Senses – A Scientific Tool for the Selection of The Right Emollient

Introduction

Face, body and hair care, sun protection, color cosmetics, antiperspirant and deodorants – the cosmetics market includes a broad spectrum of different product segments. As diversified as these applications are in terms of their requirements, they all share one aspect: Formulators must take the challenge and skillfully select from a wide variety of ingredients and combine them in perfect balance. By doing so, they shape the texture, sensory feel, overall performance and appearance of the emulsion, creating a targeted cosmetic product. The choice of the emollient, also referred to as cosmetic oil, is of paramount importance, as it constitutes the second major component in emulsion systems after water. Its basic function and benefit covers softening, moisturizing, lubricating, protecting, film-forming, conditioning, solubilizing and dispersion properties. Traditionally, most cosmetics are formulated with a mixture of emollients, carefully chosen based on their chemical structure and INCI declaration, physico-chemical properties, sensory profile as well as origin and availability. In order to aid the formulator in the decision for the appropriate emollient for their individual cosmetic product, helpful tools have been developed. They are based on scientific data compiled using a variety of different methodologies.

Abstract

One of the major challenges for a formulator of cosmetic products today is the choice out of the overwhelming variety of available raw materials. The vast majority of cosmetic products are emulsion systems where the emollient constitutes the second major component after water. Therefore, the choice of the emollient or emollient mixture is crucial, as it has the greatest influence on a variety of criteria, by which the final product will be judged. In order to guide the formulator in the proper alignment of each individual property, helpful tools were developed based on scientific data. The data was compiled in a compact format which enables a rapid overview of emollients and their associated characteristics. Among these are the chemical structure and INCI declaration, physico-chemical properties, application-technological properties, sustainability criteria and sensory profile. Application criteria cover UV filter solubility, packaging compatibility and pigment wetting performance. Here, an introduction into the so-called »Senses« scientific tool will be given, by discussing some of the most important emollients and criteria for their selection.

Emollient Chart

Very frequently, one of the first decision criteria for emollient selection is their physico-chemical properties. To facilitate the choice and have the most important criteria in one chart, a selection tool was created, which shows at a glance the five key characteristics of emollients (Fig.1) (1).

Viscosity

Viscosity measurements were conducted with a falling ball viscometer (Hoeppler Viscometer) following DIN 53015, and the values were logarithmically plotted on the x-axis. The viscosity of the emollient strongly influences the viscosity of water-in-oil (W/O) emulsions and thus their spreadability. Viscosity also determines the subjective fatty character of the finished cosmetic product.

8

SOFW-Journal 140 8 2014
Surface & interfacial tension
Surface tension and interfacial tension were both determined using the pendant drop method (Data Physics OCA 35). Measurements were conducted in a climate chamber after saturation of the emollient with water. Following equilibration of the emollient/air and emollient/water interface, respectively, the tension value was determined. The surface tension of the emollient drop against the surrounding air is plotted on the y-axis of the emollient chart. This parameter, together with the viscosity parameter, indicates the spreadability of the final emulsion as well as its stickiness, and can influence whitening properties. The relative polarity of the emollient is derived from the interfacial tension between emollient and water and is represented by the circle color in the emollient chart. Emollient polarity is a major factor influencing emulsion stability in both W/O and oil-in-water (O/W) systems and solubility of lipophilic UV filters and active ingredients.

Spreadability
The size of each circle in the emollient chart (Fig. 1) is proportional to the spreadability, which was measured as the spreading area of emollient saturated with water on a commercially available polyacrylamide gel substrate rehydrated in isotonic saline solution after 5 minutes. The substance was chosen and the method developed to closely mimic spreadability on human skin. Therefore, spreadability indicates the ability of an emollient to spread on the skin and influences the subjective absorption behavior.

Vegetable content and enzymatic production
The cosmetic oils are listed, in order of increasing viscosity, in the table with the INCI declaration, which is indicative of their chemical structure class. Two groups of emollients are highlighted in the chart (Fig. 1). Circles with green outlines indicate fully vegetable-based emollients, while turquoise outlines indicate fully vegetable-based and enzymatically produced emollients using Evonik-proprietary technology. Great environmental advantages, like more than 60% energy saving (Fig. 2) and more than 60% reduction of greenhouse gases become apparent when replacing conventional chemical.

