

A CLEAR SOLUTION

Alexander Thiemann, Jessica Scholze, Nadja Grandke and Manuela Salmina-Petersen present a mild, naturally-derived solubiliser for clear formulations

An essential physicochemical process in many cosmetic products is the incorporation of perfume oils, essential oils or other lipophilic substances into the water phase of a formulation. These oils either act as fragrances, emollients or as lipophilic actives with cosmetic properties.

OIL MEETS WATER

The ingredient needed to overcome the natural incompatibility between oil and water is a high-performing solubiliser. Solubilisers belong to a group of surface-active chemicals, able to bind lipophilic substances in water-soluble micelle structures. These micelle structures should be so small that they do not scatter light and the resulting solubilisates appear transparent. This distinguishes solubilisers from o/w emulsifiers, a group of less water-soluble surfactants of which the resulting emulsions appear white, due to the larger size of dispersed oil drops.

The main characteristic of an effective solubiliser is its large hydrophilic and relatively small hydrophobic portion of the molecule. This relation is expressed by the HLB value devised by WC Griffin in 1949^[1]. A low HLB value indicates a high lipophilic proportion, whereas a high HLB value indicates a molecule where the hydrophilic part outweighs the lipophilic part. Solubilisers usually exhibit a high HLB value close to the maximum of 20.

Solubilisers can be found in a variety of

Surfactant mildness is a major concern, especially in baby care formulations

functional groups and they differ in their molecular weight or electric charge, which either can be anionic, cationic, amphoteric or non-ionic. The most prominent solubilisers belong to the group of polyethylene glycols (PEGs).

Depending on the lipophilic part and the degree of ethoxylation, PEG compounds can be used in cosmetics as emollients, emulsifiers, thickeners or solubilisers. Benchmark solubilisers comprise highly ethoxylated, non-ionic surfactants. These partial petrochemical benchmarks include polyethoxylated derivatives, for example of hydrogenated castor oil (PEG-40 hydrogenated castor oil) or polyethoxylated sorbitan ester (eg polysorbate-20). Advantages of benchmark solubilisers are their excellent solubilisation behavior as well as their pH-independency. Nevertheless, PEG compounds bear negative connotations due to critical reports claiming their putative ability to enhance penetration of allergenic or irritant chemicals into the skin. Consumers therefore increasingly demand PEG-free cosmetic alternatives.

SOLUBILISERS' LITTLE HELPER

Naturally-derived alternatives do exist but

rarely possess the good overall performance of their petrochemical counterparts. Examples include alkyl glycosides, acylated amino acids or polyglyceryl esters. In commercial products, often mixtures of these naturally-derived solubilisers are employed in order to exploit synergistic effects between ingredients.

symbiosolv solubiliser blends are patent-pending systems consisting of a blend of plant-derived surfactants and a highly efficient wetting agent. Wetting agents in this context are defined as amphiphilic molecules of relatively small weight and HLB values in the range between 6 and 12^[2]. The strong surface activity of these wetting agents, in combination with the solubilisation capacity of the basic solubilisers, is what makes these systems so powerful that they match the efficacy of petrochemical benchmarks. Possible wetting agents belong to the group of monoglycerides of medium chain fatty acids (C6-10) or 1,2-alkanediols, like glyceryl caprylate and caprylyl glycol, respectively.

The first generation solubiliser blend based on this technology is symbiosolv XC [INCI: Caprylyl/capryl wheat bran/straw glycosides, aqua, fusel wheat bran/straw glycosides, polyglyceryl-5 oleate, sodium



TABLE 1: CHARACTERISTICS OF SYMBIOSOLV XC AND SYMBIOSOLV CLEAR

	symbiosolv XC	symbiosolv clear
Appearance	amber, low viscous liquid	slightly yellow, low viscous liquid
INCI	Caprylyl/capryl wheat bran/straw glycosides, aqua, fusel wheat bran/straw glycosides, polyglyceryl-5 oleate, sodium cocoyl glutamate, glyceryl caprylate	Caprylyl/capryl glycosides, aqua, sodium cocoyl glutamate, polyglyceryl-5 oleate, glyceryl caprylate; citric acid
Recommended dosage (ratio)	1:3 - 1:5 (oil:solubiliser)	1:3 - 1:5 (oil:solubiliser)
pH-value	4.5 - 7.5	4.5 - 7.5
Regulatory status: listed in	Europe, Japan, USA	Australia, Canada, China, Europe, Japan, USA
Natural cosmetic standards	Ecocert, NaTrue compliant	Ecocert, NaTrue compliant

Source: Dr. Straetmans

cocoyl glutamate, glyceryl caprylate]. The basic solubilisers of symbiosolv XC comprise two alkyl polypentosides, obtained from wheat straw, a polyglyceryl ester and a N-acylated amino acid, both gained from other vegetable sources. The wetting agent is a C8-monoglyceride, namely glyceryl caprylate. As such, symbiosolv XC is 100% naturally derived and PEG-free. It reveals an excellent solubilising performance and generates transparent, non-sticky solutions. It works almost pH-independent (4.5–7.5) and shows a good compatibility with alcohol. symbiosolv XC is suitable for certified natural cosmetics and is Ecocert approved (table 1).

