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The Power of Silicones in Cosmetic Applications: The Science behind the Performance

S. Marchioretto, I. Vervier, I. Van Reeth, K. Plotzke, B. Johnson

abstract

With a long-standing history of safe use in personal care, silicones have changed the face of the beauty industry. They have unique, long-lasting properties that enable increased efficiency of finished formulations [1]. These properties fuel our imaginations, enable continuous performance innovation, and contribute to a more sustainable future. Unfortunately, there are misperceptions regarding the impact of silicones on the planet and on human safety which create consumer concerns. This article bridges the gap between myths and facts for the purpose of encouraging a transparent science-based dialogue. It covers safety, sustainability, and performance benefits – but it all begins with the unique chemistry of silicones.

Silicone Chemistry [2]

Silicon (Si), the starting point for all silicone materials, is the second most abundant element in the earth's crust after oxygen, and is available under the form of quartz, sand, and even plant husk. Derived from quartz, composed of silicon and oxygen atoms, silicones are a broad family of polymers providing a wide range of materials with problem-solving benefits. In addition, silicone chemistry can be engineered to deliver beauty care ingredients from low viscosity volatile fluids to viscous or solid materials.

The most well-known structure of a silicone polymer is called polydimethylsiloxanes (PDMS) and contains repeated sequences of silicon and oxygen atoms, surrounded by methyl groups **(Figure 1)**.

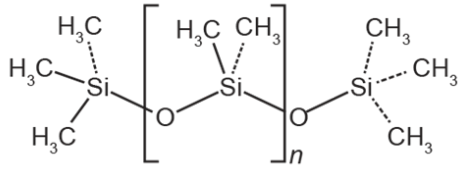

Fig. 1 Traditional representation of polydimethylsiloxanes

The performance of these polymers can be fine-tuned depending on the targeted benefits. For example, silicone polymers can be modified by varying the molecular weight, changing the structure to form a tri-dimensional crosslinked resin and/or adding other organic functionalities. The addition of organic chains helps oil or water compatibility [3], increases formulation flexibility and/or allows superior affinity for skin or hair. This can also lead to a range of sensory attributes, gaining consumer acceptance, trust, and loyalty.

Silicone Chemistry Physicochemical properties [2, 3]

Their distinctive physicochemical properties are the reason why silicone polymers offer unique performance and benefits. They display an unusual combination of inorganic high surface energy from the Si-O-Si chain with side methyl groups that are organic and often associated with low surface energy. Thanks to the methyl groups, silicone polymers weakly interact with each other **(Figure 2)**.

Compared to C-C or C-O based-polymers, Me_2Si-O repeat unit polymers possess:

- Lower rotational energy around the Me_2Si-O- bond
- Wider Si-O-Si bond angle
- Longer Si-O bond length
- Strongly polarized Si-O bond

These characteristics lead to fascinating polymers with physicochemical properties such as:

- Low surface tension, resulting in efficient wetting and high spreading [4].
- High polymer flexibility, enabling the siloxane chain to adapt its conformation to its environment. So, when applied on typically polar skin or hair surface, the silicone polymers expose their polar high surface energy Si-O-Si chain towards the substrate, creating a relatively substantive film. In this conformal arrangement, the methyl groups of lower surface energy orient outward forming an efficient hydrophobic top layer **(Figure 2)**. This flexibility also enables silicones to smoothen surfaces, hence leading to unique skin and hair feel. [4], [5], [6]
- Low glass transition temperatures (Tg: -127°C) [3] , hence remaining fluid even with high molecular weight, unless modified e.g. with more rigid organic substituents such as aryl groups.

- High solubility and high diffusion coefficient of gas into silicones resulting in high permeability to oxygen, nitrogen and water vapour.
- High resistance to UV, heat, and oxidation.
- Tunable refractive index from 1.4 to 1.6 depending on the organic group substituent.

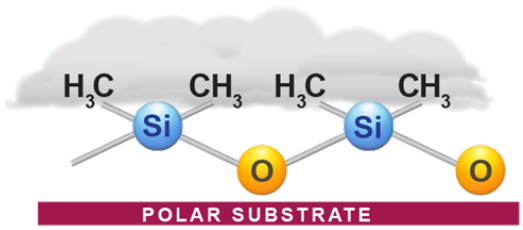

Fig. 2 Polydimethylsiloxane conformal arrangement on a polar substrate

These properties explain why silicone polymers offer unique, yet complementary performance and benefits compared to organic polymers.

Silicones Beauty

Health, Environment and Safety of silicones

a. Safety [7]

After almost seventy years of successful applications in beauty and personal care products, silicones are among the most extensively studied materials (over 1000 studies) used in current consumer and industrial applications [8].

This strong safety profile is based on the fact that silicones are non-reactive, stable, biologically inert materials under typical use conditions.

They typically do not cause skin irritation, do not have drying effects, and are not allergenic; no silicone derivatives are listed on American, European, or British allergens lists [9], hence silicones are positioned in the market for sensitive skin [10].

Several silicones have proven to be non-comedogenic ingredients [11], [12]. Most silicones used in beauty and personal care products have low to minimal dermal absorption and do not prevent cosmetic bioactives nor other actives from penetrating the skin [13], [14]. Dimethicone is also approved by the US Food and Drug Administration (FDA) as an Over-the-Counter (OTC) skin protectant for minor cuts, scrapes, burns, chapped skin and lips, etc., when used ≥ 1% level. Silicones do not promote bacterial or other microbial growth [15].

Derived from mineral, none of the PDMS components are derived from GMOs or animals, meaning most silicones are ideal clean beauty, vegan-friendly, and cruelty-free ingredients by default.

b. Silicone sustainability

In a world that strives for sustainability, silicone polymers can play a key role. The following is a review of silicone sustainability in terms of degradability, feedstock, and benefits for eco-conscious consumers.

1. Silicone degradability [16]

Most silicones used in personal care applications are not expected to reach the water environment to a significant degree, as, after application, they will have either evaporated (volatile siloxanes) from skin or hair, or when they are washed off through water and go down the drain, they will be partitioned out of the wastewater by binding to suspended particulate matters. In wastewater treatment plants, they will end in the sludge by sedimentation. The sludge is either handled as waste or may be used to spread on land for agricultural purposes. Once in the soil, silicones are degraded by the clay in the soil [17].

Silicones are considered not readily biodegradable under standard testing (i.e. OECD guideline testing for biodegradation) but the consideration of biodegradation alone does not give a complete picture of the potential for silicones to be degraded once they reach the environment [18].

Indeed, studies taking into consideration physicochemical properties show that silicones are degradable by hydrolysis either in soil or sediments for volatile and non-volatiles polydimethylsiloxanes or in the air by photolysis for the volatile siloxanes such as the cyclic siloxanes [16], [19], [20].

In soil, depending on humidity and pH conditions, PDMS are expected to be ultimately converted to silica, silicic acid, and carbon dioxide most likely via both chemical and biological degradation processes, leading to the removal of silicones from the environment [7], [17].

2. Sustainable feedstock

The transformation of silicon dioxide (SiO_2) into silicon metal is an energy-intensive process but can be produced in a highly sustainable way. For example, in Brazil, Dow has a silicon metal facility that uses hydroelectric power with a minimal impact on the environment. At the site, Dow owns 45,000 hectares of land – about 80% of which is preserved native Amazon rainforest and about 20% of which is an eucalyptus plantation. Charcoal used in silicon metal production is made from eucalyptus that is sustainably cultivated and harvested from the plantation per Forest Stewardship Council (FSC) guidelines.

Dow recently initiated Project *Ybá* [21], which will map the biodiversity of the forestland for bioactive ingredients and help develop a local cooperative that will harvest and sell them. With the launch of this project, Dow is playing an active role in contributing to the social development of the Brazilian Breu Branco community, as more than 150 families in

the region are expected to benefit through employment in a sustainable industry. Through the identification and sale of bio-active products for the cosmetics industry, this initiative can increase the income of families, while contributing to the conservation of part of the Amazon rainforest.

3. Benefits for eco-conscious consumers

In hair care, silicones, particularly aminosiloxanes, are used to protect hair against daily grooming damage thanks to the excellent lubricity obtained from their low surface tension. Silicone deposition along hair fibers helps to restore the healthy look and feel of damaged hair cuticles, providing a perception of moisturization. They are also well-known for enhancing hair shine [22].

In skin care, silicones offer a luxurious and silky feel, contributing significantly to the consumer's adoption of a formulation [23]. Silicone elastomers are critical ingredients used in "skin primers" to minimize the appearance of the pores and fill in fine lines and wrinkles, smoothing skin surface [24], [25]. They are also widely used for their sebum absorption properties, mattifying greasy skin [24], [25].

Eco-conscious consumers as well as hair and skin beauticians look for cosmetic products that save energy, reduce water consumption and waste, and potentially extend the life of their beauty devices.

Silicone materials are well-positioned to meet these sustainable requirements as most silicone polymers:

- Typically have low odor, low color, and high purity [26]
- Are offered without preservative when supplied as polymers
- Remain stable under in-use conditions, hence, have a long shelf life and do not need specialized storage conditions
- Are processable at room temperature
- Can be used at relatively low levels, allowing improved performance in high natural content formulations [27]
- Have high spreading properties and long-lasting performance, helping reduce the amount and frequency of application

Furthermore, silicones can:

- **Protect colored hair from fading:**
  Certain silicones help retain color vibrancy up to the next coloration despite repeated washes imposed by hair grooming routine [28].
  In most hair colorant systems, silicones are also widely used during the process to restore hair smoothness and shine. Examples of best-performing silicones for color retention include DOWSIL™ CE-8411 Smooth Plus Emulsion and DOWSIL™ 5-7114 Silicone Quat Microemulsion.
- **Aid hair styling:**
  Once washed, hair fibers treated with DOWSIL™ 8500 Conditioning Agent, DOWSIL™ CE-8411 Smooth Plus Emulsion, or HydroxySHIELD™ Polymer become more hydrophobic and less tangled. This leads to faster air or blow drying. If curly hair is left to dry at room temperature, curl definition is significantly improved. Even straight hair is less frizzy when treated with silicones like DOWSIL™ CE-7081 Smart Style or DOWSIL™ 3901 Liquid Satin Blend.
  When the use of electrical appliances such as straightening or curling irons are needed, the time to style the hair can be reduced when using formulations containing DOWSIL™ CE-8411 Smooth Plus Emulsion, DOWSIL™ 969 Emulsion, or DOWSIL™ AP-8087 Fluid [29]. Once hair is styled, the more hydrophobic hair fibers provide prolonged hair shape, whether curled or straightened, diminishing unpleasant frizz, even under high humidity conditions.
  Additionally, because silicones are thermally stable and form a water vapor permeable film all along the cuticle, they guard against heat damage. Silicone gum blends such as DOWSIL™ 1507 Fluid and DOWSIL™ 1508 Fluid [30] are efficient heat protectors when used in anhydrous serums. Because specific OH amino-functional silicones – such as DOWSIL™ CE-8411 Smooth Plus Emulsion and DOWSIL™ 969 Emulsion – prefer to deposit on damaged areas of hair and cuticle edges, they further prevent hair cuticle damage from heat. These properties assist formulators in using natural products such as argan oil but without the drawback of their damaging effect when used at temperatures up to 230°C.
- **Counteract negative effects of pollution:**
  Daily exposure to urban pollution particles has a negative impact on hair shine and combing force. DOWSIL™ HMW 2220 Non-Ionic Emulsion in aqueous leave-in conditioners, or DOWSIL™ AP-8087 Fluid in anhydrous gum blend serums, help to counteract these effects. Even better, by decreasing polarity and increasing hydrophobicity of hair fibers, DOWSIL™ 3903 Liquid Satin Blend based serums reduce the amount of pollution depositing on hair. Therefore, hair looks and feels good despite exposure to a polluted environment.
  In skin care, silicone such as DOWSIL™ FA 4103 Silicone Acrylate Emulsion or DOWSIL™ FA 4004 ID Silicone Acrylate are also ideal solutions to reduce the adhesion of particulates to the skin in polluted areas like cities [31]. These properties reduce the number of washes and/or facilitate them, preserving water and energy consumption.
- **Improve product spreadability:**
  Silicones contribute to an improved formulation spreadability on both skin and hair. In sun care, superior skin coverage of sunscreens is achieved, optimizing skin protection against UV damage [32]. In color cosmetics, when DOWSIL™ FZ-3196 Fluid [33] is used, pigments form a more uniform film that may lead to less product usage.
- **Provide longer-lasting benefits:**
  Film-forming silicones such as DOWSIL™ FA PEPS Silicone Acrylate impart resistance to friction and water to color cosmetic or sun care formulations [34]. These properties provide transfer resistance benefits even in presence of

sebum. The comfort of wear is maintained thanks to the high flexibility and permeability of the silicone acrylate hybrid polymer.

- **Enable superior feel of high natural and derived natural ingredient containing formulations:**
  Thanks to their bio-based carrier, DOWSIL™ 1508 Fluid or DOWSIL™ EL TIPS Silicone Elastomer Blend allow products to be formulated with an exceptional feel and texture with a natural content of more than 90% [35]. These blends also enable to formulate water-free formulation, another interest for eco-conscious consumers.

Silicone Truths vs Myths

Over the years several myths have developed concerning personal care products containing silicone. In the interest of science, below are three facts that dispel the most common myths.

1. Silicone does not build up on hair: True!
Because of their low intermolecular forces, PDMS formulations spread evenly on the hair fiber until a monolayer is covering the hair surface. Therefore, they do not accumulate in layers. This means no "build-up" effect when using the recommended amounts, depending on hair types.

Multiple Dow studies show that hair maintains its healthy look (no volume loss, enhanced shine without greasy look) and lightweight feel, even after 20 shampoo and/or rinse-off conditioner applications.

Additionally, Dow demonstrated that the silicone deposition from a DOWSIL™ CE-8411 Smooth Plus Emulsion based shampoo (1% silicone active) is not cumulative even after 10 repeated treatments **(Figure 3)**.

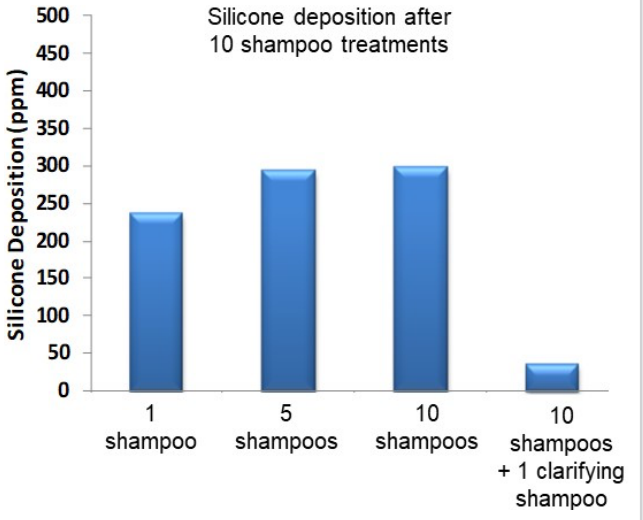

Fig. 3 Silicone deposition up to10 shampoos (ICP-OES)

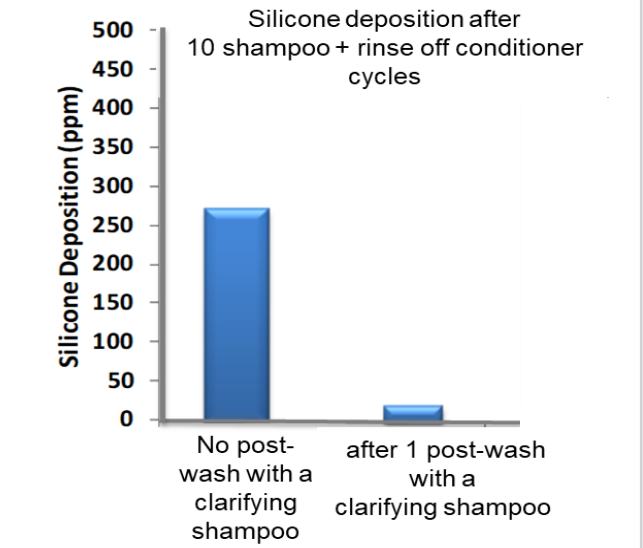

Fig. 4 Silicone removability with a clarifying shampoo (ICP-OES)

2. Silicones are washable: True!
With a relatively weak bond between the silicone and the hair or skin surface, PDMS will be easily removed after the use of a clarifying shampoo or a shower gel [36]. On hair, **Figure 4** shows that the silicone deposited after 10 shampoo treatments alone (as referenced above) or 10 shampoo and rinse off conditioner applications can be removed when post washed with a clarifying shampoo.

Most silicones deposited on the skin are also removable when surfactant-based formulations are used. However, some of them have been designed to resist to rub off or sebum secretion, an ideal benefit e.g. for long-lasting color cosmetics. DOWSIL™ EL-7314 Silicone Elastomer Blend has been particularly designed to prolong color cosmetic skin remanence up to five days, making it an ideal additive for semi-permanent tattoos. **(Figure 5)**.