---

Fig. 1 Emollient Chart with five emollient properties at one glance: surface tension, viscosity, spreadability, polarity and vegetable-based origin.
catalysis with an optimized biocatalytic process (2) (3). Several cosmetic oils like e.g. Isoamyl Cocoate (TEGOSOFT® AC), Oleyl Eru­cate (TEGOSOFT® OER), Decyl Cocoate (TEGOSOFT® DC), Cetyl Ricinoleate (TEGO­SOFT® CR) and Myristyl Myristate (TEGO­SOFT® MM) are produced enzymatically. Emollients based on this technology excellently fulfill today’s market needs, in particular for the formulation of natural and eco-friendly cosmetic products. The great advantage of this kind of depiction in the emollient chart is that it permits simultaneous comparison of several properties at a glance in a two-dimensional landscape. This can serve as a useful tool for a formulator in selecting an emollient based on the physico-chemical properties and chemical synthetic or enzymatic origin. In order to achieve the desired benefit, however, application-technological parameters have to be taken into consideration as well.

- UV filter solubility - Emollients for Sun Care

Knowing the capability of UV filter solubility is crucial for formulating efficient sun care products, especially with high sun protection factors. In addition to sunscreens, other daily wear products often contain UV filters, like facial care products, for example. Emollients help to achieve the desired skin feel and performance without jeopardizing sun protection. Secondly, formulators can take advantage of the synergistic effect between emollients and UV filters. If proper solubility of the UV filters is maintained, a SPF boosting effect of the sunscreen system can be achieved (4).

![Fig. 2 Energy resources (MJ). Generic data of Life Cycle Assessment for Myristyl Myristate (TEGOSOFT® MM) production on St scale.](image)

![Fig. 3 Solubility of UV filters at room temperature in various emollients.](image)
The solubility of UV filters can be estimated in the first instance from emollient polarity. However, this aspect was investigated in more detail. Fig. 3 displays the solubility of four of the most broadly used, lipophilic, crystalline UV filters (4). Data was collected for the UVA filter Butyl Methoxydibenzoylmethane (BMDM), the UVB filters Benzophenone-3 (BP3) and Ethylhexyl Triazone (EHT) and the UVA/UVB filter Bis-Ethylhexyloxyphenyl Methoxyphenyl Triazine (BEMT).

UV filter solubility was determined by saturation of emollient with the respective UV filter, which was added step by step until the point of saturation. The supernatant solution was then analyzed for the filter concentration by high performance liquid chromatography (HPLC). Phenoxyethyl Caprylate (TEGOSOFT® XC), for example, is a highly polar ester emollient of Phenoxyethanol and Caprylic Acid (over 50% based on vegetable raw materials), which has outstanding solubility properties and can provide a SPF boosting effect in both US and European sun care formulations (4). This emollient is highly polar and improves the solubility of lipophilic crystalline structures, compared to the industry standard C12-15 Alkyl Benzoate.

Utilizing the solubility data as shown in Fig. 3, the formulator is not anymore limited by selecting out of the few emollients known for use in sun care products, but depending on the desired sun protection factor and UV filter – can choose from a broader palette of emollients, based on their individual solubilizing properties.

Other criteria which must be kept in mind by the formulator in the creation of a targeted cosmetic product are additional application-technological properties like pigment wetting and the sensorial profile of the cosmetic oil.

