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The Road to More Sustainability and Functionality In Liquid Laundry Detergents

Clever Combinations – Protecting pH-neutral Formulations the Natural Way

M. Nahrwold

abstract

Bio-based 1,2-alkanediols are ideal ingredients for modern natural cosmetics: they are multifunctional, gentle to the skin and environmentally friendly. Moreover, formulations containing 1,2-alkanediols are typically self-preserving, even at neutral pH. Clever combinations of 1,2-alkanediols with other bio-based additives further increase the mildness of formulations and reduces their cost. In addition, liquid premixes of 1,2-alkanediols and suitable additives also simplify the application and increase productivity. However, to achieve a successful outcome requires making the right choice between different 1,2-alkanediols and different additives. This article shares guidance on the choices available to protect natural cosmetics safely and cost-effectively and includes supportive evidence.

Modern cosmetics

With today's focus on well-being, consumers are increasingly demanding natural and responsibly-made cosmetics. Natural beauty products, and those with 'clean' label certifications like 'vegan' or 'non-GMO', are very much in vogue with 'Back to basics' as the new ideal. As a result, cosmetics launched with "natural" and "sustainable" claims have seen an average annual increase of 35% over the past 10 years.[1] And of course, modern cosmetics of today should be mild to the skin and contain only undisputed ingredients that are necessary for effectiveness.

In this context, public scrutiny of preservatives has grown. Most conventional preservatives are made from fossil carbon, and some of which are harmful to the environment. Several ingredients, such as formaldehyde donors, methylisothiazolinones or parabens, have come under media fire for their controversial side effects. Safe and effective natural alternatives are thus in high demand.

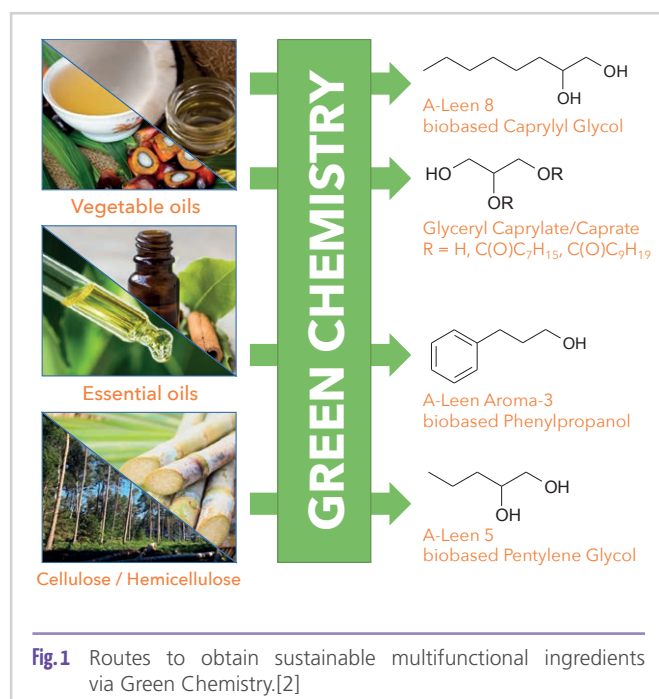
Currently, many natural cosmetics are preserved using carboxylic acids. But these are only effective in acidic environments, which may irritate the skin. Another common natural preservative is ethanol, known to be volatile and flammable and not accepted in all regions of the world. Consequently, there are only a few solutions for protecting natural cosmetics with a neutral pH-value between 5.5 and 7. Yet, it is this pH range that is especially mild and skin-friendly.

Bio-based and sustainable

Choosing to use bio-based 1,2-alkanediols to protect natural cosmetics is a relatively novel option. Two of these products have recently become available offering significant

advantages over ethanol: bio-based Pentylene Glycol and bio-based Caprylyl Glycol are skin-moisturizing, odourless, non-volatile and non-flammable. Also, compared to carboxylic acids, these 1,2-alkanediols are milder and protect formulations even in the most skin-friendly neutral pH-range.

While 1,2-alkanediols occur in nature, they are only found as metabolites of certain microorganisms. Therefore, commercially available products are man-made, either from fossil carbon or from vegetable feedstock. The bio-based versions are produced in accordance with the principles of green chemistry.[2] Bio-based Pentylene Glycol is derived from hemicellulose, while bio-based Caprylyl Glycol is obtained from natural oils (**Figure 1**).



Both ingredients meet COSMOS and NATRUE eco-certification standards, and both have a natural origin index of 1 according to ISO 16128. Their multifunctionality as skin humectants, conditioners and emollients fits well with current clean beauty concepts and can replace at once a number of conventional ingredients. This shortens the number of ingredients to be procured.

1,2-Alkanediols need help

It is possible to protect cosmetic formulations using only 1,2-alkanediols, such as bio-based Pentylene Glycol. However, it requires concentrations of about 4-5% Pentylene Glycol to pass a standard challenge test according to ISO 11930 or the European Pharmacopoeia norm. As this can be costly, antimicrobial efficacy can be significantly offset by combining Pentylene Glycol with small amounts of other multifunctional additives. Such combinations typically reduce the required amount of Pentylene Glycol to about 1.5-2.5%. The underlying effect is called “boosting,” which refers to the ability of Pentylene Glycol to disrupt microbial cell membranes: Different antimicrobial agents assist each other in penetrating the microbes, so that lower than usual concentrations are sufficient for complete preservation. Being miscible with water, Pentylene Glycol also stabilizes other antimicrobial ingredients in the aqueous phase, where most microorganisms reside. Finally, being truly multifunctional, Pentylene Glycol moisturizes the skin, helps to disperse pigments, assists in the hydration of gellants and creates a smooth and non-greasy skin feel.[3]

Compared to the water-soluble Pentylene Glycol, its longer-chain relative Caprylyl Glycol is more lipophilic. Its solubility in water is limited to 0.75%, but use levels of only about 0.5% Caprylyl Glycol are typically sufficient to completely protect a cosmetic product from microbial infestation. Its remarkable antimicrobial efficacy makes biobased Caprylyl Glycol one of the safest and most cost-effective solutions for creating self-preserving natural formulations. [4] However, Caprylyl Glycol is a waxy solid that melts at 30-35°C. The process of melting can take a long time, and the molten product has a high tendency to form supercooled melts, making the freezing point unpredictable. Finally, the material increases in volume as it freezes, which can cause drums and pipes to burst. All this makes Caprylyl Glycol a capricious ingredient that is quite inconvenient to handle. Combining biobased Caprylyl Glycol with other components in a stable liquid blend may help to improve its handling while retaining its benefits. Thanks to some boosting effects, the concentration of the 1,2-alkanediol can be reduced to about 0.2-0.4%, which can also help to reduce the cost and increase the mildness of the final formulation.

The most straightforward approach to stabilizing bio-based Caprylyl Glycol in a liquid form is to combine it with inert ad-

ditives such as water or glycerol. Interestingly, the addition of water to a mixture of Caprylyl Glycol and glycerol does not lead to phase separation. Instead, stable liquids with melting points below 20°C are formed, consisting of up to 75-80% Caprylyl Glycol. In this form, Caprylyl Glycol is easy to handle and suitable for cold processing. Simple storage at room temperature is sufficient to keep it liquid. This saves time and energy and allows safe handling without heating or local air extraction. All the positive aspects of bio-based Caprylyl Glycol are maintained, such as low odour, low cost in use and essentially no pH restriction.

Support from functional additives

In order to further increase the antimicrobial efficacy and mildness of 1,2-alkanediols, these can be combined with other bio-based and non-ionic compounds having an inherent antimicrobial effect. Two groups of components are of particular interest, because their non-ionic structures are not affected by slight changes of the pH-value:

- **Natural aromatic alcohols** are fragrance ingredients with a pleasant odour and a broad-spectrum antimicrobial effect, especially against yeasts and moulds. Aromatic alcohols are stable under acidic or alkaline conditions and sufficiently soluble in water. Examples for this class of substances are Benzyl Alcohol, Phenethyl Alcohol and Phenylpropanol.
- **Mono- and Diglycerides** are esters of glycerol and fatty acids. These compounds act as emollients and co-emulsifiers and are particularly mild to the skin. They also have a long track-record of safe use as food additives (E471) and as pharma excipients. The antimicrobial effect of short chain monoglycerides, especially against bacteria and yeasts, makes them a natural option for formula protection. However, just like Caprylyl Glycol, mono-glycerides are waxy solids that require melting and homogenization before use. Typical examples for antimicrobial monoglycerides comprise glyceryl caprylate, glyceryl caprate and glyceryl laurate.

One member of each class was selected for a deeper investigation of their efficacy in combination with 1,2-alkanediols:

- **Phenylpropanol** was selected as example of an aromatic alcohol. The substance occurs abundantly in nature, for example, in the scent of hyacinths or in the flavour of ripe strawberries. Due to its warm oriental and balsamic odour, Phenylpropanol is an attractive perfuming agent. While Phenylpropanol made from fossil carbon sources is quite common, the biobased version is a relatively novel ingredient. This new version is produced from essential oil by means of green chemistry (**Figure 1**). Just like the 1,2-alkanediols, Phenylpropanol is stable at practically any pH value.

- Glyceryl Caprylate/Caprato** was selected as example of an antimicrobial glyceryl ester. This ingredient is a mild and skin friendly emollient which is also known as pharmaceutical excipient under the names “Mono- and Di-Glycerides” or “Glycerol Monocaprylocaprato”. It can be used as a “mildness enhancer” for applications dedicated to sensitive skin or sensitive areas. This cost-effective ingredient is produced from sustainably sourced palm kernel or coconut oil. It exhibits a broad-spectrum antimicrobial effect against yeasts and bacteria within a pH-range of 4-7. The limiting factor for the pH-value is the stability of the ester bonds to hydrolysis or saponification. Glyceryl Caprylate/Caprato is soluble in oils and dispersible in water.

Performance under realistic conditions

For the efficacy screening, each of the two bio-based 1,2-alkanediols Pentylene Glycol and Caprylyl Glycol was combined separately with each of the two biobased additives Phenylpropanol and Glyceryl Caprylate/Caprato. The mixtures were formulated into storage stable liquid blends (Table 1).

For comparison, the efficacy of the two bio-based 1,2-alkanediols were also tested separately without additives. The biobased Caprylyl Glycol was finally also applied in its physiologically stabilized liquid form (“E-Leen 8”). Table 1 summarizes the different combinations tested.

The ingredients listed in Table 1 were evaluated for their antimicrobial performance in three different personal care products, thus covering common mass-market applications:

- natural O/W emulsion (Table 2 A)
- sulphate-free shampoo (Table 2 B)
- eco-friendly, cellulose-based wet-wipes (Figure 3).

The blends and single 1,2-alkanediols were tested at different use-levels and pH-values in microbial challenge tests according to the norm ISO 11930. Each product was separately infected with five different microbes (one yeast, one mould, three different bacteria). The germ counts were determined after 7, 14 and 28 days. Depending on the reduction of the germ counts, the formulations were found to either fulfil criteria A (fully protected), criteria B (partly protected) or none of the criteria (failed, not protected).

N°	Commercial name	1,2-Alkanediol	Antimicrobial additive	Stabilizing additive	Perfume free	pH limits	Solubility in water	Freezing point
1	A-Leen 5	Pentylene Glycol	-	-	X	-	Miscible	< -20 °C
2	E-Leen Green A	Pentylene Glycol	Phenylpropanol	-	-	-	3%	< -20 °C
3	E-Leen Green C	Pentylene Glycol	Glyceryl Caprylate/Caprato	-	X	4-7	Dispersible	< -20 °C
4	A-Leen 8	Caprylyl Glycol	-	-	X	-	0.75%	30 °C
5	E-Leen 8	Caprylyl Glycol	-	Glycerol/Water	X	-	0.9%	13 °C
6	E-Leen P8	Caprylyl Glycol	Phenylpropanol	Water	-	-	0.9%	5 °C
7	E-Leen GC 8	Caprylyl Glycol	Glyceryl Caprylate/Caprato	Glycerol	X	4-7	Dispersible	< -20 °C

Tab. 1 Combinations of bio-based 1,2-alkanediols with bio-based additives

Table 3 shows a summary of the results obtained for the O/W emulsion and the sulphate-free shampoo.

Results and Discussion

The test results also show that Pentylene Glycol and Caprylyl Glycol can be considered as complementary ingredients. Each of the two ingredients is particularly suitable for certain applications.

The use-levels of 2-3% for the Pentylene Glycol-based blends E-Leen Green A and E-Leen Green C (Table 3, entries 2 and 3) are comparatively high. These blends are therefore particularly suitable for formulations that benefit from the multifunctionality of the Pentylene Glycol, such as its skin-humectant, dispersing, wetting, emollient or solubilising properties. Since Pentylene Glycol is a water soluble 1,2-alkanediol, it has a low tendency to migrate into oil-phases or to get captured inside micelles. Indeed, it can even stabilize lipophilic ingredients inside water phases. All this makes blends based on Pentylene Glycol particularly suitable for formulations that are rich in oils or contain high concentrations of surfactants.

(A)	Phase	Ingredient	INCI name	%
Natural O/W emulsion	A	DeminerIALIZED Water	Aqua	ad 100
		Xanthan Gum ⁽¹⁾	Xanthan Gum	0.5
	B	Emulgade PL 68/50 ⁽²⁾	Cetearyl Glucoside (and) Cetearyl Alcohol	5.0
		Shea Butter ⁽³⁾	Butyrospermum Parkii (Shea) Butter	3.0
		Joboba Oil ⁽³⁾	Simmondsia Chinensis (Jojoba) Oil	3.0
		Hazelnut Oil ⁽⁴⁾	Corylus Avellana (Hazel) Seed Oil	3.0
	C	Bioxan T70 ⁽⁵⁾	Tocopherol	0.1
	D	aq. Citric Acid / NaOH	Citric Acid / Sodium Hydroxide / Aqua	pH 4.5-8.0
	E	A-Leen / E-Leen ... ⁽⁶⁾	Caprylyl Glycol / Pentylene Glycol + X ...	see table 3
	(B)	Phase	Ingredient	INCI name
Sulphate-free shampoo	A	DeminerIALIZED Water	Aqua	ad 100
		Xanthan Gum ⁽¹⁾	Xanthan Gum	0.6
		Plantacare 818 UP ⁽²⁾	Coco Glucoside	15.0
		Plantapon ACG HC ⁽²⁾	Sodium Cocoamphoacetate	5.0
		TEGO Betain F 50 ⁽⁷⁾	Cocamidopropyl Betain	5.0
	B	aq. Citric Acid / NaOH	Citric Acid / Sodium Hydroxide / Aqua	pH 4.5-8.0
	C	A-Leen / E-Leen ... ⁽⁶⁾	Caprylyl Glycol / Pentylene Glycol + X ...	see table 3


Ingredient suppliers: ⁽¹⁾ Jungbunzlauer ; ⁽²⁾ BASF ; ⁽³⁾ Casear & Loretz ; ⁽⁴⁾ Sanabio ; ⁽⁵⁾ BTSa ; ⁽⁶⁾ Minasolve ; ⁽⁷⁾ Evonik

Tab. 2 Natural O/W emulsion and sulphate-free shampoo, used for microbial challenge tests.


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N°		1		2			3		4	5			6			7			
1,2-alkanediol (concentration, wt.-%)		Pentylene Glycol (100%)		Pentylene Glycol (≥ 70%)			Pentylene Glycol (≥ 80%)		Caprylyl Glycol (100%)	Caprylyl Glycol (75%)			Caprylyl Glycol (≥ 50%)			Caprylyl Glycol (≥ 35%)			
+ additives				Phenylpropanol			Glyceryl Caprylate/ Caprate			Glycerin Water			Phenylpropanol Water			Glyceryl Caprylate/Caprates Glycerin			
Name of blend		A-Leen 5		E-Leen Green A			E-Leen Green C		A-Leen 8	E-Leen 8			E-Leen P8			E-Leen GC 8			
Use-level of blend		3.0%	5.0%	1.5%	2.0%	3.0%	2.0%	3.0%	0.75%	0.5%	0.75%	1.0%	0.5%	0.75%	1.0%	0.75%	1.0%	1.5%	
O/W Emulsion	pH	4.5	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		5.5	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		7.0			●	●		●	●			●	●		●	●	●	●	●
		8.0			●	●		●	●		●	●	●		●	●	●	●	●
		Use-level of blend	3.0%	5.0%	1.5%	2.0%	3.0%	2.0%	3.0%	1.0%	1.0%	1.5%	2.0%	1.0%	1.5%	2.0%	1.0%	1.5%	2.0%
Sulfate-free Shampoo	pH	4.5			●	●		●			●	●	●	●	●	●	●	●	●
		5.5	●	●		●	●		●	●		●		●	●	●	●	●	
		7.0			●	●		●	●										
		8.0			●	●		●	●						●	●	●	●	
		Use-level of blend	3.0%	5.0%	1.5%	2.0%	3.0%	2.0%	3.0%	1.0%	1.0%	1.5%	2.0%	1.0%	1.5%	2.0%	1.0%	1.5%	2.0%

● Fulfils criteria A of ISO 11930
 ● Fulfils criteria B of ISO 11930
 ● Likely to fulfil criteria A of ISO 11930
 ● Not recommended

Tab. 3 Results of microbial challenge tests according to ISO 11930.

Consequently, the two tested blends containing Pentylene Glycol proved to be the most versatile during the challenge tests. They were able to protect the O/W emulsion as well as the sulphate-free shampoo at acceptable use-levels (Table 3, entries 2 and 3). The tested sulphate-free shampoo is solely based on mild surfactants. Such kind of formulations can be very challenging to preserve. In contrast to this, many common cleaning products are based on sulphate or sulfonate surfactants. These already provide an inherent antimicrobial effect. Consequently, products containing sulphates or sulfonates are often partly self-preserving. They can therefore be protected with comparably smaller amounts of antimicrobial additives.

Caprylyl Glycol proved to be a very economical protection agent during the tests. It offers fewer multifunctional advantages than Pentylene Glycol, mainly due to its low use-level. The O/W emulsion tested was already protected with a small amount of Caprylyl Glycol. The physically stabilized liquid form “E Leen 8” (Table 3, entry 5) was comparably effective as the pure form “A-Leen 8” (Table 3, entry 4). In addition, the liquid form was significantly easier to apply. The “boosted” mixture E-Leen P8, additionally containing Phenylpropanol, proved to be even more effective than the pure 1,2-alkanediol. It consequently offers an increased safety margin for demanding formulations (Table 3, entry 6). On the other hand, the skin-friendly blend E-Leen GC 8 (Table 3, entry 7) enabled the full protection of the O/W emulsion to be achieved with lower amounts of Caprylyl Glycol.

Interestingly, despite its tremendous antimicrobial activity, relatively high concentrations of Caprylyl Glycol and corresponding blends were required to protect the sulphate-free shampoo (Table 3, entries 4-7). The reason lies in the lipo-

philicity of Caprylyl Glycol. It is thus more easily entrapped inside surfactant micelles than the hydrophilic Pentylene Glycol. The addition of Phenylpropanol provided only a limited enhancement effect, also because aromatic alcohols tend to be partially inactivated by non-ionic surfactants. Nevertheless, the Caprylyl Glycol-based solutions can be a performant and economic choice for cleaning products based on sulphate or sulfonate surfactants.

The challenges in protecting wet wipes

The final challenge for a “green antimicrobial” is probably the protection of wet wipes. Their solid support provides a large surface area, while the juice of the wipes provides water and nutrients. All these factors strongly favour microbial growth. The more “natural” a tissue is, the more likely it can serve as food or support for certain microbes.