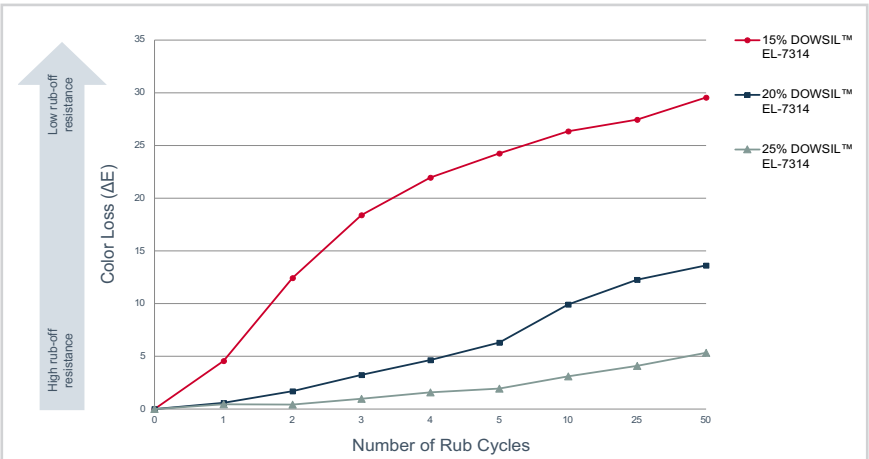

Fig. 5 Color rub-off resistance of a mascara coated on a skin-mimicking substrate after friction cycles on a felt band (Colorimeter)

3. Silicones are permeable: True!

Silicones do not interfere with the breathability of the skin and scalp as they are permeable to water vapor and oxygen. Therefore, they are non-occlusive materials, unless long chain occlusive alkyl groups **(Figure 6)** are grafted to provide skin moisturization benefits [37], [38].

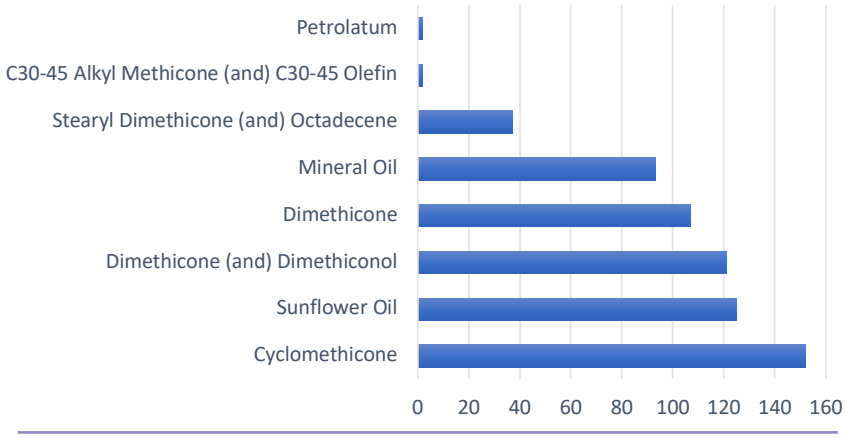

Fig. 6 *in-vitro* permeability of artificial skin (collagen) treated with neat materials (Payne-cup test)

Conclusion

Silicones have a long-standing history of safe use in personal care and consumer product applications because they allow existing materials to work more efficiently with longer-lasting performance. They have a large number of unique, long-lasting benefits in personal care applications, and can contribute to a more sustainable future. They fuel our imaginations and make new products possible. In a society that runs on performance and strives for sustainability, silicones are an invaluable and unique source of inspiration.

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Probiotic-derived Ingredient for a New Era in Skin Harmony

M. G. Bruno, S. Zanzottera

abstract

Modern cosmetics is demanding of ingredients able to positively interact with skin ecosystem in which billions of microorganisms live and where the equilibrium of protective and pathogens should be maintained. The beauty industry is moving forward to find the way to incorporate in cosmetics recipes probiotics, prebiotics or probiotic derived ingredients, well known in food supplement market.

The present paper aims at demonstrating the efficacy of a specific probiotic-derived ingredient able to strengthen skin barrier and its natural defenses promoting skin ecosystem well-being by preventing pathogens colonization.

Introduction

The skin is exposed to various endogenous and exogenous factors that may affect the skin barrier compromising its function at physical, mechanical and microbial levels. All the factors to which the skin is exposed are also called skin Exposome and the impact can lead to different skin conditions such as localized irritation or inflammation, which can cause long-term skin sensitization.

Recent study has shown the clear relation between healthy skin barrier and the correct balance in bacteria diversity, a disruption of the correct equilibrium in skin microbiota abundance may contribute also to skin barrier dysfunction [1].

A compromised skin barrier facilitates the penetration of irritants and allergens as well as microorganisms, this can lead to an imbalance condition also called dysbiosis which has often been found in some inflammatory skin diseases such as AD, psoriasis, rosacea and acne [2].

Other studies propose that in healthy skin the microbiota creates the perfect protective environment also related with correct protective immune responses and that skin harmony disruption could generates an inflammatory environment change the skin microbiota composition leading to the suppression of its protective mechanism, for this reason it is essential to have a correct cosmetic approach to preserve ski microbiota well-being [3,4].

Lactobacilli and *bifidobacteria* are the most common genera of probiotics recognized as human commensal bacteria and have been intensively reported for the treatment or prevention of gastrointestinal disorders. However, emerging clinical studies suggest that numerous strains of probiotic have great potentials beyond gut well-being, including skin ecosystem health. Increasing demand for natural formulations for skin care in the market indicate that there is an emerging new potential for probiotics in dermatology [5].

Probiotic cosmetic products are useful to all skin types and can help reduce acne, rosacea, eczema, and chronic inflammation. Growing awareness about probiotic as a beneficial element and concerns regarding skin problems, such as acne, damaged skin, breakouts, eczema, rosacea flares, and psoriasis, is the key factor driving the market growth [6].

The cosmetic market is experiencing a great revolution as regards microorganisms, considering both the latter as a target and their potential topical applications. More and more products containing pre-pro and postbiotics have been launched which claim to rebalance the skin's microbiota. [6] Along with the growing quantity of products, confusion about the ingredients used for the treatment of the microbiota and their classification also grows. The safest way to insert microorganisms as real ingredients is to make them inactivated and therefore more stable within a cosmetic formula [7].

Probiotic-derived are currently classified as 'postbiotic' and maintain structural integrity by preserving cells membrane. This allows to have an interaction comparable to probiotics and to guarantee some benefits associated with live microorganisms such as strengthen skin barrier and its natural defenses [8].

Methodology:

ROELMI HPC, starting from its deep knowledge of probiotics focusing on production of different proprietary probiotic strains and pure postbiotics, has developed different approaches to interact with localized microbiomes. First, by investigating specific interactions of probiotics for nutraceutical applications and second by exploring cutting-edge technologies for a new era of cosmetics ingredients applications on microbiota [9].

About probiotics, with a strong basis because of more on more than 10 years' experience in bio-fermentation technology, every investigated strain has shown physiological peculiarity *in-vivo*, allowing a precise targeting of the various body axis by using different bacteria. Specific strains from *Lactobacilli* and *Bifidobacteria* genera have been selected to modulate the gut-skin axis: taken as food supplement, they have shown a decrease of skin inflammation and consequently an increase of skin beauty [10,11].

As a step forward, **ROELMI HPC** moved to a different market, from nutraceutical to cosmetics, designing specific ingredients targeting the skin ecosystem. First by developing ingredients aiming to rebalance the skin microbiota affected by external stresses like air pollution or salty/chlorinated water, then by usingin activated probiotics thanks to their defense-boosting effect and molecular biomimetism properties [12].

The development of no viable probiotics has been standardized thanks to a particular gentle-heat technology that "inactivates" them after bacterial fermentation. By means of this approach, microorganisms are no longer living cells making them unable to metabolize and reproduce, and can be used as cosmetic ingredients [13]. In fact, they still maintain their mimetic effect on the skin immune system, since they do not lose their cell shape once inactivated, allowing the creation of a cross-talks communication interface with skin cells and the microorganisms that live in symbiosis with it. It means that the body is able to recognize them as bacteria, as cells are not destroyed like in lysate ingredients, so skin natural defense are reactivated [14].

Focus on a new probiotic-derived active ingredient for skin microbiota care

Focusing on biotechnology applied to cosmetic market, ROELMI HPC has enlarged its biotech portfolio with the development of EquiBiotics LRh, a probiotic-derived ingredient obtained by inactivated *L. rhamnosus* LRH020.

Targeting skin microbiota well-being, EquiBiotics LRh represents a revolutionary approach to beauty routine in which the key is to promote a balanced ecosystem while preserving or restoring the natural harmony between skin barrier and its microbiota. It supports skin microbiota ecosystem through a triple mechanism of action:

1. Molecular biomimetism: potential recognition thanks the preservation of bacteria integral structure by pursuing cross-talks specific pathways to alive probiotics
2. Prevention of pathogens colonization: by counteracting pathogens invasion through the quicker settlement and physical occupation of adhesion sites
3. "Prebiotic" effect and modulation of pathogen growth: inactivated lactobacilli could be a metabolic substrate for other microorganisms by rebalancing the resident microbiota community through the promotion of commensal bacteria and avoiding pathogens aggressions [14].

Efficacy dossier

Modulation of inflammatory status

In-vitro evaluation in presence of an inflammation agent (SDS 0.05 mg/ml). The activity was measured by TNF-alpha dosage and compared to negative control (cells without any stress condition) and to alive probiotics. Results demonstrated that, in comparison to probiotic strains, EquiBiotics LRh comparably modulates the release of TNF-α. The inflammation modulation is linked to the structural integrity, which is preserved during the biotech process. This allows EquiBiotics LRh to modulate specific inflammation responses thanks to its molecular biomimetism mechanism of action [15] **(Figure 1)**.

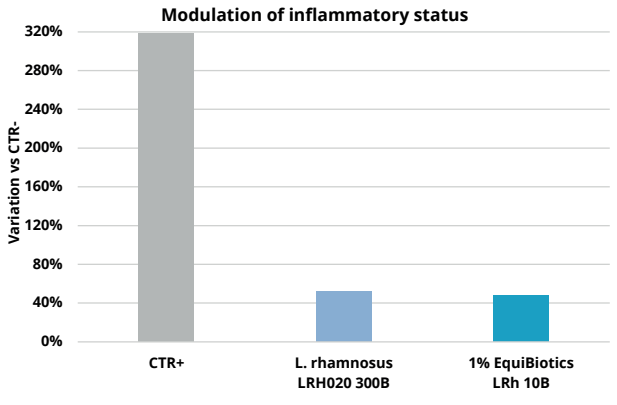

Fig. 1 Modulation of inflammatory status

Prevention of pathogens colonization

In-vitro evaluation of the bacteriostatic activity against *C. acnes* (ATCC 11827), a gram+ commensal bacteria, identified as etiological agent responsible for cutaneous distresses, like acne [16]. Parameters are expressed in log CFU/ml and were evaluated at T0, after 8 hours (T8) and 24 hours (T24). Positive control (CTR+) shows the culture medium with the ad-

dition of 10^5 CFU/ml of *C. acnes* as a title. EquiBiotics LRh, at different dosages %, shows a modulation of pathogen growth, promoting the skin microbiota equilibrium (data not shown).

Prevention of pathogens colonization
(co-aggregation study)

One of the most interesting activities of probiotics is to counteract the pathogens growth by forming aggregates with them. This mechanism is defined as co-aggregation and this property is also maintained by tyndallized probiotics [17]. The conducted study shows how EquiBiotics LRh co-aggregates with *Escherichia coli* and *Candida albicans* (data not shown).

«Prebiotic» effect

In-vitro study carried out on probiotic cultures added in several petri-dish at different prebiotics concentration (at 0.16 mg/mL of Glucose and EquiBiotics LRh). After 24h at 37°C, growth has been measured by count. Results demonstrated that EquiBiotics LRh is able to exert a "prebiotic" effect on probiotic strains, promoting growth as efficiently as glucose at different concentrations (data not shown).

Reduction of the SLS-induced redness and improvement of skin barrier

Placebo-controlled study enrolling 20 healthy female subjects. Skin redness was evaluated 24hours after a SLS patch application (T0+24H), after the measurement placebo and active creams started to be used daily by volunteers for 14 days (T14). After the long-term treatment, skin redness was evaluated after 24H of SLS patch application (T14+24H) and compared to placebo. At the end of the treatment, 1% EquiBiotics LRh cream resulted statistically significant and effective in decreasing the SLS-induced skin redness by -17.0%, thanks to a strengthened skin barrier.

Furthermore, product efficacy in improving skin barrier conditions was evaluated before and after 14 days of product use on intact skin (not SLS-treated). After 14 days, 1% EquiBiotics LRh treatment shows a statistically significant decrease of TEWL by -12.6% (data not shown) [18,19] **(Figure 2)**.

Reduction of the UV-induced redness

A placebo-controlled study carried out on 20 female subjects with skin phototype I, II or III (according to Fitzpatrick classification), average age 55 years old. Products efficacy was assessed by means of a short-term test for the instrumental evaluation of skin redness (a* parameter). The evaluation was performed before (T-1), after the induction of damage (T0) and then 1 and 2hours (T1h, T2h,) after products application in the 4 treated (2 areas for each product) and 2 untreated areas. The UV induced redness of the skin was evaluated by means of a spectrophotometer/colorimeter CM-700D (Konica Minolta). 1% EquiBiotics LRh demonstrated a decrease of skin redness linked to UV exposure up to 11% after 2 hours of active cream application **(Figure 2)**.

Reduction of skin aging signs

A placebo-controlled study was carried out on 20 female subjects clinically showing mild to moderate skin aging signs, average age 55 years old. The study duration was 28 days and products efficacy was assessed by means of a long-

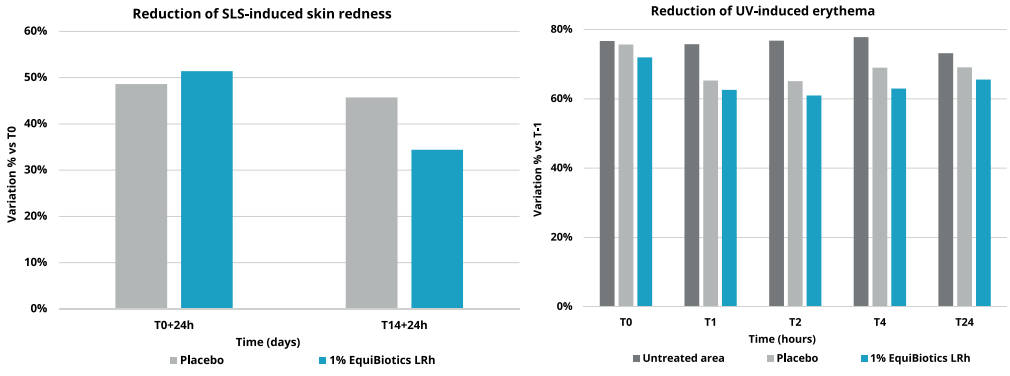

Fig. 2 Modulation of SLS-induced and UV-induced erythema

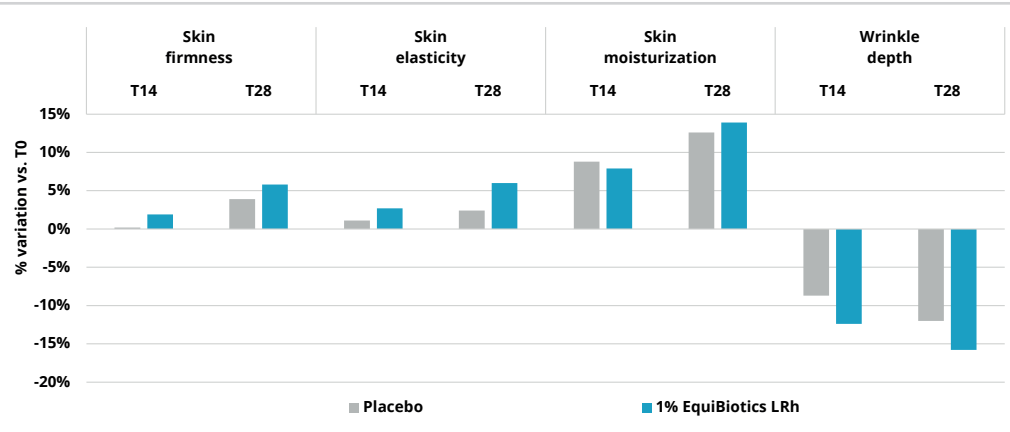

Fig. 3 Improvement of skin profilometry

term test on skin moisturization, skin elasticity (R2 parameter), skin firmness (R0 parameter) and wrinkle depth after 14 and 28 days of products use. [20] Material: Corneometer® CM 825 (Courage+Khazaka, electronic GmbH). As reported in **Figure 3**, results demonstrated:

- An increase of skin moisturization up to 7.9% and 13.9% after 14 and 28 days respectively.
- An increase of skin elasticity up to 2.7% and 6.0% after 14 and 28 days respectively.
- A decrease of R0 parameter (related to an increase of skin firmness) by -1.9% and -5.8% after 14 and 28 days respectively
- A decrease of wrinkle depth parameter respectively by 12.4% at T14 and by 15.8% at T28

Conclusions

The recent discovery of the existence of the ecosystem on the superficial layer of the skin is opening a series of studies on skin microbiota that will allow future developments in personal care field. The work provides preliminary evidences of the beneficial effects linked to the topical applications of *inactivated lactobacilli*. The ingredient, developed through biotechnology, could be therefore considered a step forward in the research of novel ingredients able to actively interact with skin microbiota. The company continues to expand research on bio-balancers that are molecules, which can preserve finished cosmetic formulas with a low impact effect on skin microbiota equilibrium.

The active product is exclusive distributed in Germany by S.GOLDMANN GMBH & CO.

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Rhamnolipid: an Eco- and Skin-friendly Alternative to Synthetic Surfactant

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abstract

The search for innovative and sustainable products that are less damaging to the skin is a matter of foremost importance in the cosmetics area. Chemical surfactants are widely used in cosmetic formulations, however, they have harmful effects, such as allergic reactions and skin irritations, therefore, it is evident that chemical surfactants need to be replaced by more sustainable compounds that present fewer or no negative effect on skin health. Biosurfactants have shown great potential, presenting advantages such as biodegradability, low toxicity, skin compatibility, increased protection and moisturizing effects. Rhamnolipids (RLs) are biosurfactants produced by some bacteria, mainly *Pseudomonas aeruginosa*. Because of the presence of hydrophilic and hydrophobic groups in the same molecule, RLs present interesting emulsifying and surfactant properties, making them a suitable alternative to chemical surfactants in cosmetic formulations. In the current study, the properties of the biosurfactant produced by Apoena Biotech were investigated through surface tension tests, CMC, foam formation and stability, antioxidant potential and makeup removal. It was found that RL is a potential substitute or co-surfactant for chemical surfactants. In addition, its antioxidant activity makes it a multifunctional active that can provide benefits to the skin, besides its surfactant's properties.