**Pigment wetting – Emollients for Color Cosmetics**

Beside traditional foundations a huge number of classical (make-up) and emerging market technologies, like blemish balm (BB) and color control (CC) formulations contain pigments. Knowing which emollient facilitates pigment wetting helps to formulate color cosmetic products. This property was evaluated using some of the most commonly applied metal oxide pigments coated with Dimethicone. Included in the systematic evaluation study were Yellow Iron Oxide (Cl 77492), Black Iron Oxide (Cl 77499), Red Iron Oxide (Cl 77491), Titanium Dioxide (Cl 77891) as well as uncoated Carbon Black (Cl 77266) (Fig. 4).
For each individual pigment the maximum ratio of pigment to emollient was determined and kept constant. Optimized emollient loadings ranged from 15% for Carbon Black to 65% for Red Iron Oxide. This allowed clear differentiation of the emollient performance. The viscosity at 1/100 seconds was measured using a rheometer (Haake RheoStress). Measurements were conducted at room temperature, except for waxy emollients, which were evaluated at elevated temperature above their melting point. The score values in Fig. 4 are based on the difference of viscosity of the pigment/emollient dispersion relative to the viscosity of the pure emollient. The lower the difference of viscosity, the higher the rating of pigment wetting. Isosoyl Cocoate (TEGOSOFT® AC), for example, a 100% vegetable-based and enzymatically produced emollient (Fig. 1), showed superior pigment wetting properties for all tested pigments. This makes it a very suitable emollient for pigment containing formulations. Cyclopentasiloxane, an emollient which is commonly employed in make-up formulations, did not show favorable wetting performance. It might influence the skin feel as such but would not help for pigment wetting. Isoamyl Cocoate (TEGOSOFT® AC), the ester of Isoamyl Alcohol and vegetable based fatty acid has a medium spreadability, good absorption and a light and non-oily skin feel. Other emollients with very high pigment wetting capability are Isopropyl Palmitate (TEGOSOFT® P), Isopropyl Myristate (TEGOSOFT® M), Myristyl Myristate (TEGOSOFT® MM) and Decyl Cocoate (TEGOSOFT® DC).

### Sensory map

The sensory profile of cosmetic consumer products is essentially influenced by the formulator's choice of emollients. An overview was developed that directly maps the effect of different oil components on skin feel, enabling the formulator to create the sensory profile that is desired.

A wide range of cosmetic oils has been comprehensively evaluated by sensory analysis. The pure emollients were analyzed in a descriptive panel. Five in-use (spreadability, oiliness, absorption, stickiness, slipperiness) and two after-feel attributes (greasy feel, silicone feel) were classified. Sensory evaluation data was analyzed by principle component analysis and cluster analysis and structured in six different clusters with similar sensory properties. The position of the clusters is schematically depicted in a sensory map spanned by axis resulting from the principal component analysis. The resulting dimensions are skin feel characteristics (light skin feel to rich skin feel) on the x-axis and oily residue (no oily residue to oily residue) on the y-axis (Fig. 5). The bubble size correlates to the area over which the emollients of the cluster are distributed. The smaller the bubble of the cluster and the closer the bubbles are located in the sensory map, the more similar the perceived skin feel. This important tool supports

---

**Fig. 5 Sensory map displaying a variety of cosmetic emollients in six skin feel clusters. Reference emollients were included in the evaluation and are given in black letters in the map.**
the formulator in choosing the right combination of emollients and creating the cosmetic product with the required sensory aspects. Isoamyl Cocoate (TEGOSOFT® AC), for example, imparts a light and non-oily skin feel with low residue, and is clustered together with Phenoxyethyl Caprylate (TEGOSOFT® XC). This cosmetic oil for sun care formulations absorbs better and provides a less oily skin feel than the industry standard C12-15 Alkyl Benzoate, which is found in the adjacent cluster, characterized by medium light skin feel with low oily residue. In comparison, natural oils and Oleyl Erucate (TEGOSOFT® OER), a 100% natural-based and enzymatically produced emollient made by enzymatic esterification, with structure and properties similar to Jojoba Oil, imparts a rich skin feel with medium oily residue.

**Summary**

All of the above-mentioned factors influence the final texture, sensory feel, and overall performance of a cosmetic product. When utilized together, the Senses scientific tool supports the formulator in the proper alignment of each individual property. It is to be taken as supporting tool in the selection of emollients, to create products with improved sensory and emotional appeal.

**References**


(3) O. Thum, «Enzymatic Emollients – Sustainability that gets under the skin» COSSMA 1-2/2010.


*Author's address:
Dr. Matthias Mentel
Evonik Industries AG
Goldschmidtstr. 100
45127 Essen
Germany
Email: matthias.mentel@evonik.com

---

**I am committed to your testing needs**

and I like putting my interpersonal strengths into the recruitment of volunteers.

Nicole P., Recruitment Manager at proDERM