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DEVELOPMENT OF THE COMPOSITION AND MANUFACTURING TECHNOLOGY OF A CERAMIDE-CONTAINING AFTERSHAVE COSMETIC PRODUCT

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Abstract: This study focuses on the development of the composition and manufacturing technology of an emulsion-based aftershave cosmetic product containing ceramides. The relevance of the study is due to the need to develop cosmetic formulations for post-shaving skin care and to maintain the skin barrier properties. CERAMIDE III EP MB raw material manufactured by Evonik (Germany) was used as a source of ceramides. A model emulsion system was developed, incorporating emulsifying, structuring, emollient, and moisturizing components. To assess the effect of ceramide concentration, five test samples containing 0.30–2.00% of the raw material and a ceramide-free control sample were prepared. The resulting formulations were comparatively evaluated in terms of appearance, homogeneity, and consistency. It was established that an increase in the concentration of CERAMIDE III EP MB affects the structuring of the emulsion system. A manufacturing process was proposed, comprising the preparation of the aqueous and oil phases, incorporation of ceramides into the oil phase, emulsification, homogenization, and controlled cooling. Based on the comparative evaluation, the sample containing 1.00% CERAMIDE III EP MB was selected for further formulation development.

Keywords: Aftershave cosmetic product, ceramides, emulsion system, manufacturing technology.

Introduction. Shaving is a common personal hygiene procedure involving the mechanical removal of hair and direct contact between the razor blade and the skin surface. Such exposure may temporarily impair the skin barrier properties, increase skin sensitivity, and cause dryness, redness, and discomfort. Therefore, the development of aftershave cosmetic products involves combining components that can provide emollient and moisturizing effects and help maintain the skin barrier function. The severity of these reactions depends on individual skin characteristics, shaving frequency, and shaving conditions.

Intercellular lipids of the stratum corneum play an important role in maintaining the skin barrier properties; their main components are ceramides, cholesterol, and free fatty acids. As noted by Feingold and Elias [1], the lipid structures of the intercellular matrix are directly involved in regulating skin permeability and limiting water loss. Moore and Rawlings [2] identified the importance of the structural organization of ceramides in the formation and maintenance of the skin barrier function.

The use of physiologically identical lipids, particularly ceramides, is a promising approach to the development of skin care products. According to Kono et al. [3], the use of ceramide-containing formulations may contribute to improved moisture retention and maintenance of the skin barrier properties. The study by Schild et al. [4] focuses not only on the biological role of ceramides but also on the technological conditions for their incorporation into cosmetic products. The authors emphasize that insufficient dissolution of ceramides may reduce the effectiveness of the finished product in restoring the skin barrier properties.

At the same time, the production of ceramide-based cosmetic emulsions involves specific technological considerations arising from their physicochemical properties, including low solubility, the need to ensure adequate dispersion, and the risk of crystallization during the formation of the emulsion system. De Paepe et al. [5] established that the method of incorporating ceramide into an emulsion system is of considerable importance for its stability. Similar technological aspects were considered by Zhou et al. [6], who investigated the use of ceramide in an oil-in-water

emulsion system and demonstrated the importance of the composition and characteristics of the dispersed system for the effective delivery of a lipophilic component.

The feasibility of using emulsion systems for ceramide incorporation is also supported by the studies of Sahle et al. [7], which examined the potential of lipid-based systems to deliver ceramides to the stratum corneum.

Thus, the development of a ceramide-containing emulsion-based aftershave cosmetic product is a promising area that requires substantiation of the component composition, determination of the technological conditions for ceramide incorporation, and evaluation of their effect on the physicochemical and rheological characteristics of the finished formulation.

The aim of this study is to substantiate the composition and manufacturing technology of a ceramide-based aftershave cosmetic product, determine the technological features of incorporating components into an emulsion system, and develop a model series of formulations for further investigation of their physicochemical and rheological properties.

Materials and Methods. CERAMIDE III EP MB manufactured by Evonik (Germany), which contains Ceramide NP, was used to develop the emulsion-based aftershave cosmetic product. This raw material was selected because it is intended for use in cosmetic skin care formulations and because the physicochemical properties of ceramides and the technological features of their incorporation into emulsion systems must be taken into account.

The auxiliary components were selected based on their functional purpose, physicochemical characteristics, and compatibility within a multicomponent emulsion system. Glyceryl Stearate Citrate was used as the emulsifying component, and Cetearyl Alcohol as the structuring agent. Caprylic/Capric Triglyceride and Squalane were used to form the lipophilic phase. Glycerin and Panthenol were intended to provide the moisturizing properties of the formulation. Bisabolol, a preservative, and a fragrance composition were also included in the formulation.

The quality assessment of the model formulations included the determination

of organoleptic characteristics (appearance, homogeneity, color, odor, and consistency) and physicochemical parameters (pH and emulsion stability).

Results and Discussion. To assess the effect of ceramide concentration on the characteristics of the emulsion system, a model series of six samples was prepared: five test samples with CERAMIDE III EP MB concentrations ranging from 0.30% to 2.00%, and a control sample without ceramides. The calculated Ceramide NP content was determined assuming that it constituted 15% of the raw material.

Based on the formulation rationale, a model composition of an emulsion-based aftershave cosmetic product containing Ceramide NP was proposed. When developing the formulation, particular attention was paid to combining emulsifying, structuring, emollient, and moisturizing components, as well as ensuring the technological feasibility of incorporating the ceramide-containing raw material into the emulsion system. The model composition is presented in Table 1.

Table 1.