Introduction

Rhamnolipids (RLs) are biosurfactants produced by some kinds of bacteria, mainly *P. aeruginosa* and, according to their structure are classified as RL1: mono-rhamno-di-lipid, RL2: mono-rhamno-mono-lipid, RL3: di- rhamno-di-lipid and RL4: di-rhamno-mono-lipid [1]. There is also a variety of fatty acids chain lengths (C8 to C14), different degrees of unsaturation and presence of branches in the rhamnose moiety [2]. Although RL1 and RL3 are the main products of *P. aeruginosa*, RL2 and RL4 are also found and considered atypical and uncommon RLs [3].

Several factors relate to the variability of the types of RLs, such as the strain used, substrate variation, process parameters, among others [4], and this variability can affect the surfactant properties. For example, while an additional ring of L-rhamnose confers greater hydrophilicity to the RL, additional carbons to the fatty acid chain or a greater number of unsaturations increase its hydrophobicity.

The presence of hydrophilic and hydrophobic groups in the same molecule gives RLs interesting emulsifying and surfactant properties, making them a suitable candidate to be applied in cosmetic formulations as an alternative to anionic surfactants, such as sodium lauryl ether sulfate, sodium lauryl sulfate, etc. In addition to the advantages presented over synthetic surfactants such as decreasing surface tension with lower concentrations, they are also functional under extreme temperature conditions, pH, salinity. They do not permanently pollute the environment, and show antimicrobial activity [5].

The application of biosurfactants follows the global trend of the sulfate-free appeal and maintains the properties of less aggressive cleaning surfactants [6]. Another application possibility is its association with other chemical surfactants, allowing a reduction to the proportion used while maintaining the product's properties. This study demonstrates the results obtained with the RL produced by Apoena Biotech, which can be used in make-up remover formulations as a surfactant with a soothing effect on the skin.

Materials and methods

Ultrahigh performance liquid chromatography–tandem mass spectrometry Analysis (UHPLC-MS/MS)

Samples (2 µL) were injected and analyzed using an ultra-high-efficiency liquid chromatograph (Shimadzu, Nexera X2, Japan) coupled to an Impact II high resolution mass spectrometer (Bruker Daltonics Corp., Germany) of Q-TOF geometry, equipped with an electrospray ionization source (ESI). The instrument was calibrated using a sodium formiate solution (10 mmol L^{-1}). The ionization source was operated in negative ionization mode, and set to 3000 V, with a potential end of the plate at -500 V. Drying gas parameters were set to 8 L min^{-1} at 200°C with nebulization gas pressure of 4 bar. Data were obtained in the range of m/z 50 to 1200 with an acquisition rate of 10 Hz. Ions were selected for fragmentation using Auto MS/MS mode (cycle time: 3.0 sec).

The collision energy was set to 15-40 eV. Data was acquired by Hystar Application version 3.2 and Otof Control software (Bruker Daltonics Corp., Germany).

Chromatographic separation was achieved with a Bruker Solo C18 column (2.0 µm, 100 mm x 2.1 mm); the column temperature was set at 40°C. With a flow of 0.30 mL min^{-1}. The mobile phase was comprised of phase A (water, 0.1% formic acid) and phase B (methanol, 0.1% formic acid). The mobile phase gradient started with 50% B, reaching 80% B in 7 min; 7-15min, 80% B; 15-20 min, 98%B; 20-22 min, 50% B; maintaining this condition for up to 28 min.

Evaluation of foam formation and stability

The foam formation evaluation assay was adapted from the Ross-Miles Test [7]. The test was carried out by comparing different concentration dispersions of the surfactants lauryl glycoside (LG), sodium lauryl sulfate (SLS) and RLs. 10mL of each sample were pipetted into each flask and then vortexed for 1 minute. Then, after agitation, the foam height was measured and noted at times of 5, 30 and 60 minutes. Apart from the pure surfactant solutions, the effect of adding 0.5% PCA-Na was also analyzed.

Measurement of surface tension and CMC determination

In order to verify the ability of RL to reduce the surface tension of water, surface tension properties were measured using cell-free broth at 25ºC, according to the De Nöuy ring method [8], using a Krüss K12 tensiometer. RLs samples with different pH, temperature and salinity values were used to compare their stability under different conditions. Measuring surface tension of serially diluted biosurfactant solution, the CMC was determined by plotting the surface tension versus concentration of biosurfactant in the solution. The determination of CMC was performed by several dilutions of crude RL.

Antioxidant Potential

For this study, human dermal fibroblast cells were cultivated, maintained in culture with Dulbecco's Modified Eagle's Medium (DMEM) with addition of supplements, in a hatchery at 37°C and 5% CO_2, and manipulated inside a laminar flow booth. The dermal cells were distributed into 96-well plates. The Samples at 1% concentration were applied to the cell culture, 100uL per well, followed by a one-hour incubation period at 37°C and 5% CO_2. After a washing step, the pres-

ence of free radicals was analyzed using the CM-H2DCFDA probe with excitation wavelength of 495nm and emission of 525nm [9]. Trolox reagent was used as a positive control. The results were evaluated using the Graphpad Prism software. The control group was normalized to 100% and the percentage of free radicals in the sample and in the positive control was calculated in relation to the control. Statistical analysis for comparison between groups was performed with One-way Anova and the level of statistical significance considered was less than 0.05.

Evaluation of RLs as an active for make-up remover lotion

The effectiveness of makeup remover lotion formulations was determined by evaluating the ability to remove makeup, specifically a dark liquid foundation. Formulations using different surfactants, such as RL, SLS (anionic) and LG (non-ionic) were evaluated. Additionally, the formulation without surfactant and a commercial make-up remover, available on the market, were also evaluated.

Approximately 0.01g of a commercially obtained dark liquid foundation was applied homogeneously to the skin of the arm in an area of delimited size. An aliquot of 0.07g of makeup remover lotion was gently applied with the aid of a spatula over the foundation, and then the excess was removed with a cotton patch. 10 smooth strokes with the cotton were made and the result obtained was photographed. Then, another 0.07g of make-up remover lotion was applied and 10 more cotton strokes were made. The result obtained was photographed again.

Evaluation of foam formation and stability

Foam is an attribute often desired by consumers in cleaning preparations, even though it is not directly proportional to the cleaning power [13]. The ability of the RL to form foam was evaluated by measuring the height of foam (in centimeters) generated after 1, 5, 30 and 60 minutes of the foaming test. Samples of RLs at different concentrations formed a foam column lower than that observed with SLS or LG, however, the foam formed was more consistent and denser when compared to commercial surfactants.

Peak	RT (min)	Name	Molecular Formula	(%) Area
1	3.84	Rha-C8	$C_{14}H_{26}O_7$	0.2
2	5.99	Rha-C10	$C_{16}H_{30}O_7$	0.6
3	8.46	Rha-C8-C8	$C_{22}H_{40}O_9$	0.2
4	10.39	**Rha-C10-C8 and-C8-C10***	**$C_{24}H_{44}O_9$**	**18.2**
5	12.26	Rha-C8-C12	$C_{26}H_{46}O_9$	3.0
6	13.67	**Rha-C10-C10**	**$C_{26}H_{48}O_9$**	**28.1**
7	17.24	**Rha-C10-C12:1**	**$C_{28}H_{50}O_9$**	**11.7**
8	17.61	Rha-C12:2-C10	$C_{28}H_{50}O_9$	0.7
9	19.49	Rha-C10-C14:1	$C_{30}H_{54}O_9$	0.5
10	19.80	Rha-C12-C12:1	$C_{30}H_{54}O_9$	0.3
11	20.41	Rha-C12-C12	$C_{30}H_{56}O_9$	0.1
12	10.09	Rha-Rha-C10-C8	$C_{30}H_{54}O_{13}$	3.3
13	10.20	**Rha-Rha-C8-C10**	**$C_{30}H_{54}O_{13}$**	**6.5**
14	11.99	Rha-Rha-C8-C12:1	$C_{32}H_{56}O_{13}$	0.4
15	13.26	**Rha-Rha-C10-C10**	**$C_{32}H_{60}O_{13}$**	**17.3**
16	16.56	Rha-Rha-C10-C12:1	$C_{34}H_{60}O_{13}$	4.1
17	18.38	Rha-Rha-C12-C10 and C10-C12*	$C_{34}H_{62}O_{13}$	4.3
18	19.21	Rha-Rha-C10-C14:1	$C_{36}H_{64}O_{13}$	0.3
19	19.54	Rha-Rha-C12-C12:1	$C_{36}H_{64}O_{13}$	0.2
20	20.13	Rha-Rha-C12-C12	$C_{36}H_{66}O_{13}$	0.1

RT: retention time in minutes; **Rha:** rhamnose moiety; The designation Cx:1 means a fatty acid chain with chain length of X and with one unsaturated bond (–2H).
*Peak contains both isomers and, the exact order of the fatty acid chains has not been determined.

Table 1: Different rhamnolipid structures detected using UHPLC-MS/MS and respective relative areas (%).

Results

Structural elucidation of RLs

UHPLC-MS/MS analysis revealed the co-production of at least twenty different RLs. **Table 1** shows the ratio of extracted ion chromatogram (EIC) peak area (% area) attributed to each rhamnolipid (RL) using mass accuracy and mass spectral fragmentation patterns and through comparison with the literature [10,11,12]. The mixture analyzed showed mono- and di-RLs, mainly from RL1 and RL3 classification. The major RLs identified were Rha-C10-C10 moiety (28.1%), followed by the Rha-C10-C8/C8-C10 (18.2%), Rha-Rha-C10-C10 (17.3%) and, Rha-C10-C12:1 (11.7%). Many other listed RL were detected in small amounts (6.5-3.3%) or trace amounts.

Another aspect evaluated was the resistance of the foam formed with the addition of a commonly used moisturizing ingredient that could interfere with foam formation. Comparing the resistance of RL foam and LG against the addition of PCA-Na, it was possible to observe that the foam column formed by RL was higher than the column formed by LG **(Figure 1)**.

Considering that the product is a sustainable biosurfactant which is more compatible to the skin compared to the tested surfactants, the RL can be used as a substitute that promotes more resistant foam formation. Or it can be used as a co-surfactant providing a reduction in both skin irritation and the environmental impact caused by typical commercial surfactants.

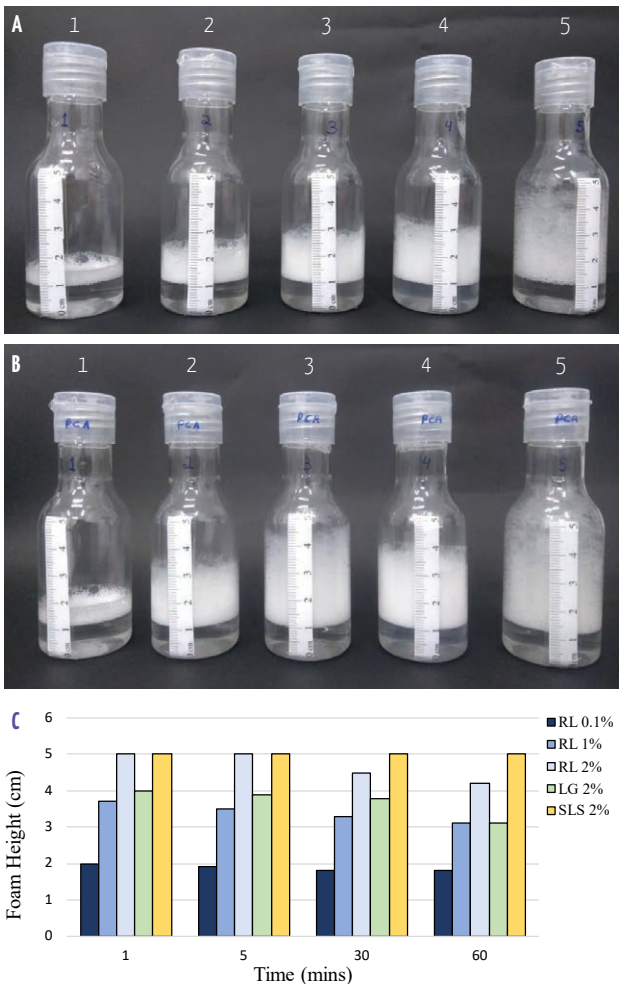

Fig. 1 RL foaming test compared to commercial surfactants **(A)** Foam formation and stability 30 min after shaking and before adding PCA-NA. 1-RL 0,1%, 2-RL 1%, 3-RL 2%; 4-LG 2%, 5-SLS 2%. **(B)** Foam formation and stability 30 min after shaking and after adding 24 drops of PCA-NA 5%. **(C)**. Stability and foaming after adding 24 drops of PCA-NA 5% at different times. RL: rhamnolipid, SLS: sodium lauryl sulfate, LG: lauryl glycoside.

When combined with commercial surfactants, RL proved to be an efficient additive, demonstrating an excellent synergism with SLS and LG. Mixtures containing 0.1% SLS or LG, when added to 1% RL, showed foaming efficacy like that observed in 2% SLS or LG solutions **(Figure 2)**.

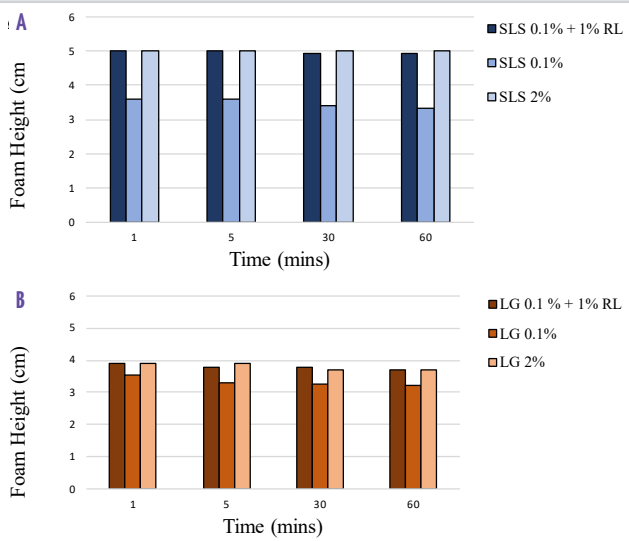

Fig. 2 RL foaming test associated with commercial surfactants. RL, rhamnolipid; Sodium lauryl sulfate, SLS; LG, lauryl glycoside. **(A)** RL compared to SLS and **(B)** RL compared to LG.

and pH, there was no change in the surfactant properties, as the capacity of the biosurfactant to reduce the surface tension of water was preserved in all conditions tested.

Comparing the ability to reduce the surface tension of RL against the SLS at the same concentrations, RL reported better surfactant activity. Moreover, by diluting the crude RL extract to a concentration of 1%, only a small loss of activity occurs **(Figure 3)**.

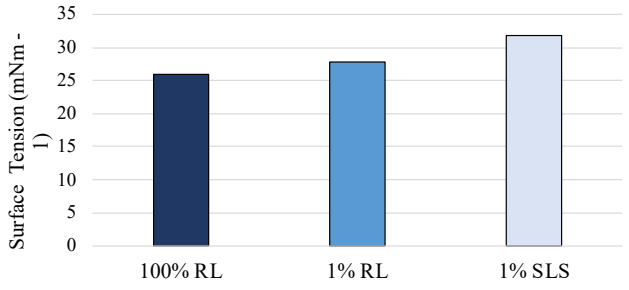

Fig. 3 Evaluation of RL's ability to reduce surface tension compared to sodium lauryl sulfate's (SLS).

Measurement of surface tension and CMC determination

Assessing the ability to reduce the surface tension of water, which has a value of 72.75 mN/m-1 at 20°C [14] it is visible that the RL presented a good surfactant activity, even in samples that were submitted to different pH, temperature and salinity values, it demonstrated stability under different conditions **(Table 2)**. The RL remained stable even after 60 minutes of heating at 100°C. With regards to salinity

Peak	Time of exposion at 100°C	[NaCl] Salinity	surface tension (mN/m^{-1})
5	-	-	26,5 ± 0,00
7	-	-	26 ± 0,12
9	-	-	26,2 ± 0,00
-	15 minutes	-	**26,2 ± 0,06**
-	30 minutes	-	26,2 ± 0,00
-	60 minutes	-	**26,3 ± 0,00**
-	-	12% (0,12 mol/L)	**26,45 ± 0,00**
-	-	6% (0,6 mol/L)	26,5 ± 0,00
control	control	control	25,9 ± 0,00

Table 2: Evaluation of RL's ability to reduce surface tension under different conditions.

The CMC is an important parameter during the evaluation of biosurfactant's activity. The surface tension of a surfactant reaches the lowest value at its CMC. Above this concentration, no further effect on surface activity can be observed. Compared to other surfactants such as Sodium dodecyl sulfate which has a CMC of 2,38 g/L [15] the RL produced by our group has a much lower CMC value, around 0,2 g/L (1% RL) **(Figure 4)**.

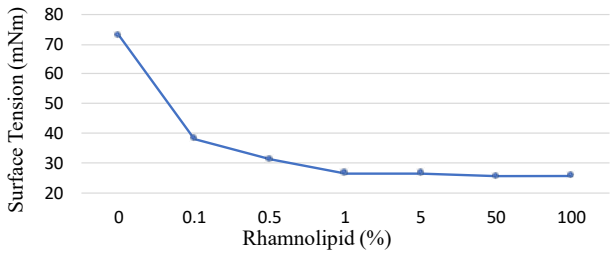

Fig. 4 CMC determination of rhamnolipid.

