Surfactants with high compatibility and conditioning properties for ...

... new ecological formulation concepts

Sugar-based multi functional surfactants with additional sensory benefits for ecological formulations with lower active content

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Clariant's new GlucoTain range of sugar-based surfactants offers good performance as well as additional sensory benefits. Thus, it helps formulators develop innovative products and platforms – based on sulfate-free, CAPB-free and EO-free formulations – for a wide range of applications.

Consumers are showing an ever increasing interest in more sustainable solutions. Greener and fully biodegradable mild formulations are among the top desired attributes, although they bring cost-efficiency and performance challenges that are not easy to overcome.

GlucoTain surfactants present a number of features that finally make it possible to formulate more ecological shower products and liquid soaps. The new EO-free and sulfate-free ingredients are based on Roundtable of Sustainable Palm Oil (RSPO) Mass Balance certified palm oil. They are readily biodegradable with 94–95% RCI (Renewable Carbon Index), a high content of non-tropical biomass and a good eco-tox profile. Superior cleansing efficacy and cost-efficacy are achieved for a range of applications such as shampoos, shower liquids, soaps, facial cleansers and shaving foams.

Biodegradable – aerobically and anaerobically

GlucoTain surfactants are non-ionic surfactants that are based on sugar and plant oils as a base feedstock. They are highly renewable and, through the sugar feedstock, they rely on a resource of non-tropical origin. They are readily biodegradable and, additionally, anaerobically biodegradable.

High renewable content and no Ecotox labelling

Compared to the widely used amphoterics in the market, they show a significantly higher renewable carbon index (RCI) of 95%, which is the highest possible renewability without compromising performance.

As one of the few surfactants on the market, the new surfactants have no GHS Ecotox label and, as such, they have a low impact on the environment in comparison to widely used betaine surfactants (Table 1*).

Thickening properties via salt

Their viscosifying properties make thickening via salt easily possible, so that no synthetic thickeners need to be used. Glucamide surfactants are known[1] for forming elongated micellar structures in aqueous solutions. At chain lengths of C_{10} and above, elongated micelles are formed. This indicates that they are able to support the formation of rod-like micelles. These are the pre-conditions that need to be met when forming highly viscous surfactant solutions by adding electrolytes. The special physico-chemical behaviour of the new surfactants is characterized by good thickening behaviour in formulation. This entails a cost advantage as, due to better thickening, the amount of actives can be lowered. At the same time, it is an ecological benefit as the carbon footprint of a formulation is, of course, directly connected to carbon content. Good viscosifying properties also help to reduce the need for non-biodegradable thickeners like polyacrylates. The thickening behaviour of primary/co-surfactant combinations depending on the sodium chloride content, was investigated at 12% active surfactant and a surfactant (SLES) : co-surfactant ratio of 10:2 at a pH of 5 (Fig. 1).

Glucamides with C_{12-14} or C_{12-18} chain lengths have a salt response similar to Cocamidopropyl Betaine (CAPB), and significantly better than Alkyl Polyglucosides. As the thickening curves were

not corrected for the intrinsic salt content of CAPB, the Glucamides show superior thickening. Cocamide MEA shows easier thickening with salt, although this is accompanied by cold instability with viscosity loss at low temperatures.

When Glucamides (GA) are added to a standard Sodium Laureth Sulfate (SLES)/Cocamidopropyl Betaine (CAPB) formulation at overall constant active surfactant content, viscosity build-up increases, especially in formulations with high SLES content. Table 1* shows the amount of sodium chloride necessary to thicken a formulation with 12% of overall surfactant concentration. The low values for the Glucamide surfactant mixtures indicate a superior thickening effect. The best viscosifying effect is achieved with the help of Glucamides with a C_{12-18} chain (Fig. 2)

Foam structure and conditioning effect

Foaming behaviour of Glucamides was compared to Cocamidopropyl Betaine in handwash tests in a 12% active system with 10% SLES and 2% of co-surfactant (Fig. 3). A combination of SLES and Glucamides shows better foam build-up on rubbing than SLES/Cocamidopropyl Betaine. C_{12-18} Glucamide with longer chain length, additionally, produces a more creamy, luxurious foam.

The sensory properties of surfactants are an important criterion when applying them to cosmetic formulations. This includes, on the one hand, foam behaviour and foam structure; but, on the other hand, skin feel on rinsing. Glucamides typically show a distinct sensory effect in the dry state after rinsing. With a chain length of C_{12-14}, Glucamide imparts a pleasant clean skin feel in the dry state. If the Glucamide surfactant contains higher chain lengths, e.g. C_{16} or C_{18}, Glucamides achieve refatting/conditioning benefits and foam creaminess is further improved.