Recently, a second generation solubiliser named symbiosolv clear [INCI:

Caprylyl/capryl glycosides, aqua, sodium cocoyl glutamate, polyglyceryl-5 oleate, glyceryl caprylate, citric acid] has been added to the range of symbiosolv solubilisers. While symbiosolv XC is based on wheat-derived alkyl polypentosides the new symbiosolv clear is based on corn based alkyl polyglucosides. This provides symbiosolv clear with all the positive features of symbiosolv XC, together with additional benefits.

Due to the absence of the fusel alcohol-derived ingredients, symbiosolv clear has a clearer, lightly yellow appearance and a milder odor. Furthermore, symbiosolv clear, besides being natural, is suitable for products claiming “wheat-free”. The latter claim may influence buying behavior, as some consumers suffer from wheat allergy or from Celiac Disease, a food-intolerance against gluten-protein from wheat-grain. Further, symbiosolv clear is readily biodegradable, Ecocert certified and compliant for NaTrue certification.

GREAT EXPECTATIONS

Solubilisers need to meet the sophisticated and interrelated demands posed on cosmetic products by different interest groups, such as formulators, retailers and consumers.

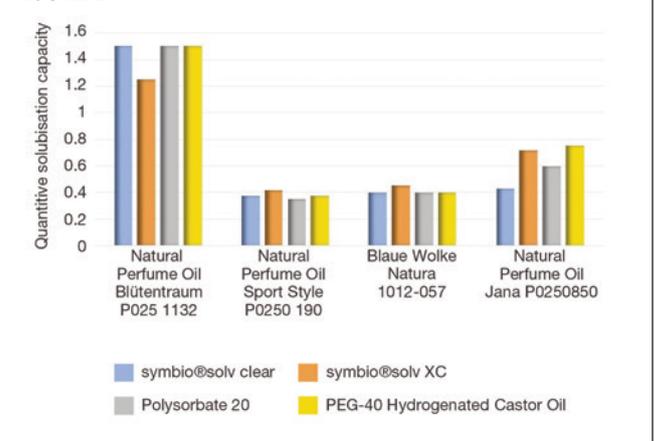
One important regulatory aspect, is symbiosolv clear's worldwide approval, including countries like China (listed on IECSC), Canada (listed on DSL) and Australia (listed on AICS) (table 1).

Formulators, however, especially have an interest in an optimal solubilisation performance. For most formulations, this implies clear solubilisates sustained by small amounts of deployed solubiliser. Examples of clear formulations are tonics, body sprays, perfumes, oral care products, transparent shampoos or deodorants.

Although symbiosolv clear's efficacy to solubilise perfume oils is excellent, a typical

Selection of perfume oils (Frey & Lau) for the comparison of the solubilisation performance of symbiosolv clear and XC and two benchmark solubilisers (polysorbate-20, PEG-40 hydrogenated castor oil). Thereby, the quantitative solubilisation capacity illustrates the ratio between the maximum amount of incorporated oil, and the amount of solubiliser needed to achieve a clear solubilisate

FIGURE 1



variability in the solubilisation performance of different oils for symbiosolv clear and also for symbiosolv XC has been observed. Nevertheless, efficacies of the symbiosolv solubilisers is generally comparable or even superior to polyethoxylated benchmark solubilisers, like PEG-40 hydrogenated castor oil or polysorbate-20 (figure 1).

Due to symbiosolv's excellent performance in achieving clear solubilisates, comparably small amounts are needed in the final formulations, thereby minimising colour and odour and having a positive effect on skin compatibility and the final price of the product. Even at higher concentrations, symbiosolv clear exhibits almost no negative impact, due to its low-key inherent features.

The majority of oils incorporated in small amounts into cosmetic formulations are fragrances. For these oils, solubilisers with a neutral odor, like symbiosolv clear, are an excellent choice to obtain the pure and clean odour of the perfume.

symbiosolv clear's low viscosity (1,000–20,000mPas) allows for simple handling in laboratory as well as in production scale. It is suitable for cold processes, which makes it superior in handling to the highly viscous, ethoxylated benchmark PEG-40 hydrogenated castor oil, which requires additional time and mechanical work for effective solubilisation results.

symbiosolv clear's versatility is reflected as well in its ability to work as an effective emulsifier for nanoemulsions. In contrast to clear solubilisates, milky nanoemulsions normally contain higher amounts of oils and are employed in formulations with a caring, re-fattening effect. With most regular solubilisers stable nanoemulsions are difficult to realise, with symbiosolv clear, however, this is feasible.

Despite their efficiency in solubilising oils, some natural solubilisers require specific pH-conditions (eg pH>6) and are

therefore limited in their application. For slightly acidic skin cosmetics this could be hard to reconcile. symbiosolv clear offers reliable solubilisation over a pH range from 4.5–7.5 and provides an excellent option for most cosmetic formulations.

Depending on the final product, formulators have to consider the right balance between performance and skin tolerance of a solubiliser. The high surface activity of solubilisers required to fulfill their technical function contains the inherent potential for eye and skin irritation. In baby care formulations especially, mildness of the surfactants is of major concern. A solubiliser with a low irritation potential is therefore of high interest for products of baby hygiene and care. HET-CAM *in vitro* studies revealed a 35.6% lower irritation potential for symbiosolv clear, compared with PEG-40 hydrogenated castor oil^{3,4}. **cb**

Authors

Alexander Thiemann, Jessica Scholze, Nadja Grandke and Manuela Salmina-Petersen, Dr. Straetmans GmbH
www.dr-straetmans.de

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