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sun care

How to Overcome the New Challenges in Sun Care

Natural-based 360° Approach for Optimized Formulations

Sunscreen Diversity – more Options for Ingredients

How Polyurethane Film Formers Can Help Reduce the Impact on the Environment

oral care

A Natural Way to Treat Tooth Sensitivity

2 sun care
How to Overcome the New Challenges in Sun Care

34 home care
60 Years Sinner Circle: The Future of Washing and Cleaning

personal care

home care

specialties

How to Overcome the New Challenges in Sun Care

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Sunscreen producers and UV filter manufacturers are currently facing urgent challenges. On the one hand, the legal situation of two widely used UVB filters Ethylhexyl Methoxycinanamte (EHMC) and Octocrylene (OCR) is unclear due to rising concerns on their safety for humans and the environment; on the other hand, the image of nano particulate UV filters is downgraded in the press and by digital apps questioning their safety profile without scientifically based evidence. Some producers pro-actively remove these UV filters from their new sunscreens' developments which is a real challenge in terms of performance achievement. This paper aims to provide UV filter system alternatives for developing efficient sunscreens without EHMC and OCR. Additionally, it clarifies the safety situation of nano-particulate UV filters and explains their usefulness in sunscreens, providing, however, UV filter system alternatives. Furthermore, this manuscript presents a calculation method to assess the impact of a UV filter combination on the environment and shows that it is possible to develop eco-sustainable sunscreens. Though, each restriction in the choice of UV filters will imply certain compromises.

Introduction

Developing new sunscreens has turned out to be highly challenging due to both the unclear fate of some approved UV filters and the hurdles to register new UV filter molecules [1]. From the UV filters under scrutiny, the widely used UVB filters Ethylhexyl Methoxycinnamate (EHMC) and Octocrylene (OCR) are heavily discussed due to rising concerns regarding their safety profile for humans and for the environment. In Europe, legally approved UV filters are additionally assessed by the European Chemical Agency (ECHA) within the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACh) process, like all other industrial chemicals. Also, in the USA, the Food and Drug Administration (FDA) issued a proposed rule to put into effect a final monograph for over-the-counter sunscreen drug products [2]. In its proposal the FDA describes the conditions under which a sunscreen active is Generally Recognized as Safe and Effective (GRASE) and highlights the safety data gaps and additional required data for each already approved UV filter to be included in category I, UV filters with a positive GRASE. In addition to the issues put forward by official authority bodies, sunscreen manufacturers must also consider the perceptions of the end consumers. The uncertainty regarding the legal fate in addition to the reticence of consumers explain the willingness of sunscreen manufacturers to pro-actively remove some widely used UV filters such as EHMC and OCR from their new sunscreen developments. This removal results in a real challenge in terms of performance achievement of sunscreen formulations. Further, in the last years the reputation of nano-particulate UV filters was heavily affected by their downgrade in the press and by consumer apps questioning their safety profile without scientifically-based evidence.

This paper aims at explaining current hurdles in developing new sunscreens and at providing hints how to overcome them. We will discuss the main concerns related to EHMC and OCR and propose solutions to achieve efficient sunscreens without these two UV-absorbers. Furthermore, this paper will discuss the issues regarding UV filters in nano form as well as the impact of UV filters on the environment and propose appropriate solutions for a suitable way forward.

Material and Methods

Formulations for Octocrylene and Ethylhexyl Methoxycinnamate Free Systems

The investigations involved two SPF 30 formulations based either on Diethylamino Hydroxybenzoyl Hexyl Benzoate (DHHB) or on Butyl Methoxydibenzoylmethane (BMDBM) as UVA filter referred to as photostable UVA and partly stabilized UVA, respectively. The two oil-in-water (O/W) sunscreens differed solely in their UV filter combinations (**Tab. 1**) and consisted in an emollient mixture of 3 wt% Dicaprylyl Ether (Cetiol OE),

UV filters	Photostable UVA	Partly stabilized UVA
EHS	5.0%	4.5%
PBSA	–	1.0%
EHT	1.5%	1.5%
TBPT [a]	2.2%	–
BEMT	1.0%	2.5%
DHHB	3.0%	–
BMDBM	–	3.0%

[a] given as active concentration

EHS: Ethylhexyl Salicylate (Neo Heliopan OS) from Symrise, Holzminden, Germany; **PBSA:** Phenylbenzimidazole Sulfonic Acid (Eusolex 232) from Merck, Darmstadt, Germany; **EHT:** Ethylhexyl Triazone (Uvinul® T150); **TBPT:** Tris-Biphenyl Triazone (Tinosorb® A2B); **BEMT:** Bis-ethylhexyloxyphenol Methoxyphenyl Triazine (Tinosorb® S), **DHHB:** Diethylamino Hydroxybenzoyl Hexyl Benzoate (Uvinul® A Plus) from BASF SE, Ludwigshafen, Germany; **BMDBM:** Butyl Methoxydibenzoylmethane (Eusolex 9020) from Merck.

Tab. 1 Investigated UV filter combinations for sunscreens without EHMC and OCR.

5 wt% Propylheptyl Caprylate (Cetiol Sensoft), and 10 wt% Dibutyl Adipate (Cetiol B) and an emulsifier mixture of 1% Disodium Cetearyl Sulfosuccinate (Eumulgin Prisma) and 3% Sucrose Polystearate, Hydrogenated Polyisobutene (Emulgade Sucro Plus). In addition to the two sunscreens, the study included a placebo formulation that did not contain any UV filters.

Measurement of Free Radicals

We assessed the number of free radicals generated in the sunscreen probes following UV irradiation according to the method described earlier [3]. Briefly, the number of UV-induced free radicals were measured via electron spin resonance (ESR) spectroscopy (MiniScope MS300, Magnettech GmbH Berlin, Germany) using a spin-probing approach. In this methodology, the spin probe PCA, (2,2,5,5-tetramethyl pyrrolidine N-oxyl, Sigma-Aldrich, Munich, Germany) which is stable over time will react with free radicals produced under UV irradiation to be reduced to the ESR-silent hydroxylamine. UV irradiation of the probes was done with a UV solar simulator 300 W Oriel (Newport). The irradiances as integrated values over the spectral ranges were 23.5 W/m² for the UVB range between 280 and 320 and 180 W/m² for the UVA range between 320 and 400 nm.

Blue Light Transmittance Measurements

To assess the reduction of blue light transmittance with particulate organic UV filters, the transmittance profile of two O/W formulations containing either 5% of Methylene Bis-Benzotriazolyl Tetramethylbutylphenol (MBBT) or 5% Tris-Biphenyl Triazine (TBPT) was measured using a Labsphere UV-2000S device (Labsphere Inc, USA). An amount of 1.2 mg/cm² of the preparation was applied on PMMA plates

INCI Name	Max %	Status
Camphor Benzalkonium Methosulfate (s57)	6%	Minimally used, < 100 to/a
Homosalate (s12)	10%	On CoRAP list
Benzophenone-3 (s38)	10%	On CoRAP list
Phenylbenzimidazole Sulphonic Acid (s45)	8%	Frequently used and not under evaluation
Terephthalylidene Dicamphor Sulfonic Acid (s71)	10%	Minimally used, < 100 to/a
Butyl Methoxydibenzoylmethane (s66)	5%	On CoRAP list
Benzylidene Camphor Sulfonic Acid (s59)	6%	Minimally used, < 100 to/a
Octocrylene (s32)	10%	On CoRAP list
Polyacrylamidomethyl Benzylidene Camphor (s72)	6%	Minimally used, < 100 to/a
Ethylhexyl Methoxycinnamate (s28)	10%	On CoRAP list
PEG-25 PABA (s03)	10%	Minimally used, < 100 to/a
Isoamyl p-Methoxycinnamate (s27)	10%	On CoRAP list
Ethylhexyl Triazone (s69)	5%	Frequently used and not under evaluation
Drometrizole Trisiloxane (s73)	15%	Minimally used, < 100 to/a
Diethylhexyl Butamido Triazone (s78)	10%	On CoRAP list
4-Methylbenzylidene Camphor (s60)	4%	Minimally used, < 100 to/a
Ethylhexyl Salicylate (s13)	5%	On CoRAP list
Ethylhexyl Dimethyl PABA (s08)	8%	Minimally used, < 100 to/a
Benzophenone-4/-5 (s40)	5%	Frequently used and not under evaluation
Methylene Bis-Benzotriazolyl Tetramethylbutylphenol (s79)	10%	Frequently used and not under evaluation
Disodium Phenyl Dibenzimidazole Tetrasulfonate (s80)	10%	Minimally used, < 100 to/a
Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine (s81)	10%	Frequently used and not under evaluation
Polysilicone-15 (s74)	10%	Minimally used, < 100 to/a
Titanium Dioxide (nano and non nano) (s75)	25%	On CoRAP list
Diethylamino Hydroxybenzoyl Hexyl Benzoate (s83)	10%	Frequently used and not under evaluation
Tris-Biphenyl Triazine (s84)	10%	Minimally used, < 100 to/a
Zinc Oxide (nano and non nano) (s76)	25%	On CoRAP list
Phenylene Bis-Diphenyltriazine (s86)	5%	Minimally used, < 100 to/a

Tab. 2 Maximum authorized concentration and status of European approved UV filters.

(SB6 from HelioScreen Labs, FR); three plates were prepared per sample and 5 transmittance measurements were performed per plate after an equilibration period of 30 min at ambient temperature.

Assessment of the EcoSun Pass Value

To assess the impact of a UV filter combination on the environment, we used a calculation method providing the EcoSun Pass value of the investigated UV filter system [1, 4, 5]. To this purpose, each UV filter was ranked according to its environmental hazard profile taking into account all available and reliable environmental fate and ecotoxicological data. The underlying six selected criteria were applied to all UV filters in the same way and allow for an unbiased and transparent assessment resulting in a substance-specific and thus individual hazard profile. The eco-friendliness of a UV filter composition can then be derived based on its individual hazard profiles, taking also into account the efficacy of the composition using the calculated SPF and UVA-PF in relation to the total UV filter concentration. Thus, the EcoSun Pass recognizes both the need for more ecofriendly and highly efficient UV filter compositions. It allows for the selection of the most appropriate candidates due to the combination of both criteria. The higher the EcoSun Pass value, the more environmentally friendly is the tested UV filter combination. Compounds proven to be either endocrine disruptor (according to the WHO definition) for the environment, or confirmed to be PBT, vPvB (according to ECHA guidance R11), or being acute (LC/EC50 < 0.1 mg/L) and/or chronically toxic (NOEC/EC10 < 0.01 mg/L) to aquatic organisms may be a serious threat for the environment and cannot be considered as eco-friendly. UV combinations containing such a UV filter compound will exhibit an EcoSun Pass value of zero. We assessed the EcoSun pass value of five different UV filter combinations with SPF 50 and a ratio UVA-PF/SPF of at least 1/3.

Results

Sunscreens without Octocrylene and Ethylhexyl Methoxycinnamate

OCR and EHMC are worldwide registered UVB filters included in 37% and 44% of the sunscreens launched in 2018, respectively [6]. In addition to their typical usage as UVB filtering molecule, EHMC efficiently solubilizes powdered form UV filters [7] and OCR efficiently photostabilizes instable filters such as BMDBM [8]. Both are currently under the spotlight due to ongoing scientific research, public perception and regulatory measures. Over past years, OCR has been incriminated in a number of adverse effects; it was cited to be a photosensitizer [9], entered the substance evaluation process of the ECHA in 2012 (Community Rolling Action Plan, CoRAP) due to the suspicion of being (very) persistent, (very) bioaccumulative and/or toxic (PBT and/or vPvB), is suspected to show an endocrine disruptor activity [10], which led to its review at the European level, and is currently subjected to further investigations [11]. Independently, its CLP (classification, labelling and packaging) classification was changed from aquatic chronic 4 to aquatic chronic 1 due to additional ecotoxicologically relevant data. Regarding EHMC, it was added to the CoRAP list of the ECHA in 2014 due to the suspicion of being an endocrine disruptor and/or PBT/vPvB [11]. Furthermore, some studies published the potential impact of certain UV filters including OCR and EHMC on the marine aquatic environment especially on coral reef viability [12–14]. It is worth mentioning that some of the studies provide some shortcomings in the study design and thus may not be considered as being suitable for further regulatory actions. However, some governments took already drastic regulatory actions by banning the sale and use of sunscreen products containing certain sunscreen agents. In fact, Hawaii banned the use of Benzophenone-3 (B-3), and EHMC from January 2019 [15] and Palau the use of B-3, EHMC, OCR, and/or 4-Methylbenzylidene Camphor (4-MBC) from January 2020 [16]. Finally, Brazil government published a draft regulation to control some chemicals to reduce their impact on the environment [17]. This ban proposal includes the use of B-3, EHMC, OCR and 4-MBC. From the UV filters concerned from the different bans, 4-MBC already almost disappeared from the market being used in only 3.6% and 0.9% of sunscreen products launched in 2018 worldwide and in Europe, respectively; the market share of B-3 in Europe is low since other efficient UVA filters are approved in this region [6].
Tab. 2 summarizes the situation of European approved UV filters with their maximum authorized concentration (given in % of the total formulation weight) and their status: i. minimally used (inferior to 100 to/a), ii. placement on CoRAP list for deep-

er review by ECHA, iii. widely used and not under evaluation. From 28 UV filters approved in Europe, 12 are not frequently used with an annual tonnage of less than 100; this can be when the UV filter was newly introduced, or to the opposite because of its old chemistry, or to patent restrictions, to specific exclusivity, or to some other reasons. From the 28 UV filters, 10 are under evaluation by the ECHA, the two main reasons are their suspicion of being endocrine disruptor or PBT and/or vPvB. From the 28 UV filters, only 7 UV filters are frequently used and are not under any ongoing evaulation. Yet, from the latter the frequent use of Benzophenone-4 and Benzophenone-5 is not connected to their use as UV filter in sunscreens; indeed no sunscreen was launched in Europe since the last five years with Benzophenone-5 and only a single product with Benzophenone-4 during the same period of time [18]. The limitation of the use of existing UV filters due to different motivations is not expected to be substituted by the introduction in the market of new UV filtering molecules. Despite being a cosmetic product in most of the regions, sunscreens are a special product category by themselves. The UV filters are subjected to an official approval process before being listed on a positive list, the annex VI of the cosmetic regulation in Europe [19]. During that process they are subject to an extensive scientific assessment to confirm their safety for human use [20]. Form a global perspective, the last innovative UV absorbing molecules were all developed and first launched within Europe. The generated data were subsequently used for their registration in the other non-EU regions relying on the safety assessment performed for their approval in Europe. An exception remains within the USA where sunscreens are Over-The-Counter drugs regulated by the Food and Drug Administration (FDA), including a much longer lasting approval process. Thus, the last UV filters approved in the USA were Avobenzone (1996) and Zinc Oxide (1998), since then no new UV filter molecule was listed on the sunscreen monograph. Some sunscreen producers used an NDA (new drug application) registration process to market a specific sunscreen containing a UV filter which is not listed on the sunscreen monograph [21].

Phasing out from the use of animal tests for the safety assessment of cosmetic ingredients defined under EC Directive 2003/15 [22] impacts the registration of new UV filters in Europe since a full replacement of the *in vivo* tests is not yet possible using alternative *in vitro* test methods only [1]. This disrupts not only the registration of new UV filters in Europe but also in all other regions following Europe. From March 2009, tests on vertebrates for cosmetic have been prohibited. This applies to ingredients as well as to the sale of finished products containing raw materials tested on vertebrates after that time. The deadline for the marketing ban for finished cosmetic products containing ingredients tested after 2009 on vertebrates was extended to March 2013 for some higher tier tests such as repeated dose toxicity, reproductive toxicity, and toxicokinetic testing. Yet, such animal tests are considered as mandatory under EU REACH regulation for the toxicological assessment of the substance requirements for annual tonnage exceeding 1 to. It is, therefore, difficult or even impossible to comply with both regulatory requirements (i.e. Cosmetics Directive versus REACH) considering a raw material which intended use is exclusively for cosmetic products. It should be kept in mind that Europe still had the biggest market share for sun care in 2017 with 32% [23]. Considering the high development costs and time to market which is roughly 8 to 10 years, the development and registration of a new molecule excluding the European market hence seems rather difficult. Going deeper, Mercosur (South American trade bloc) and ASEAN (Association of Southeast Asian Nations) countries follow Europe with respect to marketing ban of products containing animal (vertebrate) tested ingredients and the registration hurdles of new UV filters in the remaining important markets like China and USA is a further limitation. The big challenge for near future is, therefore, to develop sunscreens as efficient as they are today, while taking into account that both major UVB filters OCR and EHMC may not be available anymore, without any prospect of the launch of a new UVB filter that might replace these two. From the remaining UVB filters that are registered in most of the countries, excluding the specific situation in the USA, one can identify the efficient 1,3,5-Triazine derivatives as promising alternatives to EHMC and OCR due to their high absorbing efficacy. The performance of salicylate-based UV filters is insufficient to replace EHMC and OCR but they are highly valuable as solubilizers of other crystalline UV filters and are often used in combination. **Tab. 3** summarizes the properties of the alternative UVB filters in Europe. The E(1,1) max value corresponds to the extinction of the studied molecule used in 1% (w/v) solution at an optical thickness of 1 cm at maximum wavelength; it allows a

INCI	E(1,1) max[a]	Handling
Ethylhexyl Triazone (EHT)	1450	Lipophilic powder, to be dissolved
Diethylhexyl Butamido Triazone (DBT)	1450	Lipophilic powder, to be dissolved
Tris Biphenyl Triazine (TBPT)	1040	Water dispersion
Phenylbenzimidazol Sulfonic Acid (PBSA)	930	Water soluble powder, to be neutralized
Titanium Dioxide[b]	243	Lipophilic powder, to be dispersed
Ethylhexyl Salicylate (EHS)	200	Liquid oil
Polysilicone-15	180	Liquid oil
Homosalate (HMS)	165	Liquid oil

[a] closest rounding to a multiple of 5, measurements performed in ethanol for oil soluble, in water for water soluble UV filters;
[b] Titanium Dioxide (and) Aluminum Hydroxide (and) Stearic Acid

Tab. 3 INCI, Efficacy E (1,1) max and handling of alternative UVB filters in Europe.

direct comparison of the performance between the UV filters. The performance of a sunscreen depends not only on UVB but also on UVA filters. There are two commercially available organic UVA filters, DHHB and BMDBM. Since the combination of both is yet limited due to patent-related reasons, the formulator should choose between DHHB and BMDBM. Both are lipophilic molecules solid at ambient temperature that need to be dissolved to perform. SPF and UVA-PF are the main indicators for performance and are evaluated using harmonized ISO methods [24–26]. The loss of performance due to the photoinstability behavior of an individual or a mixture of UV filters are embraced in those methods. Not considered are the other effects due to the photoinstability or the photodegradation products of a UV filter. We compared the efficacy in terms of SPF, UVA-PF, and quantity of generated free radicals of two systems with SPF 30 based either on DHHB or on BMDBM, referred to as photostable UVA and Partly stabilized UVA, respectively (**Tab. 4**). **Fig. 1** displays their photostability profile.

The two systems show the same performance in terms of SPF and UVA-PF the performance indicators generally claimed. However, they differ in their photostability profile. BMDBM is efficiently photostabilized by OCR used at concentrations generally exceeding the concentration of BMDBM. In OCR free systems, the photostabilization of BMDBM relies only on BEMT, another efficient photostabilizer [8]. Since BEMT is used at concentrations much smaller than OCR the photostabilization by BEMT is less efficient than that of OCR and is unsatisfactory for OCR free systems (**Tab. 4**). Although the photoinstability is not reflected in SPF and UVA-PF values, potential adverse effects may exist such as the generation of free radicals. Free radicals may further react with other ingredients of the preparation, which may affect the integrity or efficacy of the formulation or, even worse, react with sensitive skin molecules and produce undesirable reactions [28]. We measured the quantity of free radicals generated following a UV irradiation in the placebo and the two sunscreens. The percentage of free radicals measured in the placebo formulation was close to zero which indicates that the formulation chassis used for the present investigation is not a source of free radical formation. The photostable DHHB-based sunscreen showed a number of free radicals similar to the placebo denoting that the used UV filters did not promote the formation of free radicals. Conversely, the partly photostabilized sunscreen generated ten or more times higher free radicals than the photostable sunscreen, which most likely is attributable to the photoinstability of the UV filter system.

This study disclosed two UV filter system alternatives for developing sunscreens without OCR and EHMC and showed that two preparations with a same SPF and UVA-PF do not show per se the same overall performance. Replacing UVB filter commodities such as EHMC and OCR will with the best of our knowledge lead to an increase in the cost of the whole filter system.

		Placebo	Photo-stable UVA	Partly stabi-lized UVA
UV filters	EHS	–	5.0%	4.5%
	EHT	–	1.5%	1.5%
	PBSA	–	–	1.0%
	TBPT [a]	–	2.2%	–
	BEMT	–	1.0%	2.5%
	DHHB	–	3.0%	–
	BMDBM	–	–	3.0%
Performance [b]	SPF	–	30	23
	UVA-PF	–	11.7	10.6
% generated free radicals		0.5%	2.7%	28.9%

[a] active amount,
[b] calculated with the BASF sunscreen simulator [27]

Tab. 4 SPF, UVA-PF, and generated free radicals (%) of DHHB or BMDBM based UV filter combinations.

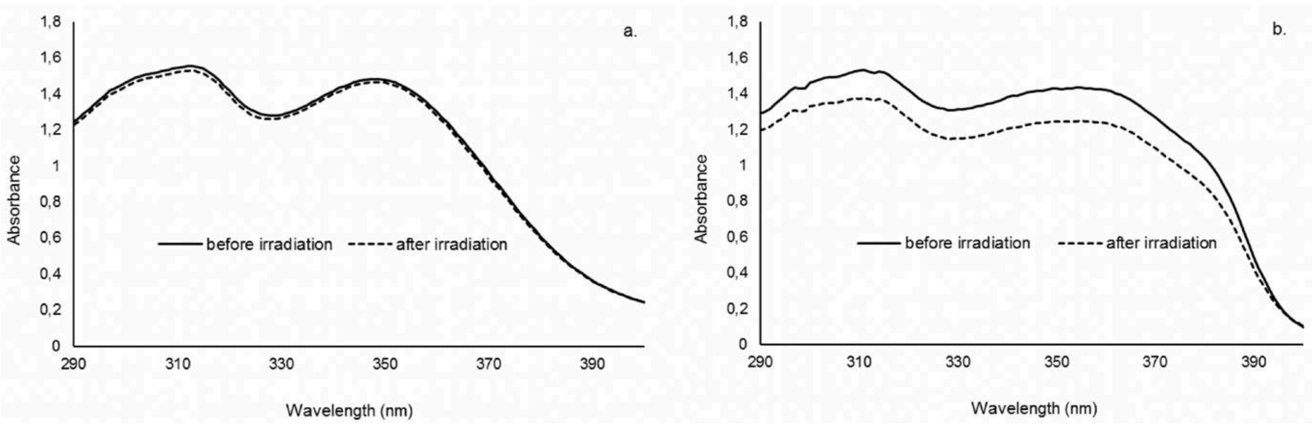

Fig. 1 Photostability profile of a) Photostable UVA and b) Partly stabilized UVA sunscreens; irradiation performed as described in ISO24443:2012.