To increase the rigor of the tests, an environmentally friendly cellulose-based airlaid tissue was used, which was kindly provided by Ascutec.[5]

The applied wet-wipes juice consisted of only water, a bio-based detergent (Natragem™ S140 NP, Croda) and a citrate buffer (Figure 3). This aqueous solution was protected with E-Leen 8 (1%), E-Leen P8 (1%) or E-Leen GC 8 (1%), respectively. The detergent also ensured stable and clear aqueous solutions in the presence of the lipophilic antimicrobial additives. Two weight equivalents of the wet wipe juice were applied to one weight equivalent of a dry wipe. The wipes were infected with germs and incubated in sealed plastic bags. The number of germs was counted after 7, 14, and 28 days of incubation in accordance with the ISO 11930 standard

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(see Figure 2). The results of the challenge tests are summarized in Figure 3.

The unpreserved wipes exhibited very high growth for all types of microbes tested (results not shown). The wet wipes protected with E-Leen 8 and E-Leen P8 passed the challenge tests and achieved criteria A. The blend E-Leen GC 8 also showed broad-spectrum antimicrobial activity, but requires a use-level higher than 1% to meet criteria A. These results confirm that solutions containing bio-based Caprylyl Glycol are a convenient option for producing skin-friendly wet wipes. The solutions provide skin-caring effects while creating self-preserving wipes. The use of irritating or persistent additives can thus be avoided. At the same time, these solutions are 100% bio-based, COSMOS and Natrue compliant and readily biodegradable. Their low use levels also make them economically interesting, and their liquid form enables high-throughput production.

Summary

The bio-based versions of the two 1,2-alkanediols “Pentylene Glycol” and “Caprylyl Glycol” prove to be versatile ingredients. In combination with other bio-based additives, they are an economical, time- and cost-saving option for the production of self-preserved natural cosmetics (Figure 4).

Bio-based Pentylene Glycol is generally suitable for products that benefit from its multifunctionality. Due to its high solubility in water, it is particularly useful as an additive to oil-based emulsions, giving them a lighter skin feel with faster absorption. Another positive aspect is its low tendency to get trapped in micelles, a very useful property for antimicrobial additives.

Bio-based Caprylyl Glycol is a high performance alternative suitable for the most common types of O/W-emulsions and surfactant products. Its low use-level makes it an unbeatably affordable option. Not least because of this, it is a real alternative for eco-certified wet wipes.

Just as complementary as the two diols presented are the two bio-based additives “Phenylpropanol” and “Glyceryl Caprylate/Caprate”.

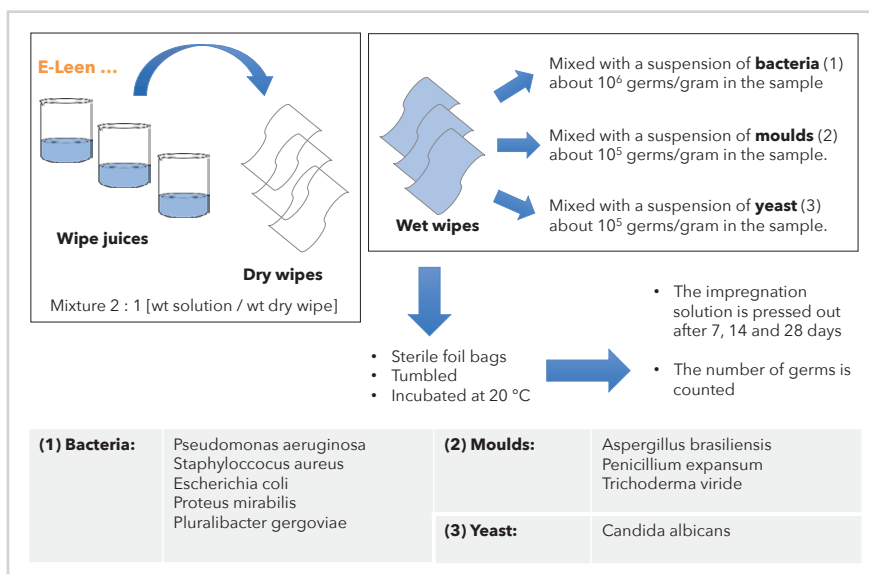


Fig. 2 Protocol for microbial challenge tests on wet wipes, adapted from ISO 11930.

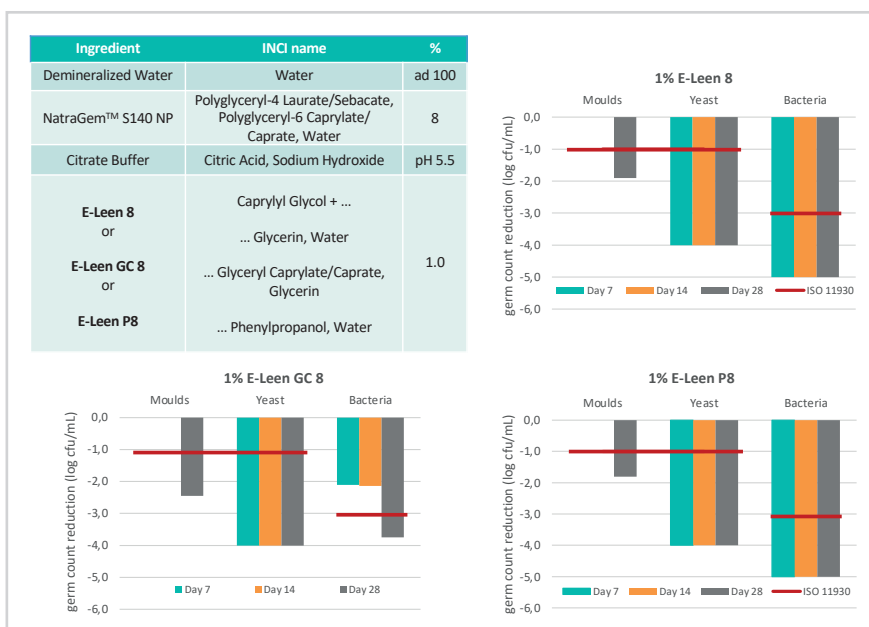


Fig. 3 Formulation of wet wipe juice, and results of microbial challenge tests of the impregnated wipes. The red bars indicate the target values for germ-count reduction after 28 days of incubation.

The aromatic alcohol is resistant to high and low pH values. It gives an extra boost to antimicrobial efficacy and provides an increased margin of safety for demanding applications. Finally, it is also a safe and pleasant perfuming component that can be dissolved in water at appropriate concentrations.

Its complementary counterpart, Glyceryl Caprylate/Caprate, is a very gentle ingredient that offers the ability to protect products for sensitive skin safely and cost-effectively. Its lipophilic structure and low solubility in water suggest O/W-emulsions as the main area of application.

Thanks to this novel toolbox, cosmetics manufacturers and consumers can benefit from milder products with fewer ingredients. The sustainable origin is a welcome advantage that meets today's consumer expectations and contributes to the global challenge of creating a circular economy based on renewable materials.

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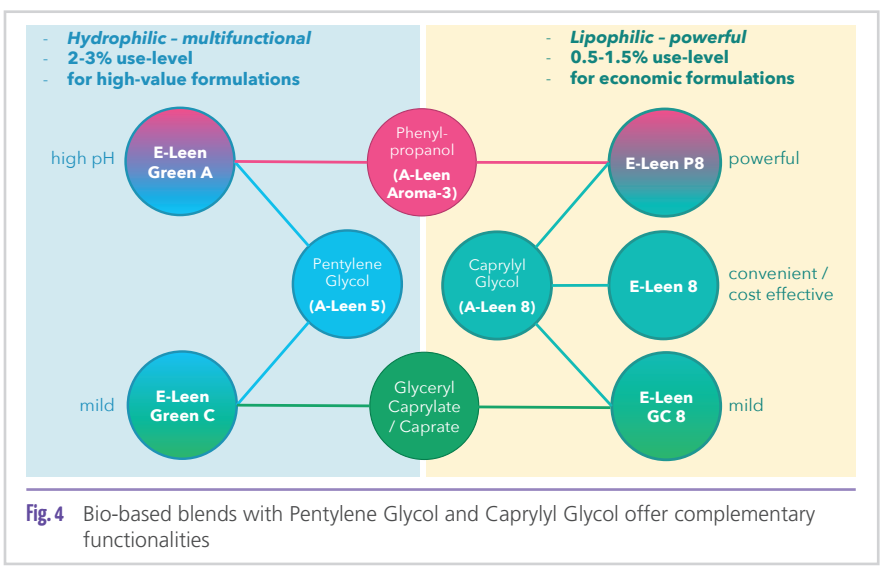


Fig. 4 Bio-based blends with Pentylene Glycol and Caprylyl Glycol offer complementary functionalities

author

Markus Nahrwold | Technical Director
Minasolve
 Rue Fond Jean Paques | 8B-1435 Mont-Saint-Guibert | Belgium
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Hydrophobic Cellulose – Micro-fine Texture at Ultra-strong Performance for a Measurable Soft-focus Effect

J. Schulte, A. Huneke, J. Ryll

abstract

Cosmetic products for a young and fresh appearance have moved beyond finding their place on the drugstore shelves merely as target group-specific niche products today. They have become established in both day care and colour cosmetics for all age groups. The soft-focus effect, for example, visually reduces small facial wrinkles to make the skin appear rejuvenated within seconds. In the process, fine powders settle into skin imperfections, causing a change in the way light is scattered. CFF GmbH & Co. KG has succeeded in developing an innovative natural raw material that achieves an extraordinary soft-focus effect and keeps up with the performance of synthetic powders such as PMMA and Nylon-12 with its hydrophobic cellulose. Hydrophobic cellulose is on par with any microplastic powders in its sensory properties and texture. It entirely imitates their characteristic profile. This article provides an overview of the application of hydrophobic cellulose as a soft-focus additive in comparison to microplastic powders.

Introduction

Aging skin loses elasticity and tone. Skin becomes thinner and drier as it matures. With the appearance of fine wrinkles, the skin begins to look uneven and less fresh. Women over the age of 35 find the changing appearance of their skin disturbing. Their desire for a flawless and rejuvenated appearance is moving increasingly to the focus.

As a consequence, the sales volumes of anti-aging products are increasing every year. The customer range has expanded considerably in terms of the age and gender of the buyers as more and more men have started using anti-wrinkle creams as well as women.

In addition to conventional anti-aging care based on active substances, visual techniques are used in day care or make-up to make the skin look rejuvenated. The principle of the soft-focus effect places fine particles in the skin folds that make incident light scatter less. Wrinkles appear reduced, making the skin look fresher and more youthful. The soft-focus effect is used in both skincare and colour cosmetics for tint products aimed at visually smoothing the skin and concealing wrinkles.

CFF GmbH & Co. KG has developed a new ingredient for an excellent soft-focus effect. Its hydrophobic cellulose is produced from plant-based raw materials such as wood or bamboo. Natural cellulose has already proven its worth for a refined skin feeling in skin care repeatedly. Cellulose stands out for its high water- and oil-binding capacity. This makes formulations appear less sticky and has them absorbed more quickly

by the skin. With its innovative hydrophobic processing, CFF GmbH & Co. KG has succeeded in specifically optimising the function of natural plant fibres using a gentle process.

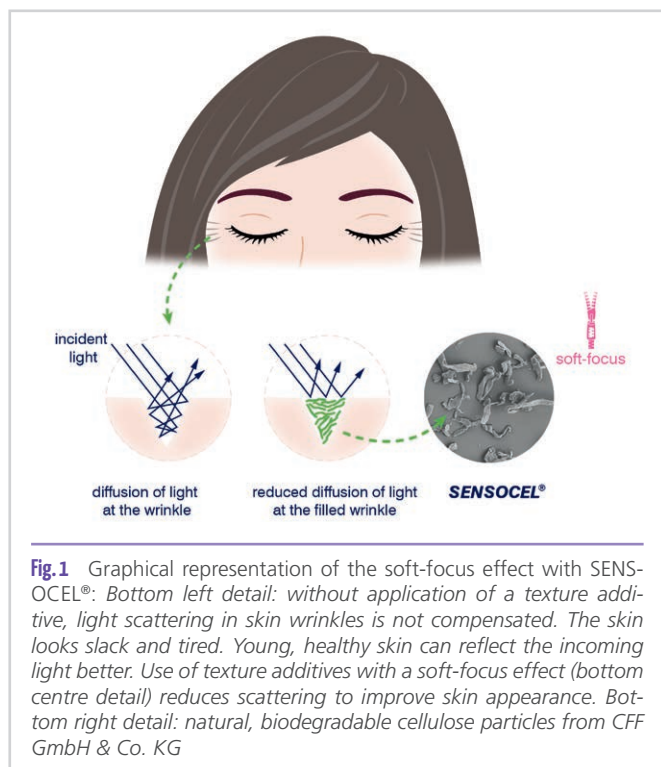
The novel hydrophobic cellulose achieves an excellent soft-focus effect while being able to imitate the characteristic skin feel of fine microplastic powders such as polymethyl methacrylate (PMMA) and nylon. In spite of widespread reporting on the subject of microplastics, these continue to be used for sensory optimisation of creams and visual softening of skin imperfections.

This article explains how hydrophobic cellulose can perfectly mimic the special properties of microplastic powders based on plant-based and biodegradable raw materials.

Texture additives for the soft-focus effect

Soft-focus technology is an important part of current anti-aging skin care, using the simplest laws of physics for its effect. The term of “soft-focus” refers to the visual concealment of small wrinkles and lines by selective control of the transmission and scattering of light into and from the skin. Skin irregularities are visually perceived by their high contrasts (**Fig. 1**). Fine texture additives settle in the skin wrinkles and act as a soft focus there. Contrast is visually reduced and irregularities on the skin surface seem to disappear. The advantage of this method over active-substance-based anti-aging care is that it can be perceived immediately after application. As soon as it is applied, the formulation makes the skin appear more even and rejuvenates the complexion

to appear velvety and fresh. Synthetic particles such as Nylon-12 and PMMA with specific particle sizes below 1-12 μm , continue to be used for the soft-focus effect. In addition to the soft-focus effect itself, they are also said to improve feel and add a matting effect. Although some natural alternatives are already available on the market, only few show an adequate, convincing performance.



The latest development from CFF GmbH & Co. KG uses hydrophobic celluloses that are in no aspect inferior to the performance of plastic powders such as Nylon-12 and PMMA. In addition to an excellent soft-focus, the hydrophobic SENSOCEL® 5+ (1-7 μm) and SENSOCEL® bc 20+ (20 μm) cellulose powders give modern skin care products and colour cosmetics a soft finish and stand out positively with their natural origin.

Innovation: Hydrophobic Cellulose

Natural cellulose serves as a tried and tested additive to positively influence sensory properties and texture in order to make skin-care products and colour cosmetics less glossy and sticky, powdery, and faster absorbed. Natural hydrophobic cellulose combines all of these properties with an even more exclusive, very powdery skin feel.

CFF GmbH & Co. KG has developed a special production process for its production of hydrophobic cellulose to allow individual control of the degree of hydrophobisation. Turning cellulose hydrophobic optimises its function and

No need for expensive scatter loss?

feel alike. SENSOCEL® 5+ and SENSOCEL® bc 20+ produce cosmetic formulations with very soft and even, skin-friendly textures – properties with positive effects in particular in loose and pressed powders. Flow properties have been optimised as well to permit easy use in body powders.

Hydrophobic celluloses offer outstanding performance in emulsions. Even small amounts achieve an exclusive, very light, homogeneous, and smooth texture. The new hydrophobic plant fibres can be stabilised easily even in formulations with low viscosity. They offer a high overall process stability.

These newly developed characteristics turn hydrophobic cellulose into a natural alternative to microplastic powders such as polymethyl methacrylate (PMMA) or Nylon-12.

Background Information on Microplastics

By banning microplastics in rinse-off products, the EU and many other countries have taken a significant step towards making the future more environmentally friendly. Developments following this regulation clearly reflect that there are natural alternatives that can replace microplastic beads in rinse-off products. The next essential step will be a ban on microplastic particles from fine microplastic powders characterised by an even smaller particle size and used in leave-on products that are not covered by the current one yet. The particularly fine synthetic powders PMMA and Nylon-12 continue to be considered important texturisers and sensory enhancers in skin-care products and colour cosmetics. Many of the plastic powders are barely – or not at all – biodegradable.

Biodegradability

Biodegradability describes the process of decomposition of organic material by microorganisms, such as fungi and bacteria, into nutrients that are either used to produce energy for the microorganisms or returned to the environment. Biodegradation is a process of self-purification in surface waters and used specifically to purify wastewater in sewage treatment plants. Various methods for determining biodegradability are known. In cosmetics, the OECD guidelines for testing chemicals have become established. Based on them, biodegradability of readily biodegradable substances is usually determined in an aquatic environment under aerobic conditions in accordance with OECD 301. Substances with limited biodegradability are analysed based on OECD 302 and considered basically or inherently biodegradable. The OECD 302 tests are performed in activated sludge. Special degradability tests such as OECD 311, run in anaerobic conditions, also determine biodegradation in digested sludge. However, a large share of microplastic reaches the sea via runoff and particle-size-related passage

through sewage treatment plants and remains in the water there for long periods. This highlights the importance of testing biodegradability under freshwater conditions.

The test method recommended to determine biodegradability of natural polymers is EN ISO 14851:2019. It determines full biodegradation in a closed respirometer by measuring the oxygen demand in an aqueous medium. As a consequence, determination of biodegradability in accordance with EN ISO 14851:2019 simulates a highly realistic sea environment.

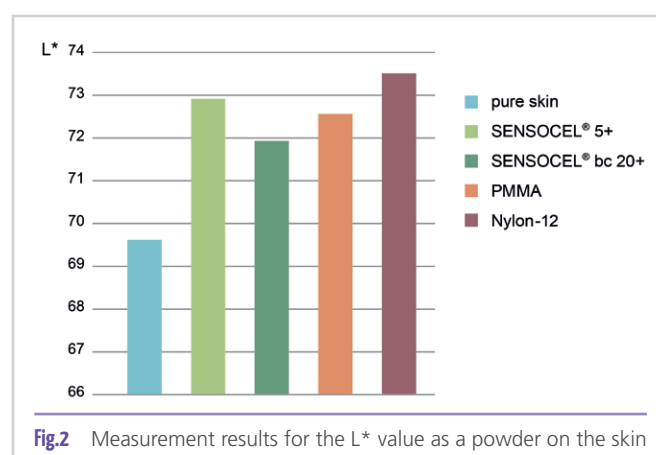
Biodegradability of hydrophobic cellulose has been determined using EN ISO 14851:2019. It came out at 71% after 44 days. Both Nylon-12 and PMMA, used for comparison with hydrophobic cellulose for all the tests described in this article, are classified as non-biodegradable.

Measurement of Light Deviation by Colorimetric Analysis

Colour measurements were performed on the skin and evaluated in order to compare the soft-focus effect of different texture additives. A Minolta Spectrophotometer CM-3500 from Konica Minolta was used for the colour measurements. Its results were evaluated using the CIELAB colour space. The hydrophobic celluloses SENSOCEL® 5+ and SENSOCEL® bc 20+, PMMA, and Nylon-12 were the texture additives chosen for analysis and comparison to each other.