Antioxidant Potential

The antioxidant potential of the sample was evaluated and compared to the control group through free radical analysis. **Figure 5** demonstrates the percent reduction caused by RL against that of the positive control (TROLOX) which showed a reduction of 92.9% (±0.91) in the production of free radicals while RLs showed a reduction of 91.4% (±0.63) 63) **(Figure 5)**.

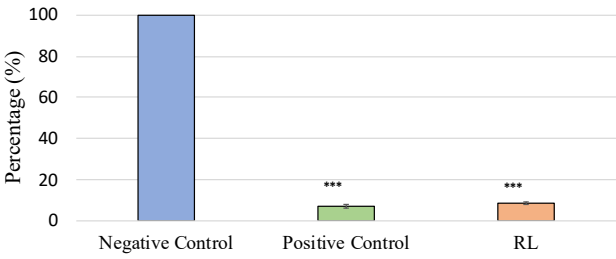

Fig. 5 Percentage of free radical production (***p<0.001).

Evaluation of RLs as active for make-up remover lotion.

By visually comparing the foundation removal using different surfactants, it can be seen that the formulation containing RL (4%) not only had a similar performance to the formulation using LG (7.5%), but was also able to remove makeup better when compared to the commercial make-up remover **(Figure 6)**, while the placebo formulation (without surfactant) was unable to significantly remove makeup when compared to formulations with surfactants. The formulation with SLS demonstrated satisfactory performance in removing makeup **(Figure 6)**.

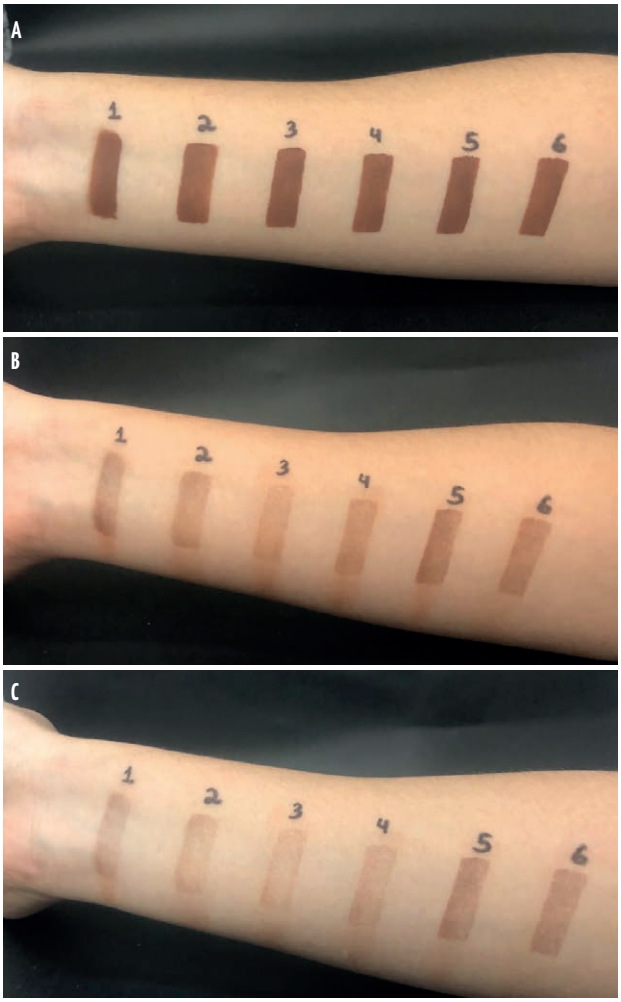

Fig. 6 Visual assessment of RLs for make-up remover lotion1 1 - Rhamnolipid (2%), 2 - Rhamnolipid (4%), 3 - Sodium Lauryl Sulphate (12.5%), 4 - Lauryl Polyglucoside (7.5%), 5 - Placebo, 6 - Commercial make-up remover. **(A)** Foundation applied to the skin before using make-up remover. **(B)** Remaining foundation on the skin after an application of make-up remover formulations. **(C)** Remaining foundation on the skin after two applications of make-up remover formulations.

Discussion

A recent study evaluated the effect of SLS, a surfactant widely used in cosmetic products, on skin physiology and microbiota. The results showed that, in addition to damaging the skin barrier, the use of this surfactant both reduced the hydration of the *stratum corneum* and caused an imbalance in the skin microbiota [16].

Biosurfactants fulfill all environmental and physicochemical requirements to replace synthetic surfactants. They are secondary metabolic produced by microorganisms, considered biodegradable and of low toxicity [17]. In addition, biosurfactants can be used as an alternative to conventional antimicrobial agents as they inhibit some microorganisms that are harmful to the skin such as acne-causing bacteria.

The release of fatty acids, present in the biosurfactant structure, helps maintain the skin's acidic pH. This encourages the

adherence of the resident microbiota and prevents the growth of harmful microorganisms, maintaining a healthy skin ecosystem. In addition, these fatty acids can act as antioxidants, preventing UV-induced free radical skin damage [18].

Corroborating literature data, the RLs produced by Apoena Biotech demonstrated functionality under extreme conditions of temperature, pH, and salinity.

In this work, it was also possible to observe that, compared to the commercial surfactants tested, the RLs presented a slightly lower foam formation, although the foam is more resistant and even surpassed the efficiency of lauryl glycoside when the addition of PCA-Na was performed. RL was extremely efficient when combined with commercial surfactants. Its addition boosted foam formation even in small concentrations of SLS or LG surfactants. RL also proved to be efficient in removing makeup with a similar effect, or even greater efficiency, when compared to surfactants available on the market.

Conclusion

From the results obtained, it can be stated that RLs are a safe and effective potential substitute, or co-surfactant, for chemical surfactants, with the advantages of being sustainable and less damaging than the conventional ones available in the market. In addition, there is a great beneficial difference between the biosurfactant produced by our group versus chemical surfactants. Its antioxidant activity makes it a multifunctional active, which can bring benefits to the skin, in addition to its surfactant properties.

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Innovation Trends News

Imaging and Visualization: A Gamechanger in Claim Substantiation

R. Campiche, M. Gempeler

abstract

Visualizing the effects of skin treatment is a key aspect of claim substantiation and the successful promotion of skin care applications. To create visuals, we have employed innovative image acquisition and image processing technologies in various ways. For example, to visualize the effects of anti-aging skin care applications we have used wrinkle segmentation on high resolution images. And with our award-winning facial color mapping technology, we can readily show differences in skin hydration and detect areas of dry and well hydrated skin both in 2D and 3D. Recently, we extended this approach to map significance and relevance as well. In this article, we present an overview of the main imaging and visualization procedures we use to substantiate claims when promoting cosmetic actives.

Introduction

As the saying 'A picture is worth a thousand words' points out, it is often easier to express something with an image or picture, especially if it is complex. Humans are visual creatures who rely heavily on visual cues in their behavior. People capture more information looking at an image than they do reading text, and the human brain processes visuals faster. Images work well with content that is difficult to explain and requires many words to convey its message. As scientific content is often perceived as difficult to understand for non-scientists or people who are not familiar with the topic, the use of visuals offers considerable potential.

Displaying scientific content in an easy-to-understand visual, infographic, or image, is essential when communicating messages to non-technical people outside their field of expertise. This is especially true at the interface between science, marketing, and sales. In this context, scientists must make sure that marketing and sales professionals understand their message, and these professionals themselves then need to translate scientific content into a less technical message for their customers and end consumers.

Modern, hectic lifestyles support the trend for visualization because when messages need to be delivered briefly and quickly, pictures are ideal. When it comes to beauty, as the outermost layer of the human body, skin offers great opportunities for visual assessment and provides a surface for image processing and augmentation. The technical possibilities today are much more advanced than they were a few years ago too. To take advantage of the visual opportunities which skin provides, and the cosmetics industry asks for, we have developed imaging and visualization technologies to translate complex scientific content into easy-to-understand visuals. In this article, we present an overview of our current facial color mapping approaches and imaging technologies.

Image acquisition

Today's skin care products need to deliver on their promises regarding a healthy and youthful skin appearance and demonstrate their ability to ameliorate specific concerns

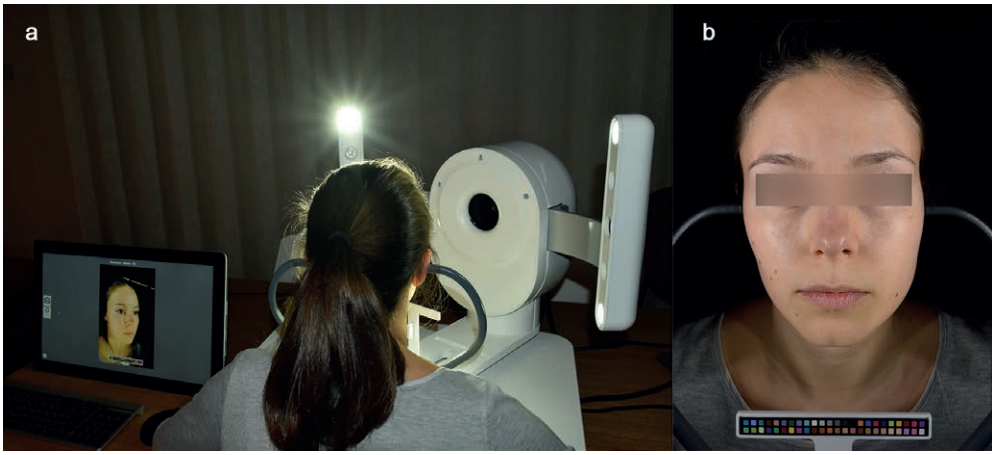

Fig. 1 High resolution image acquisition using the ColorFace® device. A) Images are obtained in various lighting modes from a front and 45° angle, and **B)** in the presence of a 48-patch color chart [1].

such as wrinkles, hydration, and skin tone. We employ state-of-the-art imaging devices to acquire high resolution images in various lighting modes. To this end, we have found that it is indispensable to use a 48-patch color chart on all images, to correct light and color variations. Once we have acquired and calibrated our images, we use image augmentation and color mapping technology to showcase the activity of our cosmetic actives *in vivo*, for optimal claim substantiation.

To achieve best-in-class image analysis, it is crucial to obtain high-quality, high-resolution facial images in various lighting modes. State-of-the-art image acquisition systems include the VISIA CR system series (Canfield Scientific, Parsippany, NJ, USA) and the ColorFace® system (Newtone Technologies, Lyon, France) with a built-in, 48-patch color chart **(Figure 1)** [1]. This color chart can also be applied to other imaging devices. It is essential to calibrate all images from a study and to correct them against minor color and lighting variations. Only by doing this, can we obtain objective and scientifically sound, image-based data.

Images can be acquired in 2D and 3D. One device used regularly is the Vectra M3 system from Canfield which produces high-quality, 3D images of the face **(Figure 2)**.

Fig. 2 High resolution image acquisition in 3D using the Vectra M3 system. *(Image source: www.canfieldsci.com)*

Continuous facial color mapping

We initially introduced facial color mapping to visualize cutaneous parameters, such as hydration, TEWL and skin surface pH [2]. We have continuously improved this technology,

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extending it to other parameters such as sebum measurements [3] and using it to display changes in the facial microbiome. In addition, as well as introducing facial maps to visualize changes in certain skin parameters, we have used them to highlight the significance and relevance of these parameters [4]. Most recently, we extended facial color mapping from single point measurements to expert grading, using a modified Griffith scale [5], so that we can map wrinkles at certain areas of the face [5]. Other scientists have published facial color maps displaying skin elasticity [6] and oxidative stress distribution in the skin [7]. This highlights how useful it is to visualize facial skin features in this way.

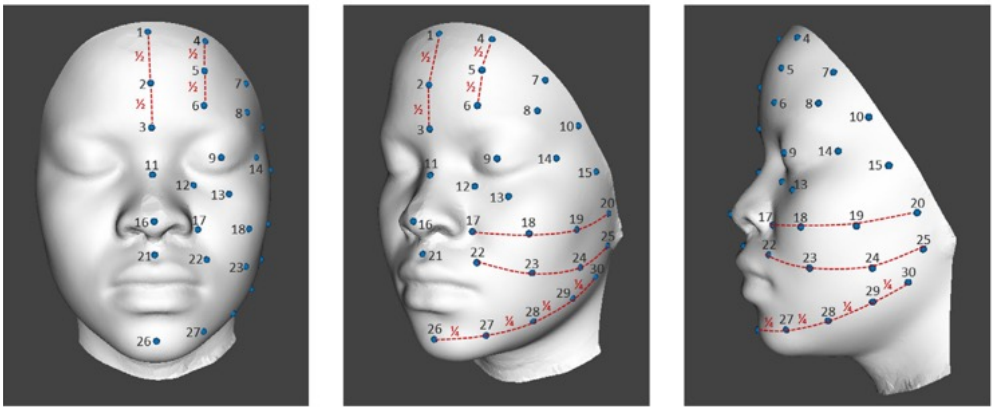

Fig. 3 **30 pre-defined measurement points across one side of the face [3].** They are used to create continuous facial color maps, e.g. for hydration, TEWL, skin surface pH, or sebum.

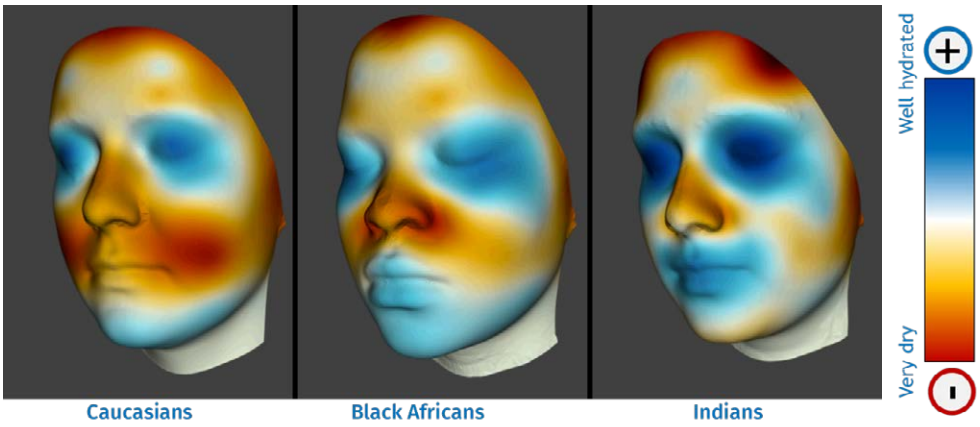

Fig. 4 **Continuous facial color map displaying facial hydration across cultures.** It is readily visible that in all three skin types, a predominantly dry skin area extends from the forehead to the nose and the cheeks, whereas mostly well hydrated areas are found around the mouth, the chin and the eyes.

To turn single point measurements into continuous facial color maps, we began by taking measurements at 30 clearly defined sites on one side of the face **(Figure 3)** [2].

From these 30 measurement points, we then drew continuous facial color maps by interpolating values between each point. For example, for skin capacitance (hydration) measurements taken with a Corneometer, we used a color gradient from blue to red to indicate the range from well hydrated to very dry skin **(Figure 4)**.

This color map has also been used to display improvements in skin hydration after treatment with a skin moisturizer such as *saccharide isomerate* (Trade name PENTAVITIN®) or an active such as niacinamide, by showing increased areas of blue and decreased areas of red.

More recently, we have extended our approach to display sebum content on the face. Here, we chose a single color gradient to show different sebum levels on the skin surface **(Figure 5)**. As the image here makes clear, we found that there was an increased sebum content in the area known as the T-zone, extending from the forehead, over the nose down to the chin, while the cheeks and the jawline showed less sebum **(Figure 5)**.

So far, we have shown how facial color maps illustrate the distribution of and changes in various skin parameters, but it is also possible to represent the statistical significance of these

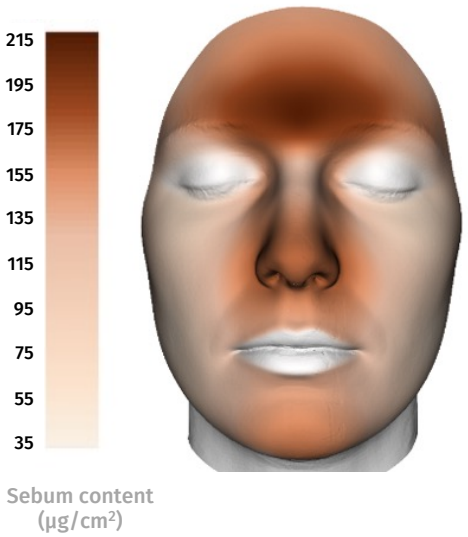

Fig. 5 **Continuous facial color map displaying sebum content.** Dark brown represents more sebum per cm² than light brown.

changes as a color map. For this purpose, changes between treatments or over time are calculated for all the facial sites where measurements are taken, and statistics generated based on these measurements. Again, a continuous facial color map, showing statistical significance as a color gradient, is created. **Figure 6** shows an example of how treatment with a moisturizer is significant (light blue to dark blue) or not (dark red to white to light blue).

We have also developed this approach further for skin tone. In this case, the color gradient is set to neutral for non-significant, and the blue and red color identifies significant values, respectively, from good to bad [4]. With this approach it is also possible to predict the direction of change, whereas in the continuous map in **Figure 6**, the direction of change is not visible.