UV filter	Form	Log Pow	Molecular weight (g/mol)	Median particle size as given in SCCS dossiers
MBBT (nano)	Particulate	12.7 [a]	659/molecule 1.4·10⁸/particle	74 nm (FOQELS)
TBPT (nano)	Particulate	10.4 [b]	538/molecule 1.7·10⁹/particle	81 nm (FOQELS)
TiO_2 (nano)	Particulate	n.a.	80/molecule 2.3·10⁸ – 4.5·10⁹/particle	28 to 75 nm (disc centrifuge)
ZnO (nano)	Particulate	n.a.	81/molecule 3.8·10⁸ – 2.4·10⁹/particle	30 to 55 nm (disc centrifuge)
PBSA	Water soluble	– 1.42 [b]	274	< 1 nm
EHMC	Oil soluble	> 6 [b]	290	< 1 nm
Polysilicone 15	Oil soluble	n.d.	6000	~ 3 nm

n.a. not applicable; n.d. no data; [a] calculated using the fragment method; [b] measured

Tab. 5 Features of nano and some soluble registered UV filters.

Nano Particulate UV Filters in Sunscreens

The image of UV filters in nano form was damaged due to downgrade in the press and by digital apps for end consumers questioning their safety profile without scientifically based evidences. This section first aims at clarifying the safety situation regarding nano-particulate UV filters and at explaining their usefulness in sunscreens. Though, UV combinations without nano particulate UV filters that might be valuable for spray applications are proposed hereafter.

Safety

The term "nano" is per definition a size descriptor and does not imply any information about human or environmental hazard. EC Regulation No 1223/2009 on cosmetic products defines a nano material as „an insoluble or biopersistant and intentionally manufactured material with one or more external dimensions, or an internal structure, on the scale from 1 to 100 nm" [29]. It seems meaningful to include the insolubility feature of a material to assess the risk since soluble nanoparticles would be dissolved and hence no longer exist in a particulate form. A concern about nano particles is their percutaneous absorption potential. Molecular weight, polarity, melting point, and thermodynamic activity (saturation concentration) of a substance are key features accounting for its skin penetration likelihood [30]. Substances with a melting point below 50°C are more likely to penetrate. Very polar substances with a partition coefficient between octanol and water (log Pow) lower than 1 and very nonpolar substances with a log Pow greater than 4 are unlikely to penetrate the skin. Additionally, according to the 500 Dalton rule, dermal penetration of substances above this molecular mass is significantly decreased [31]. There are currently four nano particulate UV filters registered: the two organic MBBT and TBPT as well as the two inorganic Titanium dioxide (TiO_2) and Zinc Oxide (ZnO) UV filters. All four went through an extensive safety evaluation of their nano form and got a positive SCCS (Scientific Committee on Consumer Safety) opinion. **Tab. 5** provides the features of the nano registered UV filters with the data for some soluble UV filters as comparison purposes. The median particle sizes (D50) were taken from the SCCS dossiers. In the case of MBBT (nano) and TBPT (nano) they were determined with fiber-optic quasi-elastic light scattering (FOQELS). This is a method based on measuring and evaluation of the diffusive particle motion and therefore is only applicable for particles which do not tend to aggregation. When aggregates are formed one would measure the size of those and not the size of the primary particles. It has been shown by electron-microscopic studies that MBBT (nano) an TBPT (nano) do not form aggregates, and thus the size distribution can be measured with this dynamic light scattering technique. With TiO_2 (nano) and ZnO (nano) disc centrifugation was used for the determination of the particle size. Since disc centrifugation is also a method based on particle motion, it is like FOQELS not suitable for particles which may form aggregates, such as TiO_2. Thus, the data given in **Tab. 5** represent most likely not the primary particle size of TiO_2. Assuming spherical geometry, one can estimate the molecular weights of the particles based on their sizes and densities. The densities of MBBT (nano), TBPT (nano), TiO_2 (nano) and ZnO (nano) are 1.12 g/cm³, 1.256 g/cm³, 4.23 g/cm³ and 5.613 g/cm³, respectively.

The log Pow of the organic nano filters MBBT and TBPT is much higher than 4, their water solubility lies in the ng/L range; their molecular weight is over 500 g/mol not to mention the molecular weight of the particles, and the melting point is 196°C and 281°C for MBBT and TBPT, respectively. Taken together these features explain the unlikeliness of nano organic UV filter to penetrate the skin. In respect of their particle size and compared to other soluble UV filters, "Nano means Big". This enlightens why there is no scientific rationale behind the fear of using nano UV filters in sunscreens due to their solely particulate nature.

Efficacy

The organic nano-particulate filters MBBT and TBPT are poorly soluble in oil; for example, the solubility in the common C12-15 Alkyl Benzoate equals 0.29% and 0.029% for MBBT and TBPT, respectively, the solubility of TBPT being one order

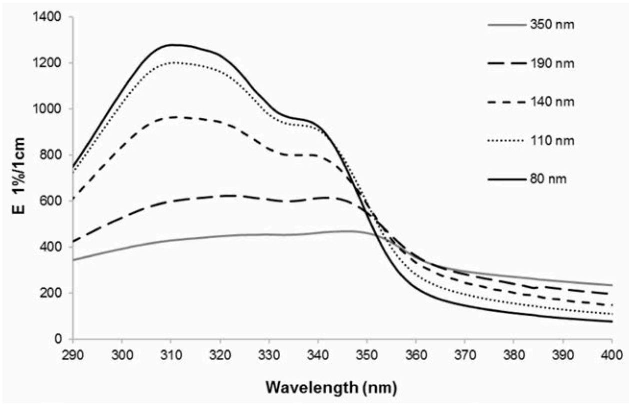

Fig. 2 Specific UV extinction E (1,1) for different particle size of TBPT.

of magnitude lower than that of MBBT. This holds also true for the solubilty in other emollients. For both, the solubility in water is much lower than in oil and lies in the range of some ng/L which makes them ideal candidates for micronization. The reduction of particle size to the nanometer-range is a prerequisite for a satisfactory UV attenuating efficacy of particulate UV-filters. **Fig. 2** illustrates the specific extinction E (1,1) as a function of wavelength for different particle sizes of TBPT. **Fig. 2** clearly shows that with the reduction of particle size a significant increase of the specific extinction of TBPT is achieved. Nano size is a must for all particulate filters to absorb efficiently UV light. However, when size reduction is achieved via milling processes, small particle size means at the same time high energy required by the mill. That means, in practice one has to find a compromise between particle size and energy consumption. It is worthwhile to notice the dependence between the spectrum shape and the particle size; the characteristic absorbance profile of TBPT is connected to its specific particle size.

Furthermore, nano-particulate UV filters show unique benefits compared to soluble UV filters. Due to their particulate nature, a part of the UV light that hits the particle is scattered; the pathlength of the light is increased and the probability that the scattered light is absorbed by another oil soluble UV filter is increased. This boosting of the photoprotection was investigated and described in details by Herzog et al [32]. An additional benefit of the scattering mechanism of the particulate UV filters is the reduction of the transmission in the visible range, especially in the blue waveband, providing an extension of the photoprotection into the visible range as illustrated in **Fig. 3**.

If nevertheless a UV filter combination without nano-particles is required, solutions are presented in **Tab. 6** for SPF 30 to 50+.

Starting from the photostable system based on EHT, DHHB and BEMT as core UV filters, the SPF is adjusted with the addition of either DBT or PBSA. A performance boosting might be obtained using the water soluble UV filter which may, however, become an issue when water resistance is targeted. This is different for the water dispersed nano-particulate UV filters which do not negatively impact the water resistance of a formulation since they are hydrodispersed and not solved in the water phase, the likelihood to be washed off is reduced.

Environmental Impact of Sunscreens

Most of us feel concerned with the climate change and its environmental consequences for our planet, people try to change their behavior to contribute at their level to the protection and saving of our earth. In the cosmetic research, scientists work on sustainable solutions in order to meet both human and environmental safety needs. From the personal care segments, the sun care field is particularly affected by the public discussion regarding the damages UV filters may have on the ecosystem as they are likely to be directly released into the environment. A major recent ecological-related public concern is related to global coral bleaching. Significant contributors to current coral reef bleaching and damaging

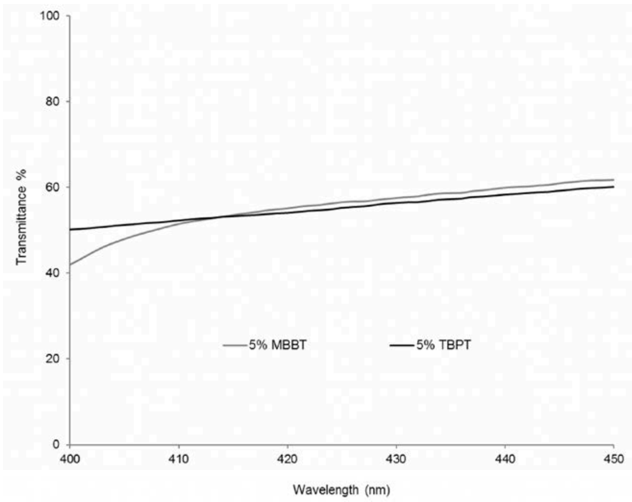

Fig. 3 Reduction of the blue light transmittance by MBBT and TBPT.

UV filters	SPF 30	SPF 50	SPF 50	SPF 50+	SPF 50+
EHS	5.0%	5.0%	–	5.0%	5.0%
EHT	3.0%	3.0%	3.0%	3.0%	3.0%
DBT	–	3.0%	–	4.0%	–
PBSA	–	–	3.5%	–	3.0%
BEMT	2.0%	3.0%	3.0%	3.0%	3.0%
DHHB	4.0%	6.0%	6.0%	6.0%	6.0%
BEMT Aq.[a]	1.0%	1.0%	1.0%	2.5%	2.5%

[a] active amount of BEMT (Tinosorb S Lite Aqua) in the formulation

Tab. 6 UV combinations without nano filters for SPF 30, 50 and 50+ with a ratio UVA-PF/SPF of at least 1/3.

	System 1	System 2	System 3	System 4	System 5
OCR	10.0%	–	–	–	–
EHMC	–	10.0%	–	–	–
EHS	5.0%	5.0%	5.0%	5.0%	–
EHT	–	2.5%	3.0%	2.5%	2.0%
TBPT	3.0%	–	2.0%	3.0%	3.0%
BEMT	2.0%	–	4.0%	1.0%	2.5%
MBBT	–	2.0%	1.5%	2.0%	6.0%
DHHB	–	8.0%	–	4.0%	–
BMDBM	4.0%	–	4.0%	–	–
Total Filter %	24%	27.5%	19.5%	17.5%	13.5%
SPF *in vivo*	53	54	–	53	57
SPF *in silico* [a]	51	50	50	49	49
EcoSun Pass [b]	0	160	195	228	272

[a] calculated with the BASF sunscreen simulator, rounded up to next whole number,
[b] application of the cut-off criterium

Tab. 7 Ecosun Pass value and SPF of five UV filters combinations.

are the increase of the water temperature and ocean acidification through the climate change, marine debris and pollution, physical stress by hurricanes, or fishing practices [33–37]. Independently, some authors investigated the impact of chemicals such as cosmetic UV filters on reef building corals [12–14] initiating the discussion on the impact of sunscreens on corals. Those studies, which at present should be considered as preliminary information only, require in depth assessment and validation (e.g. according to [38]) before they should be taken for any regulatory measures. In addition, the merit of these type of research studies is very often that they are not fit for purpose since study protocols do not follow approved principals of standardized test guidelines and thus important and relevant parameters (i.e. water quality) may have not been measured. For many non-standardised test organisms such as reef building corals, no approved and agreed study protocols exist, which on the other hand triggers the need to develop such test protocols. Meanwhile some governments already took drastic regulatory actions by prohibiting the sale of sunscreens containing some of the worldwide registered UV filters. However, such decisions are problematic since the use of sunscreens has been demonstrated to be highly valuable for human health by helping to prevent skin cancers [39–43], highlighting the importance of scientifically sound hazard and risk assessment.

The market response of some manufacturers to the consumer perception that sunscreens impact the environment is to advertise an improved biodegradability of the formulation, using however a methodology developed for the testing of raw materials and not of finished formulations [44]. Moreover, describing the eco-friendliness of a UV filter combination using biodegradability as single parameter is not sufficient. The assessment of the eco-friendliness of a UV filter system should be a global approach involving all ecological relevant and internationally accepted criteria. To this end, we developed a transparent calculation methodology, termed as EcoSun Pass to investigate the environmental footprint of UV filters and provide a solution to improve the UV filter system to be more eco-compliant. We assessed the impact of five different UV filter combinations with SPF 50 and a ratio UVA-PF/SPF of at least 1/3 on the EcoSun pass value (**Tab. 7**).

All five investigated UV filter combinations show the same efficacy in terms of SPF achieving *in vivo* values of more than 50 which correlate very well with the simulated SPF values. The five systems, however, highly differ in their EcoSun Pass value. The cut-off criterion was applied to System 1 due to chronic toxicity of OCR to aquatic organisms resulting in an EcoSun Pass value of zero; this combination cannot be considered to be eco-compatible. The EcoSun Pass value of the UV combination 2 based on the UVB filter EHMC equals 160. This value is increased in the three systems without EHMC. UV combination 3 based on BMDBM reaches a value of 195, while the value of combination 4 based on DHHB jumps up to 228. Finally, the highest EcoSun Pass value is achieved for the combination 5 which is a mixture of highly efficient and photostable UV filters. Due to the efficiency and photostability of the UV filters the total concentration is much lower than for the other tested combinations. The summation of the excellent environmental hazard score of the UV filters contained in system 5 and the low required concentration explains the high EcoSun Pass value and consequently the eco-friendliness of system 5. This shows that it is possible to develop sunscreens that consider the impact on the environment. However, the cost of an eco-sustainable sunscreen will to the best of our knowledge be higher than the one of a standard sunscreen.

Conclusion

In this contribution we have discussed some urgent challenges sunscreen developers and manufacturers are currently facing, and we have pointed out some possible solutions. However, most of these suggestions imply certain compromises. A compromise may be for instance the acceptance of nano-particulate UV filters when the primary goal is to develop a sunscreen which is safe for the environment and which does contain neither EHMC nor OCR. Another compromise may be to drop the eco-friendliness or water resistance when the target is to be free of nano-particles. Also, each UV filter choice restriction is expected to impact the cost of the product. A new issue is the discussion of microplastics, which

affects the whole personal care segment, and also touches sunscreens. Replacing some of the universally used polymers which help ameliorate formulation stability, sensorial properties and water-resistance might become a further new challenge in suncare.

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content

A Natural-based 360° Approach for Optimized Sunscreen Formulations

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abstract

Consumers expect from their sunscreen products not only highly effective protection from UV rays, optimal water resistance, formulation stability and at the same time a light and dry skin feel. The rising environmental awareness also leads to a higher demand for responsibly sourced and sustainable ingredients.

The formulator's dilemma is to find sustainably sourced alternatives to ingredients that are under scrutiny such as SPF-boosters, film formers and other typically synthetic or silicone-derived raw materials used in sunscreens – without compromise in the formulation performance, stability and skin feel.

Here we describe a multifunctional blend that is unique in its natural and holistic approach to the multiple challenges of formulating modern sunscreen products. It can effectively enhance the efficiency of the used UV-filters, improve the water resistance and formulation stability, and has a beneficial impact on the skin feel of the emulsions. Based on responsibly sourced raw materials, it is the next step towards a higher degree of sustainability and naturalness in sun protection cosmetics.

Introduction

Formulators of sun protection products are confronted with a variety of different, sometimes controversial, challenges.

- The increasing demand for high SPFs leads to higher oil content, more electrolytes and pigments which may eventually destabilize emulsions.
- High oil contents affect skin feel and texture and hinder the formulation of light and dry products.
- UV-filters do not always reach their full protection capacity due to a lack in film forming and uneven droplet distribution.
- The need for higher emulsifier concentrations to achieve stable formulations can negatively influence the water resistance of sunscreen emulsions.
- Film forming products promising to retain water resistance often lead to a tacky or dull sensation on skin, which may decrease consumer acceptance.
- The desire for more naturalness in cosmetics and the demand for ingredients to replace micro-plastics and synthetic or silicone-based ingredients.

A number of different raw materials is usually needed to satisfy every single requirement. So called SPF-boosters, film formers and co-emulsifiers are typical candidates.

SymEffect™ Sun, a multifunctional blend made of beeswax and a natural based anionic lactic acid ester fulfills all of these challenges with just using one ingredient, and thus offers a sustainable alternative for modern sun care (**Fig. 1**).

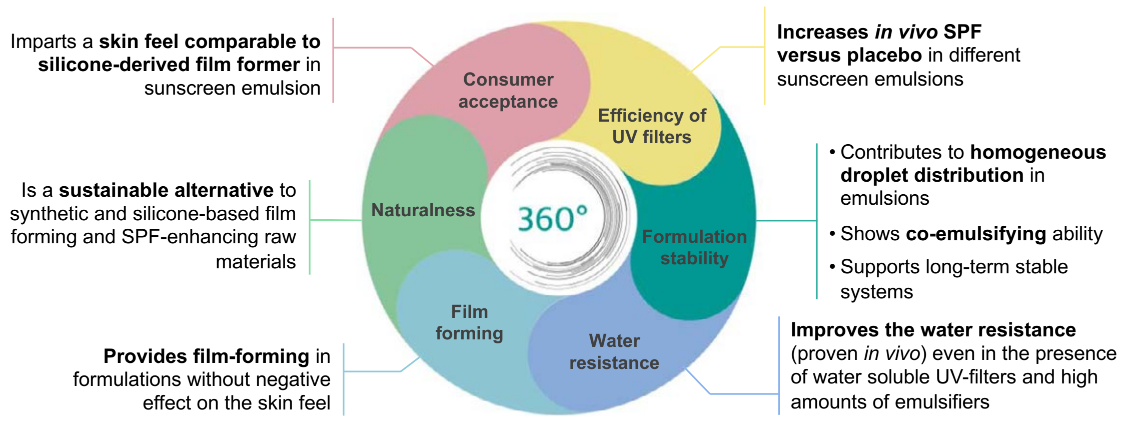

Fig. 1 360° approach – SymEffect™ Sun

Ingredient	Sunscreen Balm, emulsifier-free		Sunscreen Lotion O/W, natural based		O/W Lotion, low SPF		O/W Lotion, medium SPF		O/W Lotion, high SPF		O/W Lotion, very high SPF	
	Placebo	with Sym-Effect™ Sun	Placebo	with Sym-Effect™ Sun	Placebo	with Sym-Effect™ Sun	Placebo	with Sym-Effect™ Sun	Placebo	with Sym-Effect™ Sun	Placebo	with Sym-Effect™ Sun
Glyceryl Oleate Citrate, Caprylic/Capric Triglyceride (Dracorin® GOC)					1,50	1,50	1,50	1,50	2,00	2,00		
Potassium Cetyl Phosphate, Hydrogenated Palm Glycerides (Emulsiphos®)			2,50	2,50							2,00	2,00
Cetearyl Alkohol			1,50	1,50	3,00		3,00					
Cera Alba, Sodium Stearoyl Lactylate (SymEffect® Sun)		2,00		3,00		3,00		3,00		1,50		2,00
Butyl Methoxydibenzoylmethane (Neo Heliopan® 357)	5,00	5,00	5,00	5,00	2,50	2,50	3,50	3,50	5,00	5,00	5,00	5,00
Homosalate (Neo Heliopan® HMS)	8,00	8,00	5,00	5,00	2,00	2,00	4,00	4,00	10,00	10,00	10,00	10,00
Octocrylene (Neo Heliopan® 303)	8,00	8,00	10,00	10,00	2,00	2,00	4,00	4,00	10,00	10,00	10,00	10,00
Ethylhexyl Salicylate (Neo Heliopan® OS)	5,00	5,00	5,00	5,00	0,00	0,00	3,00	3,00	5,00	5,00	5,00	5,00
Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine (Neo Heliopan® BMT)	3,00	3,00							3,00	3,00		
Benzylidene Dimethoxydimethylindanone (SymUrban®)					0,50	0,50	0,50	0,50				
Propanediol Dicaprylate/Caprate (SymMollient® PDCC)	3,00	3,00	2,00	2,00	5,00	5,00	5,00	5,00	3,00	3,00	4,00	4,00
Cetearyl Nonanoate (SymMollient® S green)			2,00	2,00								
Ethylhexyl Isononanoate (Dragoxat® 89)	2,00	2,00	1,00	1,00					2,00	2,00		
Cetearyl Ethylhexanoate (PCL-Liquid® 100)									2,00	2,00		
Diisopropyl Adipate (Isoadipate)			1,50	1,50	5,00	5,00	5,00	5,00				
Caprylic/Capric Triglyceride			1,50	1,50	3,00	3,00						
Hexyldecanol, Bisabolol, Cetylhydroxyproline Palmitamide, Stearic Acid, Brassica Campestris (Rapeseed) Sterols (SymRepair® 100)					1,00	1,00	1,00	1,00			1,00	1,00
Caprylic/Capric Triglyceride, Hydroxymethoxyphenyl Decanone (SymDecanox® HA)			1,00	1,00	1,00	1,00	1,00	1,00			1,00	1,00
Disodium EDTA	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
Sodium Polyacryldimethyl Taurate	1,10	1,10										
Xanthan Gum			0,30	0,30	0,30	0,30	0,30	0,30	0,60	0,60	0,30	0,30
Acrylates/C10-30 Alkyl Acrylate Crosspolymer					0,30	0,30	0,30	0,30			0,30	0,30
Cyamopsis Tetragonoloba (Guar) Gum			0,17	0,17								
C18-22 Hydroxyalkyl Hydroxypropyl Guar			0,33	0,33								
Aqua	58,15	56,15	53,57	50,57	65,00	65,00	59,10	59,10	51,85	50,35	50,10	48,10
Sodium Cetearyl Sulfate			0,75	0,75								
Glycerin			1,00	1,00	3,00	3,00	3,00	3,00	1,50	1,50	3,00	3,00
Phenylbenzimidazole Sulfonic Acid (Neo Heliopan® Hydro)	1,00	1,00	2,00	2,00	1,50	1,50	2,00	2,00			2,00	2,00
Arginine (Biotive® L-Arginine)	0,60	0,60	1,00	1,00	1,60	1,60	2,00	2,00				
Sodium Hydroxide			1,33	1,33							5,00	5,00
Hydroxyacetophenone (SymSave® H)	0,50	0,50			0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
Pentylene Glycol (Hydrolite® 5 green)	2,00	2,00							1,00	1,00		
Caprylyl Glycol (Hydrolite® CG)	0,25	0,25							0,25	0,25		
Phenoxyethanol, Hydroxyacetophenone, Caprylyl Glycol, Aqua (SymOcide® PH)			1,45	1,45								
1,2-Hexanediol, Caprylyl Glycol (SymDiol® 68)					0,50	0,50	0,50	0,50			0,50	0,50
Hyaluronic Acid	0,10	0,10										
Carnosine (Dragosine®)	0,20	0,20			0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20
Fragrance					0,50	0,50	0,50	0,50				
Calcium Starch Octenylsuccinate									2,00	2,00		
Cellulose	2,00	2,00										

Tab. 1 Sunscreen formulations used for *in vivo* SPF determination

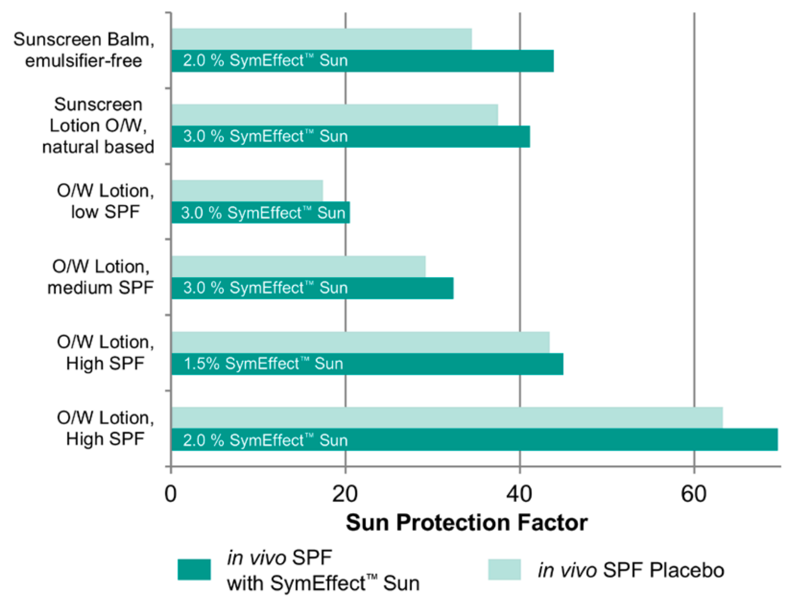

Fig. 2 *In vivo* SPF vs. Placebo in different Sunscreen formulations

The blend is easy to handle due to its convenient pelletized form and can be incorporated in sunscreen emulsions via the heated oil phase.