Colorimetric Measurements in the Pure Substance

The first measurement took place with the pure substance on cleansed, dry skin. 1 mg/cm² of product was applied to the skin respectively. Following this, luminance L* (Fig. 2) was measured. The results make it clear that all analysed texture additives positively affect luminance value to make the skin appear brighter. The hydrophobic cellulose SENSOCEL® 5+ and polyamide powder Nylon-12 influenced skin brightness most strongly in the test.



Colorimetric Measurements in Polyacrylate Gels

In the next step, the light-scattering influence of the in a neutral water-based gel (0.5% acrylate polymer) were measured by incorporating the texture additives into the gel at 2% each. Then, 6 mg/cm² of each gel were applied to the cleansed, dry skin. Each texture additive was subjected to 15 colour measurements from which a mean value was calculated (Table 1).

The results show a positive effect on the luminance value in both hydrophobic celluloses. The colour differences ΔE were determined to be between 1.0 and 3.0. This reflects visible to significant colour differences. In particular, the values of the gel with 2% SENSOCEL® 5+ show that use of hydrophobic cellulose improves the appearance of the skin almost to the same degree as Nylon-12.

Sample	L*	a*	b*	ΔE
Standard gel	69.00	6.30	14.39	
Gel with 2% SENSOCEL® 5+	70.12	7.27	12.87	2.122
Gel with 2% SENSOCEL® bc 20+	69.68	6.95	12.92	1.738
Gel with 2% PMMA	69.30	6.88	13.28	1.440
Gel with 2% Nylon-12	70.64	6.04	12.99	2.167

Tab.1 Results of colorimetric analysis in a polyacrylate gel.

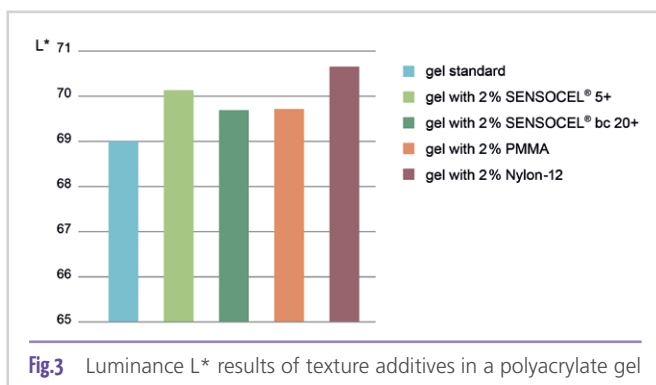


Figure 3 graphically supplements the luminance results in the gel. With a luminance value of 70.12, SENSOCEL® 5+ achieves values that are comparable to those of Nylon-12. Both hydrophobic celluloses make the skin appear lighter and reach similar luminance values in the test that are in the same order as those of the microplastic powders used in the experiment. SENSOCEL® 5+ even achieves a greater luminance than PMMA. SENSOCEL® 5+ and SENSOCEL® bc 20+ are suitable for reproducing the soft-focus effect of PMMA or Nylon-12 and for making the teint look fresher without compromising performance while using only ingredients based on natural raw materials.

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Visual Comparison of the Soft-Focus Effect

The skin area used for the measurement was analysed after application of the respective gels with the different texture additives as well as with a standard additive-free gel (reference sample) (Fig. 4). The skin area with the standard gel (4a) shows distinct wrinkling as compared to the gels with texture additives (4b-4e). The skin imperfections create a greater contrast in the standard gel, making the skin look older, while all gels with hydrophobic cellulose and microplastic show a soft-focus effect. The difference in luminance for hydrophobic celluloses (4b and 4c) compared to PMMA (4d) is not visually distinguishable, which supports the measured data.

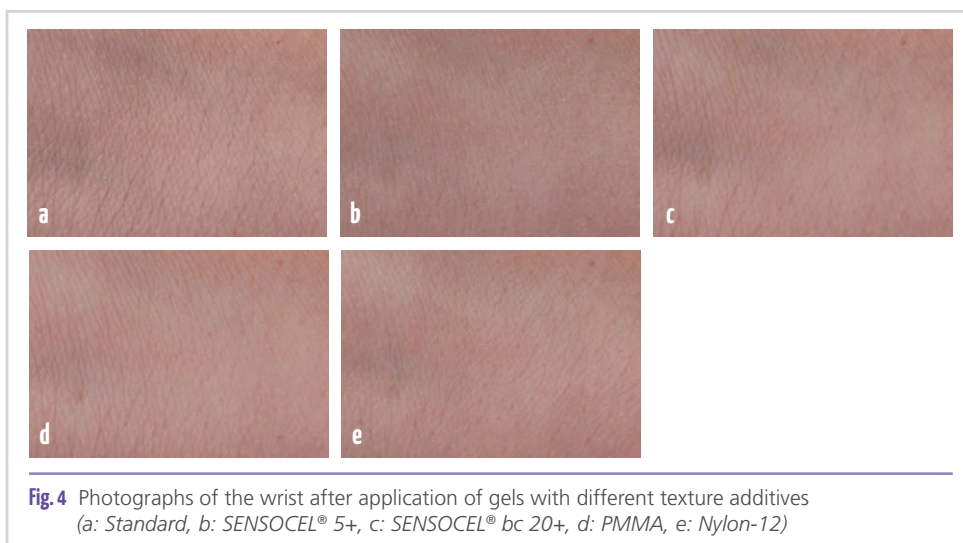


Fig. 4 Photographs of the wrist after application of gels with different texture additives (a: Standard, b: SENSOCEL® 5+, c: SENSOCEL® bc 20+, d: PMMA, e: Nylon-12)

Sensory Assessment – Comparison of Sensory Effect & Texture

The comparative test was meant to determine whether hydrophobic cellulose can reproduce the sensory and textural properties that are typical for microplastics.

Hydrophobic cellulose powders were evaluated for sensory effects and texture in direct comparison to PMMA and Nylon-12 in a face cream. The blind test comprised 39 subjects. One quarter of the subjects were male and three quarters were female, with 65% of the subjects being older than 30 years.

A face cream with 3% texture additive each (Table 2) was used as the formulation.

Sensory Effect

The sensory parameters of “matting”, “powderiness”, “heavy skin feeling”, “stickiness”, and “softness” were to be assessed.

Matting describes how matte or glossy the skin appears after the cream is applied and then absorbed. Powderiness determines how dry (powdered) the skin feels after application. Regarding a heavy feeling on the skin, the subjects were asked to compare whether one of the formulations weighed the skin down more than the other. Stickiness and softness refer to the feel of the skin right after application.

Texture

In the evaluation of texture, “homogeneity”, “spreadability”, “absorption”, and “greasiness” were defined as parameters to be evaluated. Homogeneity determines how homogeneous the formulation itself appears. Spreadability describes how easy the formulations were to spread on the skin. Absorption refers to how quickly the formulations were absorbed by the skin. Greasiness means the extent to which the formulations feel greasy when spreading

them. The subjects were asked to compare the performance of SENSOCEL® 5+ with that of PMMA and that of SENSOCEL® bc 20+ with that of Nylon-12. This comparison was chosen on purpose because the particle sizes of the two texture additives to be compared respectively are similar.

Ingredient	INCI	Supplier	Quantity [%]
Water phase Temperature 80°C			
Water, demineralised	Aqua		71.70
Glycerine 99.5%	Glycerine		5.00
Fat phase Temperature 80°C			
Cetiol SB 45	Butyrospermum Parkii (Shea) Butter	BASF	1.00
Montanov 68	Cetearyl Alcohol, Cetearyl Glucoside	Seppic	5.00
Myritol 318	Caprylic/Capric Triglyceride	BASF	8.00
Olive oil, cold pressed, organic	Olea Europaea (Olive) Fruit Oil	Gustav Heess	1.00
Extra phase Temperature 25°C			
Hydrolite 5	Pentylene Glycol	Symrise	5.00
SENSOCEL® 5+ / SENSOCEL® bc 20+ / PMMA / Nylon-12			3.00
Perfume phase Temperature 25°C			
Cotton Water	Perfume	Cosnaderm	0.30
Total			100.00

Tab.2 Face cream formulation with 3% texture additive

The face cream with SENSOCEL® bc 20+ was found to be nearly as soft as the formulation containing Nylon-12 (Fig. 5). In the criteria of “stickiness” and “heaviness on the skin”, SENSOCEL® bc 20+ was judged to be very slightly stickier and heavier. In terms of “powderiness” and “matting”, SENSOCEL® bc 20+ exceeds the rating of Nylon-12. SENSOCEL® bc 20+ has a convincing result in the “texture” test, as test subjects rate it as more homogeneous and easier to distribute. The high water-binding capacity of SENSOCEL® bc 20+ (3.15 g water/g) as compared to Nylon-12 (1.9 g water/g) noticeably affects the “absorption” parameter. Test subjects reported quick development of a dry skin feeling. Where greasiness is concerned, the formulation with SENSOCEL® bc 20+ also keeps up with the one containing Nylon-12. More than half of the test subjects would prefer the SENSOCEL® bc 20+ after direct comparison

Result

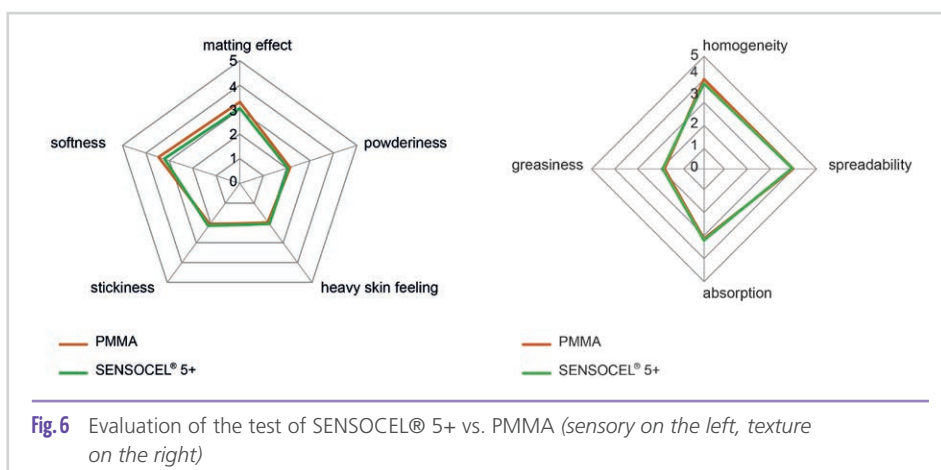
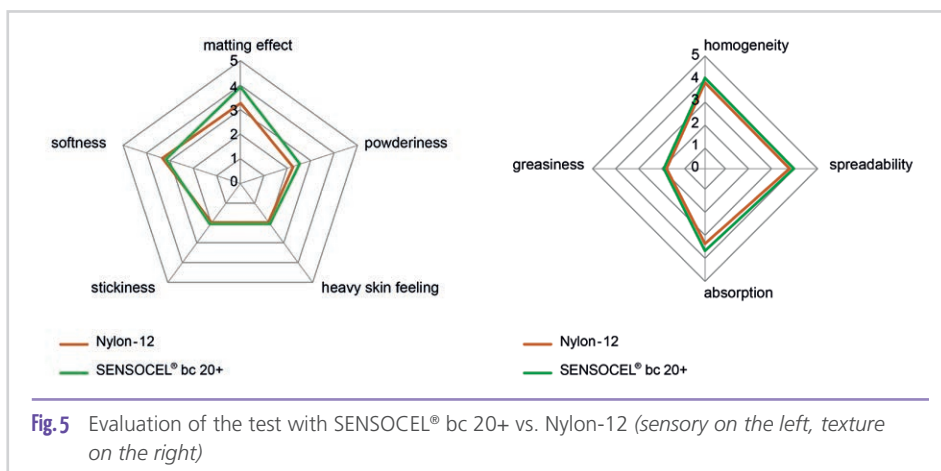
Use of texture additives with a soft-focus effect reduces light diffusion and improves skin appearance. The latest development by CFF GmbH & Co. KG has resulted in the innovative hydrophobic celluloses SENSOCEL® 5+ and SENSOCEL® bc 20+ that offer some natural, biodegradable alternatives in leave-on products.

Both hydrophobic celluloses positively affect the luminance value (ΔE) with an adequate effect when compared to the widely used plastic-based texture additives PMMA and Nylon-12, respectively, reaching between 1.0 and 3.0 in the pure substance and in a water-based polyacrylate gel. This change ΔE can be described as a visible to significant change in light scattering. SENSOCEL® is a fully plant-based method for eliminating microplastic

powders from skin care products in the future, further reducing the amount of microplastics that enter the environment.

Sources:

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Test subjects come to similar results when comparing SENSOCEL® 5+ to PMMA (Fig. 6). SENSOCEL® 5+ has a high performance that is comparable to PMMA in terms of its sensory properties. SENSOCEL® 5+ adequately simulates the characteristic texture produced by PMMA. In the direct selection, 67% of the test subjects chose the option with the synthetic powder PMMA.

authors

Schulte, Johanna | Product Manager Personal Care & Home Care
 Huneke, Alessa | Product Manager Personal Care & Home Care
 Ryll, Judith | Product Manager Personal Care & Home Care

CFF GmbH & Co. KG

Sebum Regulation, the Ethical Way!

R. Reynaud, Y. Rolland, B. Sennelier-Portet, A. Scandolera, M. Pélican, M. de Tollenaere, E. Chapuis

abstract

Derived from the green fractionation of mango leaves, Mangixyl™ (also referred as 'Mangifera Indica leaves active') is an effective cosmetic ingredient that is microbiome-friendly with proven efficacy targeting oil skin through sebum regulation. The cosmetic innovation activates specific receptors of gene's pathway normally regulated by the highly potent retinoic acid. In an era where sustainability and traceability are top of mind for consumers, the sourcing story of Mangixyl™ highlights our commitment to our Company Purpose. The mango leaves are collected in collaboration with the Association Bendia, based in Koro village (Burkina Faso, Africa). The association is a women-led initiative to contribute to the improvement of the living conditions of the community. Thus, *Mangifera Indica* leaves active is an ingredient good for the consumers, good for the planet and good for the people. This ingredient aims to relieve consumers from the discomfort caused by oily skin. It activates some receptors of the retinoic acid-regulated genes pathway and decreases *in vitro*, *ex vivo* and *in vivo* the synthesis of lipids on all skin ethnicities. Additional clinical data showed efficacy against prone-to-acne skin, and on the regulation of sebum on scalp hair. Amidst the current COVID-19 crisis, it also provides an effective response to the "maskne" phenomenon which has been gaining momentum lately.

The demand for natural products in the beauty industry has continued to grow for years. The unexpected arrival of COVID-19 has played a major role in changing the habits of consumers, who are even fonder of reliable and natural products, including in the cosmetics industry and especially in the field of personal care. Consumers now take the time to scan labels, instinctively seeking the highest rate of naturalness, compatible with their new or inked values or even a traceability that is comforting to them. Listening to consumers and their responsible demands, Givaudan Active Beauty works every day to offer natural, clean and sustainable ingredients. It is in this spirit that Mangixyl™, the 100% natural origin microbiome-friendly sebum harmoniser is launched, answering the interest of the consumer (89% - according to our global CMI study) that would be interested in a natural product that helps to balance the sebum of the skin.

Sourced responsibly

Mangixyl™ is crafted from mango leaves (*Mangifera indica* L. Anacardiaceae) that are sustainably collected in Burkina Faso (Africa) in collaboration with the Association Bendia, based in the South-East village of Koro. The association organizes a 100% traceable collect, and manages all the steps of the production of dry mango leaves of particular quality. To preserve the biodiversity and avoid any disruption of trees' natural cycle, the harvest is done in May, June and October, after the fruiting period and the wet season following good harvesting practices by collecting manually, at eye level, only 10% of leaves per tree.



Fig. 1 Two women from Association Bendia harvesting mango leaves in Burkina Faso, Africa

In the era of mindful cosmetics, where consumers hold high expectations from brands when it comes to traceability and sustainability, Mangixyl™'s sourcing is a key of differentiation and will allow consumers to ultimately make a change while empowering women. Based on volunteering, the association is a women-led voluntary initiative for fellow women to get a daily complementary salary. They find employment depending on their age, youngsters manage the harvest of leaves, and elders manage the selection of leaves, drying and stirring steps. This activity contributes to the improvement of the living conditions of the community, while ensuring a continuous development of Koro Village. Those responsible practices make Mangixyl™ an ingredient good for the consumers, good for the planet and good for the others.



Mangixyl™ extract, the microbiome-friendly sebum harmoniser

From labs to racks

S3D® Womango,
the all-complexion skin mattifier

This light daily cream is the efficient solution to tackle the overproduction of skin sebum thanks to its 3 levels of action: immediate / 24-hour / long-term. A marketing concept with 97.8% of Natural Origin Content enriched with Mangixyl™, the microbiome-friendly sebum harmoniser, Bamboosilk, a fully natural mattifier and Curbilene®, a mattifying agent and brilliance reducer. S3D® Womango is also enriched by CristalHyal®, high molecular weight hyaluronic acid and intense moisturiser to perfectly nourish the skin.

Botanical expertise in phytochemistry

The supply of mango leaves coming from Burkina Faso is carefully controlled by an exhaustive set of analysis named ID Pack, including botanical observation, DNA analysis, HPTLC and HPLC enables to warranty the authentication of the raw material and natural origin. A bio guided fractionation of the leaves allowed to complete the analytical characterization of the main phytomarkers such as Iridiflophenone-3C-β-glucoside, Maclurin-3C-β-glucoside and penta-O-galloyl-glucoside. To finalise, an additional botanical study identified the optimal position of the leaves in the aerial part of the tree. A selective harvest specification has been set up following this analysis to supply sun exposed +29% mangiferin content leaves.

Mangifera indica active and its anti-bacterial effect

Our studies have confirmed that Mangifera extract is the perfect ally to control the sebum production, avoiding an overexpression sebum making the skin appears greasy and promoting the development of blackheads or pimples. This important quantity of lipids (sebum) on the skin also creates shininess aspect, which causes aesthetic discomfort, generating a possible loss of self-confidence, and social isolation.

To fight against the visible appearance of oily skin, applying mattifying powders in order to adsorb sebum is a solution; but it requires many applications during the day, and the amount of product to apply is often visible on the face. Because if sometimes the sebum can be perceived as an enemy for the skin appearance, it's important to keep in mind that its balance is essential. Indeed, the sebum is an essential part of skin health, since it participates to the hydration of the epidermis and contributes to the suppleness and softness of the epidermis.

