size and lower PDI values, suggesting good physical stability against gravitational separation, flocculation and coalescence, and uniformity in the droplet size. The ABTS Free Radical Scavenging tests showed that the nanoemulsions loaded with ferulic acid (A1 and A4) presented superior inhibitory activity when compared to the other samples, demonstrating the positive impact of the oil concentration on antioxidant activity.

Table 1: Ferulic Acid (FA) and Avocado Oil (AO) proportions, Particle Size (Z-Ave), Polydispersion Index (PDI), Zeta Potential (PZ) and Scavenging Activity (SA) results.

Sample	FA (%)	AO (%)	Z-Ave (nm) ± SD	PDI ± SD	ZP (mV) ± SD	SA (%) ± SD
AO	-	-	-	-	-	18.86 ± 1.47
F6	-	2,5	28.2 ± 0.15	0.1511 ± 0.01	-8.302 ± 0.68	12.94 ± 0.36
F8	-	1,5	21.86 ± 0.21	0.1219 ± 0.01	-8.264 ± 1.18	13.18 ± 1.15
A1	0,3	2,5	27.87 ± 0.24	0.1661 ± 0.01	-3.953 ± 0.60	100 ± 0.00
A4	0,3	1,5	20.51 ± 0.06	0.1063 ± 0.01	-3.084 ± 0.22	47.12 ± 2.26

Conclusion

The nanoemulsions presented small particle sizes and antioxidant activity, suggesting that they can be effective in encapsulating and delivering ferulic acid. The results should allow the optimization of the samples on the technological aspects, providing an improved system to release bioactive compounds in cosmetics.

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