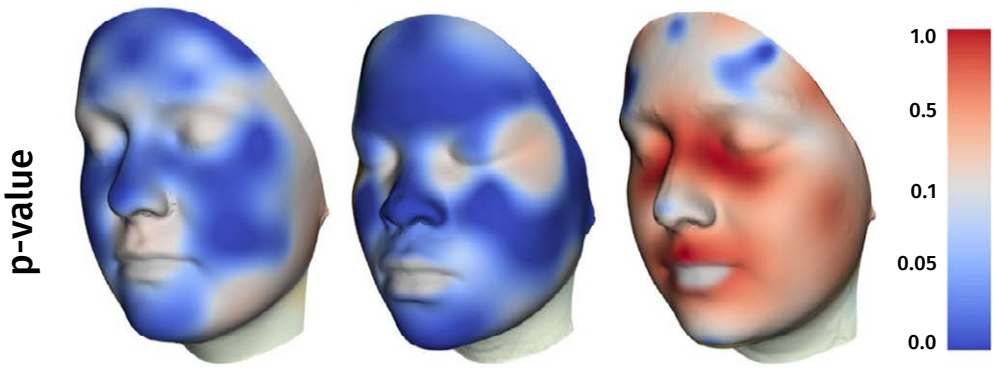

Fig. 6 Continuous p-value (significance) mapping [3]. The color gradient on the right defines significant color shades. In this example, a significant change was seen below p=0.05 (e.g. light to dark blue. Every p-value above 0.05 is displayed in light blue to white (between 0.05 to 0.1 showing a trend) and light red to dark red, meaning not significant.

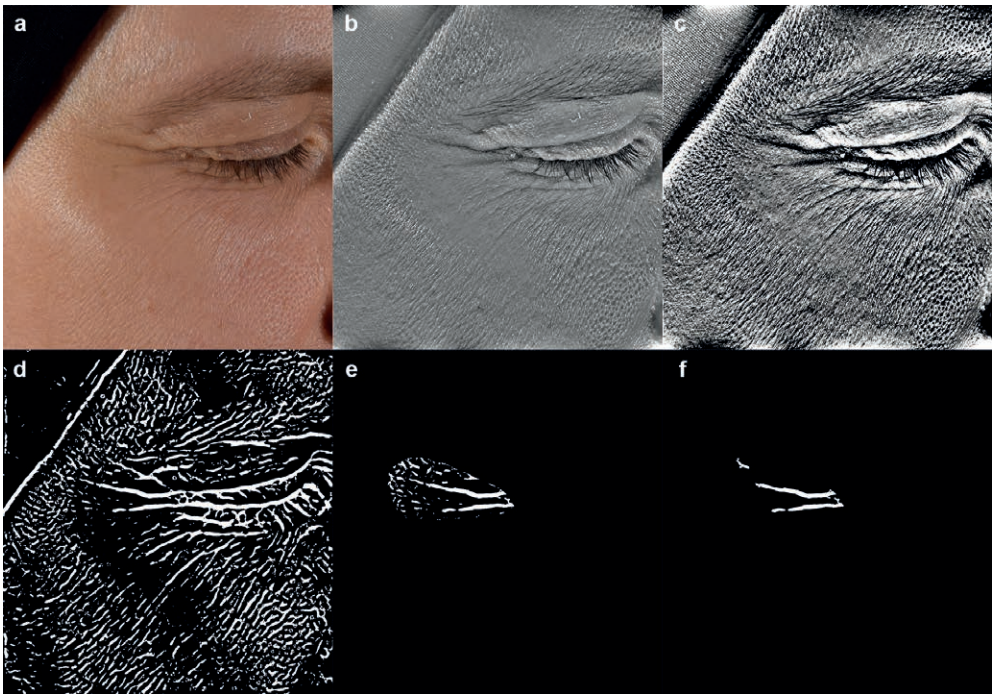

Fig. 7 Wrinkle segmentation. It starts from the original image **(A)**, where a specific grayscale is used **(B)** and shadings are removed **(C)**. After thresholding **(D)** and masking by the region of interest **(E)**, false positives are removed by mathematic morphology **(F)** to obtain the final segmentation [1].

Mapping wrinkles through segmentation

Wrinkles are a hallmark of facial aging and as an outcome, most anti-aging strategies are designed to target facial wrinkles, from fine lines to deep wrinkles. In the aging face, wrinkles are caused by structural changes within the dermis, such as degradation of extracellular matrix components like collagen or elastin [8], and mechanical changes such as facial movements and expression [9]. In view of this, there are compelling reasons for visualizing facial wrinkles and the effect of anti-aging treatments. However, in standard images, even those in high resolution, wrinkles are barely visible, unless they are big and deep, like the nasolabial folds or the marionette lines. For all other wrinkles, a wrinkle augmentation technique should be used. We use segmentation to visualize wrinkles and analyze their length, depth, area and volume [1].

Figure 7 shows the step by step process for segmenting wrinkles, through the example of crow's feet.

Facial expression wrinkles mostly appear on the forehead or on the crow's feet and are generally caused by frowning and smiling. Interestingly, genetically similar individuals like mothers and daughters show similar patterns when it comes to facial expression wrinkles [5]. This is highlighted here in **Figure 8**.

In a study comparing mothers and daughters, we found that lines that appeared on daughters' faces when they frowned or smiled, appeared in a similar pattern, but in the form of wrinkles, on their mothers' faces even when the latter's faces

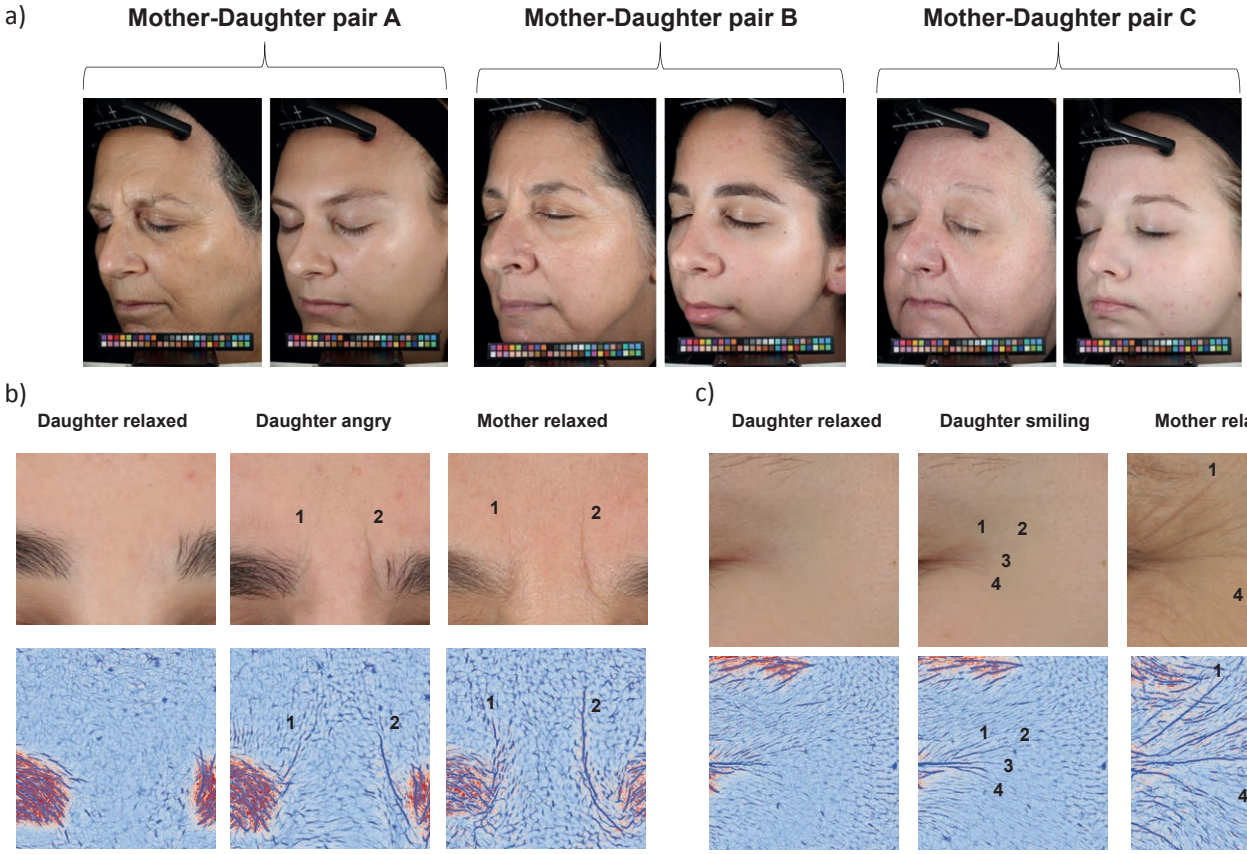

Fig. 8 **Resemblance of daughters and mothers.** **a)** Side view of biological mother – daughter pairs participating in the study. They clearly look alike. **b)** Frown lines on the glabella of a daughter's angry face look similar to these lines on her mother's relaxed face. Frown lines 1 and 2 form in the daughter when she pulls an angry face and are extended at the same place on her mother's relaxed face. The lower panel is an enhancement created to highlight the wrinkles present in the standard images of the upper panel. **c)** Crow's feet on the edge of the eye of the daughter's smiling face look similar to those on the mother's relaxed face. Crow's feet 1, 2, 3, and 4 form in the daughter when she smiles and are extended at the same place on the mother's relaxed face. The lower panel is an enhancement created to highlight the wrinkles present in the standard images of the upper panel [5].

were relaxed **(Figure 8)**. By enhancing wrinkle visibility by means of an augmentation method similar to the segmentation method shown in **Figure 7**, we can visualize this even more effectively **(Figure 8)**.

Summary

In this paper, we have reviewed the imaging technologies we have used to visualize the effects of skin care actives and applications more effectively. Complex data sets can be displayed in a customer friendly and easy-to-understand manner on images of either artificial or real faces. Various facial skin endpoints can be shown, such as hydration, wrinkles, sagging and sebum, in addition to measures such as TEWL, elasticity and the microbiome. Image augmentation and facial color maps can be of great help in translating scientific content into easy-to-understand claim substantiation messages for marketing or sales purposes.

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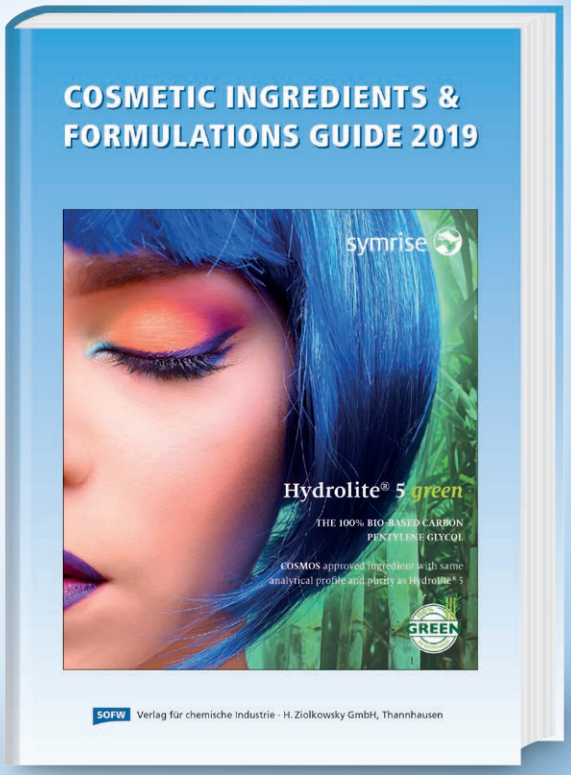

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Microbiological Quality Management for the Control of Quality Costs (Part 2)

J. Nussbaum

abstract

The definition and implementation of measures to ensure microbiological product stability, the success controls for the established measures, the detection of internal and external failures as well as their corrections cause costs, the so-called quality costs. Cosmetic companies are interested in minimizing these costs during the production of cosmetics.

The aim of this document is to present a concept for a possible cost-saving potential for microbiological expenses in the development and production of cosmetics without compromising the product safety.

Every cost-saving consideration is first preceded by an analysis of the failure potentials that could lead to a negative impact on the end product. In every process - whether in product planning, product development or manufacturing of cosmetics - a multitude of such potential failure opportunities can be identified, which are evaluated according to the probability that they will lead to a significant reduction in the quality of the end product. Corresponding protective measures have to be defined and implemented.

The next step is to consider the potential for saving testing costs and to implement cost-optimized measures. It is obvious that such optimization measures should be defined at the earliest when it can be demonstrated over a longer period of time that the entire process regarding quality planning, development and manufacturing leads to consistently good results with regard to microbiological purity and stability of the finished product. Optimization measures should be defined with a sense of proportion and evaluated for suitability by considering the entire process.

This article is a continuation of the article already published in the SOFW Journal September 2021"Microbiological Quality Management for the Control of Quality Costs (part 1)"

Introduction

The first part of the article has already considered the following aspects:

- Quality costs – General considerations
- Definition of failure costs according to DIN 55350 and their application to microbiological quality assurance
- Prevention costs
- Testing costs
- Failure costs / consequential failure costs
- Systematic avoidance of failure costs
- Limitation of failure costs (in case of unavoidable failures)

In the continuation, possible savings potentials will now be discussed and substantiated by a practical example.

5. Quality costs - potential savings

5.1 General considerations

With the goal of reducing quality costs as set in this paper, it is mainly about avoiding cost from failure and failure correction that may originate from microbiological failures. The second step is to determine the cost generated by the implemented measures. It is useful to sub-classify the costs into failure prevention costs, inspection costs, and failure correction costs.
In a further step, cost savings potential from failure prevention, inspection costs and application of cost-optimized measures are considered.

Optimized measures in terms of cost optimization can only be considered when proven that the entire quality planning, development and manufacturing processes leads to consistently good results over a longer an extended period of time, regarding microbiological purity and stability of the finished product.

Arbitrary reduction of preventive measures and the scope of testing is not conducive and can lead to fatal consequences. Properly thought-out and correctly defined processes that adapt to the settings, allow cost savings.

As shown with the practical example (see Table 1), a sense of proportion must be practiced by the savings on failure prevention measures and the inspection efforts. For example, employee-training serves to prevent failures and motivate hygienical work in the manufacturing plant, never consider economizing this measure.
The recommendation from the example described above, is to divide the manufacturing flow into critical and less critical process, and evaluate them in order to secure them accordingly.
It makes sense to regularly review existing processes and adapt them to the current circumstances. By redefining processes, several options arise through careful design and optimal planning of processes to avoid unnecessary steps.
Microbiological activities and hygiene are preventive measures. Furthermore, they must be as an effective system understood - i.e., effectiveness lies in the interaction of all measures together, so that it is hardly possible to prove the necessity of individual measures.
Consequently, it is also wrong to reduce testing efforts arbitrarily in such a way that problem identification at an early stage and trend tracking is no longer possible. Even after spending, a minimal effort on microbiological quality assurance over many years, and everything still „went well". A single major incident can mean the „end" for a company due to the recall of contaminated products and image loss. Rather, a person with experience on microbiological product safety based on the used system (integral view) should evaluate and systematically list the costs of microbiological and hygienic measures. The optimization potential can be only this way determined while maintaining to maximal the product safety.

5.2 Determinig saving potentials

The recommendation is to list and evaluate savings potentials based on defined process flows.

5.2.1 Optimization of testing costs / monitoring

5.2.1.1 Example from product development

a) Development
During the development phase of a cosmetic product, the stability assurance of the product is ensured by means of various microbiological tests.

Total viable count (TVC)
- Raw materials used
- Water used
- Lab sample product / intermediate product

Antimicrobial Effectiveness Test (AET)
- Fresh laboratory sample in the intended primary packaging
- Storage samples in the intended primary packaging
- TVC for In-Use samples, before and after use (min. 50 samples)
- TVC for market acceptance samples

b) Scale-up phase
- TVC for raw material + water qualities
- Assurance of water-based raw material pre-solutions (AET if necessary)
- Finished product from scale-up phase (TVC, AET)

c) Routine production
- Bulk / Intermediate (TVC)
- Finished product (TVC, spec. MO; AET)
- Market samples / complaints (TVC)

Savings:
How to minimize these expenses?
- *No minimization for new formulation developments.*
- *For minor product changes (e.g. change of color and fragrance, but process flow and the separation of water-based premixes remain the same):*
  - *Tests from **a** remain unchanged*
  - *Tests from **b** and **c** remain unchanged*
  - *Perform in **b** an AET of the finished product with a reduced spectrum of test microorganisms, consider the slowest microbial reduction rate from **a***
  - *Perform in **c** an AET with reduced spectrum of test microorganisms*

Caution: If the method of production change (e.g. conversion from boiler to continuous plant), it is essential to plan a new scale-up phase with all detailed tests.

5.2.1.2 Example from product development

Reception tests for microbiologically susceptible raw materials

a) Raw materials without delivery experience or with poor delivery quality)

The performed amount of tests should be according the specified sampling plan.

Take in account the requirements of ISO standard 17516 "microbial limits" (TVC and presence of spec. microorganisms) for testing and evaluation of results. Determine the expenses.
- What is the maximal content (%) of this raw material in the production portfolio? - Evaluate the formulation with the highest content of the raw material.
- How great is the risk for the finished product, if the raw material that does not comply with the specification is nevertheless processed?

Savings:
Allowing only reliable suppliers with goods that meet specifications contribute to reducing this expense. Note here that not all suppliers always check every batch sometimes may even supply a hazardous batch.

b) Raw materials with good supplying experience

Reduction to number X of test samples:
- Minimum 1 sample per batch or
- Interval testing (e.g. every 5th delivery) or
- Release via certificate (only possible after checking and comparing the testing method - see GMP 6.5.3).

Savings:
Are the savings potential of the approach used for suppliers with delivery experience larger than suppliers without or poor delivery experience?

What is the risk for the finished product, if timely detection of poor quality raw material does not occur?

Is the risk acceptable (quality and safety)?

5.2.1.3 Monitoring process water

Monitoring of quality of process water occurs usually at several points in the system: for example, quality at the intake point before and after the filter and disinfection unit, at the usage points for production, at the sampling points for cleaning procedures. The sampling points must be positioned in the system in such a way that contamination problems can be detected as early as possible (checks at the sampling points for production alone are not sufficient).

It is necessary to establish in house-specifications (microbial content specification as low as possible, but at least <100 CFU/ml). It is helpful to define warning limits and action limits, so that the water systems are regularly preventively cleaned, the "dead ends" are removed, valves and manifolds are check for leaks and cleaning methods are selected and verified.