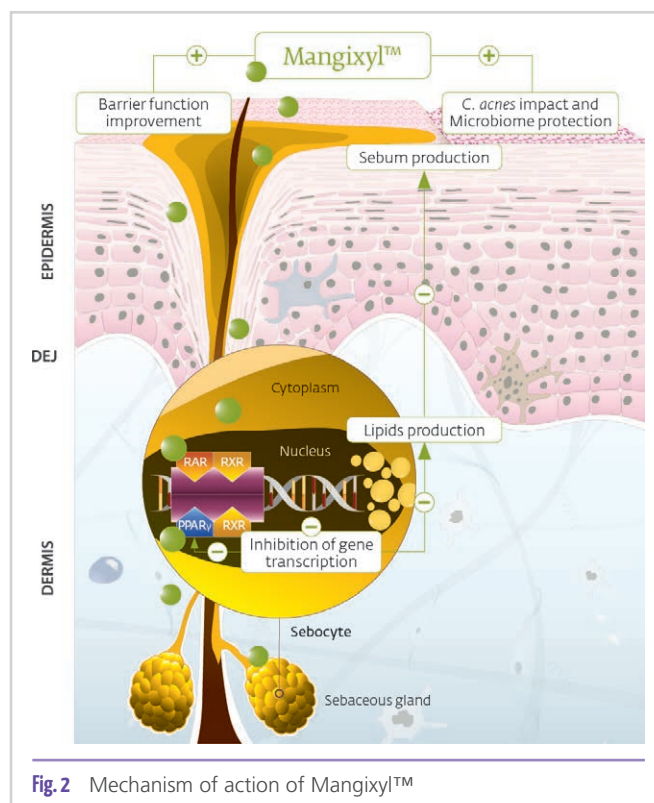


Fig. 2 Mechanism of action of Mangixyl™

Strategy to reduce sebum overexpression

The biological pathways of sebum production are modulated through several nuclear receptors families such as PPARs, and retinoids specific RARs and RXRs. Indeed, retinoic acid is a very efficient anti-sebum active, but it also modifies the structure of the sebaceous glands leading to dry skin, and it is not allowed in cosmetic application due to its toxicity. It is therefore necessary to offer a new generation of products, 100% of natural origin, capable of targeting a part of the same biological pathway as a pure retinoic acid with guaranteed efficacy.

Regulation of same transcription factors than retinoids

Identification of the inhibition pathway by RT-qPCR

Sebocytes from three different ethnicities, Caucasian, Asian and African, were cultured under sebum overproduction conditions. RT-qPCR is applied to identify which genes are up or downregulated, and to quantify these variations. Results show that Mangixyl™ at 0.3% triggered the down-modulation of the genes only associated to lipogenesis. Additionally, there is no impact on the differentiation of the sebocytes. Mangixyl™ is able to down-regulate the pathway of sebum production at different levels because it modulates genes coding for enzymes directly involved in lipid synthesis, and genes coding for transcription factors

(Inverse) Molecular docking determination

A bioinformatic calculation has been done to predict the possible interactions between some key phytomarkers of Mangixyl™ and proteins (receptors and enzymes) involved in sebum regulation. A direct molecular docking calculated the interaction between mangiferin and PPAR γ receptor and an inverse molecular docking determined which proteins (receptors and enzymes) from the lipogenesis pathway were able to interact with benzophenone derivatives, including the phytomarkers of Mangixyl™.

This analysis demonstrated that 3 phytomarkers of Mangixyl™ behave like good possible ligands for PPAR γ , PPAR δ and RXR α , thereby mimicking the action of retinoids. Those phytomarkers may also act as direct lipogenesis enzymes inhibitors.

Biological activities of the ingredient

Reduction of sebum production (*in vitro*)

Sebocytes were exposed to a 2D culture model to a lipogenic mix stimulating sebum overexpression. Cells were then treated with one of the following ingredients, reference (Olumacostat glasaretil, at 1 μ M), Mangixyl™ at 0.3%, or pure mangiferin tested at the same amount as contained in Mangixyl™ (5.7 μ g/ml).

The lipid content was measured by Bodipy® fluorescent probe after 7 days and show that Mangixyl™ at 0.3% significantly reduces lipogenesis by -40% ($p < 0.001$), better than the reference.

Lipogenesis inhibition vs retinoic acid on 3 ethnicities (*in vitro*)

Sebocytes from 3 different ethnicities (Caucasian, Asian and African) were cultivated in sebum overexpression conditions. Cells were then treated with one of the following ingredients: retinoic acid at 10 μ M (RA10) or Mangixyl™ at 0.3%. The lipids are stained by Bodipy® fluorescent probe. This study demonstrates that Mangixyl™ at 0.3% shows a significant efficacy better than retinoic acid on Caucasian and Asian sebocytes (up to -90% [$p < 0.001$] for Caucasian sebocytes) and an excellent activity on African sebocytes. Mangixyl™ is a highly potent inhibitor of sebum overproduction (lipogenesis), with an overall higher efficacy than retinoic acid.

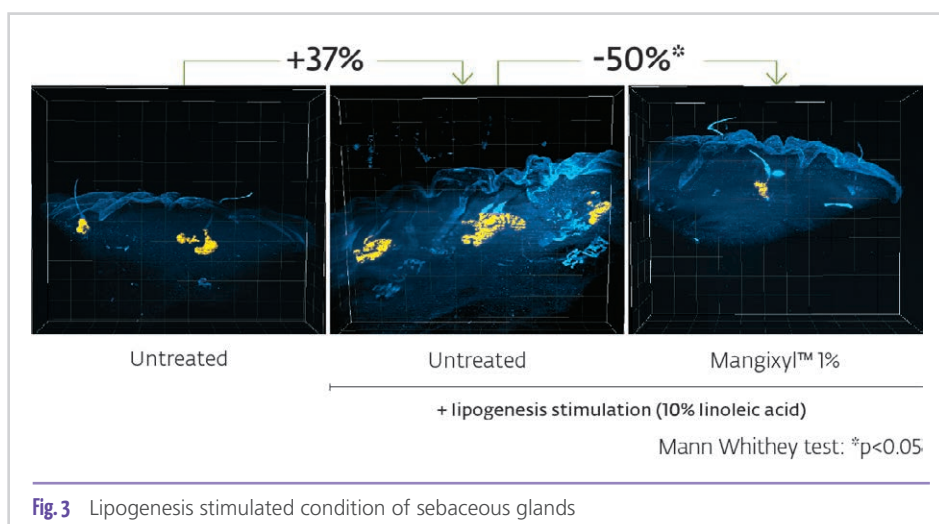
Reduction of the volume of sebaceous glands (*ex vivo*)

Explants containing sebaceous glands were treated with Mangixyl™ at 1% in a lipogenesis stimulated condition during 7 days. The quantity of lipids and the volume of the sebaceous glands were assessed, such as several differentiation markers.

The study shows that Mangixyl™ at 1% significantly reduces the quantity of lipids, thus it decreased the 3D volume of the sebaceous glands by -50% (Mann Whitney test: $*p < 0.05$) in only one week, without modification of the glands structure, unlike known action of retinoids.

Clinical efficacy: Sebum reduction on 3 skin complexion (*in vivo*)

To evaluate the benefits of Mangixyl™, three clinical tests were conducted in double blind versus placebo, on volunteers from different skin complexions: African (South Africa), Asian (China) and Caucasian (Europe).

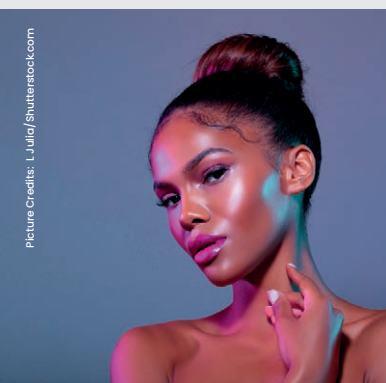




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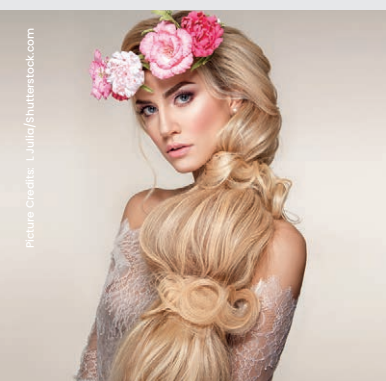
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December 02, 2021

Rapunzel, don't let your HAIR down!

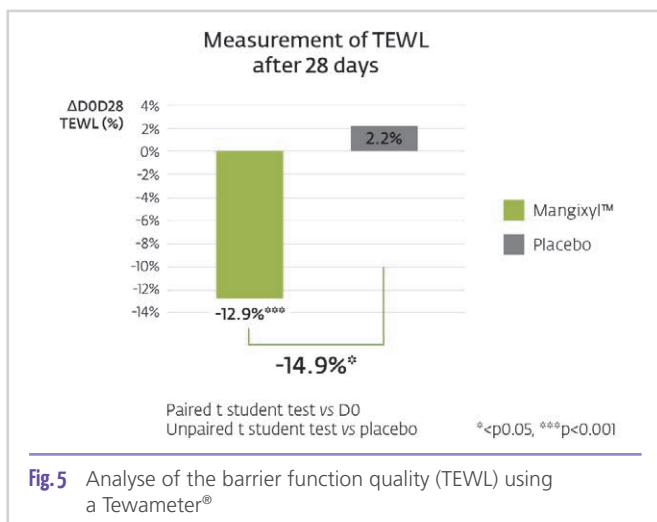
Shampoos & conditioners, Beard care
Hair styling & colourations, Hair pigmentation
Heat protection
Anti-dandruff, Anti-grease, Anti-graying

The measurement of sebum quantity was done on cheeks and nose area at D0 and D28 by sebumeter or sebuxif. The tested product was a cream, applied twice a day on the face, containing 1% Mangixyl™ for Caucasian volunteers and 2% of active for Asian and African volunteers. It appears that Mangixyl™ significantly reduces; globally twice better than placebo, the quantity of sebum in only in a month for all skin complexions.



Clinical efficacy: Improvement of the quality of the skin (in vivo)

A clinical study has been performed in double blind versus placebo conditions on a group of 15 women with oily skin in Europe. Volunteers applied twice a day on their face the pla-



Chronoglow™

the new botanical addition to our portfolio

Chronoglow™, an active ingredient crafted by green fractionation and empowered by Artificial Intelligence (AI) able to mimic botanical epigenetic mechanisms for skin care benefits. Created from *Haberlea rhodopensis* also known as the resurrection plant, Chronoglow™ is a natural cure of youth for the skin, able to reverse the effects of ageing and improve its radiance.

Chronoglow™ positively regulates the skin genetic information without modifying it. It rejuvenates the skin at different cellular levels (from epigenetics to proteins expression), and protects skin cells from senescence and oxidation. Chronoglow™ reverses skin ageing to take back youth, but also enhances skin firmness and provides 3 dimensions of glow:

- Elasticity, already after 2 weeks of use, by up to +8.9%, more than 3 times better than the placebo. This positive impact on the skin elasticity is increasing during the whole duration of the clinical test, with an increase up to +15.3% after 2 months.
- Luminosity, by up to +3.8% after 4 weeks and up to +6.4% after 2 months, significantly better than the placebo, by a factor 1.9.
- Radiance, after only 2 weeks of use by up to +6.1%, more than 4 times better than the placebo and up to +12.5% after 2 months.

Always at the forefront of the highest level of technology, our researchers have used the power of Artificial Intelligence to better represent the clinical results and demonstrate the visual benefits of Chronoglow™. They have generated a beauty avatar that represents the significant results of the 3 dimensions of glow on the face.

cebo or a cream containing 1% Mangixyl™. The skin quality of the volunteers was assessed by analyzing the barrier function quality (TEWL) using a Tewameter®. It appears that while reducing the amount of sebum, Mangixyl™ significantly improves the skin barrier function (TEWL decreased by -14.9% [$<p0.05$]) after 28 days.

A microbiome-friendly active ingredient

Prone-to-acne skin is a multifactorial condition, leading to pimples and irritation, and involving an excess of sebum production, with modified lipids composition (excess of free fatty acids, triglycerides and squalene) or/and a colonisation by some strains of *C. acnes* with specific metabolism including particular lipase activity. This is why we've also tested Mangixyl™ on several factors related to acne.

During *in vitro* test, Mangixyl™ showed a 29% inhibitory action on *C. acnes* lipase activity.

In the double blind versus placebo clinical study performed on European women with oily skin, the level of porphyrins, fluorescent metabolites related to *C. acnes* activity, has been analysed under VISIA® with UV lamp. Meanwhile, sebum composition and the evolution of their skin microbiome has been analysed. After one month with Mangixyl™ at 1%, a significant reduction by x2.4 of porphyrin intensity is observed versus placebo for 80% of volunteers, reflecting the change of *C. acnes* metabolism on the skin of volunteers.

The sebum quality has been improved by 49.5% though a better triglyceride/free fatty acid ratio. Relative abundance evolution of different bacterial genders showed that Mangixyl™ at 1% protected the skin microbiota over time, whereas the placebo group showed a skin dysbiosis.

An active for skin care and hair care

The sebum-regulating effect of Mangixyl™ on scalp hair has been assessed in a clinical study compared to placebo. Two groups of 20 women with an oily scalp applied a shampoo containing Mangixyl™ at 1%, every 2 days with two applications. At D0 and D28 the sebum content has been measured on the scalp Sebumeter®. Results showed that Mangixyl™ induced a significant decrease of the quantity of sebum by -20% ($p < 0.01$) compared to placebo after 28 days on the hair scalp.

authors

Romain Reynaud | R&D Director
 Yohan Rolland | Global Category Manager
 Bénédicte Sennelier-Portet Ph.D | R&D Manager Green Fractionation
 Amandine Scandolera, Ph. D | Head of biological evaluation
 Mélanie Pélican | Communications Specialist
 Morgane de Tollenaere | Skin Biology Scientist
 Emilie Chapuis | Clinical Trial Manager

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2,3-butanediol an Eco-alternative to Synthetic Polyol

G. Hye Yeon Park

Introduction

As widely pronounced, today's beauty means far more than the superficial. Consumers expect what is inside their beauty items does no harm to their own health, as well as to the health of the environment. This has challenged many producers to carefully select natural ingredients that pick up both naturality and efficacy.

GreenDiol®, produced by GS Caltex Corporation headquartered in Seoul, South Korea, is a natural polyol that offers a convenient alternative to producers. Produced mainly through the fermentation process, GreenDiol® functions as humectant, preservative booster, dispersant, botanical extractant, and even anti-inflammatory agent which is quite unexpected of a base polyol. The below are some of its unique characteristics that outperforms the others.

GreenDiol® and its environmental-friendliness

GreenDiol® is a tradename of a material, 2,3-butanediol (BDO) which most typically serves the functions of 1,3-butylene glycol (BG) and 1,3-propanediol (PDO). 2,3-BDO is, in fact, a material that exists in nature such as but not limited to soil, plants, honey, wine, and even human body [1].

GreenDiol® is produced primarily through fermentation of patented non-GMO microorganisms that feed on 2,3-BDO-containing raw sugar. During the fermentation process, a series of natural, and in turn, reversible microbial conversion from glucose to 2,3-BDO occurs, which makes 2,3-BDO a biodegradable product. It, then, goes through toxicity-free purification process to become colorless and odorless GreenDiol®. GreenDiol® is COSMOS, EU-REACH, VEGAN, and USDA-bio-based product certified.

Moisture retention

To evaluate the moisture retention rate, 2,3-BDO was compared with 1,3-PDO and 1,3-BG in terms of its effects on skin moisture content and transepidermal water loss (TEWL) under the infrared environment. Serum prescriptions were used, and 2 $\mu\text{l}/\text{cm}^2$ of each of the formulations were applied on the forearms and evaluated 1, 2, and 4 hours after the application.

After 1 hour, water content increased by 29.54% for 2,3-BDO, compared with 25.13% and 24.89% for 1,3-BG and 1,3-PDO, respectively. After 2 hours and 4 hours, 2,3-BDO also showed the highest rate of 28.88% and 24.63%, while 1,3-BG caused the increase of 18.12% and 16.30%, and 1,3-PDO, the increase of 20.85% and 16.08%.

For TEWL, the loss rate for 2,3-BDO was 70.3%, compared with 77.2% for 1,3-BG and 80.9% for 1,3-PDO. After 2 hours and 4 hours, the loss rate for 2,3-BDO was 65.8% and 70.7%, while for 1,3-BG, it was 80.2% and 81.3%, and for 1,3-PDO, 83.8% and 83.3%.

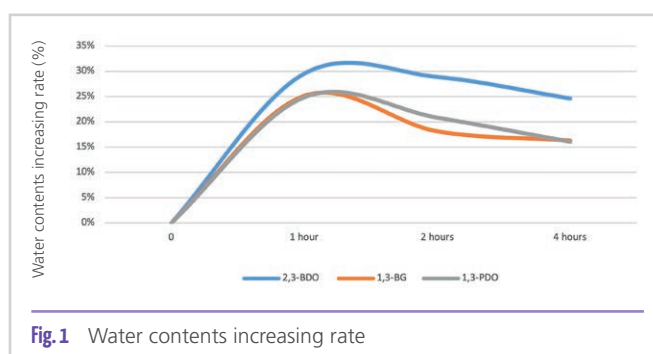


Fig. 1 Water contents increasing rate

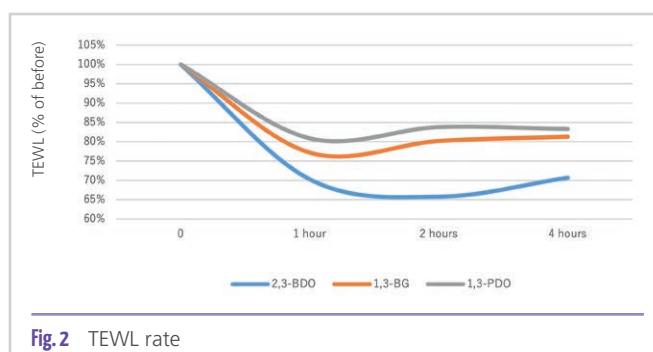


Fig. 2 TEWL rate

Dispersing active ingredients

Dispersing Vitamin C

2,3-BDO, 1,3-PDO and 1,3-BG were evaluated on their effects in dispersing Vitamin C. Given that a P/O type formulation is commonly applied to resolve instability of pure Vitamin C, P/O type prescriptions were used. 15% Vitamin C was mixed into the formulations containing 15% of each material at room temperature. For 8 weeks, the formulations in terms



GreenDiol®

2,3 Butanediol

- ✓ Plant-derived, 100% bio-based polyol produced by fermentation with non GMO feedstock
- ✓ Demonstrated safety
- ✓ Benefits include: Preservation booster, humectant, sensory enhancer and extractant of active ingredients



of spreadability and smoothness in texture, and stability were observed, and scored on a scale of 1 to 10, with 1 being the lowest and 10 the highest score.

In regards to spreadability, all appeared homogeneously spread out in a creamy texture. In sensory test, 2,3-BDO was evaluated most homogenous with no sign of agglomeration. When evaluated on smoothness, 2,3-BDO exhibited the smoothest texture, while 1,3-BG showed the most stiff texture. After 8 weeks, 2,3-BDO remained the smoothest, while 1,3-PDO showed the most stiff texture. Throughout 8 weeks, 2,3-BDO, 1,3-PDO and 1,3-BG all remained stable.

Material	After 1 day			After 8 weeks		
	2,3-BDO	1,3-BG	1,3-PDO	2,3-BDO	1,3-BG	1,3-PDO
Spreadability	9	4	6	9	4	4
Smoothness	10	6	8	10	6	5
Stability	10	10	10	10	10	10

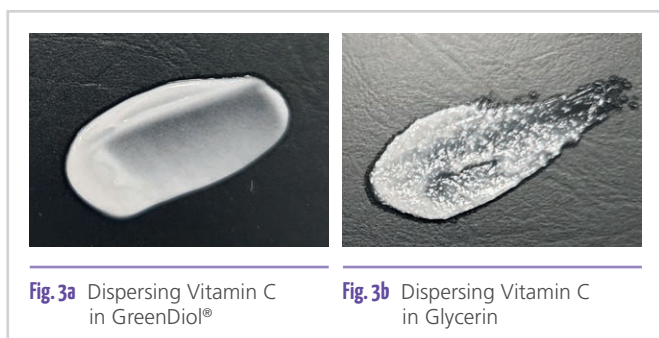


Fig. 3a Dispensing Vitamin C in GreenDiol®

Fig. 3b Dispensing Vitamin C in Glycerin

Dispensing ceramide

2,3-BDO was also compared with 1,3-PDO and 1,3-BG in dispersing ceramide. Once 1% ceramide was dispersed directly in 99% of each material at room temperature, they were heated to 80~90°C and cooled down to 30°C. The observation took place for 8 weeks.