Model composition of the aftershave cosmetic product

Component	Functional purpose	Concentration, %
Aqua	Solvent	up to 100
Glycerin	Moisturizing component	3.0
Panthenol		1.0
Caprylic/Capric Triglyceride	Emollient component	4.5
Squalane		1.5
Glyceryl Stearate Citrate	Emulsifier	3.0
Cetearyl Alcohol	Structuring agent	up to 2.0*
CERAMIDE III EP MB	Source of Ceramide NP	0.30–2.00
Bisabolol	Skin care component	0.1
Preservative	Preservative	0.9
Parfum	Fragrance composition	0.1

*The total Cetearyl Alcohol content should be adjusted to account for its proportion in CERAMIDE III EP MB.

To evaluate the effect of ceramide content on the characteristics of the emulsion, five concentration variants containing 0.30–2.00% CERAMIDE III EP MB and a control sample without its addition were prepared. The corresponding calculated Ceramide NP concentrations are presented in Table 2.

Table 2.

Ceramide content in the model samples

Sample	CERAMIDE III EP MB, %	Ceramide NP, %*
1	0.30	0.045
2	0.60	0.090
3	1.00	0.150
4	1.50	0.225
5	2.00	0.300
Control	–	–

*Calculated Ceramide NP content values are based on a 15% proportion in the raw material, according to the raw material specification.

The emulsion system was based on Glyceryl Stearate Citrate and Cetearyl Alcohol, which provide emulsification and the formation of a structured consistency. The lipophilic phase consisted of Caprylic/Capric Triglyceride and Squalane. Glycerin and Panthenol were included in the hydrophilic part of the formulation. The incorporation of CERAMIDE III EP MB was intended to enrich the lipid phase with ceramides.

During the development of the emulsion formulation, the effect of CERAMIDE III EP MB concentration on the formation of the lipophilic phase and the structuring of the emulsion during cooling was taken into account. A specific feature of this raw material is the simultaneous introduction of Ceramide NP and Cetearyl Alcohol; therefore, an increase in its content changes the ratio of lipid and structuring components in the formulation.

Evaluation of the obtained model formulations established that the concentration of CERAMIDE III EP MB is one of the factors affecting the appearance and consistency of the emulsion system. The study assessed color, homogeneity, degree of structuring, consistency density, and the presence of visible signs of physical instability.

The control sample represented the basic emulsion system without the addition of ceramides. Its consistency was determined by the ratio of Glyceryl Stearate Citrate to Cetearyl Alcohol. The addition of CERAMIDE III EP MB to Samples 1 and 2 (0.30% and 0.60%, respectively) was accompanied by a gradual increase in the

content of lipid and structuring components. The resulting emulsions were similar in appearance to the control sample but had a denser consistency.

For Sample 3, containing 1.00% CERAMIDE III EP MB, an increase in the structuring of the emulsion system was observed, manifested by the formation of a cream-like consistency. At the same time, the emulsion retained its homogeneity and ability to spread evenly.

Increasing the CERAMIDE III EP MB content to 1.50% (Sample 4) resulted in excessive thickening of the consistency, reduced plasticity, and poorer spreadability of the emulsion. Sample 5, containing 2.00% CERAMIDE III EP MB, exhibited a wax-like texture and reduced ability to spread evenly. In addition, at this concentration, complete dissolution of Ceramide NP in the lipid phase was not achieved, which was accompanied by the appearance of visible particles and a loss of emulsion homogeneity.

Thus, an increase in CERAMIDE III EP MB concentration above 1.00% was accompanied by excessive thickening of the emulsion system and deterioration of its consumer properties. Based on the comparative evaluation, Sample 3, containing 1.00% CERAMIDE III EP MB, was selected for further formulation development, as it provided an optimal balance between emulsion structuring, homogeneity, and spreadability.

The manufacturing process for the emulsion formulations involved the sequential preparation of the aqueous and oil phases, their heating, emulsification, homogenization, and cooling.

To prepare the aqueous phase, purified water was mixed with Glycerin and heated to 75 ± 2 °C. The oil phase was prepared by mixing Caprylic/Capric Triglyceride, Squalane, Glyceryl Stearate Citrate, and Cetearyl Alcohol. The mixture was heated to 75 ± 2 °C with stirring until the structuring components had completely melted. CERAMIDE III EP MB was then added, and stirring was continued until it had completely dissolved in the oil phase.

After both phases had reached a temperature of 75 ± 2 °C, the oil phase was gradually added to the aqueous phase with continuous stirring. The resulting

emulsion was homogenized for 20–30 min at an impeller speed of 1,500–2,000 rpm. After homogenization, the system was cooled to 40 °C under moderate stirring at 300–500 rpm, and Panthenol, Bisabolol, the preservative, and the fragrance composition were added. Stirring was continued for 15–20 min to ensure uniform distribution of the components, while the finished formulation was cooled to room temperature.

Conclusions. The composition of a ceramide-containing emulsion-based aftershave cosmetic product was developed, and a model series of five formulations with ceramide concentrations ranging from 0.30% to 2.00%, together with a ceramide-free control sample, was prepared. The selection and combination of emulsifying, structuring, emollient, and moisturizing components were substantiated.

It was established that a CERAMIDE III EP MB content of 1.00% provides emulsion homogeneity, a cream-like consistency, and appropriate spreadability, whereas increasing the concentration to 1.50–2.00% results in an excessively dense structure and, at 2.00%, also in a heterogeneous system. The main technological parameters for preparing the formulation were determined, including a phase preparation temperature of 75 ± 2 °C and homogenization for 20–30 min at 1,500–2,000 rpm, followed by cooling of the system and the addition of moisturizing and emollient components. The sample containing 1.00% CERAMIDE III EP MB was selected for further studies as the formulation with the best organoleptic and technological characteristics.

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