ABSTRACT
Emollients contribute to the moisturizing, lubricating, protecting, conditioning and softening performance of cosmetic formulations and therefore are key components in most personal care products.

Serving the trend for more organic and natural ingredients, new skin care formulations with CITROFOL® have been developed. CITROFOL® types are versatile citrate-based organic esters with excellent emollient properties. These new tests demonstrated their effectiveness in the formulations without interacting with or compromising other components. Their spreading values are equivalent to other common, mostly synthetic emollients.
INTRODUCTION
Consumers are becoming more environmentally savvy and seek natural cosmetic products that are safe but still perform as well as conventional products.

Ongoing interest in this trend can also be seen in past years in personal care. In addition to substantial growing interest in eco-friendly packaging and cruelty-free products, the naturalness of the ingredients on the inside of the packaging are also preferred for cosmetics. The challenge is to balance trendiness with efficacy and consumer benefits, as well as providing genuine renewable resources.

SMOOTH OPERATORS - HOW SMOOTH FEELING WORKS
Creams and lotions are designed to improve the condition of dry skin. For utilization of smooth skin feeling, three major functional ingredients are utilized; occlusive agents, humectants and emollients.

Occlusive agents increase moisture levels by providing a physical barrier to epidermal water loss. They have a low-spreading behaviour which partly leads to the “smooth skin” feeling that lasts for long periods of time. Preferred applications are for night creams, baby care, and skin care products on the eye.

On the other side, humectants are in most cases high-spreading oils which work by attracting water from the dermis below. This helps to keep that water bound in the stratum corneum. High-spreading products distribute very well and penetrate quickly into the recesses of the skin surface. They produce a fast feeling of smoothness but only for a short time period. Humectants with high spreading behaviour on the skin are preferred for low viscosity lotion, cream gel, skin and bath oils, hand creams and other “dry” formulations.

The most versatile key components in the manufacture of cosmetic products are emollients. They are absolutely necessary to contribute to the moisturizing, lubricating, protecting, conditioning and softening performance of personal care formulations.

Emollients provide some occlusive properties and improve the appearance of the skin. The “smoothness of skin” sensation is due both to the functionality of barrier and actual moisturizing. There are many different types of emollient esters and oils available. Combining emollients with different spread rates, smooth skin feeling can be optimized to the needs of the preferred application. As an additional advantage, emollients which are similar to those naturally found in the skin may also increase the rate of barrier repair.

Since there are numerous emollients available, it is difficult to select the most appropriate one to achieve the preferred properties for a specific application. Spreadability is known as a main indicator for ease of emulsification and skin feel properties. For that reason, standard emollients have been tested against citric acid-based CITROFOL® esters in various trials at the Jungbunzlauer Application Technology Center in Ladenburg.
MATERIALS AND METHOD
Based on their chemical structures and raw materials, CITROFOL® products are natural and nature-identical emollient oils. Their typical features (e.g. polarity, solubility and surface tension) are the best basis to prove their spreading attributes.

<table>
<thead>
<tr>
<th>INCI</th>
<th>CAS</th>
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<tbody>
<tr>
<td>CITROFOL®AI</td>
<td>TRIETHYL CITRATE 77-93-0</td>
</tr>
<tr>
<td>CITROFOL®BI</td>
<td>TRIBUTYL CITRATE 77-94-1</td>
</tr>
<tr>
<td>CITROFOL®BII</td>
<td>ACETYLTRIBUTYL CITRATE 77-90-7</td>
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In general, the spreading of esters on the human skin can be defined as the capability of dispersing more or less quickly on the skin surface by forming a film. A common technique for determination of the spreading values has been described by Zeidler.

The measurement of spreading values (mm²/10 min) was carried out by applying 20μl of the emollient applied in the middle of an ash-less, medium to fast filter paper at 25°C. The time between application and measurement of spreading area was exactly 10min.

**Table Spreading Values:**

| High spreading values: | > 850 mm²/10 min | Isopropyl Myristate  
| Ethylhexyl Stearate  
| CITROFOL® AI  
| CITROFOL® BII  |
| Medium spreading values: | 501- 850 mm²/10 min | Dibutyl Adipate  
| CITROFOL® BI  |
| Low spreading values: | 0 - 500 mm²/10 min | Isopropyl Palmitate  
| Ethylhexyl Stearate  
| CITROFOL® AI  
| CITROFOL® BII  |
| C12-15 Alkyl Benzoate  |

As a conclusion of the tests, CITROFOL® ester have been found ideal supplements in the category medium spreading oils. They are suitable to replace standard products like the well-known ethylhexyl stearate or decyl oleate without loss of functionality.

An example of smooth feeling hand cream, combining the medium spreading values of CITROFOL® with low (coco glycerides) and high (isopropyl stearate) spreading components was formulated in our Application Technology Center as follows:
For the manufacturing of the hand cream both Phases A and B are heated up to 80°C. Emulsify Phase B under stirring slowly to Phase A and homogenize afterwards for 2 to 5 min. Cool down to 35°C and add Phase C and D under stirring. Set up pH 6.5 with Phase E.

The resulting white lotion has a viscosity of app. 6500 mPas. Without any losses in performance its stability was proven over a period of 3 month at 20°C, 4°C and 40°C and additionally for 1 month at 45°C.

MORE THAN JUST SINGLE FUNCTIONALITY
In recent years the market for sun protection products has been increasingly driven by products with high sun protection factor (SPF); a trend is observed for special products with sun protection factors SPF 50+. Besides nourishing properties, preferred emollients should have good dissolving and dispersing properties for pigments and UV filters. For the stability and effectiveness of sunscreen products it is essential that crystalline UV filters remain dissolved over the total period of use.

In addition to the trials as medium spreading natural emollients, the solubility for a common UVA filter (Butyl Methoxydibenzoylmethane) in different CITROFOL® types was examined.
Graph: Solubility of Butyl Methoxydibenzoylmethane in Emollients

CITROFOL® products show an outstanding ability to dissolve this hardly soluble UVA filter with long lasting stability. Compared to standard emollients up to 15 to 20 % more of the Butyl Methoxydibenzoylmethane were clearly dissolved. Even after 4 weeks the solutions remain absolutely clear without any re-crystallization which is usually associated instability of the formulation.

PUTTING IT TOGETHER
Each of the commonly used emollients have a different mechanism of action when applied on skin. Depending on application, cosmetic emulsions, lotions and creams will use a combination of oils to create a synergistic effect in skin feeling. The above trials demonstrated that CITROFOL® esters are ideal emollients in modern personal care formulations and are excellent partners especially for use in sun care products. Jungbunzlauer ingredients are outstanding natural solutions to replace synthetic materials in personal care products; combining the natural derivation from renewable resources and the requirements for reliable functionality.

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