Product Performance

UV Protection

Reaching the desired sun protection factor can be a challenge depending on the formulation and the used UV-filters.
To evaluate the effect on the *in vivo* SPF, multiple sunscreen emulsions with sun protection factors from 20 to 50plus using different levels of SymEffect™ Sun were compared to placebo-formulations without the blend. Formulation bases and UV-filter combinations are evaluated as displayed in **Tab. 1**.
The tests were conducted by different independent and accredited test institutes and measured according to ISO 24444: 2010, *In vivo* – determination of the sun protection factor [1] on a reduced indicative panel of 5–6 subjects.
According to this norm, the SPF determination follows a defined test protocol.
Defined areas of a volunteer's skin are exposed to incremental increased ultraviolet light doses without any protection, while other areas are exposed after a defined amount of sunscreen product has been applied. To determine the sun protection factor, the erythemal responses of the skin (visually assessed for presence of redness 16 h to 24 h after UV radiation) are judged by a competent evaluator. The lowest dose of UV light provoking an erythemal response is defined as the minimal erythemal dose (MED). The ratio of the MED obtained on the protected skin divided by the MED of unprotected skin is calculated and defined as SPF.
The tests prove that the emulsions using SymEffect™ Sun have an *in vivo* SPF 10–27% higher than the respective placebo formulation. In **Fig. 2** the SPF of the different formulations are compared to placebo formula.
The test results show no linear correlation between the amount of SymEffect™ Sun and the increase of the SPF. We suppose that the composition of the formulation, the oil droplet distribution and the type of emulsifier and application form influence the strength of the observed effect additionally. For example, we noticed a higher increase of the *in vivo* SPF for the emulsifier-free balm formulation than for traditional emulsions.
However, the blend proves its ability to enhance the efficiency of the UV-filters in all formulations.

Formulation Stability

Particularly when high SPFs are required, the oil phase contributes to a large part of the formulation. Water soluble UV-filters increase the electrolyte content as a side effect and finally a certain amount of inorganic UV-filters may need to be incorporated. Frequently this leads to weakness in formulation stability. Counteracting here with an increase of the emulsifier concentration can negatively impact the water resistance of the final formulation.
Investigating various O/W emulsions on their particle size via microscope, it was found that the multifunctional blend can contribute to a more homogeneous droplet distribution. **Fig. 3** shows microscope pictures in a 600x magnification of a sunscreen formulation using 2% of SymEffect™ Sun versus the placebo formulation (the amount of SymEffect™ Sun was substituted with water in the placebo formulation).
Smaller and very homogeneously distributed oil droplets compared to the placebo formulation are a good indication that SymEffect™ Sun improves the formulation stability.
A long-term stability test of both formulations confirms the positive influence. The emulsion with SymEffect™ Sun has a superior stability over 3 months at elevated temperatures, while the placebo formulation starts to separate after 1 month storage at 45°C and higher.

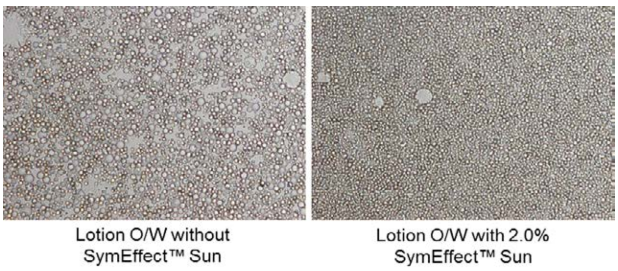

Fig. 3 Microscope pictures of sunscreen formulations without and with SymEffect™ Sun

SymEffect™ Sun contributes to formulation stability – even in the case of demanding formulation tasks it is not necessary to increase the amount of emulsifier or add co-emulsifier.

Low Viscous Formulations

Sun protection products are offered in a wide range of application forms. Creams and lotions are common, but also sticks and especially sprayable products have grown in popularity over the recent years. Therefore it is very important for a multi-functional ingredient that it can be used in all kind of application forms. The described blend is based on a high melting wax and it suggests that such a blend exhibits an increasing effect on the viscosity of the final product. Such an effect would of course be counter-productive for the development of fluid or sprayable emulsion systems.
To evaluate the effect of the waxy blend in a fluid sunscreen formula, an emulsion based on a liquid emulsifier and Xanthan Gum as water-soluble thickening polymer is prepared with increasing amounts of SymEffect™ Sun (**Tab. 2**).
The viscosity was measured comparatively one day after manufacturing and after 3 months of storage at room temperature and 40°C. For the measurement a Brookfield® DVIII rheometer is used, with spindle CP51 at rotation speed 10rpm and a controlled temperature of 20°C. The results (**Fig. 4**) illustrate that also in long-term virtually no change of the viscosity was detected. Independent from the use level, SymEffect™ Sun is suitable for low viscous systems, as well as for creams and lotions, and can support the long-term stability of an emulsion's viscosity.

Phase	Ingredient	Placebo	1.5–4% SymEffect™ Sun
A	Glyceryl Oleate Citrate, Caprylic/Capric Triglyceride (Dracorin® GOC)	2.00	2.00
	Cera Alba, Sodium Stearoyl Lactylate (SymEffect™ Sun)	–	1.50–4.00
	Octocrylene (Neo Heliopan® 303)	10.00	10.00
	Butyl Methoxydibenzoylmethane (Neo Heliopan® 357)	5.00	5.00
	Homosalate (Neo Heliopan® HMS)	10.00	10.00
	Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine (Neo Heliopan® BMT)	3.00	3.00
	Ethylhexyl Salicylate (Neo Heliopan® OS)	5.00	5.00
	Propanediol Dicaprylate/Caprate (SymMollient® PDCC)	3.00	3.00
	Ethylhexyl Isononanoate (Dragoxat® 89)	2.00	2.00
	Cetearyl Ethylhexanoate (PCL-Liquid® 100)	2.00	2.00
	Disodium EDTA	0.10	0.10
B	Xanthan Gum	0.60	0.60
C	Aqua	51.55	50.05–47.55
	Glycerin	1.50	1.50
	Hydroxyacetophenone (SymSave® H)	0.50	0.50
	Pentylene Glycol (Hydrolite® 5 green)	1.00	1.00
	Caprylyl Glycol (Hydrolite® CG)	0.25	0.25
	Carnosine (Dragosine®)	0.20	0.20
D	Calcium Starch Octenylsuccinate	2.00	2.00
	Fragrance	0.30	0.30
		100.00	100.00

Tab. 2 Sunscreen formulation using increasing amounts of SymEffect™ Sun

Water Resistance & Film Forming

To reach high and very high protection factors in sunscreen emulsions, formulators often combine oil – and water-soluble UV-filters. Combinations of oil- and water-soluble filters may exhibit a synergistic effect on the *in vivo* SPF, which results in a lower overall UV-filter amount.
Particularly Phenylbenzimidazole Sulfonic Acid (used in its salt form) is a very potent water-soluble UVB-filter and allows decreasing the content of UVB-filters in the oil phase. By reducing the content of oil-soluble UV-filters, the skin feel of the final formulation can be improved.

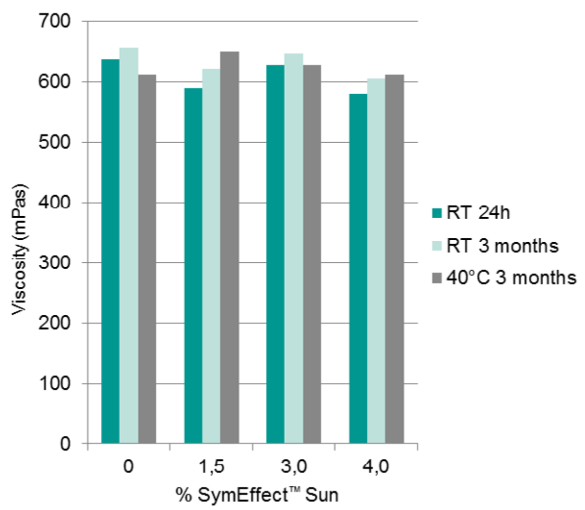

Fig. 4 Results of comparative viscosity measurement of sunscreen emulsions with increasing amount of SymEffect™ Sun

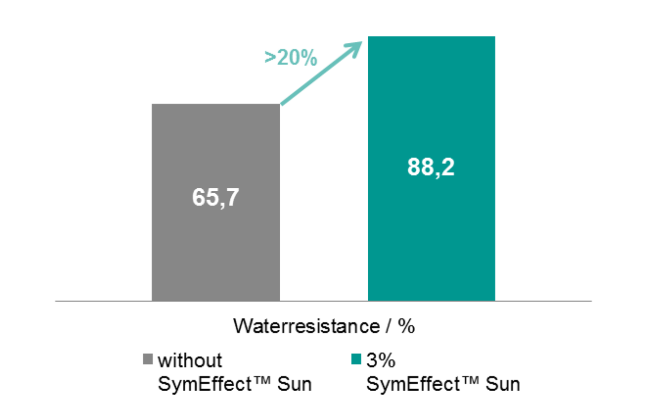

Fig. 5 *in vivo*-measurement of the water resistance

However, the use of water-soluble sunscreen filters can have an adverse effect when it comes to water resistance, an important attribute especially for beach products and kids sunscreens with high SPF.

The ability of the described blend to increase the water resistance, even in the presence of hydrophilic UV-filter, is determined in an O/W emulsion containing 2% water-soluble UV filter and 3% of the blend without additional film forming products (**Tab. 1**, Sunscreen Lotion O/W, natural based).

The emulsion is measured by an accredited and independent test institute for its water resistance in comparison to the placebo formulation, according to the COLIPA guidelines for evaluating sun product water resistance, December 2005 [2].

According to the test protocol the *static SPF* (SPF measured according to ISO 24444:2010 [1]) is compared to the so called *wet SPF:*

To determine the *wet SPF* the procedure of SPF measurement is interrupted by the water immersion step after applying the sunscreen product to the skin:

The skin is immersed with water for 20 minutes and allowed to dry for 15 min without toweling. The immersion is repeated for 20 minutes and the skin allowed drying completely without toweling for at least 15 min.

Afterwards the measurement of the SPF is resumed and the wet SPF determined. The water resistance is defined as the ratio between *wet SPF* and *static SPF.*

Fig. 5 shows the superior performance of the formulation with SymEffect™ Sun versus placebo. The water resistance is increased by more than 20%.

To illustrate the gentle film forming provided by the blend, sunscreen lotions with and without 1.5% SymEffect™ Sun are distributed on microscope glass slides and dried at room temperature for 30 min.

The lotion without the blend shows an inhomogeneous film with droplets on the surface while drying, whereas with SymEffect™ Sun, the dried emulsion did not form such

content

droplets. This indicates that the ingredients of water- and oil phase stay homogenously distributed, even after drying (**Fig. 6**).

The emulsion with SymEffect™ Sun forms a uniform surface without droplet formation. Even in the presence of water-soluble sunscreen filters the blend is able to improve the water resistance, proven *in vivo*. The use of additional film forming products which may compromise the skin feel is not necessary to enhance the water resistance.

Naturalness

SymEffect™ Sun is the next step towards a high degree of sustainability and naturalness in sun protection cosmetics.

The natural-derived blend proves to impart a positive effect on *in vivo* SPF, water resistance, formulation stability and film forming just by using one ingredient, and thus offers a sustainable alternative for developing modern sun care products.

It makes the use of synthetic and silicone-based film forming and SPF-enhancing raw materials obsolete, is compatible with various natural thickeners helping to avoid thickeners based on micro-plastics and so enhances the Natural Origin Content (ISO 16128) [3, 4] of sunscreen formulations.

As all ingredients of SymEffect™ Sun are biodegradable, the product is an environmental friendly way to improve many aspects of sunscreen emulsions.

Fig. 6 Emulsions with and without SymEffect™ Sun after 30 min drying at RT

Consumer Acceptance

Consumer acceptance is indispensable for a successful sun protection product. One of the most important parameter is its sensorial performance or in short its skin feel. The expectation is a light and dry skin feel, even for high SPF products. To evaluate the influence of SymEffect™ Sun on the skin feel of sunscreen emulsions, a sensory assessment conducted by a trained test panel was done comparing a sunscreen emulsion using 2% of SymEffect™ Sun to the formulation using the same amount of silicone-derived film former (Stearyl Dimethicone) as benchmark.

The assessment was divided in three aspects, first impression (turquoise part), during application (gray part) and after application (pink part), as shown in **Fig. 7**:

In the first impression (Pick up, Peaking, Cushion, Consistency) the formulation with SymEffect™ Sun was better rated than the one with Stearyl Dimethicone.

During application SymEffect™ Sun is found to be less waxy and less blunt and has lower whitening.

After application the emulsion with SymEffect™ Sun was rated as more waxy and the overall acceptance is rated slightly higher than the silicone formulation.

The panel attests that both emulsions have no significant deviations to each other, so SymEffect™ Sun is able to provide a skin feel which is at least comparable to silicone derived film former.

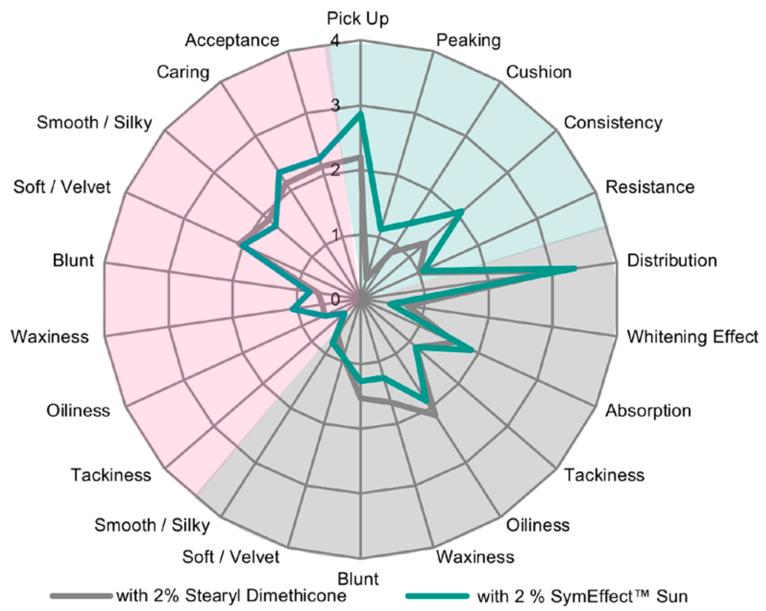

Fig. 7 SPF 30 Sun care lotion with 2% SymEffect™ Sun vs. 2% Stearyl Dimethicone

Providing gentle film-forming in formulations, SymEffect™ Sun shows no tacky or dull sensation on skin typically caused by synthetic film forming products and can narrow the negative effects of high amounts of UV-filters and pigments on the skin feel.
It enables to achieve a contemporary skin feel with almost no tack and low oiliness in sunscreen emulsions without using silicone derivatives.

Conclusion

SymEffect™ Sun offers a 360° solution for all challenges in developing modern sunscreen products. With its *in vivo* proven efficacy in enhancing the SPF and water resistance, its contribution to emulsion stability, gentle film-forming without imparting negative effects on the skin feel, it is an alternative to a bunch of different raw materials commonly used to formulate effective sunscreen emulsions.

Globally approved and made of sustainable sourced, 100% renewable raw materials, SymEffect™ Sun is the next step towards a high degree of sustainability and naturalness in sun protection cosmetics.

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Sunscreen Diversity – more Options for Sunscreen Ingredients

T. Schatz, J. O'Hara

abstract

Most consumers are not applying enough sunscreen to achieve adequate sun protection against skin cancer [1]. At the same time, an evolving FDA Monograph, regional regulations, and consumer concerns over environmental impacts are shrinking the formulator's toolbox to provide this protection, particularly in the United States. The recent surge of demand for inorganic mineral sunscreens, for example, is driven by a perception of safety, naturality, and favorable environmental impact. However, mineral formulas also have their aesthetic and safety challenges, and organic sunscreens remain the dominant technology due to their aesthetics, cost, and ease of application. To ensure consumer safety, it is critical that formulators leverage the full range of UV filters (both inorganic and organic), and supporting ingredients, to provide a wide range of choices and textures for safe, high SPF, broad spectrum protection. More diverse sunscreen options will enable consumers to find the right sunscreen for their skin needs and lifestyle, increasing use and reapplication to defend against skin cancer.

Why are Sunscreens Important?

Sunscreens are an important way to prevent overexposure to UV radiation, known to cause skin cancer (melanoma and nonmelanoma), premature skin aging (often resulting in wrinkles or age spots), immune system suppression, and other cellular damage. In particular, melanoma, a deadly form of skin cancer, has been on the rise in America for the past decade, with the Surgeon General identifying melanoma as increasing at an alarming rate. High sun protection factor (SPF; above 30), broad spectrum (including strong UVA protection), and water resistant sunscreen is a powerful defense against the harmful effects of sun damage [1]. Unfortunately, most consumers apply only 25–50% of the recommended amount of sunscreen [1]. It's important to create aesthetically-pleasing sunscreens to make it easier for consumers to apply.

Regulatory Status and Timeline

Sunscreen active ingredients fall into two major chemical categories, inorganic and organic. Inorganic or 'mineral' sunscreen ingredients include zinc oxide and titanium dioxide. Organic UV filters include avobenzone, oxybenzone, octocrylene, octisalate, homosolate, padimate O, sulisobenzone, and oxtinoxate. Both inorganic and organic sunscreens are capable of providing sun protection, but come with different regulatory considerations in and outside the US.

One of the largest regulatory changes is occurring in the US: in 2019, FDA proposed an update to the monograph for sunscreen ingredients ('Tentative Final Monograph'). As part of this assessment, it categorized the 16 sunscreen active ingredients sold on the US market into one of three categories based on safety. Only two, both inorganic – non-nano-sized zinc oxide and titanium dioxide – have been deemed generally recognized as safe (GRAS; Category I) for human use by the FDA, while a couple of ingredients have been deemed unsafe and banned for sale in the US (Category II). Most organic sunscreen actives, however, have been placed into Category III: not deemed unsafe, but requiring additional data to determine GRAS status.

On March 27, 2020, Congress enacted the "Coronavirus Aid, Relief, and Economic Security Act" ("CARES act"), which included OTC monograph reform provisions. The OTC provisions fundamentally change how the FDA regulates drugs marketed under a monograph and terminates the FDA's Tentative Final Monograph of 2019. The PCPC Sun Consortium will continue with the current workstreams while maintaining contact with US FDA to seek clarity on next steps.

So, what's next? It is expected that the FDA will resubmit the proposed sunscreen monograph rule to the white house's office of management and budget (OMB) for review by the end of 2020. Once approved by OMB, the proposed rule will be finalized and come into effect. The Personal Care industry remains able to formulate with Category III sunscreens as long as they continue to demonstrate progress toward completion of the testing requirements. Until then, the FDA is explicitly encouraging the continued sale and use of category III organic sunscreens.

Beside the FDA monograph, other regulatory changes have occurred in and outside the US. In the US, some states and cities are banning octinoxate and oxybenzone from sunscreens due to concerns of coral reef bleaching, partly driving a shift to inorganic filters. However, allegations linking oxy-

benzone/octinoxate and coral bleaching are based largely on inadequate scientific studies that do not meet required quality controls used by regulatory and scientific research bodies worldwide [2, 3].
Meanwhile in Europe, inorganic filters remain uncommon due to consumer concerns over the health effects of nanoparticles, including both consumer perception and EU classification of TiO_2 as a potential carcinogen [4]. There, emerging concerns around specific chemistries like Octocrylene have not driven a shift to inorganic UV filters but to alternative organic UV filters not yet approved in the US, such as Bemotrizinol, Ethylhexyltriazone, and Diethylamino hydroxybenzoyl hexyl benzoate.
In general, changes in both the US and the EU are increasing sunscreen costs, impacting sunscreen aesthetics and exacerbating the risk that consumers will reduce their already-insufficient use of essential sun protection products.