After 8 weeks, ceramide was homogeneously dispersed in 2,3-BDO and 1,3-BG. 2,3-BDO-containing formulation showed a sign of flowability with the viscosity of 3,667cp (6s, 12rpm, 2 min, 25°C), while 1,3-BG-containing formulation turned viscous with no sign of flowability with the viscosity of 9,000cp (6s, 12rpm, 2 min, 25°C). For 1,3-PDO, ceramide was separated and surfaced to the top throughout 8 weeks.

When ceramide was tested in solubilizing toner-type formulation, solubilizing essence-type formulation, and O/W type formulation containing 2,3-BDO, ceramide was stably dispersed in white creamy type texture with no sign of gelling.

Anti-inflammation

An *in-vitro* anti-inflammatory test was conducted by incubating RAW264.7 cells with and without various concentrations of 2,3-BDO and 1ng/mL of LPS for 24 hours. Then, the mRNA and protein expression levels of TNF-α and IL-6, pro-inflammatory cytokines, were determined in accordance with the standard curves from the Quantitative Real-Time PCR (qRT-PCR) and the Quantikine ELISA kits (R&D Systems, Minneapolis, USA).

As below graphs show, for both TNF-α and IL-6, 2,3-BDO suppressed mRNA expression, and correspondingly protein production in a concentration-dependent manner.

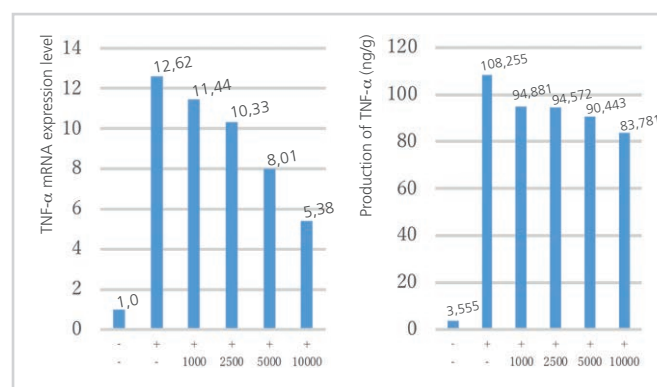


Fig. 4a 2,3-BDO-treated group's mRNA expression of TNF-α

Fig. 4b 2,3-BDO-treated group's production of TNF-α (Probability p(Mann-whitney test with Bonferroni correction))

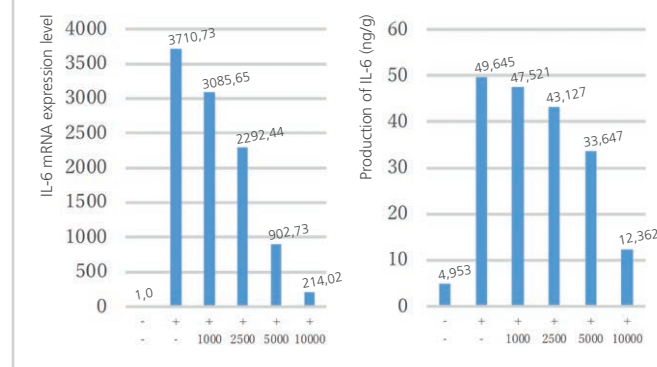


Fig. 4c 2,3-BDO-treated group's mRNA expression of IL-6

Fig. 4d 2,3-BDO-treated group's production of IL-6 (Probability p(Mann-whitney test with Bonferroni correction))

Botanical extraction

2,3-BDO was compared with 1,3-BG and 1,3-PDO in botanical extraction. 0.1g of Powdered greentea, used as extractants, was immersed in 10ml of each of the 3 materials at 60°C at 150 rpm for 6 hours, and the extracted actives were measured using LC-MS and UV analyses. The extraction level of ethanol was used as a standard reference.

In extracting catechin from greentea, GreenDiol® exceeded ethanol by 27%, while 1,3-BG and 1,3-PDO reached 76% and 62% of ethanol, respectively. For total amino acids extraction, GreenDiol® surpassed ethanol by as much as 385%, while 1,3-BG exceeded ethanol by 168% and 1,3-PDO by 104%.

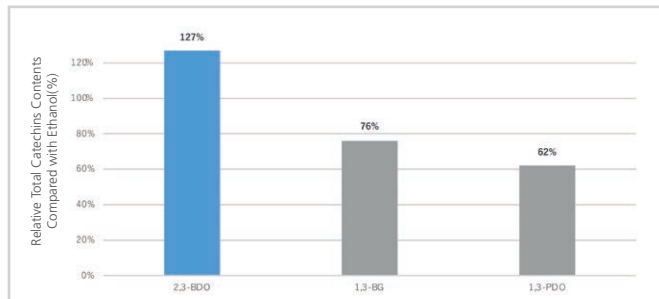


Fig.5 Catechin extraction test

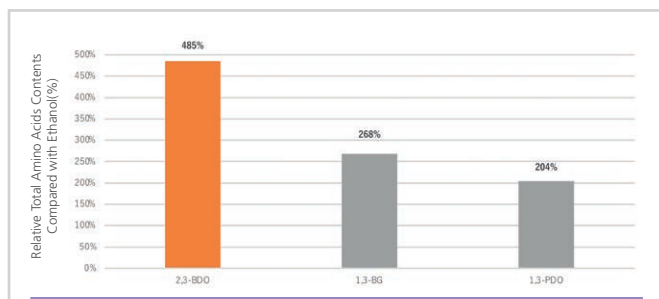


Fig.6 Amino Acids extraction test

Conclusion

GreenDiol®'s qualities are not limited to the above explanations. It also serves as preservative booster, frizz control agent, and potentially more. Buying by its progressive qualifications, a number of multinational beauty companies have adopted its to respond to market needs.

Remark

First publication: Fragrance Journal

Product Overview

- Product Name: GreenDiol®
- Labeled name: water, 2,3-butanediol
- INCI Name: 2,3-Butanediol / IECIC name: 2,3-Butanediol
- Fermented liquid
- Credentials: COSMOS, EU-REACH, VEGAN, USDA-bio-based product
- Functions: humectant, emollient, botanical extractant, carrier for active ingredient, anti-inflammatory agent, preservative booster, frizz control agent

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author

Georgia Hye Yeon Park
Project Manager | GS Caltex Corporation

SUMMIT PHARMACEUTICALS EUROPE S.r.l.
Personal Care Department

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Risk Analysis: Procurement of the All-rounder Castor Oil at Risk?

S. Steinmetz

abstract

Castor oil is a true all-rounder. Due to its chemical properties, castor oil, obtained from castor seeds, and its fatty acids are suitable for the production of cosmetics, cosmetic raw materials, and industrial products. However, the consequences of anthropogenic climate change and socio-economic challenges make it difficult to grow castor and, thus, to source castor oil from India, the main castor oil exporting country. How can the procurement of castor oil be secured? How is it possible to meet current market trends in this process? Because one aspect is for sure: supply chain transparency, compliance with social standards, and organic farming have long been among the key factors of a company's economic success in times of a growing cohort of critical consumers. This article provides an insight into the farming conditions of castor, points out sourcing risks, outlines current market trends, and presents approaches to solutions in response to any sourcing risks of the premium resource castor oil.

Risks: Droughts, water shortages and socio-economic challenges

The castor plant, also known as miracle tree, originally comes from India, Brazil, and the African continent. In these regions it grows up to 13 m high [8, 11, 18]. India is considered the main producer of castor oil on the world market [2, 8, 18]. Annual castor seed production worldwide is estimated at 1.25 to 1.5 million tonnes and castor oil production at 0.55 million tonnes [18, 19].¹

The main import markets for castor oil are considered to be the USA, Russia and Japan [11]. The economic significance of the castor oil industry for the main producer, India, is already clear from the global economic volume of castor oil marketing. The district of Kutch in the state of Gujarat is particularly dependent on castor oil cultivation [cf. 14]. There, due to an arid climate, castor is one of the only crops that can be cultivated profitably.

However, the cultivation of this resilient crop is also subject to climatic challenges and extreme weather events [1, 14]. For example, prolonged droughts in the 2019 crop year resulted in significant crop losses, causing castor oil prices to skyrocket and making it difficult to procure the cosmetic and industrial oil.

In addition to climatic risks, socio-economic grievances (including poverty) pose the risk of not being able to secure the procurement of the resource castor oil from India. This connection can be traced back to two reasons, among others: Firstly, more and more farmers leave rural areas in India and seek more lucrative jobs in urban areas such as Delhi or Mumbai.²

As a consequence, there is a threat of a shortage of farmers in rural areas to cultivate crops such as castor, which can limit the production of castor oil. Secondly, the availability of water is becoming a limiting factor for the cultivation and yield of castor oil, especially in Kutch. If farmers lack the financial means for appropriate water and soil management, the harvest yield and, thus, the procurement of castor oil are not secured. How can the risks outlined above be countered?

Approach 1: certified organic castor oil as a driver for the global natural cosmetics' market

According to the latest statistics from the Research Institute for Organic Agriculture (FiBL) and the International Federation of Organic Agriculture Movements (IFOAM), 71.5 million hectares of land worldwide were recently farmed organically (16). This corresponds to about 1.5 percent of the world's agricultural land, and the trend is upwards (16). In addition, the organic market has grown from the lowest sales in the 1990s to 105.5 billion US dollars in 2018 (15). In addition to this growing interest in organic food, consumer interest in natural cosmetic products is also growing. Most recently, global sales of natural cosmetics products were US\$36 billion, a new peak in sales.³ "Green beauty" and "clean beauty" products are particularly demanded in the field of body and hair care. Castor oil as a suitable raw material for natural lip balms, lipsticks, nail oils,

¹ See: <https://www.thehindubusinessline.com/economy/agri-business/India-major-producer-of-castor-oil/article20116366.ece> (accessed on 10 April 2021).

² See: <https://www.oxfam.de/unsere-arbeit/themen/klima-ressourcen-schuetzen/menschen-im-klimawandel/ganze-dorfer-losen> (accessed on 06 April 2021).

³ See: <https://www.futuremarketinsights.com/reports/natural-cosmetics-market> (accessed on 01 April 2021).



hair care products, and makeup remover is considered an attractive and profitable resource against this background [cf. 3, cf. 12].

This makes certified organic castor oil all the more interesting for natural cosmetics manufacturers and castor farmers, for example from India. With certified organic products, Indian farmers can achieve an average net profit that is up to 22 percent higher than with the marketing of conventional products [13]. This makes the cultivation and marketing of certified organic products more profitable, which benefits from the elimination of costs incurred for fertilisers and pesticides [9, 13].

The economic value of organic farming, not only for Indian farmers but also for the entire Indian economy, can be seen in a 10-year comparison: Between 2008 and 2018, the share of organically farmed land in India increased by 64.3 percent to 1.94 million ha [16]. This means that India is currently one of the top 10 countries worldwide with the largest area of organically farmed land [16]. Oilseeds are grown in an ecologically sustainable manner on 0.5 percent of the 1.94 million ha [16]. With this approximately 130,000 ha of cultivated area, India is one of the top 10 nations for organically certified oilseed cultivation after China [16].

The statistics presented show: The interest in India to produce certified organic products is growing and meets an increasing consumer interest in certified organic and natural products on the world market.

In addition to this economic value, the organic cultivation of castor beans, among others, offers ecological advantages such as enhanced soil fertility, soil stability, and biodiversity [5]. These factors are increasingly becoming key factors in securing crop yields, not only in India. Especially droughts, but also pesticide use, fertiliser application, and soil salinization lead to soil degradation, and crop losses worldwide, and in India [4, 7].

This is where the internationally operating castor oil producer Castor Products Company (CPC) comes in. CPC produces castor oil itself in its own production facility, supports Indian smallholders in switching to certified organic castor oil cultivation and advises CPC-associated farmers on cultivation and marketing issues. CPC and the smallholders, who are associated with CPC, rely on a water and soil management system that is adapted to the respective region. In some regions, this includes the soil-conserving intercropping cultivation method (see [10]), in which castor bean, cotton and sesame are cultivated. In other regions, a classic rotation with peanut plants is implemented or compost is added.

The aim is to build up humus, which supports the water storage capacity of the soil. Since water availability is becoming a limiting factor for crop yields, especially in the castor oil region of Kutch, such an approach is proving to be ground breaking – especially when the farms lack the financial means to irrigate their fields. This clearly shows that socio-economic grievances (including poverty) can also occur on organic farms

in India. The consequences of this have already been outlined (see risk analysis), how can the problem be addressed?

Approach 2: Addressing increasing consumer interest with fairly traded castor oil

The world market for fair-certified products has been steadily growing for years.⁴ In 2017, certified international fair trade recorded a new sales peak of 8.49 bn Euros, and comprised nearly three times the sales strength compared to 2008.⁵ Next to coffee, cocoa and bananas - the three top-selling fair trade goods - the global marketing of fair-certified (natural) cosmetics is on the rise. The market signal set by TransFair's Fair-trade seal for cosmetics in 2014 speaks for itself and shows that there is a growing market for fair natural cosmetics, or cosmetics produced on the basis of fair raw materials. This thesis is supported by market research results of the last decade [cf. 6, cf. 17].

In addition to the "LOHAS" (Lifestyles of Health and Sustainability), a consumer group from the USA that is perceived as attractive, the target group of Millennials is perceived as a critical and, at the same time, emerging consumer cohort in Europe. Both target groups have in common that their own consumption is mostly critically questioned and adapted. "Organic" alone no longer seems to be enough for many: The up-coming generation calls for fair-trade and ecologically sustainable products with a favourable ecological and social footprint (15). In addition, initial assessments suggest that increased health awareness through Corona could change future consumer behaviour. Particularly attractive are products that are not only good for one's own health, but also for all those involved in the value creation process.⁶

Fairly traded organic raw materials such as castor oil from organic cultivation and certified fair trade, as from Castor Products Company, may be put forward at this point as a blueprint for how procurement security can meet consumer interest. CPC not only supports Indian farmers with cultivation issues and a switch to certified organic castor cultivation. Instead, with the support of the German natural cosmetics producer WALA Heilmittel GmbH - the mother company of naturamus GmbH - the family-run company CPC has been helping Indian smallholders from the province of Kutch to convert from certified organic to Fair for Life (FFL) certified castor cultivation since 2017.

With the Fair for Life certification, the Swiss Organic Foundation and the internationally operating Institute for Marketecology (IMO) aim at a far-reaching promotion of social standards and economic-sustainable prosperity along the value chains they certify.⁷ In addition to the traditional approaches of fair trade such as compliance with ILO (International Labour Organization) standards, the payment of a fair price for raw



materials is demanded and controlled. A premium to support the local FFL fund is to be paid, and partnership-based trade relations are to be established.⁸

With the FFL programme, the certification institutions intend to promote organic agriculture and social sustainability worldwide in order to reduce global injustices. In this respect, the FFL seal stands for controlled product, process and partnership quality on an equal footing. Especially in the French natural cosmetics market, FFL has established itself as a seal of credibility and trust.

Against this background, the fair trade of ecologically-sustainably produced castor oil proves to be a win-win situation: On the one hand, those farmers who are associated with CPC receive a fair wage, respectively a fair price for the castor oil seeds supplied and experience support through the programmes financed with the FFL fund. On the other hand, the customers of the FFL-certified organic castor oil know that the procurement is secured, and enjoy a certain price stability. This makes the ecologically sustainable FFL castor oil producer an addressable and future-oriented premium resource on the cosmetics market.

⁴ See: <https://www.forum-fairer-handel.de/fairer-handel/zahlen-fakten/> (accessed on 06 April 2021).

⁵ See: <https://www.handelsdaten.de/handelsthemen/fairer-handel> (accessed on 06 April 2021).

⁶ See: <https://www.bayer.com/en/investors/consumer-health-megatrends> (accessed on 06 April 2021).

⁷ See: https://www.fairforlife.org/client/fairforlife/file/FFL_Flyer_2014_de.pdf (accessed on 06 April 2021).

⁸ Ibid.

⁹ See also: <https://www.basf.com/global/en/media/news-releases/2020/12/p-20-387.html> (accessed on 06 April 2021); <https://www.statista.com/statistics/1130209/total-fair-trade-revenue-france/> (accessed on 06 April 2021); https://www.fairforlife.org/pmws/indexDOM.php?client_id=fairforlife&page_id=certified&name=&programme=0&iso3166=FR&products= (accessed on 06 April 2021).

Conclusion: Ecologically and socially sustainable castor oil as an all-rounder for producers and consumers

Castor oil, mostly from India, is considered an ecologically and economically attractive resource for industrial production and the cosmetics industry. However, factors such as the consequences of anthropogenic climate change and socio-economic challenges make the cultivation of castor and, thus, the procurement of castor oil more difficult. At the same time, an ever-growing cohort of critical consumers is demanding ecologically and socially sustainable products. Sourcing ecologically sustainable castor oil producers from certified cultivation, and fair trade can both address sourcing risks and a growing global interest in organic and fair trade products. This is a real win-win situation for all parties.

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The Road to More Sustainability and Functionality In Liquid Laundry Detergents

A. Phyfferoen, J. Swazey

Introduction

When you consider the environmental impact of laundry detergent, it's almost mind-boggling. A 2017 United States Environmental Protection Agency report estimated water usage per load of laundry. The average residential top-loading washing machine can use up to 41 gallons of water per load (155.2 litres). (Newer, more-efficient machines on the market can use as low as 10.5 gallons or just under 40 litres) [1]. Now consider that, globally, 67% of people said they do laundry twice per week, according to a 2017 Nielsen survey. That is a lot of water! Along with the millions and millions of gallons of wastewater, now think about all the laundry detergent being used to clean that laundry and where it ends up. This means extraordinarily large amounts of ingredients derived from petroleum and microplastics entering our waters and potentially harming marine life.

Obviously, if consumers are doing millions of loads of laundry every year, it's because they want clean clothes. So, the market potential for someone who can crack the code of functionality and sustainability is huge. From the consumer's point of view, liquid laundry detergents are easy to dispense, dissolve quickly in cold or hot water, and can even be used to pretreat stains.

Along with functionality, the trend to develop more eco-friendly and biodegradable liquid laundry detergent continues to gain momentum. Liquid laundry detergents and pods now rival powders globally for market share. This presents a challenge, however, of finding suitable ingredients and developing formulations that can provide the performance and experience the consumer expects.

In recent years, companies have innovated the ingredient deck top to bottom with new surfactants, enzymes, brighteners and polymers. Each must be functional in the wash to prevent the redeposition of soil, but also remain stable through the manufacturing process, shelf life and consumer use.

According to Innova Market Insights, ethical-ecological claims ranked second (right behind whitening) for liquid laundry detergent positioning in 2020. Other positioning claims trending across the regions includes paraben-free/hypoallergenic in North America and Asia, pH neutral and antibacterial in Europe, and sensitive skin/hypoallergenic in Latin America [2].

As formulators look to more eco-friendly ingredients, plant-based surfactants have been found to be efficient removers of fat and oil. However, their low viscosity can make finished products appear watered-down. So, companies turned that into an asset by developing more concentrated liquid laundry detergents. Now, as more consumers pursue online buying, concentrated formulas have become a real plus.

