The development of anti-striae emulsions using experimental design

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Aim

- Striae distensae (SD) are dermal lesions with multifactorial physiopathology, but their occurrence mechanism is not fully elucidated until now. In the management of SD, the prevention involving topical formulations which maintain the elasticity and the hydration of the skin plays a major role.
- The aim of the study was to obtain W/O anti-striae emulsions recommended in the prevention or early stage of SD. For this purpose, it was investigated the effect of 4 formulation factors and 2 process parameters, as the most important elements that influence the preparation of W/O emulsions.

Material and methods

- A factorial experimental design with six variables and two levels was used and the experimental trials were performed for all 21 combinations.

•Cosmetic cream formula

•*Xiameter PMX-0246*® (Dow Corning, Midland, Michigan, United States)
•*Cetylstearyl alcohol* (Vitamar, Bucharest, Romania)
•*Mango butter* (Elemental, Oradea, Romania)
•*Butyrospermum parkii butter* (Elemental, Oradea, Romania)
•*Caprilic/ Capric Triglycerides* (Croda, Snaith, United Kingdom)
•*Glycerol* (Vitamar, Bucharest, Romania)
•*Distilled water*
•*Sepigel 305*® (Seppic, Paris, France)
•*Euxyl PE 9010*® (Schülke & Mayr, Norderstedt, Germany)

• *E1- Abil EM 180*® (Evonik Industries, Essen, Germany)
•*E2- Cerasynt SD*® (Ashland Inc., Covington, Kentucky, United States)
•*E3- Olliva*® (Elemental, Oradea, Romania)
•*Co-surfactant- Simulgel INS100*® (Seppic, Paris, France)

Table 1. The matrix of experimental design

Exp No	X_1	X_2 (g)	X_3(rpm)	X_4 (min)	X_5(%)	X_6(%)
N1	E1	19	500	5	1.5	2
N2	E1	28.5	1000	10	2	2
N3	E1	38	1500	15	3	2
N4	E2	19	500	10	2	2
N5	E2	28.5	1000	15	2.5	2
N6	E2	38	1500	5	1	2
N7	E3	19	1000	5	3	2
N8	E3	28.5	1500	10	2	2
N9	E3	38	500	15	2.5	2
N10	E1	19	1500	15	2	0
N11	E1	28.5	500	5	2.5	0
N12	E1	38	1000	10	1.5	0
N13	E2	19	1000	15	1	0
N14	E2	28.5	1500	5	1.5	0
N15	E2	38	500	10	2.5	0
N16	E3	19	1500	10	3	0
N17	E3	28.5	500	15	2	0
N18	E3	38	1000	10	2.5	0
N19	E1	28.5	1000	10	2	2
N20	E1	28.5	1000	10	2	2
N21	E1	28.5	1000	10	2	2

X1 - emulsifier type; X2 - amount of oily phase; X3 - stirring rate; X4 - time of stirring; X5 - ratio of the surfactant; X6 – the use of a co-surfactant (Yes/No)

Characterization of cosmetic formulations

→ **Sensory analysis**

Firmness, stickiness, consistency, spreadability, oiliness, penetration degree into the skin
22 volunteers→10-point scales

→ **Rheological analysis**

Viscosity values

→ **Texture analysis**

Firmness
Adhesiveness
Consistency
Stringiness
Spreadability

→ Responses: Firmness (Y1), Consistency (Y2), Adhesive force (Y3), Adhesiveness (Y4), Stringiness (Y5), Stringiness length (Y6), Spreadability) (Y7), Viscosity (Y8), Stability (Y9).
→ Experimental design, coefficient calculation, statistic parameters calculation and evaluation of quality of fit - Modde 11.0 software (Umetrics, Umea, Sweden)
→ The data fitting -method Partial Least Squares (PLS)
→ Results - evaluated by means of statistical analysis - ANOVA test

References

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▪ Lukic, M.; Jaksic, I.; Krstonosic, V.; Cekic, N. and Savic, S. A combined approach in characterization of an effective w/o hand cream: the influence of emollient on textural, sensorial and in vivo skin performance. *Int. J. Cosmet. Sci.*, 34(2), 140-9 (2012).