Why We are Advocating for Organic UV Filters in the US

Despite some of the recent challenges of organic sunscreens, they are monitored and approved for safety by regulatory bodies such as the FDA , and the resulting formulas are screened against strict safety standards. Organic UV filters have been safely used for many years to make cost-effective, broad-spectrum, long-wearing, water-resistant, easy-to-apply, non-whitening sunscreens. They enable even coverage in different product forms, and also feel better with less drag, enabling consumers to reapply more often. As consumers are already using too little sunscreen, willingness to reapply is key to preventing overexposure to the sun and the formation of dangerous melanomas.
Mineral sunscreens, perceived as a clean and/or natural solution, are experiencing both significant growth and improvements in aesthetics and performance. At the same time, many

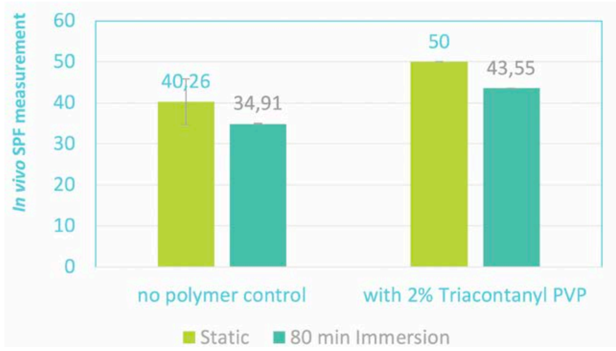

Fig. 1 *in-vivo* SPF measurement.

of them still leave a white cast on skin or furniture, impart a heavier feel, and can wear off more quickly – requiring more frequent reapplication despite an aesthetic profile that may discourage it. While zinc oxide has been favored as a 'reef safe' solution, zinc oxide is toxic to aquatic organisms [5] and may come with their own environmental hazards.
While there is no perfect sunscreen, the critical imperative is to arm consumers with the tools necessary to encourage and achieve adequate sun protection. This means maintaining and growing the formulation toolbox, of which both organics and inorganics are key and complementary components.

Enhancing the Efficacy of Organic and Inorganic Sunscreens

Formulators can work with tried-and true ingredients to achieve adequate sun protection, even when the UV filter toolbox is limited.
For example, vegan suitable *Triacontanyl PVP* and *VP/Eicosene Copolymer* film-forming polymers robustly boost the SPF of organic and inorganic formulations (**Fig. 1**). In organic formulations, these polymers can therefore compensate for

SPF challenges caused by limitations on the range of UV filters. In inorganic formulations, they can enable formulators to achieve the same SPF at lower mineral levels, significantly improving skin feel while reducing skin whitening.

In 'reef-safe' formulations where naturality and biodegradability are critical, cellulose derivatives can be used to provide improved performance. In organic formulations, certain grades of *Ethylcellulose* can provide cost-effective, nature-based water resistance in place of conventional film formers, both in emulsion and spray formats. For inorganic sunscreens, certain grades of *Hydroxyethylcellulose* can be used to improve slip and spreadability.

Some of the most significant challenges caused by limitations in the UV filter toolbox are in achieving sufficient UVA protection, a requirement in many regions and in the FDA's tentative final monograph. Here the nature-identical solubilizer *Phenethyl Benzoate* can offer multiple benefits. It is a highly efficient solubilizer for UVA absorbers (e.g. bemotrizinol, ethylhexyltriazone). Phenethyl Benzoate can also photostabilize and extend the critical wavelength of Avobenzone (**Fig. 2**), significantly improving UVA protection.

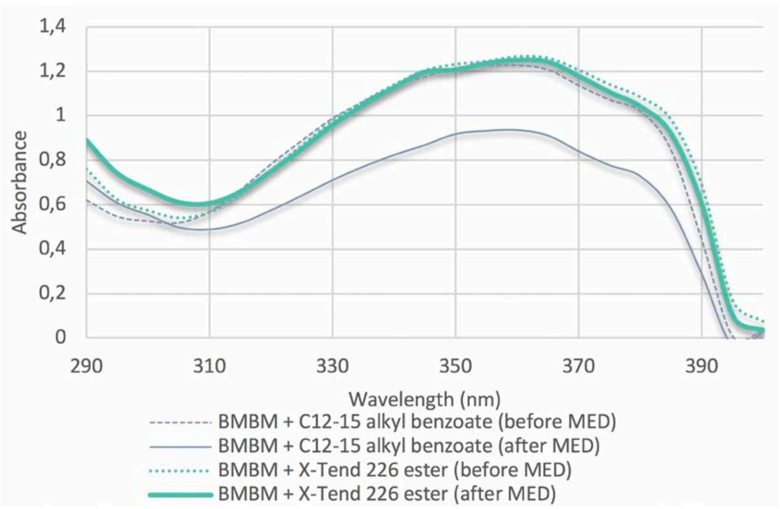

Fig. 2 Photostability of Avobenzone (BMBM) after 10 MEDs (minimal erythema doses).

How We're Helping

Ashland is a key member, and one of the few ingredient supplier members, of the Personal Care Products Council (PCPC) and participant of the PASS Coalition for the advancement of sunscreen protection for the American consumer. Within these groups, Ashland and leading sun care suppliers and finished goods providers, have proposed a scientific work plan. This plan determines if further testing is needed and is based on data from non-animal *in vitro* and *in silico* (computer modeling) studies that are validated and predictive of toxicity. This plan follows a risk assessment approach and designed to reduce the need to test in animals. In accordance with our animal testing policy, Ashland wishes to move away from animal testing requirements and will continue to work towards alternative testing methods being accepted. Ashland will continue to suggest reasonable testing and accelerated access based on risk/benefit analysis, known scientific data, and predictive indicators of toxicity that are used regularly in the toxicology community for determining the safety of products.

Specifically, Ashland is actively involved and helping to lead efforts through PCPC to address FDA requirements. We have several subject matter experts (toxicologists, regulatory professionals, and chemists) working with industry and the FDA. Our chemical formulation expert is a member of the PCPC clinical formulation working team that is developing formulation for testing in the Maximum Use Trial (MUsT) protocol. In addition, our toxicologists are part of the PCPC testing working group for developing protocols and dosing determination for safety assessment.

Conclusion

In conclusion, the next year will be a critical year for the Personal Care Products Council to work with the Sun Consortium to urge the FDA to approve category III UV filters with reasonable, non-animal testing. We want consumers to have more options for great feeling, easy-to-use, and safe sun protection with organic and inorganic UV filters, so that they'll practice sun protection in their daily lives. We look forward to helping sun care manufacturers continue advancing the science of sunscreens.

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How Polyurethane Film Formers Can Help Reduce the Impact on the Environment whilst Keeping Sun Protection High

S. Viala, A. Wulfinghoff, Y. Berezkin

abstract

The consumer demand for environmentally friendly personal care products has grown dramatically in recent years. The Sun Care industry, in particular, is under pressure to develop ocean-friendly formulations. Covestro has developed a holistic approach to its sustainability program that addresses the entire value chain from raw materials to the end of life. For sun care formulations, Covestro offers an eco-friendly film former, Polyurethane-34 (Baycusan® C 1000), that is suitable for formulating environmentally safe and sustainable products with high performance.

In this paper, results of the biodegradability study and the advantages of Polyurethane-34 in sun care formulations will be discussed. An approach to develop environmentally friendly sun care products based on selected organic UV-filters will be proposed. An effective sun protection formula was developed. This formula exhibits a high SPF value, is water resistant and offers a lightweight feel on skin. Most importantly, these formulations are ocean-friendly and compliant with global regulations.

Introduction

The impact of sun care products, especially UV filters, on the marine environment is a hot topic, as up to 14,000 tons of sunscreens are released into the water each year [1].

Along with other product categories, sun care products follow the trend of clean beauty. Besides reducing negative effects on human health and society, formulators aim to lower the impact of sun care products on the environment. This trend leads to the multiplication of new product labels related to the environment protection over the last years. Product labels such as biodegradable formula, reef-friendly, sea-safe, ocean-friendly, without zinc oxide, natural, without chemical filter (not exhaustive list) appear on packaging. But until now, there is neither an agreed-upon definition for environmental-related labels nor strict regulations by governments.

In 2018, the first regulation on UV filters appeared in Hawaii [2]. Benzophenone-3 and Ethylhexyl Methoxycinnamate will be banned in 2021, classified as potentially harmful to aquatic life. Studies [3] show that Benzophenone-3 causes bleaching on coral, mortality in developing coral and genetic damage to coral and other marine organisms. The Western Pacific nation of Palau has become the first country to ban sunscreens to protect its coral reefs from chemicals that scientists claim to cause significant damage on the marine environment [4]. Other popular vacation destinations have banned non-biodegradable sunscreen products or products containing reef-damaging UV filters.

On the one hand, due to the abundance of controversial information and the lack of legislation, the consumers have difficulties to select a truly biodegradable sun care products that would not present adverse effects to marine life by accumulating in fish or cause death of corals. On the other hand, in order to create sustainable safe sun care, formulators need transparency on the biodegradability of the raw materials from their suppliers.

Product responsibility is the highest priority at Covestro. To address the demand for biodegradable raw materials for sun care formulation, Covestro has studied biodegradability of a polymeric film formers based on polyurethane chemistry, Baycusan® C 1000 (INCI: Polyurethane-34). In this article, the discussion is limited to a safe synthetic and biodegradable film former, its film properties and strategies for the development of sustainable sun care formulation with minimum environmental impact.

Raw Materials and Methods

Raw Materials: Polyurethane-34 mentioned in this article is a raw material of Covestro sold under the trade name Baycusan® C 1000. Polyurethane-34 is a low-viscosity, milky liquid that consists of 40.0 ± 2.0% of high molecular weight polyurethane and 60% water. Capryloyl Glycerin/Sebacic Acid Copolymer and VP/Hexadecene Copolymer mentioned respectively as polyester and VP copolymer are a raw material of Inolex and Ashland, sold under the trade name Lexfilm™ Sun Natural and Antaron™ V-216.

Biodegradability Measurements: Polyurethane-34 has been tested by a renowned independent institute under Good Laboratory Practices (GLP) conditions, according to the OECD 301.

Sun Protection Factor (SPF) and Water Resistance: *In-vitro* SPF values were carried out with a Kontron 930 spectrophotometer equipped with an UV source and a double monochromator able to deliver an energy flow between 290–400 nm. The formulations were applied on 16×25 cm² PMMA plates (Helioplates® HD6, Helioscreen® Labs) at a concentration of 1.3 mg/cm². Before measurement, the formulations were pre-irradiated. *In-vivo* SPF values were determined by an independent institute according to the international method ISO 24444:2010. The water resistance evaluation was performed *in-vivo* according to the COLIPA method (2005).

Film Formers in Sun Care

Traditionally, film forming polymers' main function in sun care formulations is to impart water resistance and SPF boost to sun care products. Conventional technologies, such as VP/Eicosene, VP/Hexadene, Acrylates Copolymers are widely used for waterproofing water-based emulsions. While performance of the sun care formulations gets better with these film formers, the sensory attributes suffer due to their heavy sticky feel on skin and poor removability. Moreover, these polymers would not support claims for ocean or environmentally friendly or biodegradable sun care formulations: OECD 301 readily biodegradability test data showed zero degradation for the Acrylate copolymer, while VP-Hexadecene only reaches up to 23% rate of biodegradation within 28 days. Next generation of bio-based film formers includes Capryloyl Glycerin/Sebacic Acid Copolymer – biodegradation data is not published yet. Covestro proposes a multifunctional synthetic film former, Polyurethane-34, that besides water resistance and natural feel, adds sustainability value to sun care products by directly contributing to circular economy. Polyurethane-34 is the example of the material that is biologically degradable by microorganisms with end products being carbon dioxide, water and mineral salts. The carbon content and other individual elements of the polyurethane polymer chain then re-enter the biological cycle. This, in turn, corresponds to the principles of a sustainable circular economy of use.

Biodegradability of Polyurethane Film Formers

Covestro develops a holistic approach to the goal of becoming fully circular, with intention to reduce waste, emissions and the use of energy and raw materials to a minimum. The core efforts focus on alternative raw materials, innovative recycling, renewable energy and joint solutions. In line with its strategic goals, Covestro has studied different polymeric structures to determine factors affecting their biodegradation. Three factors seem to influence the rate of degradation:

- presence of hetero atoms in the polymer backbone
- density of cleavable bonds and
- polymer structure/morphology.

Polyurethane-34 has a favorable nature and structure susceptible to enzymatic degradation in water and soil and also to external physical processes, such as heat, UV light, pH. The cleavable linkage in its backbone are processed by microbes into smaller molecular weight species, which reenter microorganisms to be further methabolized. These characteristics positively affect kinetics of biodegradation: the polymer reaches more than 50% of biodegradation within 28 days and even 60% biodegradation within 60 days by OECD 301 [5,6]. The OECD 301 is a standard method that utilizes domestic waste water to determine readily biodegradability in water. A substance is considered "readily biodegradable" if a 60% degradation rate is reached within 28 days, within a 10-day window.
Degradation in soil is also relevant because polymers get adsorbed on water treatment plant sludge or used in in a solid product. A compostability test is used to determine biodegradation in soil. Polymeric film was placed in compost from a composting station in Burscheid, Germany (1 cm layer below and 1 cm layer above the films). A film of Polyurethane-34 is fully degraded after 30 days. The result was compared to a positive control (untreated paper). Overall, Polyurethane-34 is not persistent in the environment.

Formulating Environmental-friendly Sun Care Products

Before starting the development of a sun care formulation, basic decisions need to be taken. Regulations and consumer perception differ from region to region. Especially the choice of UV filters is dependent on the restrictions of the country. Some regions like Hawaii have issued their own regulations, which are currently not aligned with the FDA.
Formulators can utilize two approaches to environmentally friendly sun care: 1) formulations with only inorganic UV-filters 2) formulations with selected organic UV-filters. The disadvantages of the first approach are the difficulty to obtain high SPF value while achieving good aesthetics and sensorial effects. Moreover, Oil-in-Water emulsions (O/W) are limited in the quantity of inorganic filters that can be incorporated, while Water-in-Oil emulsions (W/O) have limitations concerning aesthetics and skin feel. To fulfill current consumer needs such as high SPF while having a good skin feeling the second approach becomes a more sensible choice.
For environmentally friendly sun care formulations it is important to check if the ingredients are biodegradable and have safe

eco toxicity data. According to ECHA and product literature [7] current UV filters can fulfill only one of the two conditions (**Tab. 1**). Homosalate and Ethylhexyl Salicylate fulfill both.
With organic filters that are also biodegradable it might be challenging to achieve an SPF above 25.
As consumers often prefer high SPF products it is necessary to look for more ways to formulate. Here the formulator has three options: a) use highly efficient organic filters which have at least good eco toxicity data. b) Combine with inorganic filters c) add SPF boosters.
Besides the importance of the UV filters' choice, all other ingredients in the formulation influence the end-use product environmental impact. Emulsifiers, Oils and emollients are normally biodegradable and can be easily selected, some with natural origin. Complexing agents, perfume and preservatives require a deeper look, but also here more options are nowadays available. More challenging are polymers used as thickeners or film formers.
The guide formulation Ocean-friendly Sun Cream (**Tab. 2**) was designed to fulfill the needs of a modern consumer: Light skin feeling combined with long lasting protection against UVA and UVB light. Optimal choices of ingredients in the formulation minimize impact on environment.
For example, Acrylate-based thickeners are widely used for good formulation stability, but they are known for poor biodegradability. Hence for ocean-friendly formulations, Xanthan Gum can be chosen as thickener which gives a good stability.
Film formers are mainly used in sun care to give water resistance. This function can now have a dual purpose: while UV filters stay on the skin to give long lasting sun protection, the ocean is protected from the UV filters leaching into the water. Hence, a biodegradable film former helps achieving both goals of sustainable sun care: long lasting UV protection and minimize ocean pollution as it will not accumulate when released in the water. Polyurethane-34 is the multifunctional film former with good biodegradability rate that imparts high performance to safe biodegradable sun care formulations with high performance.
Supported by the SPF boosting of Polyurethane-34 the amount of non-biodegradable UV filters can be reduced or a higher SPF can be achieved. Although the film-forming polymer itself does not contain any UV-absorbing components, the addition of Polyurethane-34 in a formulation increases significantly the sun protection factor (SPF), under special conditions. **Fig. 1** shows results of *in-vitro* SPF measurements of oil-in-water formulations containing different UV-Filters in a basic formulation. Especially in combination with Bis-Ethylhexyloxyphenol Methoxyphenyltriazine and Ethylhexyl Triazone SPF values are increased. Therefore these filters can be used in a low concentration, thus posing less environmental risk when sun care products are released into the ocean.

INCI Name	Biodegradability
Octocrylene	Non biodegradable
Ethylhexyl Methoxycinnamate	Readily biodegradable
Homosalate	Readily biodegradable
Butyl Methoxydibenzoyl-methane	Non biodegradable
Bis-Ethlhexyloxyphenol Methoxyphenyl Triazine	Non biodegradable
Ethylhexyl Triazone	Non biodegradable
Diethylamino Hydroxy-benzoyl Hexyl Benzoate	Non biodegradable
Methylene Bis-Benzotriazolyl Tetramethylbutylphenol	Non biodegradable
Ethylhexyl Salicylate	Readily biodegradable

Tab. 1 Biodegradability of UV-filters (source: https://echa.europa.eu) – interpreted to our best knowledge, please check by yourself for your own development.

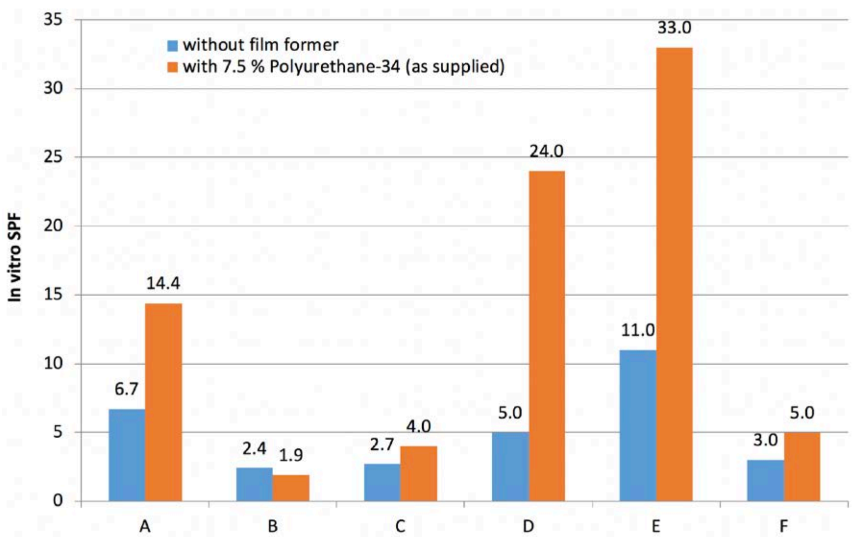
Phase	Ingredients	% by wt.
A	Aqua	35.40
	Tetrasodium Glutamate Diacetate	0.50
	Phenylpropanol (and) Propanediol (and) Caprylyl Glycol (and) Tocopherol	1.00
	Glycerin	3.00
	Citric Acid	0.10
	Propylene Glycol	5.00
	Sodium Stearoyl Glutamate	1.00
B	C12-15 Alkyl Benzoate	7.00
	Diethylamino Hydroxybenzoyl Hexyl Benzoate	6.00
	Ethylhexyl Salicylate	5.00
	Glyceryl Stearate	2.00
	Dibutyl Adipate	7.00
	Homosalate	7.00
	Ethylhexyl Triazone	5.00
C	Simmondsia Chinensis (Jojoba) Seed Oil	3.00
	Xanthan Gum	0.30
D	Panthenol	0.50
	Tocopheryl Acetate	0.20
	Polyurethane-34 (and) water (Baycusan® C 1000, Covestro)	6.00
	Alcohol denat.	5.00

Processing: All ingredients of phase A are added in a vessel while stirring and heated to 80°C until uniform. In a separate vessel phase B is heated to 90°C. Phase B is transferred to phase A under continuous mixing. The system is homogenized with Ultra Turrax at level 3. Phase C is added and the system is homogenized for two minutes at level 4 and then cooled down to room temperature under continuous mixing at 300 rpm. pH is checked and adjusted to 6.5–7.0 with NaOH (10% sol.) The ingredients of phase D are added one by one. The emulsion is stirred for an additional 5 minutes.

Tab. 2 Guide formulation "Ocean-friendly Sun Cream".

The SPF-boosting effect of Polyurethane-34 in the guide formulation "Ocean-friendly Sun Cream" was confirmed by *in-vivo* tests. **Fig. 2** shows *in-vivo* SPF results of the guide formulation with competitive polymers versus Polyurethane-34, compared to the blank formulation. Polyurethane-34 imparts to the guide formulation a higher *in-vivo* SPF value compared to the blank formulation or the formulations containing competitive polymers.

Water resistance can be achieved in the guide formulation with Polyurethane-34, whereas the blank formulation and formulations with competitive polymers are not water-resistant. More than 50% of the initial *in-vivo* SPF value was maintained after immersion by adding 7.5% Polyurethane-34, as supplied in the guide formulation. (**Fig. 2**)



A: 10% Octocrylene
B: 5% Ethylhexyl Salicylate
C: 10% Homosalate
D: 5% Ethylhexyl Triazone
E: 10% Bis-Ethylhexyloxyphenol Methoxyphenyltriazine
F: 10% Methylene bis-Benzoyltriazolyl Tetramethylbutylphenol

Fig. 1 SPF Boosting effect of Polyurethane-34.

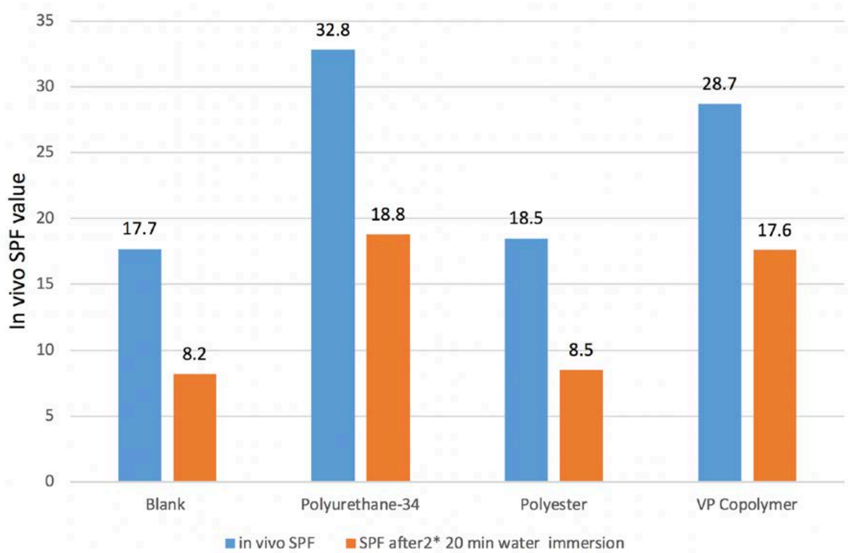


Fig. 2 *in-vivo* SPF and resistance results.