Encapsulation Requires Stabilisation

Encapsulation, or the idea of encasing ingredients in a protective "shell" that can be released when needed, has become a dream product for formulators. The technology uses polymers with varying degrees of eco-friendliness, made of polyurethane, polymethyl methacrylate, polylactic acid resins and even formaldehyde. They are designed to open upon dilution in the wash. Fragrances, enzymes and bleaching agents can all be encapsulated to provide added functionality and differentiation for laundry detergent.

In liquid laundry detergents, encapsulated decorative beads and opacifiers require suspension and stabilization. Using nature-based solutions to achieve this has previously been problematic. It is especially difficult in highly concentrated surfactant systems due to compatibility limitations and the need to avoid adversely affecting the viscosity and pour properties of the product.

With more countries imposing environment-related regulations around detergent ingredients, biodegradability becomes just as important as being nature-based. Options to replace petroleum-derived materials with those derived from sustainable sources such as crops already exist in the market. Although a partial solution, it still doesn't address a product's chemistry, which may not be biodegradable in our water systems. For example, using ethylene-derived polymers may help a company avoid the use of petroleum resources, but the final product may still not be biodegradable. Mineral-based opacifiers offer great promise in this area as an environmental option but do not self-suspend and require help with stability.

So, we see the need for stabilisation in the liquid matrix is key. A wide range of nature-based suspension aids can be considered (e.g., xanthan gum, carrageenan, various cel-

lulose-ethers, as well as natural clays) but there are limitations to their use. Xanthan gum, for example, can provide excellent suspension in surfactant-based, personal care formulations but it cannot recreate the overall rheology that is generally preferred, and that people are used to, due to its high pseudoplasticity. In addition, the use of salt-induced surfactant thickening, in combination with xanthan gum or most other biodegradable viscosity modifiers, often leads to unsightly hazing. There are also limits to how concentrated the products can be before these water-soluble, nature-based products start to precipitate out of solution and cause phase separation.

In recent years, the trend to improve the fragrance and whitening experience in laundry care has been evolving – from increasing the loading of fragrance to the inclusion of encapsulated polymers. Today, the challenge remains to sustainably suspend them. There is a critical need for a new, nature-based suspension aid that provides

- Excellent biodegradability
- Reliable performance
- Low cost-in-use
- Compatibility with high surfactant and surfactant-thickened formulations
- The ability to provide suspension properties without adversely affecting pour viscosity

FDC, a Nature-Based and Biodegradable Technology

A case can be made for fermentation-derived cellulose. Cellulose is common in nature. Chemically identical to plant-derived cellulose, fermentation-derived cellulose is a unique and readily available form, which offers properties not possible with other sources of cellulose. As a consequence of being produced through fermentation, the cellulose fibers possess a very fine diameter and exist as a three-dimensional, highly reticulated, net-like structure that gives a very high surface area-to-weight ratio. This three-dimensional, net-like structure allows the FDC to create a true yield value at low concentrations in a formulation, even those with little or no water, and so provide a mechanism for reliable structuring of liquids and stabilization of components with minimal or no impact on the finished product's viscosity and dispersibility. The best part: When the product washes down the drain, it easily biodegrades.

In addition, as it is not water soluble:

- FDC's performance does not depend on the water content of the system it is added to
- FDC does not thicken or add to the perceived viscosity at the typical use levels used for suspension
- FDC is compatible with high levels of salts and surfactants that would cause most water-soluble polymers to precipitate.

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- FDC is insensitive to many factors impacting water-soluble polymers such as temperature, shear, salt, pH, but also it is far less susceptible to acids, bases, oxidizers and reducing agents, as these cannot attack the individual linkage points as readily as when polymers are fully solubilized.
- FDC is much less susceptible to cellulase enzyme degradation compared to water-soluble cellulose derivatives (e.g., CMC, HEC, etc.) thanks to its insoluble nature and net-like structure making any enzyme degradation much slower to manifest.



Fig. 1 Fermentation-Derived Cellulose comes ready to use and does not require pH adjustment or high shear mixing to be functional. Use levels range from 0.5% to 5% depending on the formulation and what is to be stabilized.

How Should Fermentation-Derived Cellulose Be Used?

Yield stress is a measure of the force required to initiate flow in a gel-like system. FDC is effective at creating a true yield stress allowing particles to be suspended indefinitely, so long as the force (stress) required to suspend them is less than the yield stress developed by the FDC network. Very low concentrations of FDC are also needed in the formulation to create yield stress, making it an affordable suspension aid that does not disturb pour viscosity of the final product. In essence, the suspension properties of FDC are largely decoupled from viscosity effects. Formulations can be designed that range from water-thin to honey thick. FDC's high compatibility with salt-induced surfactant thickening is also unique among nature-based polymers.

In summary, the unique yield stress properties imparted by FDC can provide excellent stabil-

ity to a wide variety of surfactant-based formulations. These formulations can be highly concentrated (from typically 5% to 45%) and even some pure surfactant and non-aqueous formulations are possible.

In the manufacture of many surfactant-based laundry products, it is often convenient to add FDC as one of the last ingredients. Once added, it will quickly begin providing suspension capabilities to the formulation and care may be required to avoid trapping air bubbles. One way of achieving efficient dispersion of the FDC and prevention of air is to use an inline mixer with a recirculating line like the one shown below in **Figure 2**.

In this way, FDC can be incorporated very gently into the bulk mixing tank to prevent air but as it passes through the inline mixer, full dispersion of the FDC is achieved very rapidly. If the inline mixer is of a rotor-stator design, one pass may be enough for full dispersion and maximum yield stress.

FDC, Unprecedented Liquid Structuring and Particle Suspension

Fermentation-Derived Cellulose can provide stability at very low concentrations, which has a wide range of benefits in addition to cost in use and sustainability. In some systems, approximately 3% of the readily dispersible, activated FDC can achieve yield stress values of around 0.7-1.5 Pascal (measured using static yield stress techniques) depending on the formulation. The yield stress increases with use level at a factor of about 1.5. The yield stress triples as the FDC concentration doubles.

In some liquid laundry systems, concentrations below 1% generated sufficient yield stress to give long term stability of encapsulated fragrances. The yield value required will depend upon what is being suspended but most fragrance encapsulates and pearlescents can usually be stabilized with a yield stress of less than 0.1 Pa. Most decorative beads can be suspended with a yield stress of 0.6 to 1 Pa. Opacifiers, depending on their concentration, size, and density may be stabilized with as low as 0.5% FDC. These low-in-use concen-

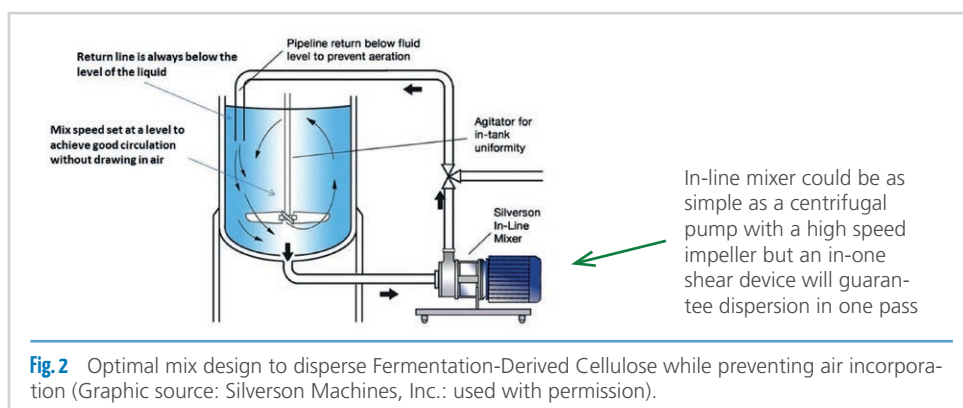


Fig. 2 Optimal mix design to disperse Fermentation-Derived Cellulose while preventing air incorporation (Graphic source: Silverson Machines, Inc.: used with permission).

trations allow FDC to be used in formulations where transparency is required.

Identifying which grade is best for any given formulation is a relatively simple process: the best grade is that which gives the highest yield stress at any given concentration and under the mix conditions available. If proper dispersion was attained, the yield stress should not significantly change if mixed under strong mixing conditions. The yield value should be stable or modestly increasing with time. Once the best grade is identified, its concentration can be optimized. This article focuses heavily on the application of FDC in laundry and homecare products, but its valuable properties will also make it useful in a wide variety of related applications and formulations, providing good suspension at very low use levels and without creating high pour viscosity.

Conclusion

As consumer trends push the laundry markets towards more environmentally friendly formulations and practices, these industries will need an alternative technology to provide reliable suspension. FDC is a powerful option for both performance and increased sustainability, offering excellent suspension

properties, low cost in use, and due to its insolubility, unmatched limits of compatibility. Its three-dimensional net-like structure enables FDC to structure liquids, suspend perfume microbeads at inclusion levels as low as 0.5%-1.5% "as is", and stabilize opacifiers and any insoluble ingredients with inclusion levels that will depend on the density difference between the media and particle size.

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contact

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Alain Phylfferoen | Technical Support & Development Manager EMEA
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Mixtures of Trisodium Citrate Anhydrous and Dihydrate as Builders in Dishwashing Detergents – Effects on Tablet Stability and Disintegration

K. Mück, S. Rotermond, F. Weiher,

abstract

Trisodium citrate is an ecologically friendly, non-toxic alternative to phosphorus-based builders in automatic dishwashing detergent (ADWD) tablets. It exists in two forms: trisodium citrate dihydrate (TSC), which contains two water molecules in the crystal, and trisodium citrate anhydrous (TSA). The latter is produced by removing the water of crystallisation from the crystalline matrix, thus creating a porous structure. TSA can be loaded with liquid substances and will remain a free-flowing powder because of these pores. In the present analysis, the effects of TSC, TSA and mixtures thereof on critical tablet parameters, such as disintegration and stability, were examined. The study shows that replacing part of the TSC in the formulation with TSA decreases disintegration time and increases breaking strength after tablet pressing. This finding is supported by an existing patent (EP 3 431 575), which additionally shows that mixtures of TSA and TSC improve tablet cleaning performance. Furthermore, the present study demonstrates that the storage stability in polypropylene packaging of tablets containing TSA/TSC mixtures is comparable to that of tablets which only use TSC as the builder. Thus, TSA and TSC are not only eco-friendly builders, but can be used to modulate tablet disintegration time and stability as needed.

Introduction

Automatic dishwashing detergent (ADWD) tablets consist of various ingredients, such as surfactants and bleach for dissolving grease and removing stains, and enzymes to remove protein and starch found in food residues. In addition, builders form an essential part of ADWD tablets due to their ability to bind cations, which softens the water and reduces limescale deposits.[1] Trisodium citrate is an excellent builder and has experienced a tremendous increase in popularity as an ingredient of ADWD tablets over the past five years. Whereas trisodium citrate was essentially not present in any new product launches in 2015, about 20% of all new ADWD tablet product launches in 2019 contained trisodium citrate (Innova Market Insights). This is certainly a consequence of changes in legislation, which have led to strict limitations of the use of phosphates as builders in ADWD tablets due to their detrimental effects on the environment.[2] Trisodium citrate presents a viable, eco-friendly alternative builder.

Jungbunzlauer offers two forms of trisodium citrate: trisodium citrate dihydrate (TSC) and trisodium citrate anhydrous (TSA). Both forms occur as white, crystalline powder and are chemically stable when stored at ambient temperatures. TSC and TSA are non-toxic, fully biodegradable and can be disposed of with regular waste. Both are covered under the listing of trisodium citrate as a generally permitted food additive in the EU and they have GRAS status in the US. TSC is produced by complete neutralisation of citric acid with a highly pure sodium source and subsequent crystallisation. TSA is

manufactured from TSC by removing the water molecules from the dihydrate crystals without destroying the original crystal matrix.[3]

The resulting TSA crystals have a porous structure that can be used as a carrier for inorganic and organic substances such as perfumes, peroxides and surfactants. Due to the water having been removed, TSA has an active content of 100% and does not add water to the formulation – unlike TSC, which has a water of crystallisation content of 12% (dihydrate). TSC and TSA can be used as builders in ADWD tablets either on their own or together as mixtures.

The aim of this study was to elucidate the impact of TSA/TSC mixtures on critical tablet performance parameters, such as disintegration time, tablet breaking strength and storage stability.

Experimental procedure

A hydraulic tablet press was used to produce the ADWD tablets. The tablets had a weight of 16 g and were pressed according to formulation I in **Table 1** for all experiments, apart from the analysis of storage stability. For the latter experiment, the formulation was slightly adjusted: 2.25 wt% of sodium sulfate was replaced with a non-ionic surfactant (formulation II). The trisodium citrate used was either in the form of TSA alone, TSC alone or different mixtures of TSA and TSC.



In order to analyse the disintegration time, the tablets were placed in a basket with a mesh size of 5 mm in a water bath at 30°C. The basket was agitated in the water in an up-and-down motion (60 times/min). The time taken for the tablets to fully disintegrate with no remains left in the basket was then measured. To examine crack formation, tablets were put into an agitated water bath (150 times/min at 22°C). After 2 minutes or 6 minutes, the tablets were removed and shock frozen in liquid nitrogen to preserve their surface structure. The tablet surfaces were then examined for signs of cracks using an electron microscope (40x magnification).

Breaking strength was determined by measuring the force which had to be applied to a tablet to break it into two distinct parts.

This analysis was performed immediately after the tablets had been pressed.

For storage stability tests, the tablets were wrapped and sealed in 28 µm thick polypropylene foil immediately after pressing. After this, the tablets were stored at 25°C and 60% relative humidity for 8 days, then unwrapped and visually evaluated for crack formation and crumbling.

Results

Mixing TSA and TSC accelerates tablet disintegration

Tablets were pressed according to formulation I, containing TSA, TSC or different mixtures thereof as builders. The disintegration time was then analysed as shown in **Figure 1**. Tablets with either TSA (8 min 6 s) or TSC (8 min 48 s) demonstrated similar disintegration times. Ratios of TSA/TSC between 1/3 and 6/1 decreased the disintegration time in a manner proportional to the amount of TSA in the tablet. Tablets with a 6/1 TSA/TSC mixture had the fastest disintegration

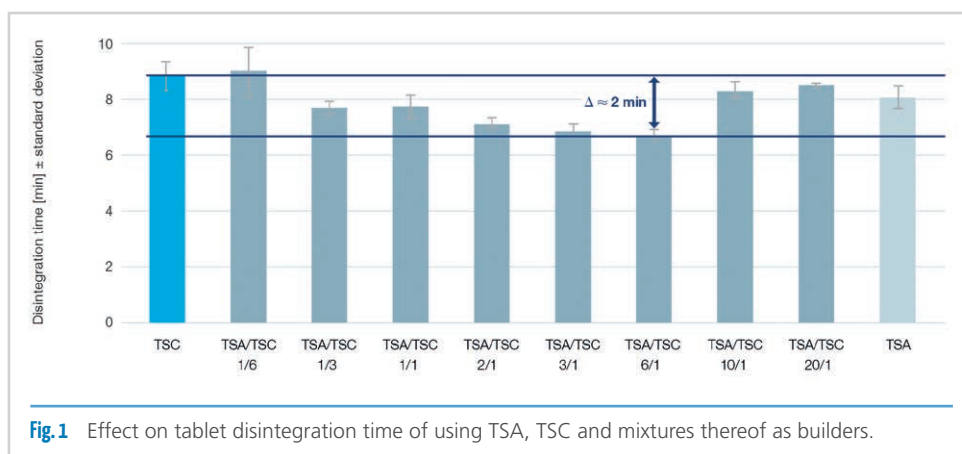


Fig. 1 Effect on tablet disintegration time of using TSA, TSC and mixtures thereof as builders.

time of 6 minutes 42 seconds, which was around 2 minutes faster than with TSC alone as the builder. A further increase of the TSA content to a 10/1 ratio of TSA/TSC did not lead to a further reduction in disintegration time; these tablets had a disintegration time of 8 minutes 18 seconds, similar to tablets containing only TSA as the builder.

The formation of cracks on the surface of the tablets was evaluated by electron microscopy. Tablets

Ingredients	Formulation I [wt%]	Formulation II [wt%]
Sodium Carbonate	40	40
Trisodium Citrate	30	30
Sodium Percarbonate	10	10
Sodium Disilicate	5	5
Sodium Sulfate	13	10.75
PEG	2	2
Surfactant	0	2.25

Tab. 1 ADWD tablet formulation.

with TSA alone, TSC alone, a 1/1 TSA/TSC ratio or a 6/1 TSA/TSC ratio used as the builder (formulation I) were tested.

As shown in **Figure 2**, no cracks were found in the surface of any of the test tablets before disintegration in the water bath. After contact with water for 2 or 6 minutes, the increase in crack formation was inversely proportional to the observed decrease in disintegration time for tablets containing mixtures of TSA/TSC. Tablets containing TSA or TSC alone displayed very few cracks after 2 minutes and 6 minutes in the water bath. In contrast, more and bigger cracks were noted in the surface of tablets with a mixture of TSA/TSC after 2 minutes and 6 minutes in the water bath. This effect was most pronounced for the 6/1 TSA/TSC ratio, which corresponds to the fact that this ratio had the fastest observed disintegration time.

TSA increases breaking strength

Tablets were produced according to formulation I, and their breaking strength was measured immediately afterwards as a surrogate for tablet stability. The different test tablets contained TSA only, TSC only, or mixtures of TSA/TSC ranging from 1/6 to 20/1. Tablets containing TSA alone as the builder, as well as tablets with TSA/TSC mixtures containing at least 50% TSA, displayed a breaking strength of between 64 N and 78 N, which is around twice as high as tablets with TSC alone as the builder. TSC-only tablets had a mean breaking strength of 39 N. There was no significant difference in breaking strength of tablets with between 50% and 100% TSA as the builder in the formulation. Thus, replacing at least half of the TSC in the formulation with TSA doubles the breaking strength of the tablet (**Figure 3**).

This finding is supported by an

existing patent, which covers the use of TSA/TSC mixtures of between 5/1 and 1/5 in the enzyme phase of the tablet. [4] The authors not only found that replacing part of the TSC with TSA increases tablet breaking strength; they also reported that TSA/TSC mixtures enhance tablet cleaning performance.

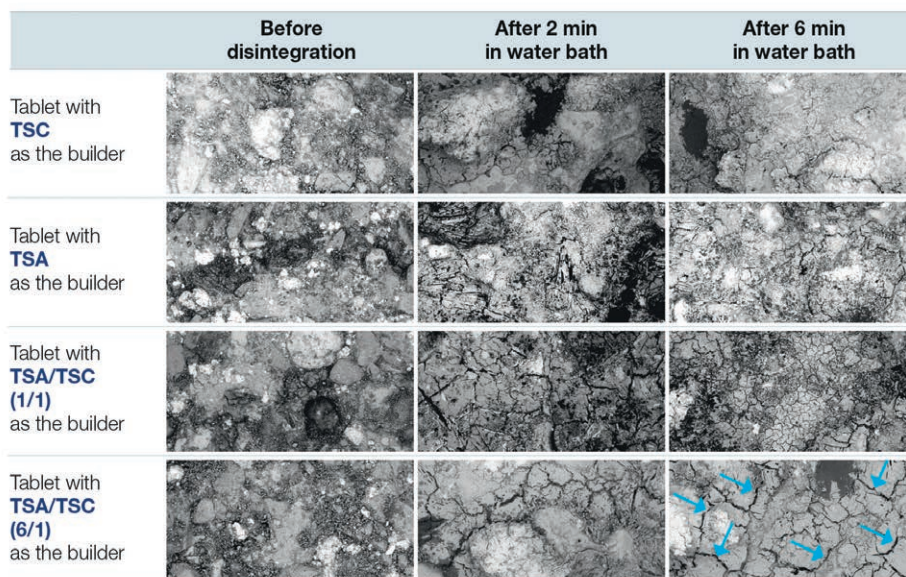


Fig. 2 Marked crack formation during disintegration of tablets with TSA/TSC mixtures as builders.