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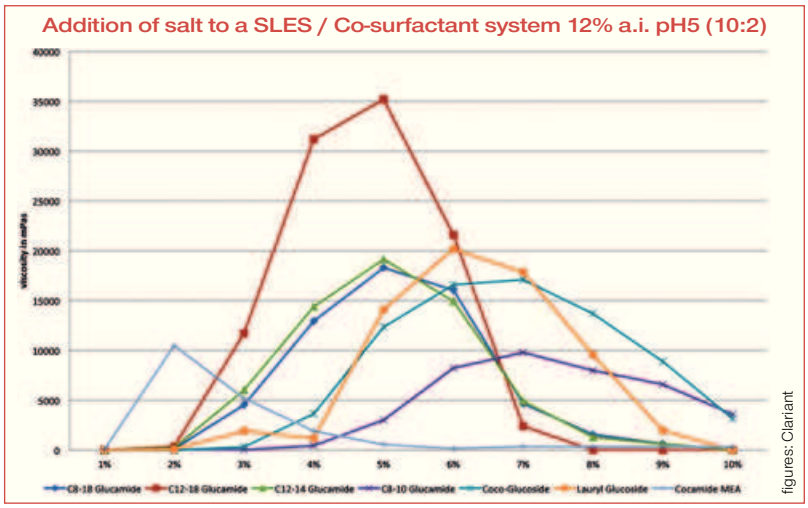

Fig. 1: Thickening curves of SLES/Co-surfactant mixtures with sodium chloride

Creating innovative formulations

Based on these findings, the question arises: can the use of Glucamides as co-surfactants enable the formulator to create innovative formulation chassis which are also environmentally beneficial? The answer is: Yes. The multi-functionality of **GlucoTains** allows the simplification of modern cosmetic formulations without compromising the product properties of the final formulation.

The basic composition of a shower gel/liquid soap is typically:

- a primary surfactant for detergency and foam buildup
- a co-surfactant to achieve better foam and mildness
- refatting/skin conditioning agent to improve the sensory properties of the formulation
- perfumes, preservatives and other minor components.

Generally, the surfactant base of a skin cleansing formulation is complemented with a separate refatting agent/skin conditioning agent not only to mediate the detergency of the surfactant mix and ensure a pleasant after-feel on the skin, but also to boost foam and improve sensory properties in the wet state. Typically used ingredients are e.g. PEG-7 Glyceryl Cocoate, the association of Coco-Glucoside and Glyceryl Oleate or Polyquaternium-7. The latter, in particular, is not biodegradable and therefore no longer preferred for formulations with a good eco-profile.

The target of the first study was therefore to assess if the use of GlucoTain surfactants could eliminate the need for adding skin conditioning additives to the formulation. To demonstrate this, formulations A, B and C below were prepared. Formulation C is a standard formulation using Cocamido-