In case of contamination:
Find the source of failure, start extensive microbiological testing. Disinfect the system.

Savings:
Equip the water sterilization system with an alarm signal and an automatic water stop. In case of failure of the sterilization system, it will minimize the risk of contamination.

If the process water quality is constantly good, the number of testing intervals and, if applicable, the number of test samples can be reduced. Nevertheless, the routine water quality monitoring has to include at least the downstream disinfection unit and at usage points (e.g. weekly).

For the analysis of larger volumes of water, it is recommended to use the filtration method (see ISO Norm), alternative methods with media immersion are much too inaccurate (only show bacterial counts >1000/ml).

In case of a deviation in the water quality, it is essential that bulk and finished products, produced with water out of the specification, are blocked and more thoroughly tested than usual.

5.2.1.4 Monitoring process water

In-process microbiological monitoring includes routine testing of raw materials, manufacturing water, water-based raw material pre-solutions, bulk product, intermediate storage container and finished product.

Savings:
How to minimize these expenses?

- *Reduce the number of samples if there are demonstrably well assured manufacturing processes (observe over a sufficiently long period, constantly low microbial count of the above-mentioned process stages).*
- *Sampling from boiler and storage tank (bulk): collect samples and only if the finished product is contaminated, carry out testing of these samples.*
- *Test the finished product at the beginning, middle and end of a shift. If the experience is good, i.e. increase of bacterial counts are not expected, savings can be made by examining mixed samples. Only in case of positive results, evaluate the complete process via the examination of individual samples and the retained bulk (boiler or storage tank) as well.*

IMPORTANT: Always test microbiologically at least one sample per batch. It is not possible to carry over the results from previous batches.

The release takes place under the internally defined specifications, which have to meet at least the requirements of the ISO 17516 standard „Microbiological limits".

In case of positive microbial detection within the specification, prove of no further microbial increase, differentiation, research of the causes and a risk assessment are the obligatory measures.

This expenses can be reduced if the process is sufficiently well assured so that a microbial limits of <10 CFU/g (detection limit of the plate count method) or non-detectable in 1 g (detection limit of the enrichment method) are achieved.

Since cosmetics production is not a sterile production, the recommendation is to carry out initial tests not until 8-24 h after filling, as very low bacterial counts are often no longer detectable over this period, and follow-up tests can be omitted.

An alternative approach to avoid failures is an early detection of the introduced microorganisms by promptly testing.

Practical example:
Excessive efforts in the wrong position

Cause: Planning failure
After testing three samples per batch based on ISO 17516, there was no differentiation and follow-up testing after detecting growth below the specification limit. Instead, numerous semi-finished products testing was conducted and no water quality monitoring.

This situation needs a procedure instruction describing the actions to carry out in case of growth detection below the set limit, and a list of list of actions required to detect possible sources of contamination.

Events / Process flow	Failure	Required improvements	Additional failure prevention costs (xx) / Subsequent failure costs
Container-preparation In a cosmetic company, the cleaning of IBC containers (Intermediate Bulk Container) starts manually, then on the inside with a high-pressure washer and afterwards disinfection with isopropanol (spray disinfection). An untrained leasing employee helps in the area. He is working under time pressure. Then employee sprayed isopropanol inside the completely clean container with residual water inside. Then the container stayed in the temporary storage area for 4 days before it is used.	1. Container not suitable, because reliable R&D is not possible. 2. Employee not sufficiently trained. 3. No controls of the leasing employee 4. Missing validated R&D procedure	1. Adequate Container 2. Sufficient Instructions / Training of leasing employee 3. Control by supervising personnel 4. Replace R&D process with validated/automated process	(1.Investment: different Containers) 2. Instruction / Training **15 Min. = 20€** 3. Basic procedure 4. Basic procedure / Investment
Day 1 (shower gel campaign) **Production:** Shower gel Var. 1 (3 ton, Prod.-Batch 1-1). Bulk filled in the container (see above) and 2 other containers.	No second disinfected was conducted on the container *(Not completely dry container. MO can multiply in the residual water)*	Essentially, due to the poor R&D situation, execute an additional disinfection step after storage.	Additional disinfection 15 Minutes/Container = **3 containers = 60€**
Day 2 Bulk (Ch. 1-1) transferred in 3 containers by truck to a sister company for filling.			
Day 4 **Filling:** Shower gel Var. 1 (Batch. 1-1) Transfer of 3 containers to a 3-ton storage tank then filled into 300 ml bottles. **Production:** Shower gel Var. 2 (3 ton, Produced-Batch 2-1). Shower gel Var. 3 (3 ton, Produced-Batch 3-1) Shower gel Var. 4 (3 3 ton, Produced-Batch 4-1) The only difference between shower gels is the pigment. Containers filled with bulk material and transported to filling location (see above). **Microbiological testing 1**: Filling Batch 1-1	No microbiological testing of the bulk material in the containers before for filling	Stored/transported bulk material should be microbiologically tested before filling	3 microbiological tests of the container goods **12 containers = 240€**
Day 5 Filling-preparation: Bulk Var.2 (Batch 2-1) filled in 3-ton storage container (previously used for Batch 1-1). Container and filling Water rinsed out only with water. Easy surfactant removal this way.	Increased risk when using the same equipment for all product variants, as there is no experience with the respective precursor.	Disinfect equipment if no microbiological information/ experience on precursor is available.	R&D costs for the equipment: 3 hours **3 times product change = 900€**
Day 6 **Filling:** Shower gel Var.2 (Batch. 2-1) **Filling:** Shower gel Var. 3 (Batch. 3-1) For **Filling:** All variants use the same feed tank and the same filling equipment. Rinsing conducted between shower gel variant changes. **Microbiological results 1**: Results are available for the filling Var. 1 (Batch 1-1) 20 CFU/g. The values are within the internal specifications limit. **Microbiological results 2:** Filling Batch. 2-1 **Microbiological results 3:** Filling Batch. 3-1	Investigation is carried out without identification of the found microorganism (risk assessment is hindered)	In the case of positive results, an identification provides a meaningful risk assessment.	Identification of microorganisms: **4 Findings = 120€**

Table 1: Practical example: failure costs

Events / Process flow	Failure	Required improvements	Additional failure prevention costs (xx) / Subsequent failure costs
Day 7 **Filling:** Shower gel Var. 4 (Batch 4-1) (Preparation: as previously described) **Microbiological results 2:** Filling Var.2 (Batch 1-2) (Preliminary reading) - 50 CFU/g. **Microbiological results 3:** Filling Var. 3 (Batch 3-1) (Preliminary reading) – 2000 CFU/g.		Repetitive positive findings in certain degree with significantly high values should trigger further decisions (blocking/ stop of production). This applies to the entire project, since the root cause has not yet been determined.	
Day 8 **Follow up results:** 2 further samples show uniformly > 30.000 CFU/g. **Production will be stopped.** All filled goods of the shower gel (Var.3 and Var.4) will be blocked. As the customer is waiting for the goods and is threatened with a fixed penalty - Var.1 and Var.2 (batches 1-1 and 2-1) will be released. Reason: existing findings were low in the limit range. The **root cause research** starts. Extensive **cleaning and disinfection** of the tank and filling system is carried out, which is successful.	The first 2 batches can not be released despite the low findings. Since the cause is not clear, the process must be considered as a whole.		**Subsequent failure costs:** 2 batches of 60,000 bottles are blocked = **Material costs = 20,000€** **Subsequent failure costs:** Cleaning/disinfection of the equipment **3 hours = 300€**
Day 12 Cause investigation shows that the origin of the contamination was most likely the transport container (see container preparation). Containers had not yet been cleaned and could therefore be examined.			**Subsequent failure costs :** Cause investigation with document inspection and microbiological analyses **approx. 700€**
Day 14 **Microbiological results:** The control sample of the 2 first batches (batch 1-1 and 2-1) are available - very high findings can now be detected here as well. The (released) goods have to be recalled. Fortunately, the goods were still available in the stores' individual warehouses and should not be recalled from the market. Customer no longer wants the goods.			**Subsequent failure costs:** microbiological follow-up analyses **approx. 350€** **Subsequent failure costs:** Blocked a total of **120,000 bottles = 40,000€** Collection / return shipping costs = **30,000€** Contractual penalty = **40,000€** Destruction costs = **5,500€** --- **TOTAL: 115,000€**
Additional activities Various microbiological follow-up analyses Internal processing (various areas) Damage to image *(for contract manufacturers: can be existence-threatening)*			**Subsequent failure costs: 1,000€** **Subsequent failure costs:** 20 employees/ 20 working days **= 25,000€** **invaluable**
		Total balance:	Reasonable additional prevention costs: **approx. 2,000€** Resulting direct follow-up costs: **approx. 115,000 - 120,000€**

Table 1: Practical example: failure costs - *continued*

5.2.1.5 Monitoring process water

The analysis of an obviously contaminated site within the routine environmental monitoring, does not give any additional benefit. Forehand knowledge about the poor cleaning of an examination site that may cause microbiological, chemical or physical contamination of the subsequent batch. Sites with standing water in direct contact with the product, address a risk.

Sometimes regular short inspections involving responsible persons and employees on-site are more efficient than a very extensive monitoring program.

A system based on hazard analysis, with variable monitoring points, can help to cover a larger area with fewer points.

5.2.2 Optimization of the Cleaning costs

- Optimize frequency of cleaning measures /
- Adjust the equipment usage exactly to the formulations (microbiological stability, formulation type and process/ equipment risk); if possible process several batches of a formulation in a row without intermediate cleaning.

Caution: Evaluate downtimes of more than 24h. Can contamination take place, for example via the pistons of a filling system, valves, distributors, pipes or condensate water?

- Adapt the frequency of cleaning measures to the circumstances. Are there any possibilities of contamination (risk assessment)? In case of low risk, disinfect only at the end/ beginning of a campaign. If the product is non-low risk (Aw-value and pH, etc.), then cleaning measures should be at least weekly.
- Investment in Cleaning in Place (CIP) systems (well-defined, reproducible cleaning processes without disassembly can be implemented).
- Investment in a pigging system. (Clean batch separation can be achieved, cleaning costs (product/water mixtures) can be minimized, as well as product loss due to cleaning processes.
- Optimal combination of chemical agents/temperatures/ manual cleaning effort (if CIP systems are not possible).
  - Before: W/O cream: 3 employees 5 hours
  - After: One employee, 2 hours in optimized processes.
  - Consultations on cleaning agents can be helpful.

Caution:
Check the water quality used for cleaning measures.
Frequent cleaning, but the water used is not microbiologically tested or comes from an old system that has not been disinfected. Standing water after cleaning, unless cleaned with steam, represents a major risk for product contamination within a few hours.
Remaining straightforward hygiene weakness: Carrying out many cleaning measures but the weakness remains. In this case, a complete modification is often less expensive than constant cleaning and measuring.

6. Concluding remarks

Expand the examples of cost savings listed here with more precise analysis and assessment considering the framework of each individual factory. Avoid selective reduction of the established measures; always assess first the potential effects on the finished product. The recommendation is to apply a systematic approach, taking into account all eventualities.

Establishing a very cost-effective microbiological quality management results from combining systematic risk-based analyses to avoid failure costs.

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Pre-screening Rinse Surfactants for More Sustainable ADW Formulations

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abstract

Rinse surfactants are core ingredients of automatic dishwashing (ADW) product formulations, integral to key performance aspects. As Home Care product launches with environmental and ethical claims now exceed those without, formulators require the support of ingredient developers to quickly identify new more sustainable surfactant options suitable for delivering on these criteria plus consumer-demanded high effectiveness in rinse performance.

To effectively achieve this balance, the surfactant creator is challenged to replace some or all ingredient building blocks with more renewable, sustainable alternatives.

Supporting more efficient and systematic surfactant development for sustainable ADW formulations, Clariant has introduced a new system for efficiently pre-screening surfactant characteristics and relating them to required ADW performance benefits. The process advantages extend beyond Clariant's faster and resource-saving development of market-relevant ingredients. The pre-screening also provides performance indicators plus temperature and concentration dependent measurements to support customers' selection of surfactants based on specific needs and formulations.

This paper details the unique combination of laboratory methods employed to ultimately select the best-performing surfactant within a product group. The pre-screening study example features renewable substances with RCI >50% compared to benchmark petrochemical-based products.

Introduction

Efficiently finding ingredients for changing needs

In 2019, global Home Care launches with "ECO" claims outpaced those without them for the first time. The new trend was even more apparent in 2020 [1]. However, for formulators in the Automatic Dishwashing (ADW) space, successfully addressing the growing consumer demand for convenient, high performance and responsible products brings with it the challenge of quickly finding suitable ingredients.

As rinse surfactants are core ingredients of ADW formulations and integral to key performance aspects, they are particularly impacted by the changing market needs. End consumers expect excellent rinse performance, but a switch to more natural alternatives is often associated with performance drawbacks. There is also only a limited choice of combinations of ingredients to obtain environmental labels. Plus, as a general observation for the household cleaning segment, it is difficult to contribute to climate change mitigation without compromising on hygiene and cleanliness.

For formulators to satisfy all three consumer demands, it requires new rinse surfactants to tick multiple boxes. They should be based on affordable raw materials of at least partial natural origin, be produced with an efficient process, contribute towards a substantially lower product carbon footprint, be compatible with environmental labels, and deliver good performance as a prerequisite. This is a challenging set of requirements for the surfactant creator and the end-product formulator to fulfil.

To support the development of new more sustainable ADW formulations with these priorities in mind, in this article we share a new **systematic and sustainable pre-screening** testing approach introduced by Clariant for efficiently pre-selecting potential rinse surfactants. The new system, which features a unique combination of methods, makes it considerably quicker to identify and pursue surfactant candidates that have strong relevance to market needs, and to eliminate those that underperform on the criteria from any further exploration and testing. Narrowing down the focus supports faster development of market-relevant products.

Tangible pre-screening value

Pre-screening surfactant characteristics also provides the industry with **valuable performance indicators** related to ADW performance needs, which can be extended to **offer temperature and concentration dependent measurements**. All of these can be used by the formulator to make an informed selection of a particular renewable-based surfactant based on the very specific needs of their product or formulation.

Clariant applies sustainable pre-screening methods in developing more sustainable products. This significantly saves water and raw material consumption compared to full application tests in the dishwasher. Also, with the added benefit of testing many more samples within the pre-screening set-up within the same time. Based on the simple calculation of material consumed by one dishwasher application test compared to that of a pre-screening test and the time necessary for each, in the featured study, we achieved 98% less water consumption, 96% less raw material consumption and the number of samples tested increased by factor five.

To demonstrate the potential of efficient pre-screening for supporting changing industry needs, we feature a study example using renewable substances with Renewable Carbon Index (RCI) >50% compared to benchmark petrochemical products. Here we detail the unique combination of laboratory methods employed to ultimately select the best-performing rinse surfactant within a product group.

Pre-screening study: selecting the best-performing surfactant

Materials

Sustainable product development requires the exchange of some or all building blocks by renewable, sustainable alternatives. In this study, we show pre-screening with two standard petrochemical-based C-chain surfactants, which we will refer to as the benchmark EO-PO products, and four bio-based alternatives based on renewable C-chains and a renewable hydrophobic end-cap. This leads to surfactants with an RCI of >50%. The hydrophobic end-cap is the same for all bio-based alternatives.

Petrochemical-based C-chain surfactants:
- $C_{12/15}$-$(EO)_8$-$(PO)_y$
- $C_{12/15}$-$(EO)_6$-$(PO)_y$

Bio-based alternatives:
- Oleyl-$(EO)_6$-Endcap
- Oleyl-$(EO)_{10}$-Endcap
- Lauryl-$(EO)_6$-Endcap
- Lauryl-$(EO)_8$-Endcap

The objective was to explore which bio-based alternative would provide the best rinse performance.

Main pre-screening methods

Clariant mainly employs three main methods in developing ADW additives. While the methods are not new, it is the first time that they have been used in this combination in order to select suitable surfactants for ADW products.

Stage 1: *Dynamic surface tension measurements*.
The primary screening is determining the dynamic surface tension by bubble pressure method at 50°C [2]. This fast and easy method allows us to determine if a substance is a suitable rinse aid and take an educated guess at how well it will perform compared to a benchmark. Temperature dependent surface tension measurements allow us to determine the cloud point and the temperature at which the additive will be most effective in rinsing.

Stage 2: Afterwards the suitable candidates are tested for their affinity to the most crucial materials when it comes to rinsing [5].

Stage 3: Finally, we use contact angle measurement to test the most promising substances on different surfaces to determine the effective concentration range and minimum concentration necessary.

Parameters

In order to assess effective rinse aid performance, we look at a number of indicators. Dynamic surface pressure is one of these, and it can be evaluated when the dynamic surface tension is measured [3]. Here, we are looking for a sigmoidal course of the surface tension over time. This is typically exhibited by non-ionic surfactants.