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Results and discussions

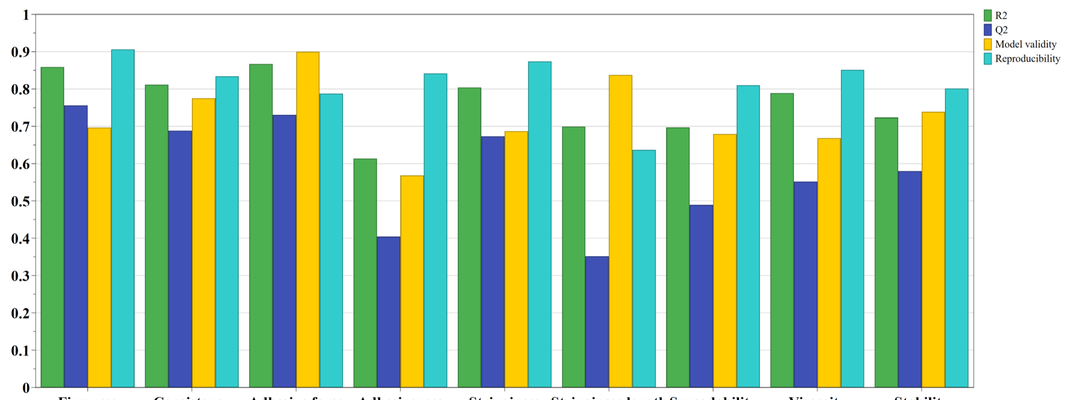

Figure 1. Results summary of fit

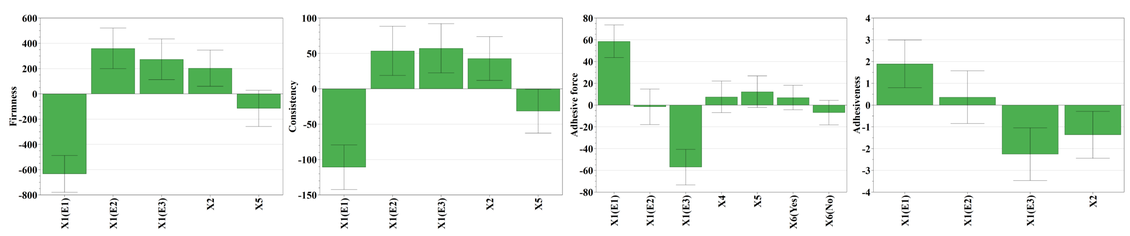

Figure 2. Influence of the formulation factors on the firmness, consistency, adhesive force and adhesiveness of the emulsions.

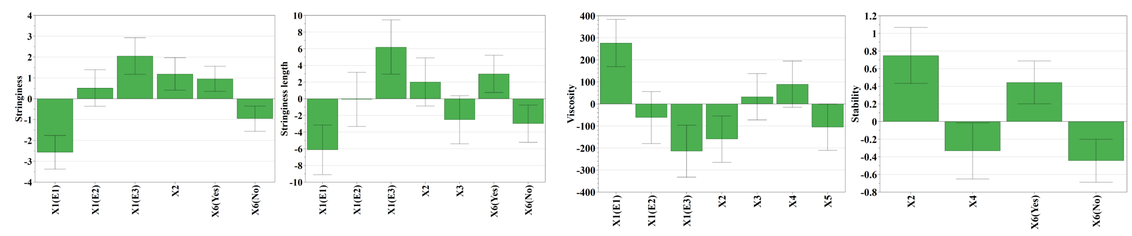

Figure 3. Influence of the formulation factors on the stringiness, stringiness length viscosity and spreadability of the emulsions.

▪ Among the formulation factors, the type of emulsifying agent (X1) and the oily phase amount (X2) influenced mainly the physical properties of the emulsions. Thus, the type of emulsifying agent influenced the ***firmness (Y1)***, ***consistency (Y2)*** and ***stringiness (Y5)*** of the emulsions, decreasing when Abil EM180® was used and increasing in case of Cerasynt SD® and Olliva® or when the amount of oily phase was greater.

▪ ***Adhesive force (Y3)*** and ***adhesiveness (Y4)*** increased when Abil EM180® was used and decreased when Olliva® emulsifier was used.

▪ The type of emulsifying agent influenced also the ***stringiness (Y5)*** and the **stringiness length *(Y6)*** of the emulsions. The presence of a co-surfactant and a high level of lipophilic phase had as well, a positive effect on the stringiness of the emulsions.

▪ A high percentage of lipophilic phase and the present of the co-surfactant improve the **stability (Y9)** of the emulsions.

▪ ***Viscosity (Y8)*** of the emulsions decreased when Olliva® was used or when the amount of the oily phase and ration of the surfactant were lower.

▪ The optimum conditions were determined based on the revised equations and surface response plots using as selection criteria a good spreadability and stability, a medium consistency and firmness and low adhesiveness.

Ingredients	Amount
Cetylstearyl Alcohol	2.48
Mango butter	6.20
Butyrospermum parkii butter	6.20
Caprylic/Capryc Tryglicerides	6.20
Xiameter PMX-0246	2.48
Olliva	3.00
Sepigel 305	1.50
Euxyl PE 9010	1.00
Glycerol	5.00
Distilled water	to 100

Optimal formulation: ingredients of the cream base

▪ **Sensory analysis** of the optimal formulation revealed that the product was well tolerated and appreciated by the consumers regarding spreadability, penetration ability and lack of stickiness, due mainly to the emollients with textural qualities.
▪ The optimal cream formulation, with active compounds integrated, will be evaluated in a future study in order to assess the efficacy of the product for the prevention of SD.

Conclusions

▪ The use of an experimental design to formulate a cosmetic product, allows to set the best ranges for the technological and formulation factors that influence the preparation of the W/O cosmetic emulsions. Together, rheological, texture and sensory analysis are useful in the formulation process to fully characterize the cosmetic product.