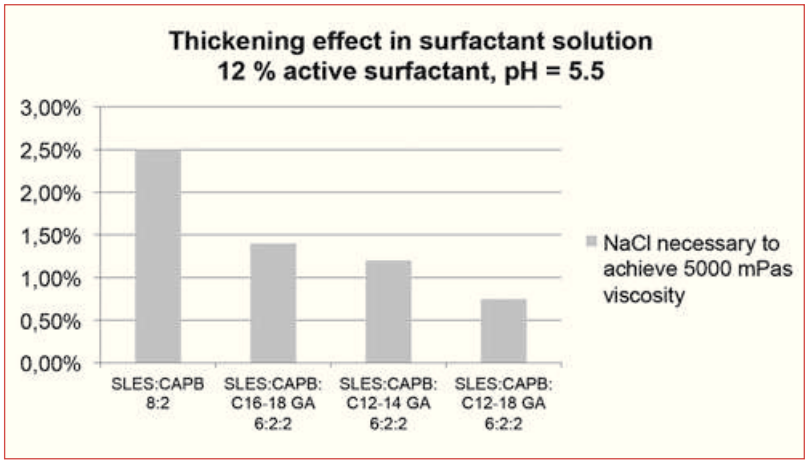

Fig. 2: Thickening effect of Glucamides in SLES/CAPB systems

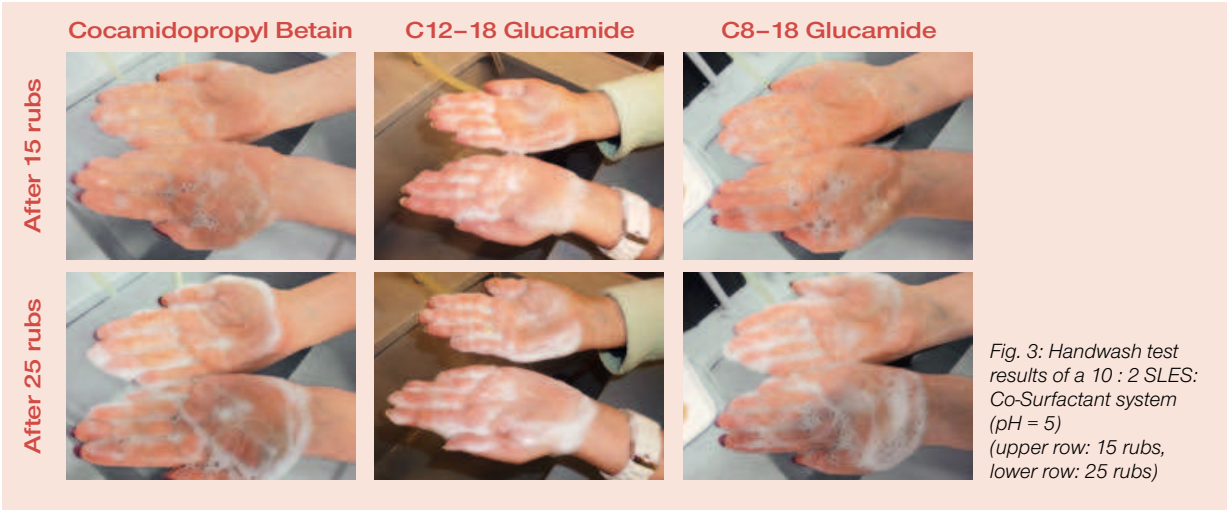

Fig. 3: Handwash test results of a 10 : 2 SLES: Co-Surfactant system (pH = 5) (upper row: 15 rubs, lower row: 25 rubs)

propyl Betain in combination with Polyquaternium-7; formulation B is a comparative formulation using a combination of Cocamidopropyl Betain and Coco-Glucoside/Glycaryl Oleate and formulation A uses **GlucoTain Care** (Cocoyl Methyl Glucamide) with no additional refatting agent on top (Fig. 4*).

The three formulations were assessed by a trained panel of 10 participants following a double blind protocol[2] and the acquired data was treated with a statistical method (t Test).

The GlucoTain Care system (C_{8-18} Glucamide) showed a significant improvement in rinsability compared to other systems and provided comparable benefits on every other sensory attribute tested i.e. it allowed cost effective formulations without Polyquaternium-7 and was also equivalent to the combination of Cocoamidopropylbetain and Coco-Glucoside/Glyceryl Oleate at lower overall active concentration (Fig. 5).

In another study an economic formula from the European private label market was reconstructed (Fig. 6*). Based on this formulation, a complete replacement of all co-surfactants and refatting agents (total concentration 3,0%) with Lauroyl/Myristoyl Methyl Glucamide (GlucoTain Flex) was tried (totally 2,0%).

When the co-surfactants and re-fatting agents (total: 3.0%) were replaced by **GlucoTain Flex** (2.0%) the formulation had a more creamy foam and good re-fatting effect (Reformulation 1). The chassis can be significantly simplified, is more economic and has a better foam structure.

Replacing the co-surfactants and re-fatting agents (total: 3.0%) by a combination of GlucoTain Flex (1.0%) and coco-betaine (1.0%) resulted in a formulation with more creamy foam, sufficient re-fatting effect and significantly reduced sodium chloride level (Reformulation 2). Based on the latter, even lower active formulations may be possible in a further optimisation step. The chassis can be significantly simplified, is more economic and is improved in the foam structure.

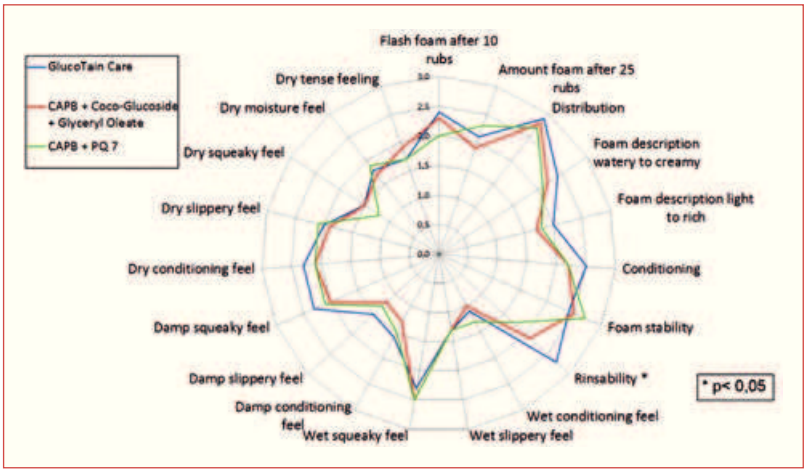

Fig 5: Results of three assessed formulations

Creating new ecological surfactant formulations

Today's solutions for sustainable and biodegradable formulations often face the challenges of cost and performance. A more robust approach is needed to reconcile consumers' needs with formulators' requirements.

GlucoTain's thickening and structuring characteristics, along with its additional conditioning properties, however, will enable formulators to generate new ecological surfactant formulations with lower active content and thus lower our carbon footprint without compromising product performance. And thanks to their nonionic nature, they are highly compatible with all kinds of cosmetic formulation ingredients.

[1]Balzer, D, Hoffmann H: Verfahren zur Umwandlung hexagonal-flüssig-kristalliner wässriger Tensidphasen, EP 0 662 511: p. 5

[2]22 ml product applied for 10 and up to 25 rubs; evaluation of performance on a scale from 1 to 3, one being low and 3 being high

*These tables and formulations, as well as additional figures and product information, can be found on the Internet – see Internet panel

Sergio Manzano
Marketing Manager, Carina Mildner, Lab Scientist, Ute Back Lab Scientist, Charlotte Stricane Application Development Manager and Wiebke Johannpeter Lab Scientist, Clariant, Business Unit Industrial & Consumer Specialties (BU ICS) Frankfurt, Germany

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