Conlusion & Outlook

Both consumers and formulators can benefit in a variety of ways when formulating sun protection products with Polyurethane-34 (Baycusan® C 1000, Covestro). This film former allows the formulation of sun care products fulfilling the consumer requirements in terms of sensory properties, sun protection and water resistance. For the formulators, Polyurethane-34 opens new routes of formulating high SPF sun protection with better biodegradation than the state-of-the-art film formers while maintaining high performance. Polyurethane-34 degrades up to 60% over 60 days according to OECD 301 guideline whereas competitive polymers are mostly not biodegradable. In addition, The SPF boosting effect of Polyurethane-34 allows formulators to reach high SPF without overloading the formulation with UV filters and therefore reducing the environmental impact of the formulation as well.

Another way to improve the environment impact of sun care formulation is to increase the naturality of ingredients. Covestro proposes with the Baycusan® eco product line polyurethane film formers containing more than wt. 50% renewable content, such as Baycusan® eco E 1001 (INCI name Polyurethane-99) for sun care applications.

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Positive Impact of Emulsifiers on End-user Skin Benefits

S. Cambos, A. Roso

abstract

The aim of this study was to investigate the contribution of two oil-in-water emulsifiers with long C20-22 fatty chains to skin benefits for end-users, from minimalist emulsions compared to the appropriate reference. Complementary evaluations were conducted, using classical measurements such as corneometry for moisturizing effect, dosage of heavy metals in skin stripping to measure potential protection from pollution, advanced spectroscopy, and the latest visualization imaging technology to evaluate effects on the skin surface, such as potential skin roughness or mattifying properties. A second part was dedicated to better understanding the mechanism of action of each emulsifier by exploring what happens to the emulsion after application using scanning microscopy or X-Ray microdiffraction: does the formulation have film-forming properties? What is the interaction of the emulsion with the *stratum corneum*? The results demonstrated different benefits according to the emulsifier structure and pointed out their interest versus reference emulsifiers. The anionic structure forms a matte film which increases water resistance and protects the skin from atmospheric pollutants. The non-ionic structure strengthens the skin barrier by gently inserting itself within the *stratum corneum* lipid lamellar structure, resulting in reduced skin roughness and increased moisturisation up to five hours after application.

Introduction

The primary function of an emulsifier is to stabilise the emulsion. It has also been demonstrated that emulsifiers can play a role in the sensory profile of emulsions [1]. Moreover, the fatty chain length chosen in the lipidic part of the ingredients, especially in the structure of the emulsifiers, has a key impact on their ease of handling, properties, and sensory input [2]. In fact, however, excipients such as emulsifiers can contribute to skin benefits. The most universal skin needs are protection from environmental aggressions (UV radiation, air pollution, wind, etc.) and skin hydration, also in connection with climate conditions such as cold, heat, and humidity level. The protection and hydration intensity depend on the mechanism involved: film-forming effect, interaction with the *stratum corneum* lipids, etc.

The aim of this study was to measure the impact of stable basic oil-in-water (O/W) emulsions on end-user performance by varying only the nature of the emulsifier, with a focus on two emulsifiers with long fatty chains. The second step was dedicated to better understanding the underlying mechanism of action.

Methodology

Two emulsifiers based on the same C20-C22 fatty chains were studied: an AlkylPolyGlucoside with a non-ionic structure and an anionic emulsifier supported by a phosphate group. In the past, both emulsifiers have demonstrated their effectiveness in stabilising different kinds of oils in large quantities. The two emulsifiers provide a light sensory profile with a soft afterfeel, judged as more powdery for the anionic structure.

O/W Emulsion Compositions Tested

Non-ionic Emulsifier

In a first approach, the moisturising effect was measured with a simple formula, representative of the skin care market. To minimise interactions with the other ingredients and evaluate only the effect of the emulsifier, the hydration mechanism (skin rugosity and interaction of the *stratum corneum*) was assessed on an even more basic emulsion, with a reduced oil quantity and without a thickening polymer. Appropriate references were chosen according to the parameter being measured (**Tab. 1**).

Anionic Emulsifier

Film forming effect, water resistance and protection against pollution were assessed on a simple formula representative of the skin care market. In order to investigate only the emulsifier's influence, the film appearance and skin gloss were assessed on a basic emulsion with reduced oil quantity and without thickening polymer (**Tab. 2**).

Investigations were conducted at equivalent pH for all emulsions. It should be noted that the anionic emulsifier is expected to provide thick to more fluid textures when the pH increases, as is generally the case for anionic emulsifiers.

Evaluation Methods

Non-ionic Emulsifier

Hydration kinetics was assessed first with classical *in vivo* corneometry measurements (Corneometer® CM 825 from Courage + Khazaka) on 20 volunteers with dry skin (< 50 a.u.). The corneometry was monitored for five hours after a single application of the emulsion on legs.
Two complementary tests were carried out on a basic emulsion to investigate the mechanism of action.
The effect of the emulsion on the skin texture was evaluated with the ColorFace® [3] acquisition system (Newtone company). This system, including a rotation at − 45°, 0°, + 45°, allows a 3-Dimensional high-resolution full-face image acquisition in real time without requiring movement from the volunteer. The study was conducted on 20 women with uneven skin texture and shiny skin. The face photography of ¾ profiles with cross polarised and parallel polarised lights were analysed at 0 and 30 minutes, after a single application of 300 mg of each emulsion on half-face (C20-22 emulsifier versus reference on the other half-face). Results are compared using the skin surface roughness index Sdev equal to the ratio between the developed area (relief) and the total area analysed.
To better understand what happens to the formulation after application to the skin, the impact of the emulsion on *stratum corneum* (*ex vivo*; triplicate; 2 mg of emulsion / cm²) was analysed by x-ray microdiffraction at wide and small angles

Moisturizing effect
(versus reference: without emulsifier)

Ingredients (Structure / INCI name)	% w/w
Emulsifier: Arachidyl Alcohol & Behenyl Alcohol & Arachidyl Glucoside (C20-22 Alcohols & C20 Glucoside)	3.00%
Cetearyl Ethylhexanoate	20.00%
Sodium Acrylate / Sodium Acryloyldimethyl Taurate Copolymer & Isohexadecane & Polysorbate 80	0.50%
Preservative	as required
Demineralized water	up to 100%
pH	5.5 to 6.0

Skin rugosity (versus reference: emulsifier Cetearyl Olivate & Sorbitan Olivate)

Ingredients (INCI name)	% w/w
Emulsifier: Arachidyl Alcohol & Behenyl Alcohol & Arachidyl Glucoside	3.00%
Caprylic / Capric Triglyceride	5.00%
Preservative	as required
Demineralized water	up to 100%
pH	5.5 to 6.0

Interaction with *stratum corneum*
(versus reference: untreated *stratum corneum*)

Ingredients (INCI name)	% w/w
Emulsifier: Arachidyl Alcohol & Behenyl Alcohol & Arachidyl Glucoside	3.00%
Caprylic / Capric Triglyceride	5.00%
Preservative	as required
Demineralized water	up to 100%
pH	5.5 to 6.0

Tab. 1 Tested emulsions with non-ionic emulsifier.

Water resistance effect (versus reference: emulsifier Potassium Cetyl Phosphate 3% + Cetyl Alcohol 1%)

Ingredients (INCI name)	% w/w
Emulsifier: C20-22 Alkyl Phosphate & C20-22 Alcohols	3.00%
C15-19 Alkane	9.00%
Caprylic / Capric Triglyceride	6.00%
Acacia Senegal Gum & Xanthan Gum	0.50%
Preservative	as required
Demineralized water	up to 100%
pH	5.5 to 6.0

Skin gloss & film appearance
(versus reference: non ionic emulsifier with same fatty chain)

Ingredients (INCI name)	% w/w
Emulsifier: C20-22 Alkyl Phosphate & C20-22 Alcohols	3.00%
Caprylic / Capric Triglyceride	5.00%
Preservative	as required
Demineralized water	up to 100%
pH	5.5 to 6.0

Protection against pollution (versus reference: emulsifier PEG-100 Stearate & Glyceryl Stearate 2% + Cetyl Alcohol 1% + Caprylic / Capric Triglyceride 15% + Carbomer 0.1%)

Ingredients (INCI name)	% w/w
Emulsifier: C20-22 Alkyl Phosphate & C20-22 Alcohols	3.00%
C15-19 Alkane	9.00%
Caprylic / Capric Triglyceride	6.00%
Acacia Senegal Gum & Xanthan Gum	0.50%
Preservative	as required
Demineralized water	up to 100%
pH	5.5 to 6.0

Tab. 2 Tested formulas with anionic emulsifier.

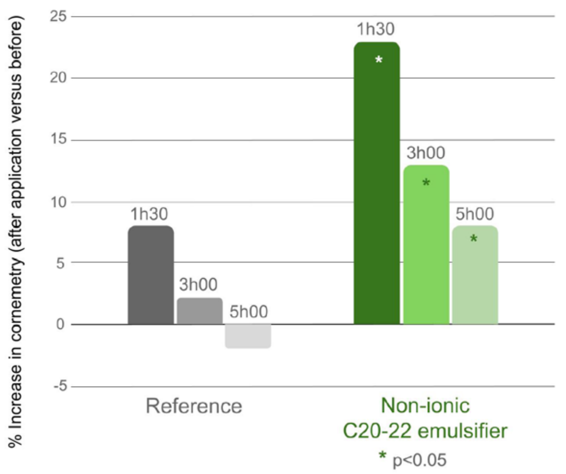

Fig. 1 Corneometry evolution over time.

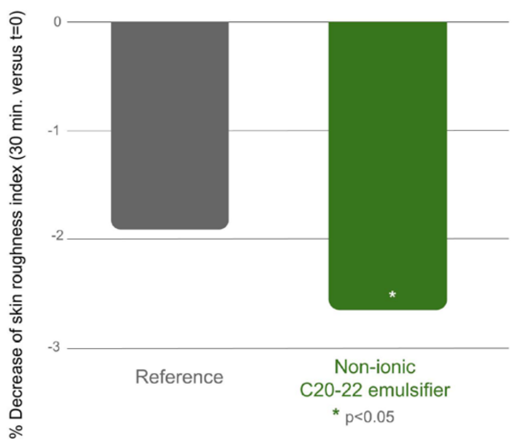

Fig. 2 Skin roughness index.

(WAXS and SAXS respectively). The x-ray beam was parallel to the *stratum corneum* and images were acquired with a sweep from the external face of the *stratum corneum* to its internal face lasting one hour [4]. X-ray diffraction provides information on the more or less orderly organisation of molecules and their orientation. In the present case, it was applied to study the packing of intercellular lipids and inter-layer and intra-layer lipid arrangements (amorphous, hexagonal and orthorhombic) inside the *stratum corneum* before and after application of the emulsion. The diffraction intensity is proportional to the diffracting material content, i.e. lipids in the present study.

Anionic Emulsifier

First, a potential film-forming effect was evaluated using an internal *in vitro* method. The water resistance capacity of emulsions was assessed by weighing a plexiglass plate (on which a film of emulsion was applied in a standardised way) before and after two baths of twenty minutes in hard water, with fixed rotations of the plate.

Two additional tests were performed to explore the film properties.

The appearance of the film was captured by the ColorFace® acquisition system, *in vivo*, with 20 volunteers who applied a basic formula once. The images of the volunteers' faces were analysed at 0 and 30 minutes. Two gloss indexes were calculated: the contrast gloss (difference between shiny areas and black areas), and the specular gloss (ratio between reflected and incident luminous flux). These measurements were completed by *in vitro* scanning microscopy observations (SEM-FEG Zeiss Supra55VP under vacuum) and goniospectrophotometry analysis (film of standard 50 µm thickness – Seelab® GPD device). Specular gloss was calculated using multi-angle equipment to remove diffuse light, as well as Glow index = Specular intensity/Diffuse intensity, after measurements from 0° to 60°.

Lastly, the film's ability to protect skin from atmospheric pollution was investigated. The test was conducted in real conditions on 20 women who were subjected to pollution in Beijing for six hours after applying a simple formula to their face (2 mg/cm²; anionic emulsifier on half-face/reference on half-face). Typical heavy metals, Chromium (Cr) and Zinc (Zn), found both in pollution [5] and cigarette smoke [6], were quantified by atomic absorption spectroscopy in the skin stripping solution (six strips discharged).

Results and Discussion

C20-22 Non-ionic Emulsifier

Moisturising Effect

The simple emulsion with C20-22 non-ionic emulsifier has a better moisturising effect than the reference (**Fig. 1**). The effect is prolonged and still significant five hours after application. This result confirms a previous publication highlighting moisturising effects lasting up to five hours with medium-chain triglyceride and avocado oil but achieved with a higher dosage of the non-ionic emulsifier [7].

Influence on Skin Surface Texture

The analysis of skin surface texture demonstrates a significant decrease in skin roughness at 30 minutes with the C20-22 non-ionic emulsifier compared to baseline, whereas the reference provides non-significant results (**Fig. 2**). Despite the fact that it can be perceived as common, this is the first evidence obtained from direct analysis of skin images after application of a minimalist emulsion.

Interaction of C20-22 Non-ionic Emulsifier with the *stratum corneum*

In normal *stratum corneum*, lipids surrounding the corneocytes are organised in a three-dimensional lamellar bilayer structure, predominantly parallel to the skin surface, often referred to as Landmann unit. Inside the lamellae, the lipids are arranged laterally in three types of packing from the non-ordered state to the more densely packed: liquid or amorphous, crystalline hexagonal and orthorhombic lipids [8, 9].

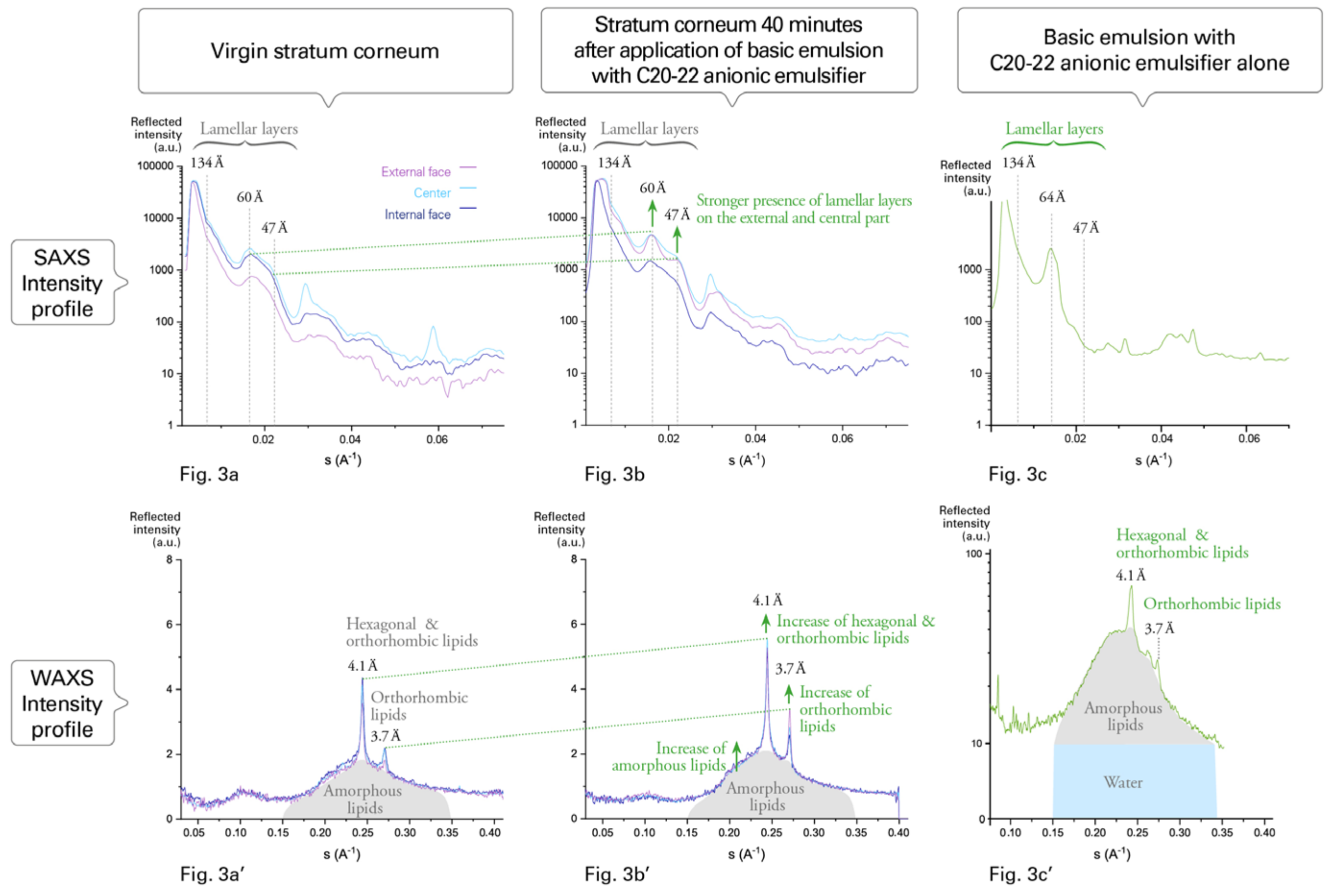

Fig. 3 X-Ray microdiffraction intensity profiles.

Fig. 3a and **3a'** reflect the typical x-ray diffraction pattern of a normal *stratum corneum*. The SAXS profile (**Fig. 3a**) is characterised by a series of peaks at around 134 Å, 60 Å and 47 Å representative of the *stratum corneum* bilayer structure. The WAXS profile (**Fig. 3a'**) shows a large signal coming from amorphous lipids, and two peaks indicating crystalline lipids, at 4.1 Å for hexagonal and at 4.1 Å and at 3.7 Å for dense orthorhombic lipids. There is wide agreement on the high importance of this organisation of lipids for a healthy, functional skin barrier. Some publications have reported that orthorhombic lipids, less permeable to water, are essential to control trans-epidermal water loss [10]. Other investigations suggest that the overall organisation and balance of the lipids are more important in maintaining the skin barrier's functionality than the orthorhombic lipids themselves [11]. Indeed, evidence of a change in the balance of the distribution of intra-lamellar crystalline hexagonal and orthorhombic lipids was observed in lamellar ichthyosis and atopic dermatitis skin diseases, associated with an impaired skin barrier [9]. Moreover, disruptions of the equilibrium between the three types of packing with transitions from solid orthorhombic or hexagonal crystalline phase to liquid amorphous lipids were reported to occur after application of some compounds at the surface of the skin in combination with disturbed skin barrier integrity [12]. More recently, potential disturbance of *stratum corneum* lipid arrangements by classical non-ionic emulsifiers has been described, according to their chemical structure and HLB value [13].

Fig. 3b and **3b'** show the X-ray diffraction profile of the *stratum corneum* 40 minutes after application of the emulsion with the non-ionic C20-22 emulsifier. A first reading, compared to the *stratum corneum* alone, shows clearly that the general profile is identical in SAXS and WAXS, with the same peak positions. The preservation of diffraction signal quality demonstrates that the non-ionic emulsifier does not disrupt the inter-lamellar (SAXS) and intra-lamellar (WAXS) organisation of lipids in the *stratum corneum*. Moreover, closer observation taking into account comparable intensity scales between profiles shows that the signal intensity increases, in particular around 60 Å in SAXS (**Fig. 3b**), and in the whole SAXS profile (**Fig. 3b'**) meaning that the lamellar structure is strengthened, in addition to amorphous, crystalline hexagonal and orthorhombic lipid organisation (peaks at 4.1 and 3.7 Å in **Fig. 3b'**) increasing in the *stratum corneum*.

These results indicate that the emulsion lipids gently insert between skin lipid molecules, as illustrated in **Fig. 4**, resulting in a strengthened skin barrier, decreased skin roughness, and increased moisturisation.
The C20-22 non-ionic emulsifier promotes liquid crystals in the emulsion which have the same lamellar organisation as *stratum corneum* lipids, explaining these observations (see SAXS and WAXS profiles with typical peaks in **Fig. 3c** and **3c'**; divergences in the intensity value are due to the very high quantity of water in the emulsion compared to the *stratum corneum*).

C20-22 Anionic Emulsifier

Film-forming Effect

A simple emulsion with C20-22 anionic emulsifier has better water resistance than the reference (**Fig. 5**), expected to be brought about by a film-forming effect. This expectation is challenged by image analysis on an even more basic emulsion composition, which should allow the appearance of the film to be viewed *in vitro* and *in vivo*.

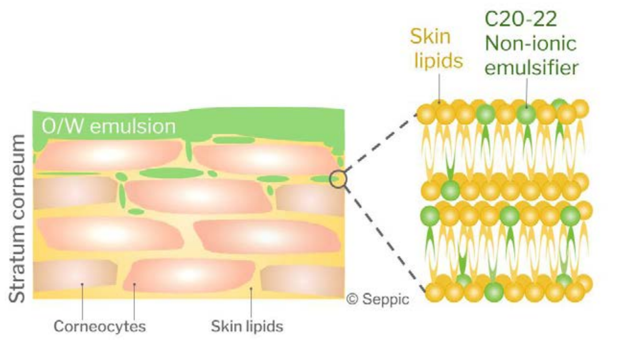

Fig. 4 Interaction of C20-22 non-ionic emulsifier with the *stratum corneum.*

Film Appearance and Skin Gloss

Scanning microscopy observation of the basic emulsion with C20-22 anionic emulsifier spread on a black rigid support confirmed the film-forming property. The resulting film is uniform and continuous with a slight roughness (**Fig. 6**). The film's very low specular gloss and glow index values (11 and 4 respectively) were consistent with a matte film appearance. When applied on volunteers' faces, the basic emulsion with

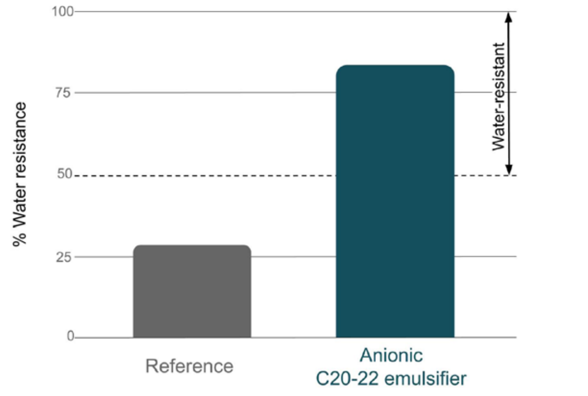

Fig. 5 Water resistance effect.

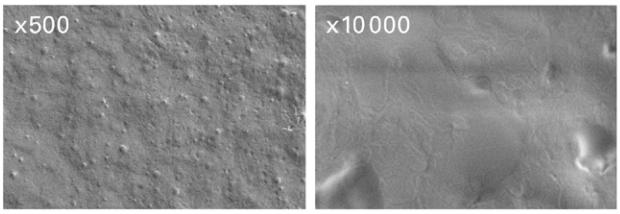

Fig. 6 SEM-FEG images of the film formed by emulsion containing anionic emulsifier.