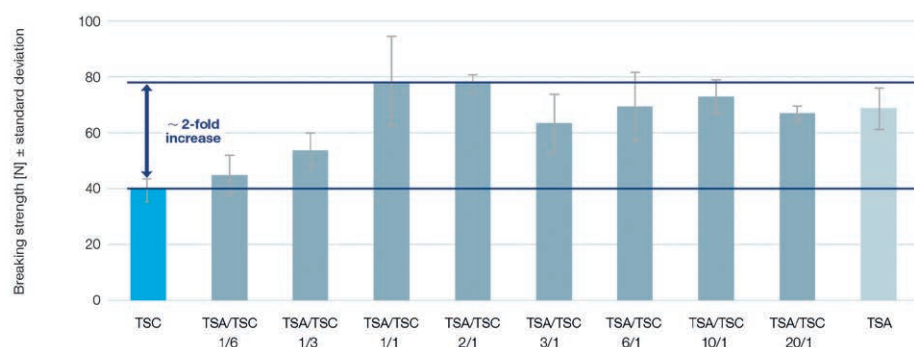


Fig. 3 Replacing part of the TSC with TSA improves tablet breaking strength after pressing.



Fig. 4 The choice of TSA, TSC or mixtures thereof as builders has no impact on storage stability in polypropylene packaging.

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Equally good storage stability in polypropylene

In line with the previous experiments, tablets were pressed according to our experimental formulation, but this time with the addition of 2.25% surfactant (formulation II). Surfactant was added to the tablets for the experiments on storage stability, since the stickiness of the surfactant enhances tablet stability. For trisodium citrate, tablets were tested containing 1/3 TSA/TSC, 6/1 TSA/TSC, TSC only and TSA only. After pressing, the tablets were wrapped and sealed in 28 µm thick polypropylene foil. The tablets were placed in a climate chamber at 25°C and 60% relative humidity for eight days. After this period, the tablets were unwrapped and visually evaluated for signs of crumbling. None of the four builder formulations tested displayed any cracks or signs of falling apart. Thus, the choice of TSA, TSC or a mixture of both in the formulation of ADWD tablets does not seem to affect their storage stability in polypropylene packaging.

In addition to conventional packaging in polypropylene foil, there is also a market for ADWD tablets in water-soluble packaging and unpackaged tablets, with the aim of reducing packaging waste. Preliminary data indicate that tablets with TSA only and TSC only as builders demonstrate good storage stability in water-soluble polyvinyl alcohol packaging after 16 days of storage under the conditions mentioned above. Using mixtures of TSA and TSC as builders for tablets in polyvinyl alcohol packaging may also be possible if the foil is wrapped very tightly around the tablet. Furthermore, no signs of crumbling in tablets with only TSC as the builder were observed, even when stored completely unwrapped for 16 days.

Summary and conclusion

The present study shows that different forms of trisodium citrate have diverse effects on crucial tablet performance parameters, such as disintegration time and tablet breaking strength. Using only TSA as the builder or a combination of TSA and TSC doubles the breaking strength compared to using TSC alone, which indicates higher tablet stability. This is supported by an existing patent, which also shows that mixing TSC with TSA as the builder improves tablet cleaning performance.[4]

In addition, TSA can be loaded with ingredients such as surfactants and will remain a free-flowing powder due to its porous matrix. Mixtures of TSA and TSC also significantly decrease the disintegration time of ADWD tablets compared to when only TSC is used as the builder. Importantly, all three variants tested – TSA, TSC and TSA/TSC mixtures – demonstrate excellent storage stability in polypropylene packaging. Thus, TSA and TSC represent more than an environmentally friendly alternative to phosphorus-based builders in ADWD tablets. Replacing part of the TSC in the formulation with TSA allows fine-tuning of tablet disintegration time and breaking strength.

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About Jungbunzlauer

Jungbunzlauer is one of the world's leading producers of biodegradable ingredients of natural origin. We enable our customers to manufacture healthier, safer, tastier and more sustainable products. Thanks to continuous investment, state-of-the-art manufacturing processes and comprehensive quality management, we are able to assure outstanding product quality. Our mission "From nature to ingredients" commits us to protecting people and their environment.



authors

Dr. Katharina Mück | Product Management Citrics
Jungbunzlauer International AG
katharina.mueck@jungbunzlauer.com

Sandra Rotermund | Application Technology
Jungbunzlauer Ladenburg GmbH
sandra.rotermund@jungbunzlauer.com

Dr. Felix Weiher | Application Technology
Jungbunzlauer Ladenburg GmbH
felix.weiher@jungbunzlauer.com



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Rise Above the Maze of „Clean Beauty“ – RAHN-Cosmetic Actives' Approach

E. Besic Gyenge, S. Hettwer, B. Suter, B. Obermayer

Introduction

Extensive analysis of the beauty market and literature research on the definition of “clean beauty” or “clean products” reveals that this is a question of one’s own interpretation. Those definitions are still not subject to an established cosmetic regulation or label, so they may be misleading and misused. Nevertheless, “clean beauty” is an emerging need and the new star on the cosmetic beauty sky. RAHN is aware of this new star and therefore, we created our Clean Beauty Compass, for the development of the RAHN - Cosmetic Actives (RCA) which helps us navigate through the cosmetic world of “Clean Beauty cosmetics”.

The most important drivers are consumers and their newly gained consciousness of sustainability. The “clean beauty” movement evolves beyond recyclings and includes a more holistic view on personal responsibility, identity, surrounding and rights [1,2].

With the access to more information than ever before, consumers have been demanding greater transparency from the brands they buy from. Armed with a clearer picture of what’s behind the curtain, and awareness of how our culture of consumption has impacted the environment, the consumers of tomorrow are looking for the reconnection with nature, local communities and technologies to optimise the lifestyle and mitigate their environmental impact. Furthermore, the lines between natural, man-made, city and forest, home and office are blurring. Consumers of tomorrow are redefining their values and are looking for simple, flexible, multi-functional, safe and high-quality goods. According to Mintel, consumers are willing to pay more for products of a higher quality and they are concerned that the ingredients used in natural products are not sustainable [3]. Environmentally friendly practices are the best way for brands to represent values [4]. Consumers’ perspectives of brand morality have heightened. Additionally, quick wins such as banning plastic straws are no longer adequate. The actions must be more critical and salient. Brands need to be actively part of the solution and ECO-lution. There is an essential demand for trust and reliability. The RAHN-Cosmetic Actives’ Wind Rose gives an insight into our way of bringing everything under one roof.

RAHN-Cosmetic Actives' Wind Rose

To elucidate our way of thinking and to give clear directional options to our customers including the latest demands of end consumer, we have created a clean beauty compass (Figure 1). The cardinal and ordinal directions facilitate the navigation through the cosmetic world of clean beauty and convey the trust, reliability and loyalty to our customers.

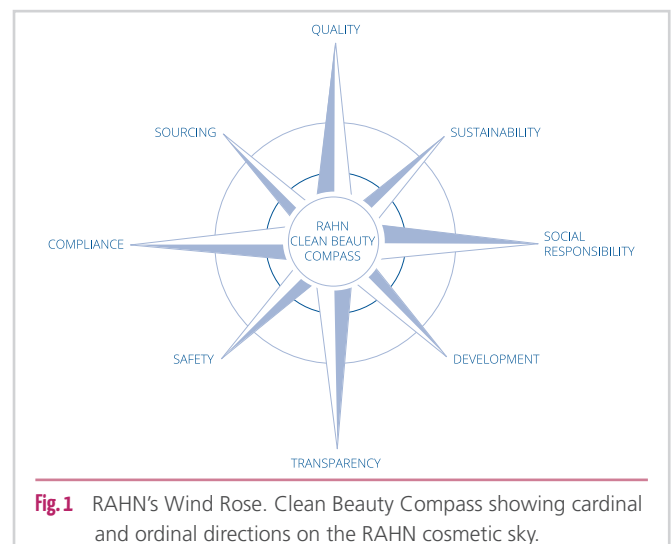


Fig. 1 RAHN's Wind Rose. Clean Beauty Compass showing cardinal and ordinal directions on the RAHN cosmetic sky.

RCA's cardinal directions

Quality – Nothing else matters

The quality of the finished cosmetic product is only as good as the raw materials used. This means that all our raw materials for the manufacturing of RAHN-Cosmetic Actives (RCA) conform to defined specifications to guarantee a stable level of quality over time. Wide ranges of different test methods such as physical, chemical, microbiological, and analytical (spectroscopy, chromatography) analysis is used to ensure this. The batches are always carefully examined during the manufacturing process and later regularly by our quality manager. The samples are stored for a long time to enable the regular review. The findings for each our RCA are summarised in our comprehensive Technical Data File (TDF) and stability documents.



We always strive to deliver the highest quality to our customers and to produce as little waste as possible. Through continuous analysis of the batches, the shelf-life is guaranteed.

Transparency – From Cradle to Gate

Transparency is key to building long-term trust and loyalty to our customers. Since the birth of the internet, our access to information has skyrocketed. Despite the information access and education, the trust in the “system” has declined globally. Consumers want to see proof, consistent results and they need products that stand for something. Since transparency has many faces, it is not easy to meet consumer needs and earn their trust. RCA were and are always produced with utmost care and knowledge about the supply chain. In 2018 we decided to bring this information proactively to our customers. Product life cycle (PLC) assessment (cradle-to-gate) has been used to systematically analyse the product's impact on nature and environment throughout the whole production process [5]. CO₂ produced is offset by different international climate projects [6]. RAHN endeavour to perform continuously PLC assessment to all its active ingredients if manageable.

Social Responsibility – Human first

RAHN works in long-term partnerships with suppliers and CRO's. Whenever possible, RAHN supports local companies and thus safeguards jobs. Our partners are continuously optimising their working processes to meet highest economical, legislative and ecological standards. Thanks to dedicated partnerships around the world, RAHN contributes to securing jobs in remote rural locations and thus also promotes the school education of children. Furthermore, RAHN supports social projects through its Cosmetic Actives developments: RAHN supports 7 climate projects worldwide and contributes to 16 out of 17 United Nations Sustainable Development Goals.

RAHN promotes education and knowledge sharing, regularly collaborates with universities, provides internships and supports the preparation of final theses by young academics.

Compliance – You can rely on us

RAHN recognises the importance of the Nagoya Protocol and took an active part in the public consultation on the Nagoya ordinance in Switzerland. RAHN-Cosmetic Actives comply with the Nagoya Protocol and the related Access and Benefit Sharing principles. We strive to protect the environment, to respect biodiversity and to preserve and restore natural habitats. The RAHN-Cosmetic Actives are made without the use of rare, protected or endangered plants. Additionally, RAHN recognises the guidelines for natural cosmetics and conforms to standards such as COSMOS, Natrue or ISO 16128. RAHN complies with global regulations that apply to the production and marketing of cosmetic active ingredients, such as ISO 9001:2015, Cosmetics GMP ISO 22716:2007 and international chemical and cosmetic regulations (EC 1223/2009, REACH, IECIC, IECSC, etc.).

RCA's cardinal directions

Development of RCA – In tune with nature and science

Cosmetic industry requires continuously innovative and authentic active ingredients. We at RAHN-Cosmetic Actives always strive to do comprehensive literature research in advance, bringing our knowledge up to date. The effectiveness of the active ingredients is analysed by *in-vitro*, *ex-vivo* and clinical tests. Cutting-edge science is our constant companion in elaboration of plausible modes of actions. RAHN-Cosmetic Actives always provide complete scientific dossiers for each

of our active. Our findings are not only presented in many cosmetic magazines and on scientific posters but also in peer-reviewed scientific journals such as the International Journal of Cosmetic Science.

Safety – Safer is better

Cosmetic products made available on the market must be safe for humans when they are used. Dependent on the respective country, forbidden and allowed materials for the manufacturing of cosmetic products are listed in the legislation. For this reason, it is necessary to determine and monitor the contents, the purity and all possible limit values of unavoidable impurities of the raw materials. Our safety data sheets and our toxicological package are very comprehensive, and it is always compliant to the newest chemical and cosmetic regulations.

Sustainability – The Future is greener

RAHN strives to protect the environment and exclusively uses renewable agricultural resources. An example is the use of plant-derived glycerin. For our production processes, as little solvent as possible is used and as little residue as possible is produced. We strive to apply different extraction methods such as supercritical CO₂ or aqueous extraction. Furthermore, we prioritise the use of green solvents. Whenever there is no reasonable natural alternative to palm oil derivatives, RAHN uses solvents from RSPO palm oil, Mass Balance quality. For our product preservation we prioritise the use of natural ingredients or, if needed, as little synthetic preservatives as possible. Our manufacturing processes consume, in general, low amounts of energy: The majority of the RAHN-Cosmetic Actives is produced without the use of heat. Furthermore, RAHN is aware of the threat that CO₂ emissions represent to the climate and has taken the necessary countermeasures. All our actives are readily or inherently biodegradable and are completely harmless for the water ecosystem.

Sourcing – Responsible and fair

Whenever possible, RAHN uses cultivated plants with short pathways from harvesting to manufacturing and favours cultivation in accordance with the Good Agricultural and Collection Practice guidelines. In addition to the means of plant cultivation, a high content of active substances is particularly important in order to achieve the best possible level of efficacy. RAHN strives to ensure the sustained growth of the crop plants and to restore natural habitats. RAHN prioritises long-term partnerships and collaborations with local manufacturers in Switzerland or neighbouring countries. More than 90 % of the RAHN-Cosmetic Actives are produced at production sites in Switzerland and Germany.

The implementation of theory into practice at RAHN-Cosmetic Actives department

RAHN's current portfolio of active ingredients follows the principles for clean cosmetic solutions. The following two examples demonstrate implementation of our values: LIFTONIN®-QI, which is our latest development, launched this year (2021) and AQUARICH®, which is a part of our existing portfolio. Detailed data regarding technical characteristics, toxicology, biodegradability, regulatory issues, performed studies and extensive background information may be found in our comprehensive documentation.

LIFTONIN®-QI – For a skin in harmony and balance

LIFTONIN®-QI is a water-based extract obtained from the fungus *Ganoderma lucidum* (Figure 2), which has been used for thousands of years in Traditional Chinese Medicine (TCM). We have selected a cultivation of this rare mushroom in a laboratory environment in Europe. This guarantees a consistently high quality and preserves the mushroom population in its natural environment. The cultivation is organic. *Ganoderma lucidum* is a saprobiont, which means it grows on dead wood. It converts cellulose into valuable amino acids, sugars and secondary metabolites. The product life cycle has been assessed and used to calculate the energy consumption from cultivation, harvesting, processing, manufacturing and transportation, ensuring transparency in our supply chain. The used energy has been converted in CO₂ equivalents and offset by supporting projects in Switzerland and China, covering 15 of the 17 UN sustainability goals [6].

LIFTONIN®-QI is able to reset the epigenetic clock to “youth time” by positively regulating epigenetic processes in the cells and leads to a relaxed facial expression.



Fig. 2 *Ganoderma lucidum* is traditionally used for tea preparations.

AQUARICH® – Modern Hairchitect and Epidermal Moisture Ally

AQUARICH® is one of RAHN's most successful and best-known products. Already in the development phase, in the first decade of the new millennium, it was compliant with the Clean Beauty Compass. The emphasis was placed on natural and plant products with little to no preservatives. Furthermore, a comprehensive documentation and complete toxicology profile were routinely prepared. The *Avena strigosa* for AQUARICH® is cultivated locally only for RAHN's purposes. The black oats are very rare in their natural habitats and threatened by genetic erosion or even extinction. With the cultivation of the *Avena strigosa* we contribute to the renaissance of those rare species. Additionally, the manufacturing is done by our local partners in Switzerland ensuring short transportation ways. In light of a constant product modernization and adaption to a fast-changing environment, the product life cycle assessment has been done, re-evaluating our production and supply chain. The CO₂ emissions generated have been calculated and offset by means of contributions to two climate-friendly projects: a regional forest project in Switzerland and a wind energy project in Tangier, Morocco [6].

The intelligent blend of natural water-retaining substances in AQUARICH® is able to improve skin hydration and the struc-

tural architecture of dehydrated and stressed hair. Furthermore, we have performed additional experiments to show AQUARICH®'s efficacy in tensile strength and hair gloss after just one application and in different hair care formulations.

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Contact

Emina Besic Gyenge
emina.besic@rahn-group.com

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Creating a Signature Touch with Natural, Sustainable Emollients



Interview with **Jyle Cäcilie Garleff**, Product Manager Personal Care & Cleaning, **Biesterfeld Spezialchemie GmbH** and **Insa Waller**, Application Engineer, **IOI Oleo GmbH**

Emollient –from the Latin emollire – means softening. In cosmetic and personal care products, the main purpose of an emollient is to improve the sensorial experience, making it a key ingredient for successful formulations. A broad range of natural-based, vegan and easy-to-use emollients is available.

Jyle Garleff, emollients are an important part of your personal care portfolio. Where do your emollients come from? Who is your principal?

For emollients, we have been working since 2016 with IOI Oleo GmbH, a partner with a comprehensive product portfolio. They are produced in Germany and differ, for example, in terms of polarity and spreadability and can give a formulation the desired sensory properties depending on the requirements. In addition, the majority of IOI's emollients are natural and vegan and also respond to other current trends such as sustainability. For example, IOI always prefers - if possible - the closest available and most sustainable source when selecting its raw materials in order to keep transport distances as short as possible. 12 of IOI's 15 emollients are already of 100% sustainable origin and 80% of the IOI portfolio is 100% natural according to ISO 16128 (Natural Origin Index (NOI) is 1).

Insa Waller, your company invents, develops and produces sustainable emollients, among other ingredients. What does this involve?

As customer preferences change, there is an increasing interest in knowing what is inside a product, apart from packaging, sensory, price or scent. Sustainability, origin and naturalness of the ingredients, traceability and the environmental awareness of all companies involved play just as much a role for the consumer as quality and efficacy.

With our motto "Touching Technologies", we have made it our mission to offer emollients that convince - through their skin feel, performance and ease of use, but also through their story.

Our goal is to make the world a little greener. In our opinion, this can only be done with respect for nature and, above all, with transparency and commitment. As a subsidiary of the

IOI Group (co-founder of RSPO), we offer RSPO Mass Balance certified goods as standard, and we are also involved in FON-AP for sustainable cultivation and a responsible supply chain. We have already come a long way on our path to greater sustainability. Protecting our environment is an essential part of our corporate values and occupies a central position in our policies and global business activities. In addition, all IOI emollients are based on plant-based, natural, sustainable resources and are therefore ideal for the realisation of current trends such as vegan or clean beauty.

Ms Garleff, why is the right choice of emollients important in formulation development?