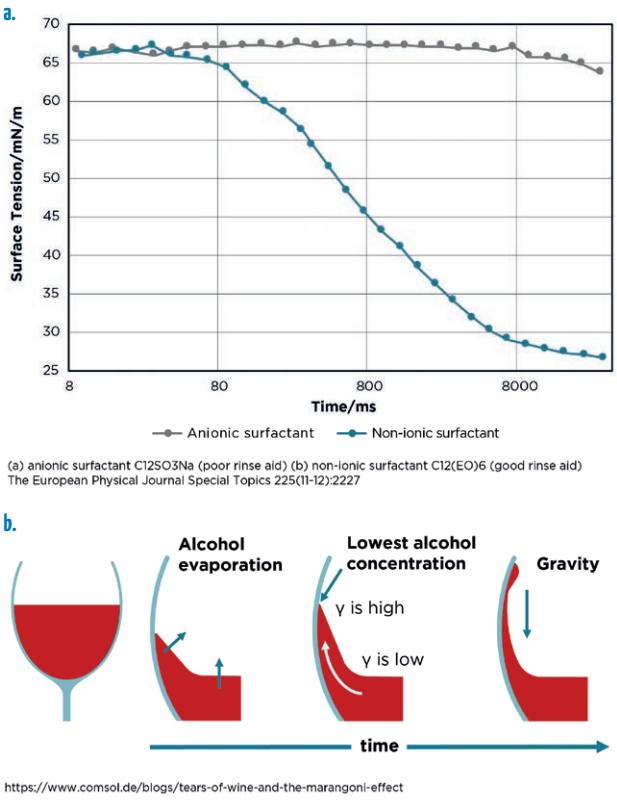


Fig. 1 Dynamic surface tension comparison between anionic surfactant and non-ionic surfactant; and illustration of the Gibbs-Marangoni-Effect (GME) [3]

In contrast to an anionic surfactant, the non-ionic surfactant will inhibit the tendency of the water to move away from areas of low surface tension. This reduction of the Gibbs-Marangoni-Effect (GME) is what causes a rinse aid to be effective. Exemplary for the GME is the formation of the so-called tears of wine. **Figure 1b** shows the GME, when the alcohol in a glass of wine evaporates, which causes the water to move to areas of high surface tension. This tendency is so strong that it causes the wine to move against gravity until the pull is too strong. The more the GME is reduced, the better the water drains with gravity.

In the dishwasher we do not want the GME to occur, ideally the water drains with gravity. An anionic surfactant would lead to the effect seen in the wine glass while a non-ionic surfactant will inhibit this.

Results

Rinse capability – relative dynamic surface pressure

When assessing the rinse capability of a surfactant, in this context it should be noted that the lower the value, the better the performance.

From the dynamic surface tension measurements, it can be clearly observed that the standard EO-PO benchmarks exhibit the previously mentioned sigmoidal curve of the surface tension. Furthermore, this behavior can be observed with the bio-based Lauryl alternatives. The two bio-based Oleyl alternatives behave in a similar fashion but in contrast to the other four these two do not reach an equilibrium after 30 seconds. It can also be noted that both Oleyl alternatives take a significantly longer time to become surface active. This is not necessarily a sign of bad rinse performance but rather a positive sign. Most of the commercially-available effective rinse aids show this tendency. The longer-lasting decays – the drop in surface tension - seem to favor drainage with gravity in the dishwasher, however this is merely a theory which remains to be proven.

On the right hand side **(Figure 2)**, the graph depicts the relative dynamic surface pressure (RDSP) calculated from the surface tension profiles. The EO-PO benchmarks depict a low value as expected. Three of the bio-based products have similar value. The high RSDP value of one of the Lauryl surfactants means it can be eliminated from the testing.

Rinse performance – QCM-D measurements

In this next stage, we use QCM-D measurements in order to further distinguish between the selected candidates. The quartz crystal microbalance with dissipation is a crucial instrument when it comes to determining the interaction between chemistries and surfaces. In this technique a quartz crystal is driven to oscillate at constant frequency. Changes in frequency or dampening (dissipation) of the oscillation from substances adhering and detaching from the surface results in a measured signal. Furthermore, swelling and deswelling of a surface layer can be monitored in this way. The frequency shift gives information about layer thickness and adsorbed mass while the dissipation shift depends on the rigidity of the layer.

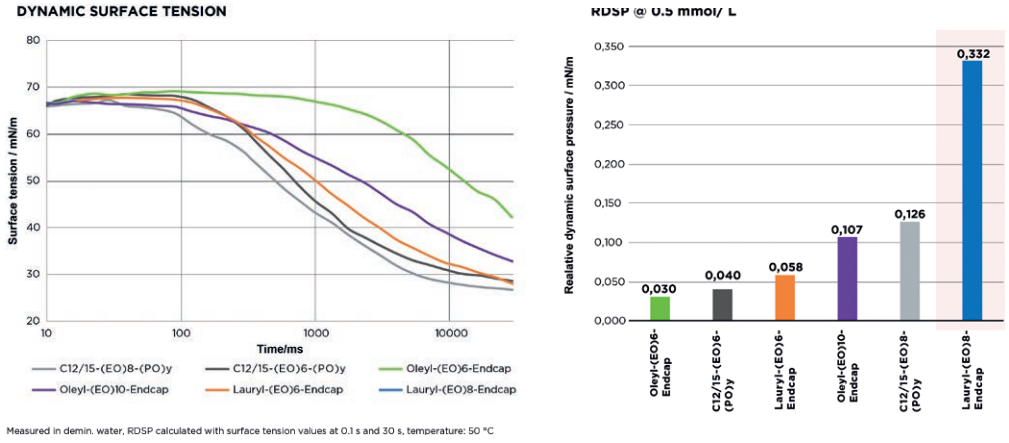


Fig. 2 Relative dynamic surface pressure – rinse capability

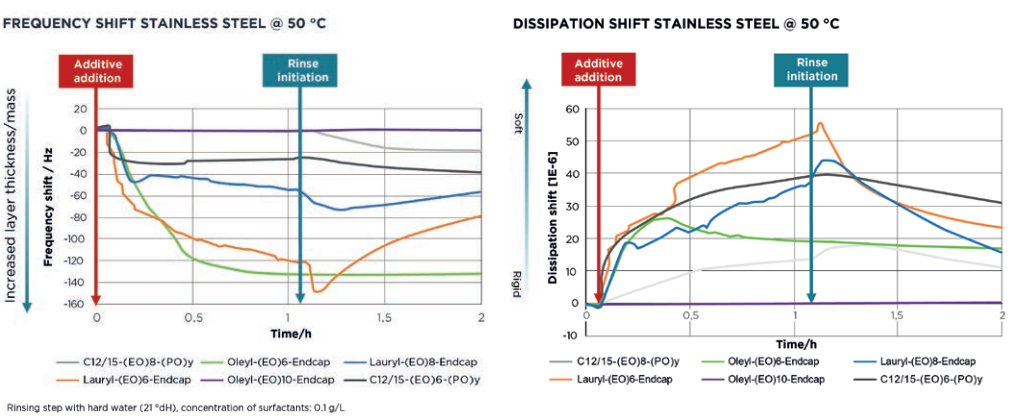


Fig. 3 Rinse performance - frequency shift and dissipation shift stainless steel

The crystal can be coated with a variety of materials. A gold coating is standard in QCM-D testing but many other substances, such as metals, polymers, metal salts, PET, cellulose and latex, can also be used. In the pre-screening for dishwashing we usually employ steel and lime glass due to these being the crucial surfaces when it comes to rinse performance.

On steel

In **Figure 3**, the left graph shows the frequency-shift when the surfactant is added to the solution, and the right one shows the dissipation shift. The different affinities to steel can be seen very clearly. The substances Lauryl-$(EO)_6$-Endcap and Oleyl-$(EO)_6$-Endcap have a very high affinity; the substances Oleyl-$(EO)_{10}$-Endcap and $C_{12/15}$-$(EO)_8$-$(PO)_y$ depict low affinity. Two points of particular interest are noted – the point of surfactant addition and the point of rinsing. The latter shows the point when the surfactant is rinsed with clear water to test the adhesion of the surfactant on the surface. Most substances show a decrease in load, while the benchmark $C_{12/15}$-$(EO)_8$-$(PO)_y$ increases in load.

In the dissipation curve of $C_{12/15}$-$(EO)_8$-$(PO)_y$, it can be seen that there is adhesion from the beginning. This shows that a small amount is absorbed on the surface over time, but upon rinsing this surfactant layer swells instead of being washed off.

We concluded that since steel is a high energy, hydrophilic surface it already offers high-performance when it comes to rinsing and drying. The most effective rinse aids for steel should therefore be the ones that do not alter the surface significantly, therefore a weak adsorption should result in good performance.

On glass

While rinsing of steel should work best when the surface modification is minimal, this is not true for glass. Due to the high affinity of water towards glass, the surface should be modified to ensure rinsing. Strong adsorption of the surfactant is expected to result in advantageous modification.

In **Figure 4**, we see in the frequency and dissipation shift that the EO-PO benchmarks modify the glass heavily with a thick, soft layer. From the bio-based alternatives, the Lauryl-(EO)8-Endcap and Oleyl-(EO)10-Endcap show the most favorable behavior on glass. The Oleyl based alternative exhibits the most persistent modification since after the rinsing step the layer thickness and rigidity do not alter significantly.

The important results from QCM-D measurements are summarized in the following graphs **(Figure 5)**. They indicate

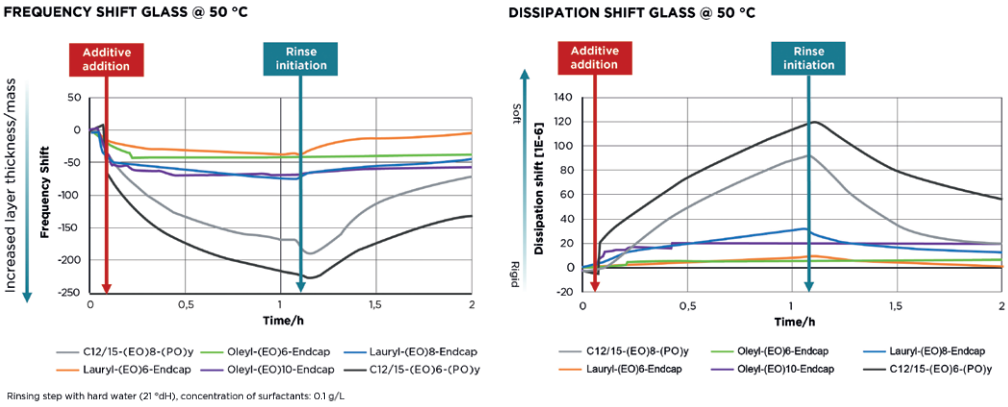


Fig. 4 Rinse performance - frequency shift and dissipation shift glass

	Relative dynamic surface pressure	QCMD on steel	QCMD on glass
Lauryl-(EO)6 -Endcap	✓	✗	✗
Lauryl-(EO)8 -Endcap	✗	✗	✓
Oleyl-(EO)6 -Endcap	✓	✗	✗
Oleyl-(EO)10 -Endcap	✓	✓	✓

Fig. 5 Summary of results from QCM-D measurements

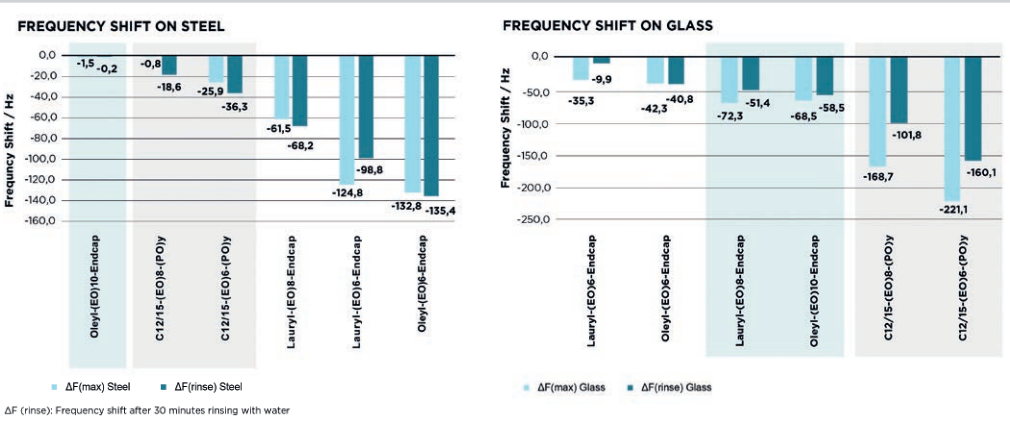
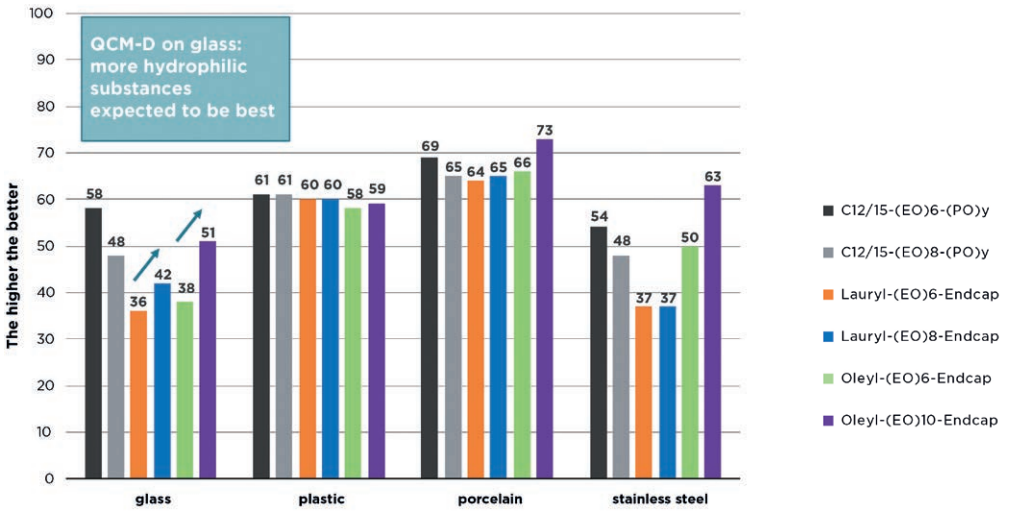


Fig. 6 Oleyl-$(EO)_{10}$-Endcap shown to be best performing substance

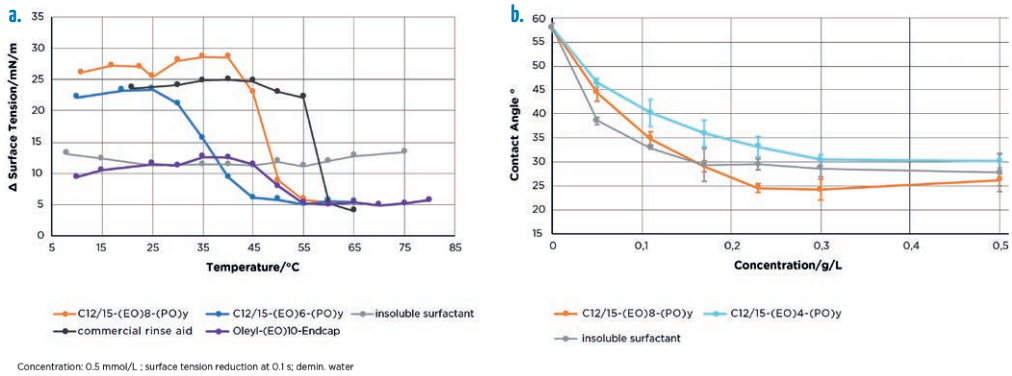
that the substance Oleyl-$(EO)_{10}$- Endcap is expected to be the best-performing bio-based alternative, which shows low affinity to steel while strongly modifying glass. The latter is also true for the substance Lauryl-$(EO)_8$-Endcap, but its high affinity towards steel indicates that it is unlikely to perform well on metal surfaces.

The summary in **Figure 6** shows that after stage 1 and 2 testing, only one of the bio-based surfactants - Oleyl-$(EO)_{10}$-Endcap - remains for full dishwashing application testing.



Rinse Performance Evaluation in Miele G 1222 SC GSL, 50 °C in cleaning step, 65 °C final rinse, 1 cleaning cycle for pre-conditioning/ 3 cleaning cycles for evaluation, 21 +/- 1°dH, each cycles with ballast soil and 4% surfactant in ADW basic powder; Average score by material group per item of 3 evaluated cycles (min: 10; max. 100)

Fig. 7 Automatic dishwashing test confirms pre-screening results



Concentration: 0.5 mmol/L ; surface tension reduction at 0.1 s; demin. water

Fig. 8 Information about effective temperature (left) and effective concentration (right) [6]

Validation Trial

For proof-of-principle, we tested the performance of all bio-based surfactants in the dishwasher **(Figure 7)**. The result highlights that the substance selected from the pre-screening does outperform the other three alternatives.

We tested the rinse performance on four material classes, namely glass, plastic, porcelain and stainless steel. The surfactants were tested at a concentration of 4% in a base ADW Multitab formulation. Plotted are average values of 3 cycles, representing performance indices. A higher value is associated with a better rinse performance.Hence, these results prove that the pre-screening methods are reliably selecting good performing surfactants for automatic dishwashing.

Additional performance insights

Through extending the pre-screening methods we are able to generate more information about tested surfactants and their benefits. This can aid the formulator in determining potential suitability for specific requirements.

We can determine the **effective temperature range** of a surfactant by conducting dynamic surface tension measurements at different temperatures. The temperature during the drying process in the dishwasher decreases from above 60°C to 50°C with a subsequent cool-down to room temperature before emptying. To be a viable contender for ADW formulations, the surfactant should effectively reduce the surface tension over this temperature range.

Furthermore contact angle measurements at different concentrations can be performed on a variety of materials [6]. This allows us to detect the **minimum effective concentration** of soluble as well as insoluble surfactants [7]. The data in **Figure 8b** is from measurements on surfactant pre-treated glass. Ideally, we want a low contact angle when testing for rinse capabilities, as it hints at a filming of the liquid on the surface, indicating that in the dishwasher the water would drain as a film without leaving spots. By visually assessing the glass slide we can determine the concentration when spotting due to residues starts.

The reduction in contact angle here shows that the surfactant is adhering to glass. The contact angle reaches a plateau at optimum rinse aid dosage, which is different for every surfactant but usually around 0.2 g/L. It is observed that under dosage of the surfactant will lead to spotting, while over dosage to filming.

Conclusion

The pre-screening study example demonstrates that such tests are reliable indicators for selecting surfactants for ADW application. In addition to guiding the development focus, they can be used by formulators to determine the most appropriate surfactant based on specific customer needs.