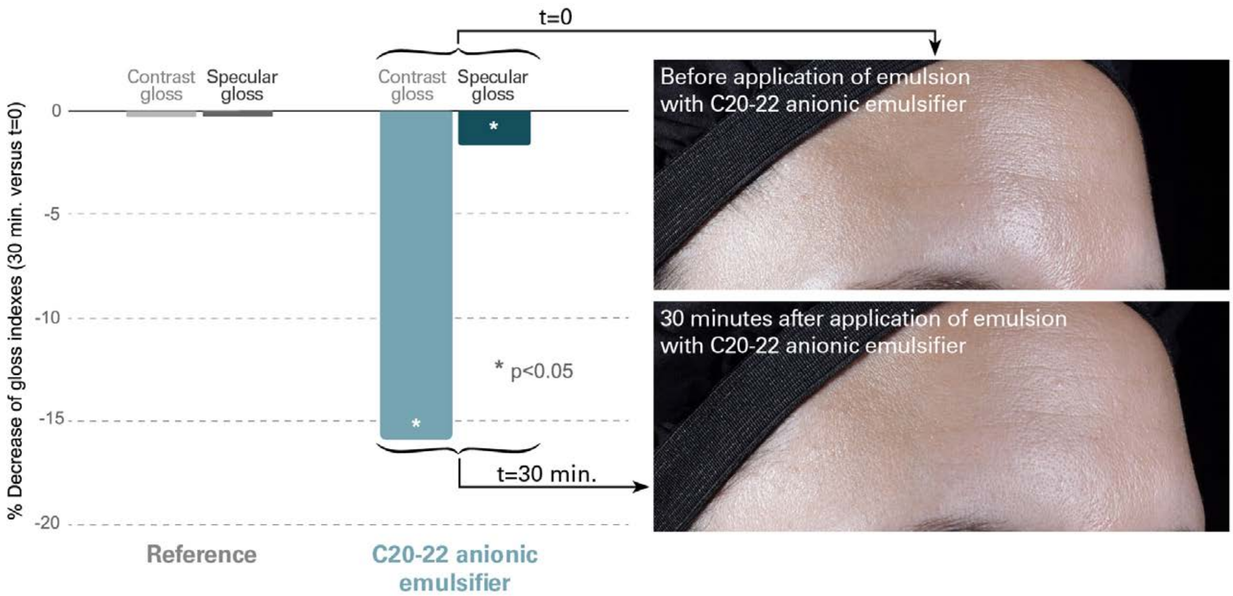

Fig. 7 Film mattifying effect *in vivo.*

the anionic emulsifier leads to a significant decrease of the gloss indexes 30 minutes after application compared to baseline, whereas the reference does not induce any change (**Fig. 7**). Emulsion with C20-22 anionic emulsifier forms a matte film, easily visible in **Fig. 7**, confirming previous *in vitro* evaluations.

Protection against Pollution

The increase of heavy metal content in the first skin layers, up to stratum disjunctum, after six hours of exposure to real city pollution is significant for the reference emulsion. On the contrary, for both chromium (Cr) and zinc (Zn), the change is not significant after application of the emulsion with the C20-C22 anionic emulsifier, indicating that the film formed is able to protect the skin from the adhesion of pollutants (**Fig. 8**). Additional measurements of trans epidermal water loss indicated that the film is not occlusive (no significant effect on TEWL after 1 hour) and lets the skin breathe naturally.

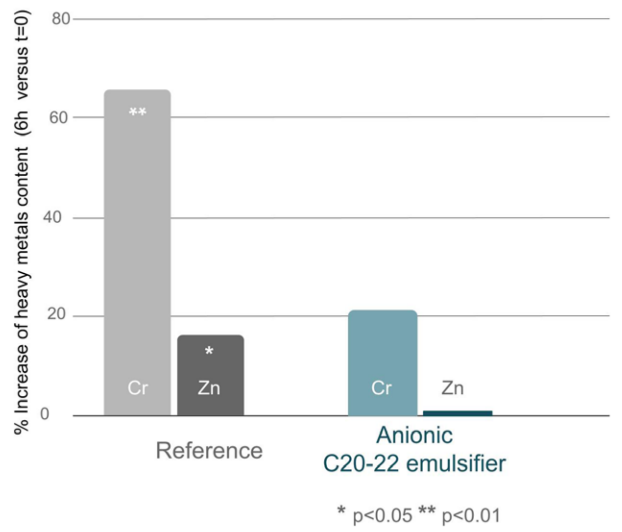

Fig. 8 Heavy metal dosage in skin strips after exposure to polluted atmosphere.

Conclusion

This work confirms that emulsifiers not only contribute to emulsion texture, stability, and sensory properties, but they also influence the performance of the emulsion in providing end benefits to the skin, with different mechanisms according to their chemical structure.

- Non-ionic C20-22 Glucoside emulsifier (INCI: Arachidyl Alcohol & Behenyl Alcohol & Arachidyl Glucoside) imparts a restructuring effect explained by its interactions with *stratum corneum* lipids. The bio-compatible non-ionic emulsifier inserts between the *stratum corneum* lipids and strengthens the lamellar structure of skin lipids, which results in reduced skin roughness and higher skin hydration evaluated by corneometry. From a formulation perspective, its non-ionic character and ether structure impart a versatile compatibility with active ingredients, including cationics, D.H.A., and hydrogen peroxide, even in a wide pH range from 3 to 10.
- Anionic 20-22 emulsifier (INCI: C20-22 Alkyl Phosphate & C20-22 Alcohols) forms a homogeneous matte film at the skin surface that imparts water resistance and protection against heavy metals present in polluted atmospheres. Associated with a great compatibility with pigments and minerals such as titanium dioxide, the C20-22 anionic emulsifier is a useful candidate in skin care, foundation and sun care.

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60 Years Sinner Circle: The Future of Washing and Cleaning

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abstract

Since 1959, Sinner's Circle has been describing the influence of chemistry, time, temperature and mechanics on the result of a washing or cleaning process in a qualitative way. With the recent opportunities of digitalization and design of experiment, these variables can now be refined and quantified.
On top of the appliance and the detergent, the digital knowledge about performance as a function of these multiple variables plays an important role. This will enable consumers to tailor and finetune washing and cleaning performance to individual needs and scenarios. These scenarios enable hygienic cleanliness while using resources in an optimal way and ensuring the best level of sustainability.

Dedication

This paper is dedicated to Dr. Herbert Sinner, a former research chemist at Henkel, recognizing and honoring his contributions for a deeper understanding of the major impact factors in washing and cleaning processes.

1. Historical Background

In 1959, Dr. Herbert Sinner (**Fig. 1**), head of detergents development at Henkel, defined chemistry, mechanical power, temperature and time as the four universal factors which determine the success of a wash cycle [1]. When each of these factors represents a circular sector with a size representing the relative contribution of the particular factor, all four circular sectors have to add up to a full circle, named for its inventor Sinner Circle (**Fig. 2**).

The validity has not changed. But the demands for the several factors have significantly changed. The same is true for their content und understanding. For this reason, the authors extend the development of the Sinner Circle into the future and search to anticipate the future of washing. Four megatrends will have a significant impact: The creation of new business models, new product forms and product designs, new ingredients and cleaning technologies and the requirements of a climate-neutral circular economy. Intensity and dynamics of change are driven by a further growing digitalization and partially just enabled by it.

Herbert Sinner himself developed his circle to describe the new paradigm of washing: washing by hand and in vessels heated by wood or coal fire was substituted by the emerging technology of automated washing machines. For the ecosystem of laundry cleaning, this was a huge paradigm shift, as a new player appeared on the scene: washing machine manu-

Fig. 1 Herbert Sinner [2].

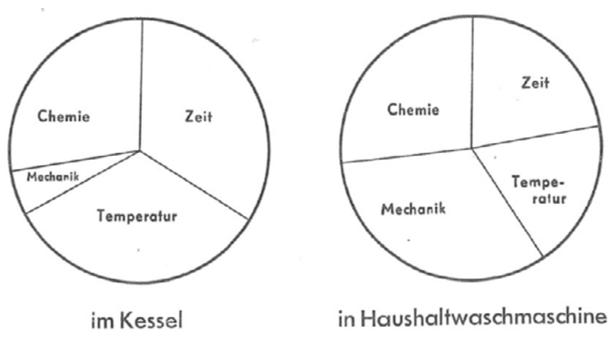

Fig. 2 The original display of the Sinner Circle, comparing the ratios of contributors (chemistry, time, temperature, mechanics) to the washing result in a vessel and in an automated washing machine [1].

facturers, the white goods industry was born. The oldest recycling process of mankind – cleaning clothes to make them wearable again – was based until that time on two main constituents: the person who cleans the laundry mainly by hand with help of mechanical treatment and heating, and the provider of the chemistry that supports this cleaning process. At this very moment of technology change, the manual work of mechanical treatment and the manually steered heating was taken over by a machine. (3) Today we would call it an ecosystem combined with a business model. At Sinner's time, the roles and responsibilities of the participants were very clear: the housewives needed to invest not only into detergents but also into an automatic washing machine.

2. Ecosystem of Laundry Cleaning

And as it was at the time of Herbert Sinner's invention, we are again in the middle of a technological transformation which has at least the revolutionary power for the way how we will do our laundry in the future as it was 60 years ago. The next decades are defined by a transformation towards a climate neutral circular economy. And beside important needs for technological breakthroughs the biggest enabler and influencer is digitalization. By that the ecosystem of laundry cleaning will be defined in a new way and we are witnessing the multiple tremors in all areas of our business.

2.1 New Approaches to Detergent Purchase

At first, the globalization of automated washing has included the huge and fast-growing markets in Asia. And these markets – particularly the Chinese market – are a very special new field for experimentation. For instance, when talking about initiatives by fast growing big players like Haier and Midea in the field of home appliances and manifold start-up companies offering new products and services. But also established global players from our industries – be it in detergents or household appliances – use Asia as a big lab for new approaches. Many of these new attempts might fail, but the new quality is the frequency of challenges to an established system dominated by a consumer who does the washing at home in his or her washing machine and buys regularly one or more detergents for this purpose. How these detergents will arrive at home – by physical or virtual shopping –, could be the topic of an article of its own to speculate about the future roles of manufacturers and established physical and more and more growing virtual retail. The key words are e-commerce, Consumer Relationship Management (CRM), Direct-to-Consumer (D2C), Business-to-Consumer (B2C) and similar.

2.2 New Business Models

The same is true for a second element. While washing at home was the paradigm for the vast majority of households, all partners in today's ecosystem try to find out alternatives to this classical model. For example, detergent manufacturers use the trust in their flagship brands to create laundry services following concepts like dry laundries or – as combination with digitalization and e-commerce logistics – like a laundry service which collects at home, cleans and brings the laundry back home. Or white goods manufacturers think about lease and rent concepts of their machines, as it is already practice for printers and copy machines in most offices.

In this context, we want to start our journey into the future with the typical home washing using a modern washing machine and a modern detergent. The core of business ecosystem was until recent past the "appliance" and "chemistry". Of course, "chemistry" is understood in a much broader sense than only the combination of up to 40 ingredients. As we know we are talking about a very smart optimized synergy of various high-performance materials with an increasing share of biobased and/or biotechnology-based materials.

2.3 Digital Know-how

Now – with the power of digitalization – the core of the ecosystem grows by a third element: the "digital know-how". What do we mean by this? Up to now, the know-how about an optimized washing process was a kind of built-in factor included in the fixed programs of the washing machine and the various detergents with their specific formulations for different washing programs. The digitalization and with its highly sophisticated algorithms allow the combination of the know-how of engineers to run a washing machine and the chemists of developing the best formulations in one overarching software which can – tremendously better than today – orchestrate all the multiple parameters and influencing factors. It is like the "digitalization of the Sinner Circle" or the "Digital Sinner" as we call it (**Fig. 3**).

The digital knowledge goes even beyond the parameters within the appliance. Digitalization allows the combination of data lakes. Wash lab, ingredients, processing, consumer and sales data lakes can be connected in order to provide the optimal washing experience under the best economic and ecological conditions for the consumer. In this article, however, we will focus on the parameters within the appliance (**Fig. 4**).

3. Digitalization of Knowledge through Smart Algorithm

Like industrial processes are reproduced in "digital twins", the digitalization of the Sinner Circle will enable us to create a digital twin of the wash cycle. The idea of a "digital twin" for a washing machine or a "virtual washing machine" is not new. Important research on that topic paved the way for today's digitalization [4, 5]. But at that time, there were just three different equations which described the dependency of one parameter on only four others. It has always been the vision to have all relevant parameters in only one equation with at least 8 or more parameters. And this single algorithm should allow to describe each of them as the function of all

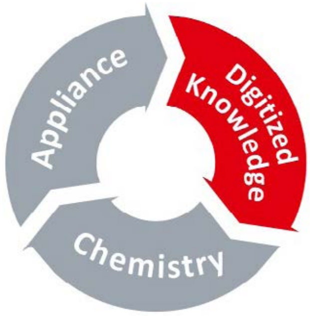

Fig. 3 Digitized knowledge as a complement to appliance and chemistry in the future washing process.

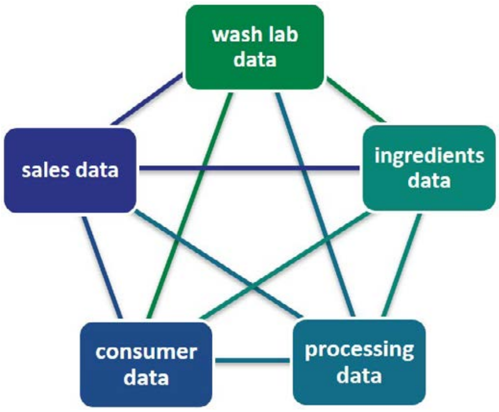

Fig. 4 Various data lakes can be connected to provide the optimal consumer experience.

the others. By that step, the qualitative relationship formulated by Herbert Sinner will be upgraded into a quantitative parametrization. This will enable fully new opportunities for the prediction and the optimization not only of the four factors of Sinner. Furthermore, additional factors like types and amounts of chemical ingredients, the time those various ingredients or compounds thereof and the dosage at which they are added, as well as different kinds of fabrics need to be integrated into this breakthrough functional relation.

Parametrizing the Sinner factors, it needs to be considered how to make them quantifiable. Parameters for the factor Chemistry are the amount (α), the soiling / stains (σ), the water hardness (θ), furthermore the ingredient split and the dispensing time.

Parameters for the factor Time are the main wash time (t), but also the time at a certain temperature, the soaking time and the after-wash time.

Parameters for the factor Temperature are the peak temperature (τ), but also the temperature profile of the main wash.

Parameters for the factor Mechanics are the laundry load (ω), the fabric type (Λ), the drum speed in the main wash (δ), furthermore changes in the rotation direction and the frequency of active/pause times.

In our approach, we made the Performance (P) a function of the parameters above that are symbolized by letters.

Hence, the experiments were performed in the 9-dimensional room given by the following equation:

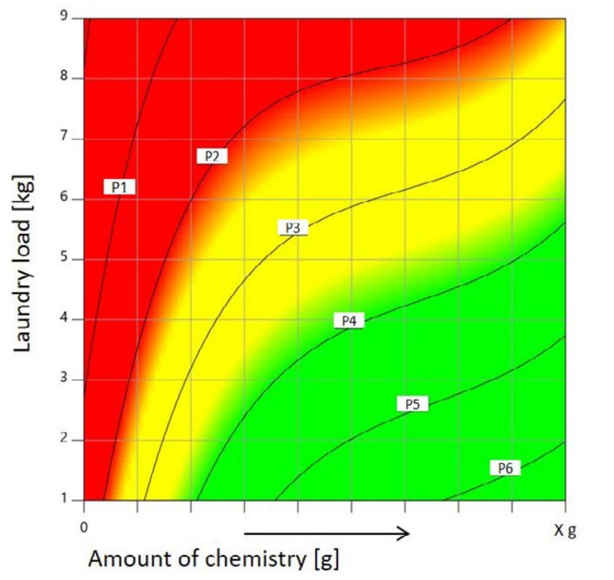

Fig. 5 Performance on an ensemble of 20 stains as a function of the dosage and the load.

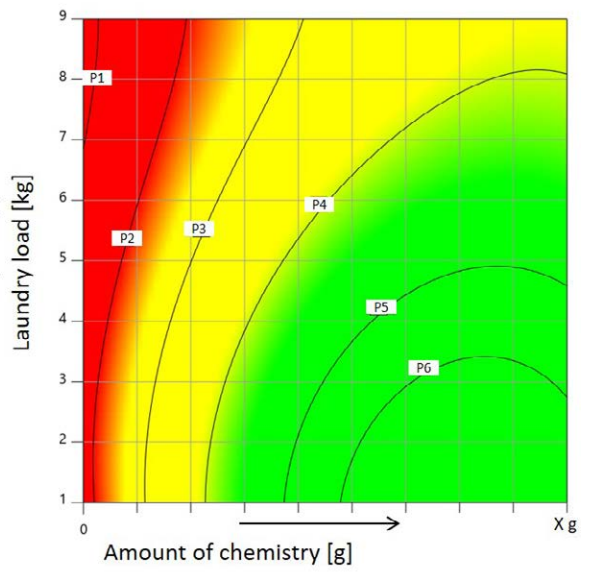

Fig. 6 Performance on an egg stain as a function of the dosage and the load.

$$P = f\,(\alpha, \sigma, \theta, \omega, \Lambda, \delta, t, \tau)$$

with P = performance; α = amount of chemistry; σ = soiling/stains; θ = water hardness; ω = laundry load; Λ = fabric type; δ = drum speed; t = main wash time; τ = peak temperature.

In **Fig. 5**, the washing performance on an ensemble of 20 stains as a function of the dosage and the load is given. At laundry loads above 6–7 kg, the performance worsens and can be increased by additional detergent dosage.

The washing machine industry has basically developed the major part of programs for the most efficient and most modern machines – the horizontal axis machines – on the base of the former 5-kg wash load machine. In the last decades, consumers have asked for bigger machines and manufacturers have reacted with new machines offering a maximum load of up to 12 kg on a 60 x 60 cm footprint. Dosing schemes provided by the machines – even those for automated dosing of liquids – and the dosing schemes provided by the detergent manufacturers can of course not follow the variation of loads in a continuous way but steer or recommend a dosage for certain clusters [6]. It is quite logical that this is not the optimum which could be achieved when knowing and using the full functional correlation.

The same is true for the quality of textiles. Several programs are designed for specific kinds of fibers. But major challenges occur for mixed fibers. The majority of laundry is based on pure cotton and on cotton-polyester blends. Detergent manufacturers know that a detergent can be optimized on cotton and can be optimized on polyester [7]. Let us imagine that we could read out the weight and type of fiber for every single item the consumer is loading into the washing machine. This technology is not so far away as digitalization, but also increasing electronics technology will allow quite soon an individual RFID or NFC chip printed on a textile and providing this information. Under these circumstances, the Digital Sinner can adapt the dosing of the detergent and – thinking in the direction of dosing several components separately – dose specific ingredients at different amounts.

Another important aspect is the removal of specific stains and/or specific kinds of soil. Some washing machine manufacturers offer advanced programs which are designed to remove specific stains, like a "egg stain program" to remove egg yolk stains. It is very questionable whether consumers use this kind of programs. These programs can only be used if the "stain history" is known, i.e. that the consumer knows the origin and the circumstances how the concerning stain has occurred. Even if this information is given for the specific stain, what about other stains, and are there enough items with tomato stains to start an extra program? And from our consumer research we know that consumers do not know the "stain history" in most cases and expect a washing program and a detergent which can deal with it without this information – at least without the consumer being obliged to provide this information.

The digitalization of the Sinner Circle can make a difference here as well. The parametrization of the washing process includes the functional dependency between the cleaning performance – also for special frequent stains – and all other parameters which can be set accordingly for the machine and the chemistry. In addition, the future home washing machine might have a separate or included stain detection device which identifies the major part of the stains in the various laundry items e.g. in the moment they are put into the washing machine.

In **Fig. 6**, the washing performance on an egg stain as a function of the dosage and the load is given. The performance mainly depends on the detergent dosage, the laundry load plays a minor role.

If appliances or devices can detect specific stains, the washing parameters can be adapted to the problem to be solved.

4. Sustainability and Smart Adaptation of Washing Programs

The Digital Sinner will mark a step change towards sustainability. All dimensions which have already been discussed, describe a new way of washing which "achieves more with less" in general, particularly shorter process, less but right chemistry, more gentle mechanics in the machine. One important factor for optimal performance is of course the right washing temperature. And as we all know, washing at the lowest temperature possible is the major contribution to energy saving and to reduce unneeded CO_2 emission [8, 9].
For this reason, the European detergent industry is advertising a lot for washing at lower temperatures. For example, with the campaign "I prefer 30" [10] as an industry or partially specific consumer advice like the current "Wash Cold" initiative from Henkel. Many consumer associations and institutions for product testing have intensively recommended washing at low temperatures, too. The measurable change in consumer behavior is limited – despite of all this initiatives and advices. Over the last decade we see – if any – only a reduction by very few degrees Celsius.

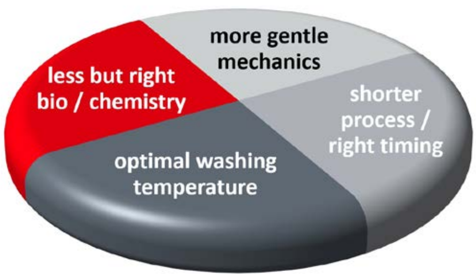

Fig. 7 Opportunities to optimize the parameters of the Sinner Circle.

A significant optimization is possible if the new software decides by itself about the optimal parameters including the right temperature (**Fig. 7**). Consumers will stay in the driver seat as they can select several scenarios for the final result. All the rest will be steered by the smart software of the Digital Sinner. Here are three examples for these kinds of scenarios:

- Quick wash: Dosage, water consumption, temperature and mechanics are adapted to a short washing time in accordance with a pre-selected level of cleaning and with the lowest possible CO_2 footprint [11]
- Ecology: Target is the lowest total environmental footprint in material consumption (dosage) and CO_2 emission in dependency on fibers, filling level, stains, kind of detergent [12]
- Hygiene: Target is the maximum level of hygiene and germ removal by optimizing all other parameters including again the lowest possible environmental footprint [13, 14].

5. Conclusion

The digitalization of the Sinner Circle will allow a more sustainable and more convenient future of the washing process. 60 years after its invention, we are in the middle of the next paradigm shift. The new ecosystem is not any longer built by only the washing machine and the detergent. The "Digitalized Know-how" generates a link between both.
At best both industries will collaborate along the value chain of the newly defined ecosystem in order to shape the future, together.

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A Natural Way to Treat Tooth Sensitivity

T. Budde

Introduction

Tooth sensitivity is a common condition endured by millions of people around the world – many of whom are unaware that treatment can simply be a matter of choosing the right toothpaste

Perhaps now more than ever before, tooth sensitivity is an important topic. With dental services unavailable or restricted to varying degrees around the world as a result of the coronavirus crisis, increasing numbers of people are looking to take extra care and safeguard their dental health at home.