A formulation, such as a cream, depends to a large extent on the sensory properties and skin feel that the user experiences during and after application. If the product is perceived as unpleasant or perhaps even sticky, it will not satisfy the consumer. The sensory properties can be precisely controlled via the right choice of emollients to meet the user's needs. For example, the emollients can be used to develop a cream that is perceived as rich or a lotion that leaves the skin feeling light and silky. Tricaprylin is an exciting example because it is a sensory transformer. It feels very rich and oily during application, but leaves the skin feeling non-oily, light, soft and silky after application. In addition, it is good at dispersing UV filters or pigments. So it is a very versatile raw material.

Ms Waller, what are the most important characteristics for selecting the right emollient? Why do you recommend formulations with emollients with different spreading behaviour?

Basically, there are various parameters according to which formulators can select emollients. Spreading behaviour is one of the most important characteristics and describes how quickly an emollient spreads on a surface. A fast-spreading emollient such as Coco-Caprylate/Caprate spreads quickly on the skin and provides immediate smoothness, while a slow-spreading emollient such as Caprylic/Capric/Succinic Triglyceride spreads slowly but provides long-lasting smoothness. The type of emollient can often be identified when the raw material is first tested on the skin, or according to of physicochemical parameters such as molecular size, weight or viscosity.

The challenge is to strike a balance between immediate and long-lasting smoothness. Therefore, the so-called spreading cascade provides a useful guide. It is a synergistic system with which the ideal sensory curve can be achieved.

The idea of using fast-, medium- and slow-spreading emollients to achieve the desired sensory properties is not new, but still very effective. Medium spreaders play a special role here, as they combine the properties of fast- and slow-spreading oils and thus ensure an ideal sensory transition on the skin. An example here would be Triheptanoin.

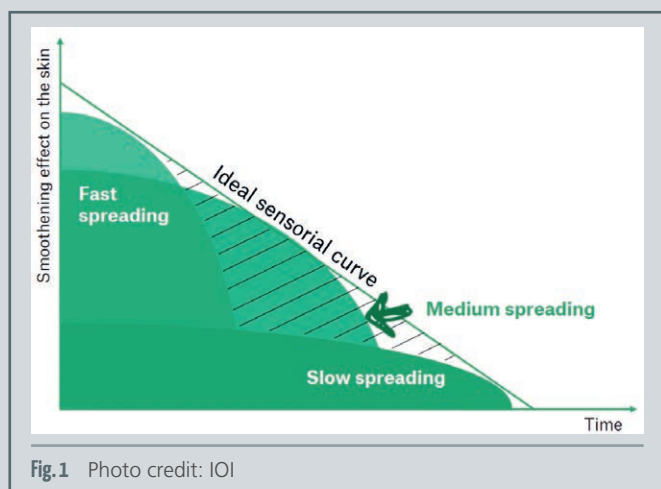


Fig.1 Photo credit: IOI

Furthermore, they can be selected according to sensory profile (e.g. light, soft, silky or rich, oily, long-lasting) or polarity.

What are the advantages of combining emollients of different polarities?

Polarity has a major influence on the formulation. Highly polar oils such as Butylene Glycol Dicaprylate/Dicaprate, for example, make for better colour care and sun care formulations, as they facilitate the wetting of pigments and the dispersibility of lipophilic, crystalline UV filters. Low polar oils like Coco-Caprylate/Caprate help to stabilise emulsions (O/W and W/O) as they can reduce Ostwald ripening, a precursor to phase separation.

We recommend combining emollients of different polarities to achieve the desired performance and optimum stability. For this purpose, we offer three natural-based groups: the low-polarity wax esters, the low- to high-polarity triglycerides and the high-polarity glycol esters. They are miscible with other oils and complement each other perfectly in their properties.

The combination of emollients with different sensory profiles, spreading properties and polarities creates the “signature

touch” typical of a brand. It describes an individual, special and recognisable sensory experience and texture, combined with emotional requirements such as sustainability and environmental awareness, leads to repeat purchases.

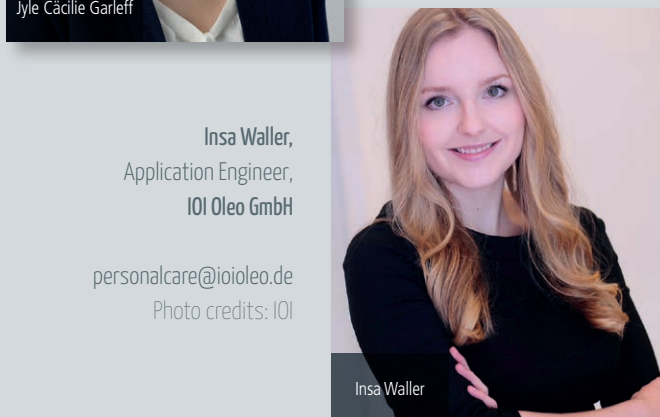
Ms Garleff, how can you support your customers in the selection process? What service do you offer?

As a technical distributor, we specifically go beyond application-related product advice and aim to offer our customers a holistic service and solutions throughout Europe. We evaluate each customer inquiry individually and address the customer’s specific product requirements. With our holistic, but also specialised portfolio, we can make targeted product or development recommendations. We can also offer our customers customised product solutions, jointly developed with the manufacturer. We ensure this through a close dialogue with both our customers and the manufacturers in order to meet their requirements. In addition, we are always working in our laboratories on different frame formulations and concepts in line with the current trends in personal care, which we make available to our customers. With our laboratories we can also actively support customer projects. Through our Europe-wide sales team with technical knowledge and application know-how, we are always close to the market. We also offer training courses and seminars on current market topics or product challenges - in some cases together with our partners - in order to provide complete customer support.



Jyle Căcilie Garleff,
Product Manager
Personal Care & Cleaning,
Biesterfeld Spezialchemie GmbH,

j.garleff@biesterfeld.com
Photo credits: Biesterfeld



Insa Waller,
Application Engineer,
IOI Oleo GmbH

personalcare@ioioleo.de
Photo credits: IOI



SOFW eVENTS virtual: a review

- „The future of cleaning“
- „SpringTIME to innovate.“



Dr. Hans Jürgen Scholz, 1st Chairman of SEPAWA e.V. and Managing Director at IPPM Technologies, and Robert Fischer, General Manager and Editor in Chief at SOFW, moderated the Home Care Event and were available live to answer participants' questions.

On **March 25, 2021**, the virtual home care event „The future of cleaning“ took place.

More than **500 registered participants** from **53 countries** reflected how important the digital exchange of information is at times when on-site exhibitions cannot take place.

Visitors had the chance to listen to seven interesting presentations, make new contacts and discuss with **the exhibitors**:

- **Ashland LLC**
- **Celanese Europe B.V.**
- **Corbion**
- **Emerald Kalama Chemical**
- **Evonik Industries AG**
- **Harke Group** - at the virtual booth.

The lecture topics ranged from new challenges in hygiene due to COVID-19, washing processes and disinfectants to the increased use of biological ingredients and preservatives in the home care industry.

On average, more than **100 participants** attended each presentation in the lecture rooms.

On **April 15, 2021**, we followed up with our first virtual event for the personal care industry, themed: „SpringTIME to innovate.“

Six companies:

- **CLR Berlin**
- **MC Beauty Science GmbH**
- **ProTec Ingredia**
- **Provital S.A.U.**
- **Roelmi HPC SRL**
- **Woresan GmbH**

presented their latest product developments: from the beauty trends CBD and hemp oil, as well as anti-aging products for a pink complexion, to decorative cosmetics and anti-inflammatory, skin-soothing ingredients, to a rebalanced skin microbiome that leaves the skin glowing healthy and young - real all-rounders for the skin!

Additionally, sustainable sourcing of ingredients, reduction of CO₂ emissions in supply chains and product manufacturing, upcycling and bio-based ingredients were also a major consideration.

In line with this, the keynote presentation by **Dr. Alex Föller, Secretary General of TEGEWA e.V.**, referred to the „European Green Deal“ and explained how the chemical industry can contribute to the goal of becoming climate neutral by 2050.

Be part of it as an exhibitor or visitor!

For **more information** on this and all upcoming eVENTs

please visit:

<https://www.sofw.com/de/events/sofw-events>

or write an email to: eVENTS@sofw.com

We have already successfully run two eVENTs and the **next SOFW eEVENT highlight** is on the horizon:



„Here comes the SUN - TakeCARE!“ will take place on **June 17, 2021**

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The speed of innovations in the cosmetics industry continues to be fast-paced.

Who has new ideas and formulations? Which marketing strategy do I pursue with my product? What is the consumer trend? Which topics are relevant?

Many new products and technologies were presented at the various trade fairs during the past year. The Cosmetic Ingredients and Formulations Guide 2019 presents some of these new products and cosmetic topics with a large number of formulation examples and provides an overview of the suppliers of active substances and ingredients.

Find the latest inspirations and trends in the Cosmetic Ingredients and Formulations Guide 2019.



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Skin Care Pure Balance Bi-Phase Serum | VIII-3.135.01A

Phase	Ingredient	US INCI	Supplier	% material
A	Deionized Water	Water	N.A.	67.88
	Trisodium Citrate Dihydrate	Sodium Citrate	Merck	0.20
	Microcare SB	Water / Sodium Benzoate / Potassium Sorbate	THOR	0.60
	Puricolor Yellow AYE 23 (0.2%) / Blue ABL9-X FDA (0.05%)	Water / Acid Yellow 23 / Acid Blue 9	BASF	0.12
	Rheocare XGN	Xanthan Gum	BASF	0.20
B	MultiMoist CLR™	Fructooligosaccharides Beta Vulgaris (Beet) Root Extract Water	CLR	3.00
	AnnonaSense CLR™	Annona Cherimola Fruit Extract	CLR	3.00
C	CutiBiome CLR™	Octyldodecanol Leptospermum Scoparium Branch/Leaf Oil Piper Nigrum Seed Extract Magnolia Officinalis Bark Extract	CLR	3.00
	Cetiol J 600	Oleyl Erucate	BASF	13.88
	Cetiol C 5C	Coco-Caprylate/Caprate	BASF	8.00
	Perfume Shaolin	Fragrance	Frey+Lau	0.12
				100.00

OPERATING INSTRUCTIONS

Mix A until uniform. Add B in the given order to A and stir. Premix C and add to AB.

DIRECTIONS FOR USE

Take a few drops of the serum and gently massage into the skin. Shake before use.

DISCLAIMER:

The recommendations and formulations given are based on our knowledge and experience in the field of technical application.

They are, to the best of our belief, correct, but are offered without obligation.

Those who use our recommendations and formulations as well as those who process CLR Active Agents are themselves responsible for the adherence to prevailing statutory regulations and the observance of patent rights as well as other protective rights for other companies.

This formula has been manufactured and stability-tested using a special preservative, but has not been subjected to microbiological challenge tests.
CLR - Chemisches Laboratorium Dr. Kurt Richter GmbH - www.clr-berlin.com

Looking for the right formula? Check out the formulation section on www.sofw.com

Skin Care Comfort Cream Stick | EU07664



Long-term solid anti-aging cream


Phase	Ingredient	US INCI	Supplier	% material
A	EMOGREEN™ L19	C15-C19 Alkanes	SEPPIC	13.00
	EMOGREEN™ L15		SEPPIC	13.00
	MONTANOV™ 202	Arachidyl Alcohol and Behenyl Alcohol and Arachidyl Glucoside	SEPPIC	3.00
	SENSANOV™ WR	C20-22 Alkyl Phosphate and C20-22 Alcohols	SEPPIC	2.00
	PHYTOWAX 16L55	Hydrogenated Olive oil cetyl esters	SOPHIM	32.00
	AQUAXYL™	Xylitylglucoside and Anhydroxylitol and Xylitol	SEPPIC	3.00
	SEPIlift™ DPHP	Dipalmitoyl Hydroxyproline	SEPPIC	1.00
	LANOL P ÉCAILLES	Glycol Palmitate	SEPPIC	5.00
	LANOL 14M	Myreth-3 Myristate	SEPPIC	5.00
	BEURRE DE KARITE	Butyrospermum Parkii Butter	SOPHIM	23.00
	Parfum Aloe Bamboo Hydro	Fragrance	Expressions Parfumees	0.50

FORMULATION ADVICES: Laboratory Scale - 100 g

Put all the ingredients in a beaker and melt them in a water-bath at 80°C. Remove the beaker from the water-bath and add all the heat-sensitive ingredients (AQUAXYL™ and the Fragrance). Once the mixture is homogeneous, pour it in the sticks.


DISCLAIMER:

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Cosphatec

Cosphatec Presents New Raw Material **Cosphaderm® Zinc Lactate Natural**

Hamburg/Germany, May 9, 2021.

Cosphatec has been a very successful specialist in the natural stabilization of cosmetic formulations for many years now, delivering high-quality raw materials and comprehensive service to its customers. This new product demonstrates the company's innovative strength once again.

Cosphaderm® Zinc Lactate natural is a zinc salt derived from lactic acid that can be used in many different ways and is a real problem solver. It exhibits outstanding antimicrobial properties against bacteria and yeasts. As a zinc salt, it also provides the anti-inflammatory properties that zinc is known for. It also has deodorising effects. These properties make it an ideal component for deodorants, skin care and intimate care products. But it also offers good potential for use in oral care due to the good water solubility, which is important for its processing. Its antioxidative properties also support developers in using fewer ingredients overall for their cosmetic product, lowering input concentrations and thereby meeting the latest developments in customer requirements.

With Cosphaderm® Zinc Lactate natural, Cosphatec offers a raw material that can even win over newcomers and sceptics of alternative preservatives. Apart from the extensive product properties already mentioned, the product can also boast a very good price/performance ratio. More detailed information and samples can be requested as of now.

www.cosphatec.com

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Lubrizol Life Science Introduces **Actismart™ SW extracts,** Botanicals from Around the World



Cleveland/USA, May 06, 2021.

Lubrizol Life Science – Beauty (LLS Beauty) introduces new Actismart™ SW extracts, sustainably sourced botanicals from around the world with multiple beauty benefits.

The unique extracts made in France and in the United States are prized for their natural beauty-enhancing value. Each known for their aesthetic and medicinal benefits, the extracts originate from a variety of sources including plants, flowers and fruits.

“At Lubrizol we’re committed to developing ingredients that are not only effective, but also sustainable and as natural as possible,” said Bianca McCarthy, Ph.D., Global Marketing Manager, Active Ingredients, LLS Beauty. *“Our new Actismart™ SW extracts are a great example of that commitment, providing beauty benefits from a natural resource and sourced through an innovative, eco-friendly process.”*

Actismart™ SW extracts are harvested utilizing Phenobio™ subcritical water technology. The technology is an alternative to conventional solvents, allowing the extraction of a broader range of phytoactives using only water as the extraction solvent. This is all completed with a short extraction time with no thermal degradation associated, to provide pure, sustainable and ecologically conscious extracts.

In addition, along with this sustainable extraction technology, most of the extracts come from organic certified raw materials, and some are upcycled byproducts from the food, spice, paper and forestry industries for an additional environmental benefit.

www.lubrizol.com.



Colors & Effects® Cosmetics Completes Roundtable for Sustainably Sourced Palm Oil Certification for Entire Effect Pigment Portfolio

Ludwigshafen/Germany, May 6, 2021.

Colors & Effects® brand completes RSPO (Roundtable for Sustainably Sourced Palm Oil) certification for three additional product families, completing the certification process for its entire effect pigment portfolio. The Roundtable for Sustainable Palm Oil is an industry effort to source and track palm oil and its derivatives throughout the supply chain, supporting ethical farms and reforestation efforts. The Cellini®, Timica® Terra and Chroma-Lite® families were just certified as of February 2021, joining Mearlmica® Treated SVA and Chione™ M-SVA, which achieved certification in 2020. The remaining products in the portfolio do not use palm oil or its derivatives.

"We are proud to complete the RSPO certification after diligently working towards it for many years," commented Diane Jansson, Global Business Manager, Cosmetics. *"This has been a sustainability target for both us and our customers."*

The Colors & Effects brand highlighted this certification along with other sustainable pigment innovations with a new edition of its "Color of the Moment" trend series. Featuring two naturally derived substrates, "living forest" showcases a rich green shade with vivid sparkles for the color cosmetics and personal care industries. This monochromatic color story includes Reflects™ Dimensions Shimmering Green G830Z, based on calcium sodium borosilicate, and Cloisonné® Nu-Antique Super Green 827CB, based on natural mica.

"With our 'living forest' installment, we build on our commitment to sustainability, especially bringing forward our new palm oil certification," said Kristina Brueggeman, European Marketing Manager for Cosmetics. *"With each of us considering our own personal impact on the earth, 'living forest' captures this mood through color and technology."*

Cloisonné® Nu-Antique Super Green 827CB, the effect pigment featured in "living forest," is part of the Colors & Effects cosmetics portfolio, which boasts more than 145 natural mica-based effect pigments. These products are sourced from the brand's wholly owned and operated mine in Hartwell, Georgia, USA, where mining methods include use of recycled water from an on-site pond, a solvent-free process and continual reforestation. These environmentally conscious practices, coupled with a focus on worker safety and supply chain traceability, bring peace of mind to cosmetic customers and beauty consumers.

www.colors-effects.eu

Azelis to Enter Flavors and Fragrances Market in the US with the Acquisition of Vigon International

Holzminden/Germany, March 11, 2021.

Azelis announces it has signed an agreement to acquire 100% of the outstanding shares of Vigon International, Inc. ("Vigon"), a leading US specialty distributor and manufacturer of ingredients for the flavors, fragrances, and cosmetics market segments. Vigon offers a comprehensive product portfolio to its customers, including flavors, natural and synthetic aroma chemicals, actives, functional ingredients, and essential oils. The acquisition of Vigon will provide Azelis access to these strategic end markets and enhances Azelis' position in the life sciences sector.

Highlights & rationale

- The acquisition of Vigon enables Azelis to gain a strong position in the growing and non-cyclical markets of flavors and fragrances in the Americas.
- It will increase Azelis' presence in the life sciences sector.
- The transaction, expected to close the second quarter of 2021, is consistent with Azelis' strategy of complementing organic growth with strategic acquisitions.

Based in East Stroudsburg, Pennsylvania, Vigon represents some of the world's most prominent flavor and fragrance producers and ingredient manufacturers serving over 1,000 customers in the flavors, fragrances, and cosmetics markets. Vigon employs 120 team members and is owned and managed by Steve Somers Sr., and his son Steve Somers Jr., who will both remain with the company post-closing to continue to lead the business. Vigon was founded in 1988 and has been under the current management since 1998. The company enjoys an excellent reputation as a result of their longstanding relationships with various blue-chip principals, breadth of product portfolio, value-added contract manufacturing and blending capabilities, exceptional customer service, and growing presence in fast-growing natural ingredients.

Both companies have a strong focus on sustainability, digitalization and providing innovative solutions. Throughout its history, Vigon has been committed to health and safety, the welfare of its employees and the environment, and energy conservation. Azelis has had two consecutive EcoVadis Gold ratings and has just released its new sustainability strategy, 'Action 2025', that outlines the company's commitments to sustainability until 2025.

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Editor in Chief

Robert Fischer | robert.fischer@sofw.com

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editorial@sofw.com

Advertising

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Subscriptions

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Address

Verlag für chemische Industrie H. Ziolkowsky GmbH
Dorfstr. 40 | 86470 Thannhausen
Germany

Phone

+49 8281 79940-0

Fax

+49 8281 79940-50

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Tel: +49 8281 79940-0

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