Pre-screening saves resources, by eliminating unsuitable candidates from further testing requirements. Dynamic surface tension measurements in combination with QCM-D allow for an efficient preselection of potential rinse surfactants, while additional insights provide valuable performance information. Temperature and concentration dependent measurements help to further specify the properties of new developments. This does not eliminate the need for application testing. Dishwashers with their specific temperature profiles, mechanical effects and water distribution are complex systems and every surfactant needs to be subjected to these parameters, as well as the topologies of a full dishwasher loading, in order to truly assess their performance.

Discussion

Identifying rinse aids for customers

Laboratory testing provides valuable insights into surfactant characteristics and behavior. With an increased understanding it allows us to utilize these methods for pre-selecting suitable surfactants for different applications. By employing multiple methods we are able to screen for numerous performance indicators while accounting for diverse surfactant behavior. Contact angle and QCM-D measurements can be performed on pure substances as well as full formulations allowing for a screening of different chassis, which enables us to directly target performance in customer formulations. Providing them with the best substance specific to their needs.

On top of that we are able to adjust parameters like water hardness, formulation, temperature and pH to adapt to different market conditions.

Lastly, the pre-screening is an ecofriendly process, saving a lot of resources by reducing the number of application tests, all while increasing the number of substances we can test. This allows us to compare performance in a very controlled, standardized, laboratory environment, producing highly comparable results.

References:

[1] Source: Mintel, Global New Products Database. **Super-Category** matches Household, **Claims*** matches/does not match Ethical & environmental as the claim (e.g. carbon neutral, biodegradable, environmentally friendly), **Date Published** is between Jan 2010 and Dec 2020

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Beauty with Silicones: Hair Care

Interview with **Isabel Almiro do Vale**
Global Strategic Marketing Director, **Dow Personal Care**


Isabel Almiro do Vale

What are silicones?

Silicone technologies are a broad family of polymers that take numerous forms, from low viscosity fluids to viscous gums, cross-linked elastomers, and hard resins. They can be leveraged to deliver a nearly unlimited range of problem-solving benefits depending on the consumer's needs.

The starting element for all silicone materials is silicon (Si). It is found in quartz, sand, and even in certain plant husks and is the second most abundant element in the earth's crust after oxygen. A broad range of silicone materials have been used in beauty and personal care products for close to seventy years and are considered the ingredient of choice for a wide range of formulations. They can be used as-is or blended to deliver beauty care ingredients from low viscosity volatile fluids to viscous or solid materials, providing a wide range of materials with multifunctional benefits.

What benefits are your silicones providing for hair products?

Silicones are a very broad chemical class of materials that provide many different benefits in hair care applications.

Because of their low surface energy, silicones easily spread over the surface of the hair, providing conditioning benefits and an overall healthy look and feel to hair. Because of their hydrophobic properties, Dow silicones can be used as either a pre-treatment or post-treatment to maintain or restore hair to a healthy look and feel despite daily exposure to urban pollution and UV damage.

To prevent hair breakage, amino silicones are ideal as they form a shield to safeguard hair from heat, chemical damage such as bleaching or daily grooming. They are also ideal candidates to avoid color loss for dyed hair. Amino silicones also erase the signs of damage by being excellent anti-frizz products and restoring smoothness, shine, and alignment of damaged hair.

Gum blends are the main class of ingredients used in water-free hair oil formulations, providing benefits like smoothness, shine, frizz control, and heat protection.

How do silicones meet the needs of all consumers?

Silicones provide benefits for consumers with diverse needs as they are extremely multifunctional. With a unique set of chemical and physical properties, they not only condition hair, but enhance shine, facilitate grooming, provide color protection, help guard against damage from heat during styling, restore damaged hair, give a perception of moisturization, aid curl retention, control frizz and provide desired hair volume.

Can you tell us about the sustainable nature of silicones in hair care products?

Silicone polymers used in personal care products are non-GMO, chemically inert, and non-reactive biocompatible ingredients that are stable substances under usual environmental conditions. Non-functional silicones are colorless and odorless. None of their components are derived from animals, meaning silicones are vegan-friendly and cruelty-free by default.

In the environment, silicones are expected to be ultimately converted to silica, silicic acid, and carbon dioxide, primarily through non-biological degradation processes such as hydrolysis or photolysis, and through biodegradation by biological organisms.

How is Dow debunking the myths and controversy around silicones in cosmetic products?

Several myths have developed concerning personal care products containing silicones. However, silicones have a long-standing history of safe use in personal care and consumer product applications because silicones fuel our imaginations and make new products and benefits possible.

For example, some believe that silicones build up on the hair. However, their unique spreading and low intermolecular forces lead to the formation of a single layer, hence silicones do not buildup. Additionally, silicone can be easily removed from hair by a clarifying shampoo.

Others believe silicones can negatively affect the coloration process. On the contrary, studies have shown silicones pro-

vide a more vibrant color to the hair when added to the colorant.

Some consider silicones as occlusive materials. Silicones fascinating physico-chemistry provides hydrophobic, hence waterproof, properties when water is in its liquid form. However, the conformation and flexibility of O-Si-O bounds enables water in its vapor form as well as oxygen to pass through a silicone film. This is one of the reasons why silicones are also used in scar treatments, limiting bacterial growth. Thanks to this non-occlusive property, silicone film formers are an ingredient of choice for long-lasting foundations as they do not interact with the breathability function of the skin.

How are silicones used in hair care products? What are Dow's product offerings for silicones in hair care formulation?

Dow is creating differentiating specialty silicone technologies that bring beauty to life in a way that has a lasting effect on formulations and on the lives of consumers everywhere.

Examples of Dow's best-performing silicone technologies include **HydroxySHIELD™ Polymer** which helps reduce breakage and ease hair styling by restoring the hair's hydrophobic state. This innovative hydroxyamino functionalized silicone delivers superior conditioning of the damaged hair surface and can be used in shampoos, leave-in products, rinse-of conditioners, or colorants.

DOWSIL™ PMX-1508 Fluid is a gum blend in a bioderived, inherently primary biodegradable carrier that can be used in hair care, skin care, sun care, and color cosmetic applications. This unique silicone technology provides multifunctional benefits such as improved dry and wet combing, enhancing hair shine, smoothness, and more.

Another exciting ingredient is **DOWSIL™ 3903 Liquid Satin Blend** which helps to reduce the number of environmental pollution species adhering to the hair.

And silicone technologies are not only leveraged in hair care products, but they also bring an array of benefits to skin care products: A standout silicone technology is **DOWSIL™ 1686 Resin**, which offers shine and radiance, contributes to color value, enables good coverage and moderate wear in personal care applications. This non-GMO silicone resin can be used in a variety of ways in color cosmetics, skin care, and hair care.

www.dow.com

Thanks
to our exhibitors, visitors and speakers who participated in the SEPAWA® CONGRESS VIRTUAL 2021!
We are happy that you are part of our #sepawafamily.
See you next year.

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Dr. Joachim Storsberg

Interview with Dr. Joachim Storsberg

Head of Department of Healthcare, Biomaterials & Cosmeceuticals, Fraunhofer Institute

Dr. Storsberg, in 2020 you received, together with Dr. Anne Krüger-Genge, the SEPAWA Innovation Award for your presentation entitled: *"Non-invasive long-term method to study the efficacy of potential agents on hair growth"* Belated congratulations!

What are the advantages of the method?

The advantages of the process are of great scope and significance in the development of functional cosmetics or cosmeceuticals.

Our *in vitro* screening tests active ingredients for medicine, pharmaceuticals and cosmetics for efficacy and toxicity - quickly and early on in the development phase and without animal testing.

Because we carry out the screening with human cells specific to the application site, we can make realistic statements, e.g. about how it could work in humans later on. This means that active substances that are of interest to us can be selected in advance. There is a great need, especially in the cosmetic sector, to be able to scientifically prove the efficiency of a product - and not just advertise it.

Why do you say that in addition to the cosmetic sector, this method also has very high potential for many areas in the personal care and detergent sectors?

The cosmetics sector is only one area where this process can be used. Basically, all areas are interesting where products come into contact with the user's body. This also applies in particular to the personal care, detergent and cleaning product sector. You can imagine that it is particularly useful here and also of great interest to health to make reliable statements. This applies, for example, to detergents or cleaning agents with which one comes into contact, be it during the cleaning itself - or even if residues (even traces) are still present after washing (also on washed clothes that we put on).

How does in vitro testing work for screening potential combinations of active ingredients with regard to their toxicity?

With the help of this procedure, potential active substances can be examined in various concentrations in short- and long-term tests with site-relevant primary cells (which are important for the respective cosmetic or hair growth) with regard to a possible cytotoxic influence. In addition, the influence of active substances that promote cell growth or cell function will also be investigated. The potential active agent can be administered once or repeatedly. The influence on various cellular parameters such as cell adhesion and cell proliferation is then measured by detecting the AC resistance across the cell lawn. Immediately after the addition of the active substance, the influence of an active substance on the cells can already be detected. The addition of "external" markers, which are used e.g. to stain or label cells for the detection of certain parameters, is not necessary.

What advantages does this innovation offer compared to other methods?

This method uses a detection method that does not require the use of additional dyes, antibodies, etc. The analysis is carried out continuously over time and not just at a few points in time. Thus, we can directly examine the toxicity, but also the efficacy of active substances without external, possibly damaging influences and without accepting a possible influence/damage of sensitive primary cells. By combining the cell impedance-based method with further biological *in vitro* investigations such as ELISA-based techniques, Western blot for the detection of protein expression as a marker of cell function, vitality and metabolic investigations, we then obtain a clear result on the toxicity, effectiveness and biocompatibility of a potential active substance.

What has happened since you won the Innovation Award?

A lot has happened! We have suddenly made a name for ourselves, many companies did not know at all that we were doing something like this.

We are of course very pleased that this is possible through the SEPAWA Innovation AWARD - and that we can thus contribute to the development and the safety AND the scientific proof of a certain effect of a product.

Thank you very much!

www.iap.fraunhofer.de

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HPCI CENTRAL & EASTERN EUROPE

WARSAW | 21-22 SEPT. 2022

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SOFW JOURNAL
BEST PAPER AWARD 2021

THANNHAUSEN, GERMANY, 2 DECEMBER 2021

For the second time the SOFW best paper awards winners have been selected. Again, an independent panel of specialists assessed 65 papers published in the SOFW journal in 2021.

Two of the winning papers focus on Home Care, one on Personal Care. We congratulate the winners and encourage everyone in the industry to continue submitting technical and scientific articles. One of our readers from a prominent producer of both Home and Personal Care products recently mentioned, that reading in our trade literature inspires innovations.

Unfortunately, once again the pandemic situation hinders a face to face award ceremony. Never the less we are happy to announce the winners here and sincerely hope, that in 2022 we can all meet in person again.

Congratulations again and: Stay healthy!

The winner of the first prize is the article:

1 The Road to More Sustainability and Functionality in Liquid Laundry Detergents

Authors: A. Phyfferoen, J. Swazey
Companies: CP Kelco UK Ltd. & CP Kelco U.S., Inc.

Abstract: 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 (fermentation-derived cellulose) 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.

The winner of the second prize is the paper:

2 Hydrophobic Cellulose – Micro-fine Texture at Ultra-strong Performance for a Measurable Soft-focus Effect

Authors: J. Schulte, A. Huneke, J. Ryll
Company: CFF GmbH & Co. KG

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.

The winning article of the third prize is:

3 A Natural, Powerful and Biodegradable Suspension Agent for Home Care

Authors: S. Zhou, M. Chabert, C. Orizet
Company: Solvay

Abstract: We present an innovative, natural and readily biodegradable suspension agent that opens new possibilities to homecare formulators. When added to detergent formulas, it brings a very powerful suspension capacity without any perceivable impact on viscosity. The agent is based on activated cellulose fibers obtained through the fermentation of starch using specific bacterial strains. We present rheology measurements that allow us to predict the suspension power of a detergent formula supplemented with the agent, based on its rheology at low shear rates. The yield stress value extracted from Bingham plots highly correlates with the density and size of the objects that can be suspended with the agent. We show the application of the agent in multiple home care formulations, in particular the suspension of decorative visual beads and concentrated fragrance in a typical liquid laundry formula. We describe how it is simple to add the suspension agent to a formula due to its pre-activated liquid format. A formula supplemented with the suspension agent is stable for several months at 45°C, with sustained suspension power and no demixion or change in aspect, highlighting the suitability of the suspension agent for commercial consumer products.

Ammonia-Free Glass Cleaner

Mirapol® Surf S-110, Rhodasurf ® L-7/90

Home Care Formulation – HC-2025

Ingredient	Function	W/W %
Water	Carrier	QS to 100
sodium lauriminodipropionate	Amphoteric Surfactant	0.30
Isopropanol	Solvent	5.00
Mirapol® Surf S-110	Aqueous Solution of an Acrylic Polymer	0.80
Rhodasurf® L-7/90 (Laureth 7)	Nonionic Surfactant	0.15
Dowanol® PnB [(2)]	Solvent	1.00
NaOH, 50%	pH Adjust	QS
Dyes, Colorants, Fragrance	Aesthetics	QS
Preservative	Preservative	QS

Manufacturing Procedure:

Step 1. Charge ingredients in the order listed, mixing well between additions.
Step 2. Adjust pH to 8.0-9.0 with NaOH, 50%.
Step 3. Add dye, colorants, fragrance, and preservative as desired

Typical properties

Appearance at 25°C: Blue thin liquid
Brookfield Viscosity at 25°C: <100 cps
Storage: Stable for 3 months (25°C; 50°C; 4°C) 3 Cycles Freeze/Thaw
pH: 8 - 9

Suppliers:
[(2)] DOW

Description:
Mirapol® Surf S-110 makes surfaces more hydrophilic and allows rinsing water to flow as a thin film that dries fast and leaves a streak and spot free shine. An added advantage is that the polymer reduces soil adhesion and scale build-up on the surface which means easy next time cleaning. Spend less time cleaning and more time having fun!

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FORMULATIONS

Thick Toilet Bowl Cleaner

Mirapol® Surf-S 900, Rheozan®

Home Care Formulation – HC-2018

Ingredient	Function	W/W %
Water	Carrier	QS to 100
Mirapol® Surf-S 900	Aqueous solution of polymer	2.00
Disodium Cocoampho dipropionate	Surfactant	5.00
Hydrochloric Acid	Acid	32.00
Rheozan®	Thickener	0.20

Manufacturing Procedure:

Step 1. Slowly charge Rheozan® to the water while continuing to mix at high agitation for 30 minutes.
Step 2. Add Hydrochloric Acid and mix until uniform.
Step 3. Add Mirapol® Surf-S 900 and Miranol® FBS and mix until uniform.

Typical properties

Appearance at 25°C: Clear amber colored liquid
Viscosity: 1,000 cps
pH: < 1.0

Description:
The formulation features Mirapol® Surf-S 900, a polymer designed to enhance cleaning performance and prevent soil adhesion to hard surfaces in extremely low pH applications such as toilet bowl cleaners. Rheozan® efficiently thickens the acid and foaming detergent, creating a stable thick cleaner that efficiently covers toilet bowls for easier and long lasting cleaning.

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FORMULATIONS

Date	Event	Website
2022		
11–12 January	**Cosmet Agora**	http://www.cosmetagora.fr/
27–28 January	**HPCI India**	http://www.hpci-india.com/home
15–18 February	**Vivaness**	https://www.vivaness.de
02–04 March	**PCHi China**	https://www.pchi-china.com/en
05–07 April	**in-cosmetics Global**	https://www.in-cosmetics.com/global
03–04 May	**NYSCC Suppliers` Day**	https://nyscc.org/suppliers-day/
12–14 May	**China Beauty Expo**	https://www.chinabeautyexpo.com/
01–02 June	**Cosmetic Business Munich**	https://www.cosmetic-business.com/tradefair/en/
12–14 July	**Cosmoprof North America**	https://cosmoprofnorthamerica.com/
13–15 July	**in-cosmetics Korea**	https://korea.in-cosmetics.com/
19–22 September	**IFSCC Congress London**	https://www.ifscc2022.com/
21–22 September	**in-cosmetics Latin**	https://latinamerica.in-cosmetics.com/
21–22 September	**HPCI CEE Poland**	https://www.hpci-events.com/central-and-eastern-europe/
26–28 October	**SEPAWA Congress**	https://sepawa-congress.de/en/
31 Oct–02 November	**Beautyworld Middle East Dubai**	https://beautyworld-middle-east.ae.messefrankfurt.com/dubai/en.html
01–03 November	**in-cosmetics Asia**	https://asia.in-cosmetics.com/
16–18 November	**Cosmoprof Asia**	https://www.cosmoprof-asia.com/en-us/
TBA	**SCC Conference New York**	https://www.scconline.org/Events/Annual-Scientific-Meeting

A comprehensive overview of events is given in SOFW Journal, published by VCI. All dates, venues, contacts are given without any obligation.

Interested parties should contact the corresponding organizer for exact details and possible changes.

If you want to add any cosmetic, personal-, home-care relevant event to this calendar, please send your information to **vci@sofw.com**

Contact

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✉ vci@sofw.com
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Date	Lecture Event of the Specialist Group / Section
2022	
24–25 March	German Association of Perfumers
18–19 May	Cosmetic Applications and Technology (CAT) & Legislative-Environment-Consumer (LUV)
16 June	Section Benelux
20–21 June	Professional Cleaning & Care (PRP)
29–30 June	Small and Medium Enterprises (MI)
	More details and further upcoming events you find on:
	https://www.sepawa.com/en/upcoming-events/

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event report

H.L. Möhle, E. Diaz, A. Wilsch-Irrgang
The 67th SEPAWA® CONGRESS VIRTUAL, the 16th European Detergents Conference and the Forum Cosmeticum 2020 as virtual events from 28 – 30 October 2020

home care

M. Squire
Disinfection Yesterday, Today and Tomorrow – Effective Chemistry in the Fight against a Global Viral Danger

personal care

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