For many people, sensitive teeth are already an issue. Indeed, according to a systematic review of data published in 2013, most dentists consider tooth sensitivity, or dentin hypersensitivity (DH), to be a relevant problem within their practice [1]. The review found that between 25 and 30 percent of adults suffer from the condition, with the peak age for incidence being between 30 and 40. Women are more likely to be affected than men, and the problem is more common in the maxillary (top) teeth as well as on the buccal (outer) surfaces.

Causes and Symptoms

DH is characterized by sharp, short pain that can be triggered by tactile, chemical, thermal or air blowing stimuli. Consumption of certain foods and drinks is, for instance, a common trigger for pain. Acidic and/or cold beverages, ice cream, citrus fruits and hot drinks like tea and coffee are among the most widespread causes. People who suffer from DH often start to avoid consuming potential trigger products because they are afraid of the pain. However, these are only the triggers, and the underlying problem persists, despite the change in lifestyle habits.

Dentin hypersensitivity arises when tubules within tooth dentin become exposed. This can occur for various reasons. Aggressive tooth brushing is a common cause, but teeth can also become sensitive after dental work such as scaling, root canal or tooth whitening procedures. Exposed dentin and therefore DH can also be caused by periodontal disease.

Once dentin tubules are exposed, it is easier for them to come into contact with stimuli such as hot, cold, sweet or acidic foods and beverages, and this can induce the movement of fluid within the tubules. This movement then triggers nerves within the pulp, which ultimately causes the short, sharp pain [2,3].

Effective, Natural Treatment Exists

DH affects enjoyment of daily activities and quality of life, but many patients tolerate this, unaware that it is in fact a manageable condition that can be treated by various means. One simple and affordable approach is to occlude the dentin tubules during tooth brushing with specialist toothpaste and thus prevent stimuli from provoking the movement of dentinal fluid.

Suitable for formulation into such toothpastes, Omyadent® 200-OG has been specifically developed to meet the requirements of teeth with exposed dentin characterized by dentin sensitivity. Thanks to its small, tailored particles, Omyadent® 200-OG penetrates the tubules in the dentin and occludes them effectively [4–7].

The completely natural ingredient has a core of calcium carbonate and a shell of hydroxyapatite – a calcium phosphate that is a major component of teeth. This hydroxyapatite shell gives Omyadent® 200-OG exceptional affinity with the surface of the teeth and therefore excellent performance characteristics. In addition, the hydroxyapatite shell delivers improved acid resistance versus calcium carbonate and enables Omyadent® 200-OG to survive acid attacks more effectively.

Backed by Scientific Studies

Comprehensive scientific studies have proven the performance and effectiveness of Omyadent® 200-OG as a tubule occlusion particle and desensitizing agent for oral care.

In one study, dentin specimens were treated with either Omyadent® 200-OG-particles, a toothpaste formulated with Omyadent® 200-OG, a negative control or a positive control. The positive control was a commercially available toothpaste with a desensitization/tubule occlusion claim, while the negative control was hydroxyethyl cellulose, which was expected to have no occlusion properties.

Fig. 1 shows scanning electron microscope (SEM) images of the treated dentin specimens. The excellent tubule occlusion

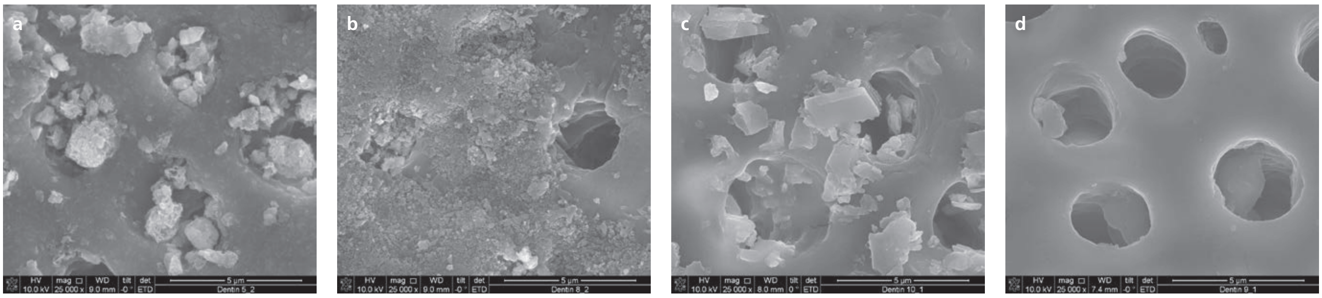

Fig. 1 a) 5 % Omyadent® 200-OG particles. b) Toothpaste with 5 % Omyadent® 200-OG. c) Positive control, market toothpaste. d) Negative control, hydroxyethyl cellulose.

properties of Omyadent® 200-OG are clearly visible: The particles on their own can be seen to occlude the tubules (**Fig. 1a**), and there is even greater occlusion in the toothpaste formulated with the particles (**Fig. 1b**). There is a marked difference between these specimens and the controls, including the commercially available toothpaste.

Easy to Formulate

Omyadent® 200-OG is easy to incorporate into toothpastes based on different types of cleaning particles. For instance, toothpastes based on natural calcium carbonate, such as Omya's Omyacare® cleaning particles, have been formulated and tested successfully. Silica-based toothpastes have also been trialed and shown to have high tubule occlusion efficiency when combined with Omyadent® 200-OG.
Offering these types of products to consumers can give hope to DH sufferers that the condition is treatable. Simply switching to a specialist toothpaste can have a marked impact on their overall quality of life, improving symptoms and alleviating pain. Contrary to what many people currently believe, DH is not a condition that cannot be treated, nor is a visit to the dentist an unavoidable necessity.

Diary Dates: Webinar and International Forum

Omya hosted a free-to-access webinar on 9th June focusing on the latest as well as future oral care trends. Details are available online at healthybite.omya.com, where you can also find out more about Omya's second international conference. Following its successful debut last year in Lucerne, Switzerland, Omya's has scheduled a second event for 8th June 2021 at Castle Laufen in Dachsen, Switzerland. The conference promises to be an exciting forum for specialists involved in various aspects of dental health.

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SAFIC ALCAN innovative solutions

Phase	Trade Name	Supplier	European I.N.C.I. Name	Function	%
A	Demineralized water	–	Aqua	–	to 100
	Brilliant Blue FCF 85% E133 1% aqueous solution	SYMRISE	Aqua, C.I. 42090	Color	0,02
	Yellow Quinoleine 70% E104 1% aqueous solution	SYMRISE	Aqua, C.I. 47005	Color	0,03
B	**SAFIC' Care T CK2**	SAFIC-ALCAN	Chondrus crispus	Gelling agent	2,00
	Amaze™ XT Polymer	NOURYON	Dehydroxanthan Gum	Suspensive agent	0,25
	Glycerin 4810	OLEON	Glycerin	Humectant	5,00
C	Glycerin 4810	OLEON	Glycerin	Humectant	1,00
	Prestige® Silver	SUDARSHAN	Mica, Titanium Dioxide	Effect pigment	0,10
D	Hydrolite® 5 Green	SYMRISE	Pentylene Glycol	Solubilizer	3,00
	Sensicare® C1090	CHEMIPOL	Phenoxyethanol, Ethyl-hexylglycerin	Preservative	0,70
	Kale Cucumber 58980	RAVETLLAT	Parfum	Fragrance	0,30
E	Demineralized water	–	Aqua	–	2,00
	ResPlanta Phyto Broccoli MB	RESPHARMA	Brassica Oleracea Italica Seed Oil, Polyglyceryl-4 Esters, Aqua	Active	2,00
F	Biolime	BIOLIE	Aqua, Propanediol, Citrus Aurantifolia Fruit Extract	Active	1,00
	Greentense	BIOLIE	Aqua, Propanediol, Lactuca Scariola Sativa Leaf Extract	Active	1,00

SAFIC' Care is a trademark of SAFIC-ALCAN

Procedure:
Phase A: Heat up to 75°C under stirring.
Phase B: Pre-mix then add to phase A and stir for 15 minutes at 75°C until homogeneous.
Phase C: Pre-mix then add to phase AB. Allow to cool down to room temperature.
Phase D: Pre-mix then add to phase ABC and homogenize.
Phase E: Heat to 40°C and stir until dissolved then add to phase ABCD and homogenize.
Phase F: Add to phase ABCDE and homogenize. Supplement in water, homogenize then adjust pH to 5,5–6,5.

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This natural sunscreen SPF30, composed exclusively of non-nano mineral filters, is perfect for protecting your skin from UV rays at the beach while protecting the environment! Unlike most natural sunscreens, its texture is soft, easy to spread, and leaves no sticky nor greasy film thanks to Emulium® Illustro. A mix of active ingredients brings energy and radiance to the skin.

Phase	Name	INCI	Supplier	%
A	**EMULIUM® ILLUSTRO**	POLYGLYCERYL-6 POLYHYDROXYSTEARATE, POLYGLYCERYL-6 POLYRICINOLEATE	Gattefossé	4.5
	LABRAFAC™ CC MB	CAPRYLIC/CAPRIC TRIGLYCERIDE	Gattefossé	5.0
	CETIOL® C5	COCO-CAPRYLATE	BASF	8.0
	CETIOL® OE	DICAPRYLYL ETHER	BASF	7.5
	RHEOPEARL KL2	DEXTRIN PALMITATE	Miyoshi	2.0
	ZINCLEAR® XP65 COCO	ZINC OXIDE, COCO-CAPRYLATE/CAPRATE	Antaria	14.0
	ZnO-C-NJE3	ZINC OXIDE, JOJOBA ESTERS	Kobo	4.0
	SOLAVEIL™ XT-40W	TITANIUM DIOXIDE, ALUMINA, WATER, POLYGLYCERYL-2 CAPRATE, SUCROSE STEARATE, SIMMONDSIA CHINENSIS (JOJOBA) SEED OIL, STEARIC ACID, GLYCERYL CAPRYLATE, SQUALANE	Croda	15.0
B	DEMINERALIZED WATER	WATER	–	25.1
	GEOGARD ULTRA™	GLUCONOLACTONE, SODIUM BENZOATE, CALCIUM GLUCONATE	Lonza	0.5
	BIO-PROPANEDIOL	PROPANEDIOL	Connect Chemicals	3.0
	MAGNESIUM SULFATE 7H2O, CODEX	MAGNESIUM SULFATE	Merck	2.0
C	**GATULINE® RC BIO**	WATER, FAGUS SYLVATICA BUD EXTRACT	Gattefossé	2.0
	GATULINE® RADIANCE	PROPANEDIOL, EVODIA RUTAECARPA FRUIT EXTRACT	Gattefossé	2.0
D	TOCOPHEROL	TOCOPHEROL	-	0.1
	COSM'OIL KD-S	PONGAMIA GLABRA SEED OIL	Cosmact	5.0
E	PERFUME LUX & CO – NATCO 1510063	PARFUM	Expressions Parfumées	0.3

Operating Instructions:
1. Heat A to 70°C.
2. Disperse powders under ultra-turrax for 5 min.
3. Under rapid mixing (rotor stator 3000 rpm), add slowly B to A at 70°C.
4. Maintain under rapid mixing for 10-15 min.
5. Cool under mixing (rotor stator 2000 rpm).
6. At about 35°C, add C, D and E.
7. Complete cooling.

Properties:
• Beach use
• Environment-friendly
• Non-tacky

Specifications:
• Aspect: Light yellow cream
• Viscosity Brookfield RV (spindle B, speed 5): approx. 28 000 mPa·s after 24h
• SPF *in vivo* (ISO 24444): 34,4 (5 subjects)
• Photostability: 86%
• UVA *in vitro* (ISO 24443): 13,1
• Broad Spectrum (FDA): 379 nm

DISCLAIMER: This formula is presented in good faith, however, no warranty as to the accuracy or completeness of results, or fitness for a particular use is given, nor is freedom from the infringement of any intellectual/industrial property rights to be inferred. It is provided "as is" for your consideration, investigation and verification. To the extent permissible by applicable law, Gattefossé shall in no way be liable for any reliance upon information or materials provided.

ATMOSPHERE SHIELD Protective Cream SPF15* | F17003.03

vytrus biotech

This protective cream fights against accelerated inflammation and stress, while deeply repairing the extracellular matrix and protecting it preserving the potential of progenitor cells, collagen, and elastin levels. The skin remains hydrated, more elastic, and visibly with less wrinkles.
*SPF15 based on theoretical calculation according to filter combination used.

Phase	INCI	Trade Name (Supplier)	% (w/w)
A1	WATER (AQUA)		52.29
	DISODIUM EDTA		0.20
	ACRYLAMIDE/SODIUM ACRYLATE COPOLYMER, PARAFFINUM LIQUIDUM, TRIDECETH-6		0.20
A2	XANTHAN GUM	COSPHADERM X34	0.30
	GLYCERIN		3.00
A3	POTASSIUM CETYL PHOSPHATE		0.30
	WATER (AQUA)		10.00
B	POLYGLYCERYL-6 DISTEARATE, JOJOBA ESTHER, POLYGLYCERYL-3 BEESWAX, CETYL ALCOHOL		4.00
	CETEARYL ALCOHOL		1.50
	CAPRYLIC/CAPRIC TRYGLYCERIDE		4.00
	DICAPRYLYL ETHER		2.00
	BUTYLENE GLYCOL COCOATE		2.00
	OCTOCRYLENE		10.00
	BUTYL METHOXYDIBENZOYL METHANE		5.00
	BHT		0.01
C	GLYCERIN, GOSSYPIUM HERBACEUM (COTTON) CALLUS CULTURE, CITRIC ACID	**ARABIAN COTTON** PRCF (VYTRUS BIOTECH, S.L.)	2.00
	CURCUMA LONGA (TURMERIC) CALLUS LYSATE, GLYCERIN, CITRIC ACID	**TURMERIA ZEN** PRCF (VYTRUS BIOTECH, S.L.)	2.00
D	PARFUM (FRAGRANCE)		0.20
	PRESERVATIVE		1.00

Procedure:
1. Disperse the components of phase A1 for 10 minutes.
2. Mix the components of phase A2 and phase A3 separately and add them to the phase A1.
3. Heat the mixture to 75°C.
4. Mix the components of phase B and heat it to 75°C.
5. Add the phase B over the phase A and homogenize for 10 minutes.
6. Below 40°C add the components of phase C and D and shake it for 5 minutes.

Properties:
Rich cream, highly emollient and nourishing, with a non-greasy, soft, velvety, and very comfortable final touch that creates a double protective shield: interior and exterior. The combination of TURMERIA ZEN and ARABIAN COTTON protects the skin against aggressions that it suffers daily such as the stress to which we are subjected, radiation (UV/VIS/IR/blue light) and inclement weather.

Appearance:
Slightly yellowish white cream.

Specifications:
• Viscosity: 5000–10000 cP (8316 cP; ST-2020-R SELECTA, sp5 rpm 40; 20°C)
• pH: 5.00–6.00

Blue Light Blocking Cream | with Carotolino and Mexican Arnica Pro | FF10021-1_022020

Lipoid Kosmetik

Phase	Ingredient	INCI	Function	Supplier	% w/w
A	Deionized Water	Aqua (Water)			Ad 100
	Glycerin 99.5%	Glycerin	Humectant		2.50
	KELTROL® CG-SFT	Xanthan Gum	Thickener	CP Kelco	0.20
B	Phytocream® 2000	Cetearyl Alcohol, Glyceryl Stearate, Potassium Palmitoyl Hydrolyzed Wheat Protein	Emulsifier	Sinerga	3.00
	TEGO® Care 450	Polyglyceryl-3 Methylglucose Distearate	Emulsifier	Evonik Nutrition & Care	2.00
	Myritol® 318	Caprylic/Capric Triglyceride	Emollient	BASF	6.00
	dermofeel® sensolv	Isoamyl Laurate	Emollient	Evonik Nutrition & Care	4.00
	Coconut oil native, organic	Cocos Nucifera (Coconut) Oil	Emollient	All Organic Treasures	3.00
	Shea butter organic	Butyrospermum Parkii (Shea) Butter	Emollient	Emile Noel	3.00
	Beeswax pesticide removed	Beeswax	Consistency agent	Hammonia Oleochemicals	0.80
	Lanette® O	Cetearyl Alcohol	Consistency agent	BASF	1.20
C	**Carotolino**	Canola Oil, Daucus Carota Sativa (Carrot) Seed Oil, Helianthus Annuus (Sunflower) Seed Oil, Tocopheryl Acetate, Beta- Carotene, Daucus Carota Sativa (Carrot) Root Extract, Citric Acid, Tocopherol	Active ingredient	Lipoid Kosmetik	0.50
	Mexican Arnica Pro	Heterotheca Inuloides Flower Extract, Water, Glycerin, Sodium Benzoate, Citric Acid, Potassium Sorbate	Substantiated extract	Lipoid Kosmetik	0.50
D	E-Leen® Green C	Pentylene Glycol, Glyceryl Caprylate/ Caprate	Preservative	MinaSolve	4.00
E	NaOH	Sodium Hydroxide	Neutralizing agent		q.s.
	Vitamin Cocktail 1765-0	Fragrance, Citral, Geraniol, Limonene, Linalool	Fragrance	Essencia	0.50

Procedure:
1. Prepare phase A and B separately and heat them up to 75°C
2. Add B to A and emulsify until homogenous
3. Cool down to 40°C under stirring
4. Add the ingredients of phase C and homogenize until Carotolino is evenly dispersed
5. Add the ingredients of phase D and E and homogenize shortly
6. Adjust the pH to 5.5–6.0

Technical Data:
- Appearance: yellow, glossy cream
- pH value: 5.5–6.0

Formulation Stability:
Successfully passed internal stress test (3 months at 5°C, 25°C and 40°C)

Microbiological Stability:
Successfully passed microbial challenge test (ISO 11930)

Benefits:
- Blue light protection for sensitive and irritated skin.
- Skin color improvement adds liveliness, compensates pale skin tones, is not perceived as too orange.
- Carotolino adds value to the formulation and increases buying intention (please request our product flyer).

"Our Ideal of Beauty has Changed – and that is Good"

Interview with Dr. Daniel Ibarra, Senior Vice President EAME Sales & Global Marketing, Symrise

Symrise's Cosmetic Ingredients Division will be presenting its new marketing campaign, the story behind it – and a new brand ambassador. In an interview, Dr. Daniel Ibarra, Senior Vice President EAME Sales & Global Marketing at Symrise, explains the idea behind the new campaign.

Dr. Daniel Ibarra

Symrise's Cosmetics Ingredients division has a new look. Why is that?

Beauty today is more diverse than ever. The focus is no longer on the conventional beauty ideals of the past; now, it has shifted to encompass character and values, individuality and self-assurance. Today, beauty means feeling comfortable in one's own skin. That is precisely the starting point for the Symrise Cosmetic Ingredients division's product concepts and solutions: They aim to serve a modern idea of beauty in all its countless facets. This is the message we want to communicate, and we are using a modern marketing concept to do this. The concept creatively communicates our specific and unique strengths: Our holistic approach to the concept of "beauty"; our ability to unite the best of nature, science and technology and harness the results to develop truly outstanding solutions for beauty and personal care. This is a concept that reflects not only our expertise, but also our identity, our philosophy and values: Protecting our planet, respect, diversity, tolerance. A sustainable lifestyle and economy. Integrity and resilience.

Do you think the world is ready for this new idea of beauty?

It is well on the way to accepting it, and I really don't think that this inspirational change can be halted. We consider ourselves pioneers and guides on this journey. Beauty is no longer exclusively dependent on models and idols; instead it has become an expression of individuality and how we choose to present ourselves. It has gained an incredible and also astonishing diversity. Beauty has evolved far beyond superficial perfection; more than ever, it is a question of character. The emergence of the LGBTQ movement has changed the way we see and comprehend roles and beauty. Our new approach is rooted in this altered reality. I believe that we are experiencing an evolution rather than a revolution. This is not just a fashion – it is an enduring shift towards a great and inspiring diversity.

Values obviously play a major role in your story. How do you make this claim come alive?

That's something we do every day. Sustainability has always been an integral part of our business model. We assume responsibility and in all our activities we consider their impact on our customers, consumers, our employees and the world we are leaving for our children.

We have a long tradition of using active ingredients from nature. One example is our production facility in the Amazon, which opened in 2015. We designed it to incorporate sustainability aspects along the entire value chain – from the procurement of raw materials to production and social commitment in the region. These are key aspects, and as such we want to go beyond just presenting them visually. Instead, as a division and as individual members of Symrise Cosmetic Ingredients, we want our vision and philosophy embodied by an authentic personality with a credible narrative who can communicate our values to the outside world.

So where did you find this "new" face for Cosmetic Ingredients?

We hunted in many different directions, looked at many people, including models, actors, athletes and environmental activists. Finally, we came across Domitila Barros. I have rarely experienced such a unanimous decision at Cosmetic Ingredients! *(laughs)*

She is our perfect ambassador. We share the same values and the same understanding of modern, sustainable and responsible beauty and personal care.

Let me tell you little bit about Domitila: she was born in 1984 in Recife, Brazil, and presently lives in Berlin. She grew up in a favela with no schools, no hospitals, not police stations, no playgrounds. In 1983, her parents set up CAMM, a project to help street children. As a young woman, Domitila became involved in the project and in 2000 received the United Nations' *Millennium Dreamer Award* in recognition of her work. She has a master's degree in politics and social sciences and works as a consultant, actor, presenter and model. In 2017, she founded a sustainable beachwear and jewelry label called *Sheisfromthejungle;* 10 percent of all profits are donated to the CAMM project. Domitila is the perfect match for us, and her commitment to social causes is a constant reminder for us to examine our values and keep them strong.

» page 48

symrise

Can you tell us a little more about the communications concept behind the new campaign?
In the past, our product categories were represented by different models. For the new campaign, though, we deliberately chose a single model, a model who is very versatile and highly recognizable.
Faced with a growing number of products and advertising messages in Cosmetic Ingredients, we decided to communicate to the market that despite the complexity and the many different product categories, they all belong to one family, namely Cosmetic Ingredients. This was a key consideration when we were looking for our ambassador. The new "face" had to comply with the requirements of our new branding concept in terms of both looks and presentation. Domitila ticks every single box – she is perfect for us. But rather than me trying to explain, I'll let the images that embody the new image of Cosmetic Ingredients speak for themselves.

Domitila is also an influencer with nearly 80,000 followers ... Does this mean that you intend to step out of the B2B world and communicate more with consumers in future?
Absolutely! Just look at where communication is heading in terms of technology and content. Businesses simply cannot afford to ignore this development. Our goal is to go beyond exclusively communicating with the B2B sector; we also want to make consumers aware of us and our values. Although we do not offer consumer-ready products, we want consumers to perceive us – through our ambassador – as an important and sustainable supplier of key ingredients for the products they use.

It's unusual for an individual division to have its very own branding. What's the story behind this?
The Symrise divisions – scents and flavors, cosmetic raw materials and active ingredients, functional ingredients and nutrition solutions – offer very specific services for very specific target groups, all with their own aesthetics and messages. Naturally, the Symrise brand umbrella always ranks highest in terms of importance, but within this framework we are relatively free to design and project an identity that is unique and recognizable in our market.

What do you hope to achieve with the new visuals?
We want to communicate our strengths even more effectively with a distinctive look, to boost our authenticity by using a strong ambassador. And above all, we want to be an inspiration for the industry – in keeping with our brand claim "always inspiring more."

www.symrise.com

SPINCONTROL Asia
EFFICACY AND SAFETY TESTS OF COSMETICS


Fabrice Perin

Interview with Fabrice Perin

CEO of Spincontrol Asia

Mr. Perin, can you briefly tell us something about the history of Spincontrol Asia?

Spincontrol has been founded almost 30 years ago by Dr. Patrick Beau, a researcher from the University of Tours, in France. This company started as a truly innovative laboratory where high-tech *in vivo* magnetic resonance spectroscopic and imaging methods were used as research tools for the food, pharmaceutical, cosmetic industries. After 3 years of operations, Spincontrol became a cosmetic Contract Research Organization as it is well known today, able to provide standard and research protocols for the substantiation of cosmetic claims. At that time, some of our European clients were looking for evaluating the effects of their products on Asian skin. Therefore we have created Spincontrol Asia to meet these regular requests, the rationale being that it is easier to find Asian subjects in Asian rather than in France. Moreover cosmetics developed for Asian markets are tested in one Asian country on Asian subjects which makes more sense. We launched Spincontrol Asia in 2003 in Bangkok, as a joint-venture with Chemico Inter Corporation, a well-established distributor of cosmetic and food ingredients in South-East Asia. Since 2003, Spincontrol Asia has grown continuously, has been certified ISO 9001, and has been able to attract clients from the five continents.

What services do you offer for the cosmetic industry?

We provide *in vivo* testing services for the manufacturers of active ingredients and finished cosmetic products. Our main strength is about efficacy testing. Indeed we have a large number of methods and techniques to propose for the assessment of face and body care products, hair care products, oral care, and make-up products. But we also have a very significant activity in the field of tolerance studies which include patch testing, dermatological, ophthalmological and odontological controls of the compatibility of cosmetic formulations. Last but not least, we also perform consumer studies.

Spincontrol has branch offices in 5 countries.
What is the special focus of Spincontrol Asia in Bangkok?

Indeed we are present in France, Thailand, Canada, India and Indonesia. In Bangkok, we focus on pigmentation problems. Having a white skin is an extremely important element of the women's beauty in Asian cultures. This desire for a light complexion comes from traditional Asian values and beliefs, but has been also reinforced by Western cultural influences. Because whitening/lightening products are the best-selling products in Asia, it is logical that many manufacturers contact us to scientifically demonstrate the *in vivo* efficacy of their new formulations. We have also quite a lot of tests related to sebum and acne. Spicy food is popular in South-East Asia and is known to boost excessive sebum secretion. For this reason, many of our studies deal with sebo-regulating and mattifying products. Finally anti-aging are the other claim of importance in our laboratory.

You have a motto called PROOF. What does that mean?

This motto has two origins and a double objective. On the brochure of our group appear one sentence attributed to the famous mathematician Euclid: "What is expressed without proof can be denied without proof". I feel that this sentence perfectly suits with our mission which is to provide the scientific evidence that one cosmetic is effective and safe. Because I liked this saying, I have tried to use the acronym *PROOF* for internal and external communications: internally to remind my employees that I have and we have some important commitments to respect; externally to confirm to our clients that our words engage us. Spincontrol Asia is *Professional*. We are committed to provide high-quality services for cosmetic testing in Asia. We strive for continuous improvement through training and innovation. We *Respect* our employees, our clients, suppliers and partners and we respect all regulations. Spincontrol Asia is *Open*. We are willing to receive ideas, opinions and critics. We are committed to communicate with full transparency. *Others* matter. We are committed to build lasting relationships with our clients and partners, based on mutual trust. Employees are responsible for the performance and reputation of the company and should be rewarded for their efforts. Volunteers who participate to our studies deserve our best consideration. *Fairness* is the last point. We conduct fair business with our clients. Justice, honesty, equality and solidarity between managers and employees are the rules. We have a large poster displayed in our office to ensure that staffs and visitors understand that we are fully committed. Should we fail to work on our rules, they have the right and the duty to remind us of our motto.

What is your vision for the future?

We are working to continuously improve ourselves so as to be a major cosmetic CRO in Asia. The idea is to identify our strengths and weaknesses, systematically eliminate the weak points while still consolidating our strong points. The fact that Spincontrol has 5 branches will help us to develop a synergy between the centres. And the recent acquisition of Spincontrol France by BIO-EC laboratory, a specialist research center for cosmetic and dermatological efficacy and safety studies with an expertise in *ex vivo* tests, will help us to expand the range of our technical and scientific solutions by developing more relevant and original protocols.

www.spincontrolasia.co.th

Lubrizol Life Science Beauty Supporting Local Hospitals in Spain and US during COVID-19 Pandemic

Interview with Elena Cañadas, Global Marketing Director, Lubrizol Life Science Beauty


Elena Cañadas

Lubrizol's motto is: "we have a mission to improve lives". During this global pandemic, how has Lubrizol been able to make this motto live?
First, we maximized production of the Carbopol® polymer, a thickening agent found in most hand sanitizing gels and cleansing applications, to assist with the global fight against COVID-19. In addition, our company has been making every effort to use its science to support the pandemic fight. Lubrizol in Barcelona is supporting health workers with hand creams; donating 7,000 hydrating and repairing hand creams to local hospitals, not only in Barcelona, but the U.S. as well.
Globally, Lubrizol has been working to create hand sanitizers, medical gowns, face masks, medical devices and other items needed for the COVID-19 pandemic and has committed to donating $2 million to support COVID-19 needs.

What do you expect for the post-coronavirus world?
In a post-coronavirus world, hygiene will be the primary consumer concern, so there will be higher consumer demand for products that focus on hygiene, cleanliness and protection. As frequent handwashing and sanitizing become the new norm, consumer need for hand care has increased significantly and will continue growing.
Lubrizol Life Science (LLS) Beauty has a complete portfolio of ingredients and the formulation expertise to create hand cleansers and sanitizers, as well as hand creams that treat, soothe and protect hands. From surfactants to active ingredients, we have a full range of products to meet all formulator and consumer needs.

Many first-responders are not only dealing with the need for more effective disinfectants, but also the need to protect or calm the 'stressed skin'.
Going forward to implementing new hygiene guidelines how will you address this need to the global markets?
Our Spanish facility have developed, through the Accelerator Program – our finished goods service – special hand creams for hands damaged by frequent washing. We have donated these hand creams to local hospitals to help health workers take care of themselves while they save lives. We have received a lot of positive comments from the users, they have even sent us before-and-after photos of using the cream!
We've also donated some hand creams to U.S. hospitals, where it's been well received. And now we also want to offer this highly effective formulation to customers so that they can get them to the consumer, and for each unit we sell to our clients we will donate one unit to hospitals.

What are the hazards of frequent disinfection and hand washing?
Frequent handwashing can damage the barrier integrity of the skin, stripping away natural oils and causing hands to become dry, sore and irritated. As we wash our hands, we must also take care of them, keep them moisturized and with an intact barrier function. A wide range of our active ingredients can be used to provide these benefits.
Busy hands can become damaged even under normal conditions. LLS-Beauty wants to celebrate our hands, helping with their hygiene and health, so we can enjoy them while taking care of ourselves.

Why are rheology modifiers and emollients important in future formulations?
Rheology modifiers, such as our line of Carbopol® polymers, the heart of our portfolio, are critical for the formulation and texture of hand gel sanitizers. Several ingredients from the Carbopol® line can be used for this purpose. In addition to the rheology modifier, many sanitizers include emollients and humectants, such as Glucam® E20 or Hydramol® PGPL ester, that provide good aesthetics and tactile properties.

Has your business model changed in a now virtual reality of meeting your customers' needs / demands?
We have been meeting the needs of our customers during these difficult months without compromising our rigorous focus on keeping our workers safe. Our plants have remained active and responsive to customer orders.
Our sales teams have continued to attend to customers electronically, and we have held several digital events to make sure we are coordinating our efforts and serving customers.
We will continue to look for ways to support our communities in these unprecedented moments and to offer our clients the innovative ingredients they need to face the new normal that is coming.

www.lubrizol.com/Life-Science

Biesterfeld Opens Lab and Innovation Centre in Hamburg

Hamburg/Germany I June 30, 2020. Biesterfeld is expanding its laboratory capacities in Hamburg with the opening of the *Biesterfeld Lab and Innovation Centre.* Covering a total area of 800 m² the premises will be used with immediate effect for application-related laboratory activities. These include the development of innovative and market-oriented formulations, carrying out of product tests and customer-specific project work. The Biesterfeld Group also has regional laboratories in Norway, Turkey and Poland.

An existing laboratory in Hamburg has been integrated into the new application laboratory to make the new Biesterfeld Lab and Innovation Centre. The premises also contain a conference room and a modern presentation and meeting area, which can be used for product launches and technical training sessions.

"In our application laboratories we develop tailored solutions to cater for the needs of our customers. An innovative formulation, for example, can be made market-ready through the addition of additives from our wide-ranging portfolio and thus support marketing work", reports Dr Lisa Nahrwold, Laboratory Manager at Biesterfeld Spezialchemie. "Alongside individual project work in accordance with customer requirements, the laboratory will be used to screen new raw materials from our partners and to conduct comparative studies. Comprehensive regulatory consulting rounds off our range of services."

"We can also draw on even more extensive resources by working together with external laboratories and institutes", adds Peter Wilkes, Managing Director of Biesterfeld Spezialchemie. "Our technology-based laboratory work constitutes a valuable service for our customers and provides customer-specific solutions. I am therefore delighted that we are also able to offer sufficient space in our Hamburg application laboratory for an interactive exchange of ideas with our suppliers and customers."

www.biesterfeld.com

Symrise Strengthens its Partnership with CRIEPPAM and Supports Biodiversity Research Project for Lavender Farming

Holzminden/Germany I June 26, 2020. Symrise is launching a joint research project with CRIEPPAM on lavender farming aimed at crop resilience, improved biodiversity and additional income for farmers starting in June 2020. The CRIEPPAM research institute, local farmers and Symrise have been working towards increasingly cultivating lavender in a sustainable way for several years. Lavender and the Provence form a fragrant pair. Its aromatic tribute to the region in the South of France earned it the reputation as "blue gold" and fragrance of the region.

To improve biodiversity and soil health farmers use inter-cropping methods. They shall benefit the lavender and lavandin fields. The project of CRIEPPAM and Symrise will identify the best inter-cropping options in lavender farming. They aim at improving biodiversity, increasing quality and yields of lavender and lavandin essential oils. At the same time they shall also provide valuable additional income for farmers. The inter-crops investigated will range from cereals to aromatic herbs, which grow well in the Mediterranean climate. In addition, the project will focus on developing practical agro-ecological techniques, which support biodiversity and inter-cropping such as new harvesting techniques and devices.

"We are delighted to be working with CRIEPPAM on this project, which will determine the benefits of intercropping on the health of plants and the quality of lavender and lavandin essential oils" says Beatrice Favre-Bulle, SVP Perfumery Excellence and Sustainability at Symrise.

"We are happy about the continued support by Symrise. The project will benefit biodiversity, and will also identify the best inter-crops to bring additional value to the farmers, thereby improving livelihoods and benefitting the local community." says Bert Candaele, Director of CRIEPPAM. The project will last three years with CRIEPPAM reporting annual progress to Symrise.

www.symrise.com I www.crieppam.fr

Vytrus Biotech Launches CSR Action to Research and Preserve the Olive Tree in Catalonia

Barcelona/Spain I June 23, 2020. Vytrus Biotech and IRTA, the Institute of Agri-food Research and Technology of the government of Catalonia, announce their agreement that aims to research and preserve the different traditional varieties of olive tree in Catalonia through joint initiatives and actions. The biotechnology company allocates to this project a percentage of the turnover of one of its cosmetics ingredients, OLEA VITAE, a revitalizing cellular oil enhancer obtained from the stem cells of wild olive tree.

Òscar Expósito, CEO, CSO and co-founder of Vytrus Biotech, says: "The collaboration with IRTA represents for Vytrus Biotech a strategic alliance, aligned with our commitment to conserve and promote the plant biodiversity and resources of our planet. And what better way of supporting global sustainability than starting with our local natural resources!". To which he adds: "Our experience supports this premise: it is possible to innovate in science, be sustainable and, at the same time, grow economically. We must learn to devise business models in which it is possible to grow with other parameters than purely economic ones".

IRTA, the Institute of Agri-Food Research and Technology of the government of Catalonia has a research team focused on olive growing in Catalonia. This team participates in the Nutrisalt project (initiative promoted by local institutions) by giving support in the innovation of companies where this collaboration is framed. And within this framework, one of IRTA's research activities has been the creation of the Catalan Olive Variety Bank, a project that consists of prospecting, identifying, characterizing, and preserving the indigenous genetic resources of olive trees in Catalonia. So far, the Bank has 80 traditional Catalan olive varieties. The study of indigenous varieties may be of great interest in situations of climate change, either to identify genes for resistance to emerging pests, or to identify genes for adaptation to drought conditions, or to identify functional compounds of interest to companies developing new products.

"The collaboration between IRTA and Vytrus Biotech in olive growing allows IRTA to complement the study of Catalan autochthonous varieties from a new perspective, such as that of biotechnological applications. The classic variety evaluation considers aspects of agronomic behaviour, climate adaptation and oil quality. Including biotechnology criteria could allow us to recover some variety of agronomic value and with good potential for the development of new products", explains Dr. Agustí Romero, IRTA specialist researcher.

www.vytrus.com

Picture © JonoErasmus – stock.adobe.com

SCC Announces Initiatives Supporting Equity, Diversity and Inclusion in the Cosmetic and Personal Care Industry

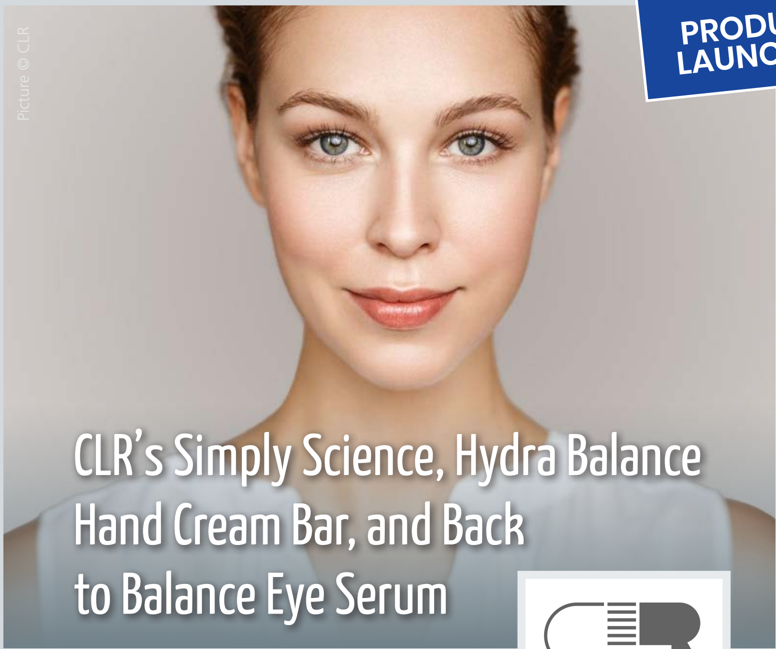
New York/NY/USA I June 19, 2020. Juneteenth is a day of true freedom for all! While the Emancipation Proclamation ended slavery in 1863, it wasn't until June 19, 1865, that Union soldiers enforced the order on the last remaining slave holders in Texas. In celebration of this day, the Society of Cosmetic Chemists (SCC) is announcing its initiatives to support diversity, equity and inclusion, ensuring the voices of people of color, and all minorities, in the cosmetic and personal care industry are heard and supported. The SCC has committed to:

1. Create scholarship opportunities for under-represented minority students pursuing an undergraduate or graduate degree in chemical, physical, medical, pharmaceutical, biological or related sciences and technology.
2. Address the industry's needs and advancements in serving communities of color with a dedicated session at each Annual Meeting.
3. Publish manuscripts in the Journal of Cosmetic Science that feature research focused on advancements in serving communities of color.
4. Provide opportunities to showcase the work of black chemists.
5. Hold a session at Career Development Day on diversity, inclusion and equity with an opportunity for people of color to share their experiences in the industry.
6. Develop relationships with historically black universities and colleges in support of cosmetic science program development.

"As we grieve with the black community, and in support of all who have endured systemic racism and oppression, the time for commitment to action is now," said Erica O'Grady, CAE, CEO of the Society. "The SCC is proud to pledge its resources and undertake additional efforts to support diversity, equity and inclusion for all participants in the cosmetics and personal care industry."

We encourage all of our members, and the global industry as a whole, to join us in ensuring that the voices of the oppressed are heard and to actively support efforts to end systemic racism and injustices around the world.

www.scconline.org


Picture © CLR

CLR's Simply Science, Hydra Balance Hand Cream Bar, and Back to Balance Eye Serum

Berlin I June 10, 2020. CLR's Simply Science: Consumers are well informed and demanding. Concerns about health of body & mind as well as concerns about the future of our planet play an important role for the way people live their lives and their purchasing decisions. The current situation has further strengthened this mentality. Priorities have shifted, the focus is back on the essentials, and with tighter budgets, each product has to prove its value.

Functionality and safety are at least as important as the 'feel good-factor' of using cosmetics. Importantly, the promise made must be well-founded. The effectiveness and safety must be proven scientifically and rigorously and only credible corporate ethics will ensure the sustainability of the product and the processes through which it is obtained.

CLR has a holistic and well-founded approach to responsible research. We care for the body with goal-oriented and effective active ingredients with the aim to be relevant for the consumer, always backed by scientific studies. We care for the mind by targeting unmet, but essential skincare needs and their impact on quality of life to provide relief and a sustainable feeling of well-being. We care for nature as we use the most modern methods and technology available – for products which are potent, relevant, natural and safe.

To illustrate our responsible research for body, mind & nature, we developed the "**Total Balance**" formulation series.

Hydra Balance Hand Cream Bar: Hands are easily stressed though exposure to disinfection and frequent washing. To keep them smooth and soft they need extra care. The Hand Cream Bar provides a sustainable and effective solution whether at home or on the go.

Back to Balance Eye Serum: The appearance of your eye area is an important feature of the way you are perceived by others – especially when wearing a face mask. Stress and a lack of sleep can easily make you look tired. This highly effective serum supports you with a triple complex to look your best in one simple step.

Discover all formulations and the key ingredients in our Formulation Lab at www.clr-berlin.com/2020/03/formulation-lab-total-balance.

www.clr-berlin.com

New Enzyme to Advance Surgical Device Cleaning

Raleigh/USA I Juni 30, 2020. Novozymes, the world leader in biological solutions, today announced the launch of a unique and advanced enzyme solution for cleaning surgical instruments and devices – **Remify Everis 100 L**. Preventing Healthcare Associated Infections (HAIs) has become more important than ever also with the COVID-19 pandemic. Not only can these result in death, but also in significant costs and loss of reputation for hospitals. It is well-recognized by the industry that inadequately cleaned surgical equipment is a key source of HAIs.

"The current cleaning processes used for medical devices, including multiuse endoscopes and surgical instruments, do not always guarantee that instruments are free of contamination. The formulation of the detergent used is crucial in effectiveness," says Rene Garza, Novozymes' Vice President for Household Care Americas. "**Remify Everis 100 L** is a unique and patented phosphodiesterase (PDE) – a nuclease – that removes free DNA soils. It has never been possible to specifically target these with detergent ingredients before."

Remify Everis 100 L represents a brand-new enzyme class for detergents that can be used to help prevent HAIs.


Picture © sudok1 – stock.adobe.com

Proven Performance

Novozymes has invested significantly in research into the performance of its new technology and the results have shown that detergents, optimized by using **Remify Everis 100 L**, one of the company's most advanced enzymes, provide better cleaning performance at the right dosages, removing stuck-on soils quicker and with less effort.

"With appropriate use of **Remify Everis 100 L**, healthcare organizations can improve patient outcomes by reducing the risk of HAIs. Other benefits are improved rewash rates and decreased operational costs," adds Rene Garza.

With demand for effective hygiene products at an all-time high, the launch of Novozymes' **Remify Everis 100 L** provides detergent manufacturers with a new option to satisfy customer requirements. Novozymes anticipates that the product will play a significant role in medical device cleaning in the future.

new.novozymes.com/remifyeveris

PRODUCT LAUNCHES

Givaudan

Givaudan Launches Koffee'Up™, a New Sustainable Beauty Elixir Crafted from Upcycled Arabica Coffee

Geneva/Switzerland | June 22, 2020. Givaudan Active Beauty is proud to launch **Koffee'Up™**, a scientifically proven premium coffee oil crafted using upcycling techniques. **Koffee'Up™** is referred to as the "new argan oil" in the beauty industry as a result of its natural, eco-conscious, and effective properties, bringing a myriad of facial skin care benefits to consumers such as hydration, protection, and anti-ageing.

The revolutionary beauty product was developed in collaboration with Danish start-up company Kaffe Bueno, the winner of the 2019 edition of MassChallenge Switzerland. As Givaudan is a founding partner of the distinguished start-up accelerator, this is the first product collaboration to result from working with one of the start-ups based in the incubator. The biotech start-up focuses on upcycling spent coffee grounds, or coffee waste, into active and functional ingredients for cosmetics to bring health and skin benefits to consumers. The strong sustainable mission of Kaffe Bueno is also in line with our approach to sustainability, adding value by using upcycling, or by-products from side streams, to enrich our portfolio with products that are also good for the planet.

Laurent Bourdeau, Head of Active Beauty, said: "We are thrilled of this unique collaboration with Kaffe Bueno and we're eager to start using the new product in creative solutions for customers. The high quality, traceable and upcycled ingredients used in **Koffee'Up™** showcases a prosperous new avenue for using sustainable coffee in the world of beauty. This is a big achievement and opportunity, and we're looking forward to presenting this innovative beauty elixir to customers."

Maurizio Volpi, President of Givaudan Fragrances: "Our Company purpose and sustainability approach are at the core of our business and the launch of **Koffee'Up™** fits perfectly well with creating for happier, healthier lives with love for nature. The innovation surrounding upcycling in the cosmetics industry today is a crucial point for the evolution of sustainable business and we're thrilled to partner with a young start-up company at MassChallenge Switzerland who values the same sustainable practices we do."

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