

The Sunny Skin Microbiome

The pioneering investigation revealing the impact of UV irradiation on the human skin microbiome and the benefits of UV filters by dsm-firmenich

May 2025

dsm-firmenich 

Executive summary



dsm-firmenich conducted the 1st exploratory clinical study on Skin Microbiome & UV exposure that showed an active benefit of sunscreen application.



We found out that an SPF 20 sunscreen used in test positively influenced the bacterial **diversity** – on which *Lactobacillus crispatus* has emerged as a key player in the UV-irradiated Skin Microbiome.



We showed *in vitro* that **specific UV filters protected beneficial skin bacteria** such as *Lactobacillus crispatus* and reduced the proliferation of opportunistic pathogen *Cutibacterium acnes*.



We concluded that UV protection of microbiome by UV filters can result in **more resilient cutaneous defense**. Based on those results we developed respective skin strengthening claims and filed two patent applications.



Besides microbiome claims for an active benefit of UV filters we offer “microbiome-friendly” certifications for our UV filters PARSOL® 1789, PARSOL® EHT, PARSOL® Shield and for a new SPF 30 sunscreen formulation.



01 Agenda

- 01 Micro(biome) but MEGA-important!
- 02 UV and Microbiome
- 03 Study results at a glance
- 04 Customer benefits & recommendations
- 05 Key takeaways

Micro(biome), but MEGA-important!



Micro(biome), but MEGA-important!

How did it all start?

+27%* ↑

Microbiome has been a topic for Health and Nutrition for decades

Food and Gut Health new discoveries inspired Innovative Skin Care solutions

A new generation of skin care ingredients is therefore emerging



Several **Food products – such as Probiotics Yogurts and Fermented Drinks** – contain “food” for good bacteria, as well as live bacteria and the beneficial compounds resulting from fermentation to facilitate a healthy digestion. Probiotics and fermented foods have become a key element of the food and drink habits of many people.



More recently, new scientific discoveries proved that **similar ingredients are very beneficial for the skin**, opening up the space for new cosmetic products promoting skin health and great appearance.



Microbiome-friendly products help deliver healthy- and good-looking skin by **restoring the biodiversity of the skin ecosystem: the skin microbiome.**

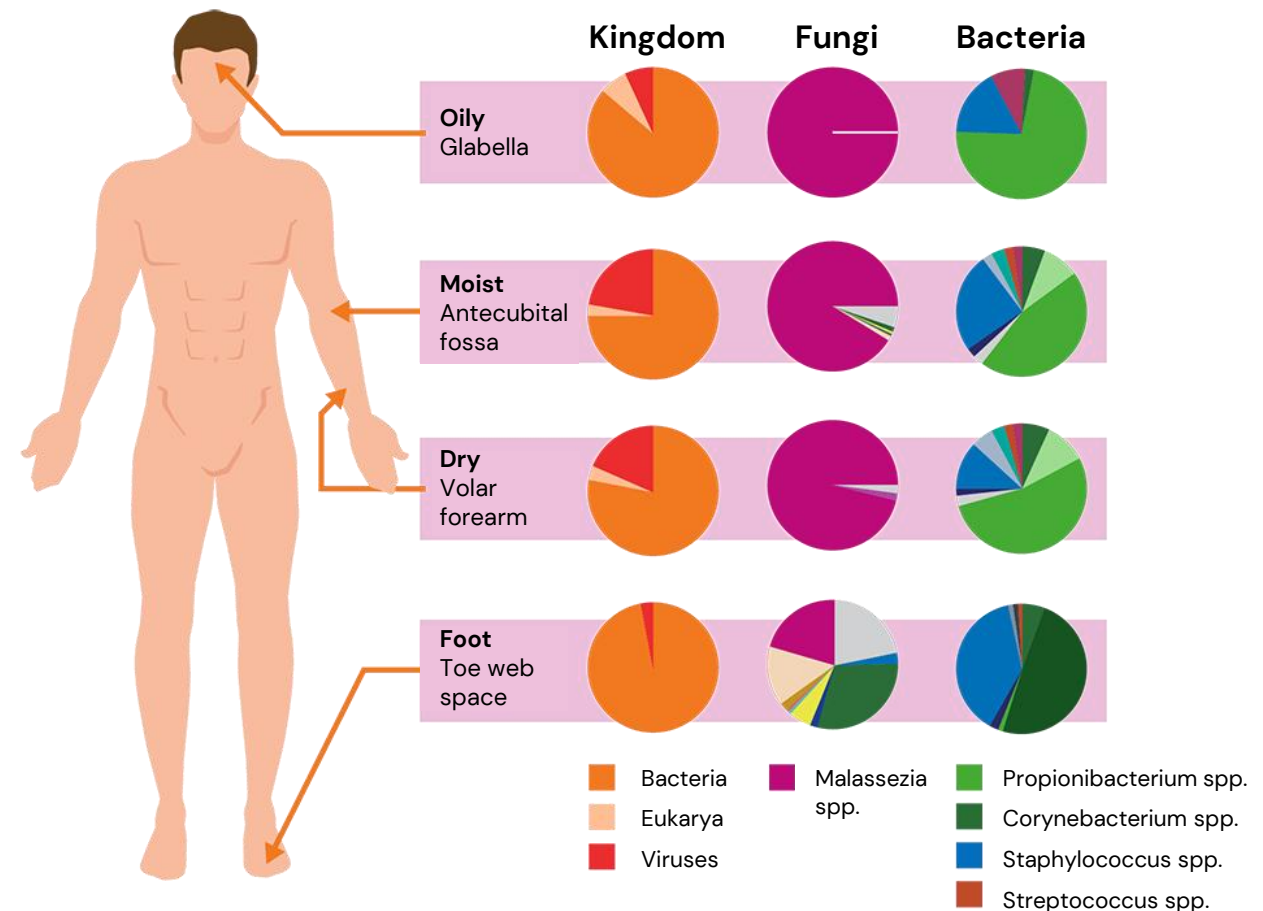
*Source: Mintel GNPD – Growth of product launches within Personal Care category with a link to Skin Microbiome in 2021 vs 2022

Micro(biome), but MEGA-important!

What is the Skin Microbiome and its role?

- The Skin Microbiome is the **community of all microorganisms present on skin** (bacteria, fungi, viruses, etc.) and its interactions¹.
- **Bacteria** are the most abundant microorganisms in the skin and differ depending on the body sites (moist, dry or oily skin conditions).
- It has an **important role** in the health, wellbeing, and protection of the human body.
- Skin microorganisms provide **nutrients, essential protection against pathogens, support of our skin barrier and immune system** and therefore impact skin health.
- Microorganisms may have **symbiotic or pathogenic interactions** with one another or with the skin cells

The human skin microbiome²



Both – quantity AND quality of microbiome is important.

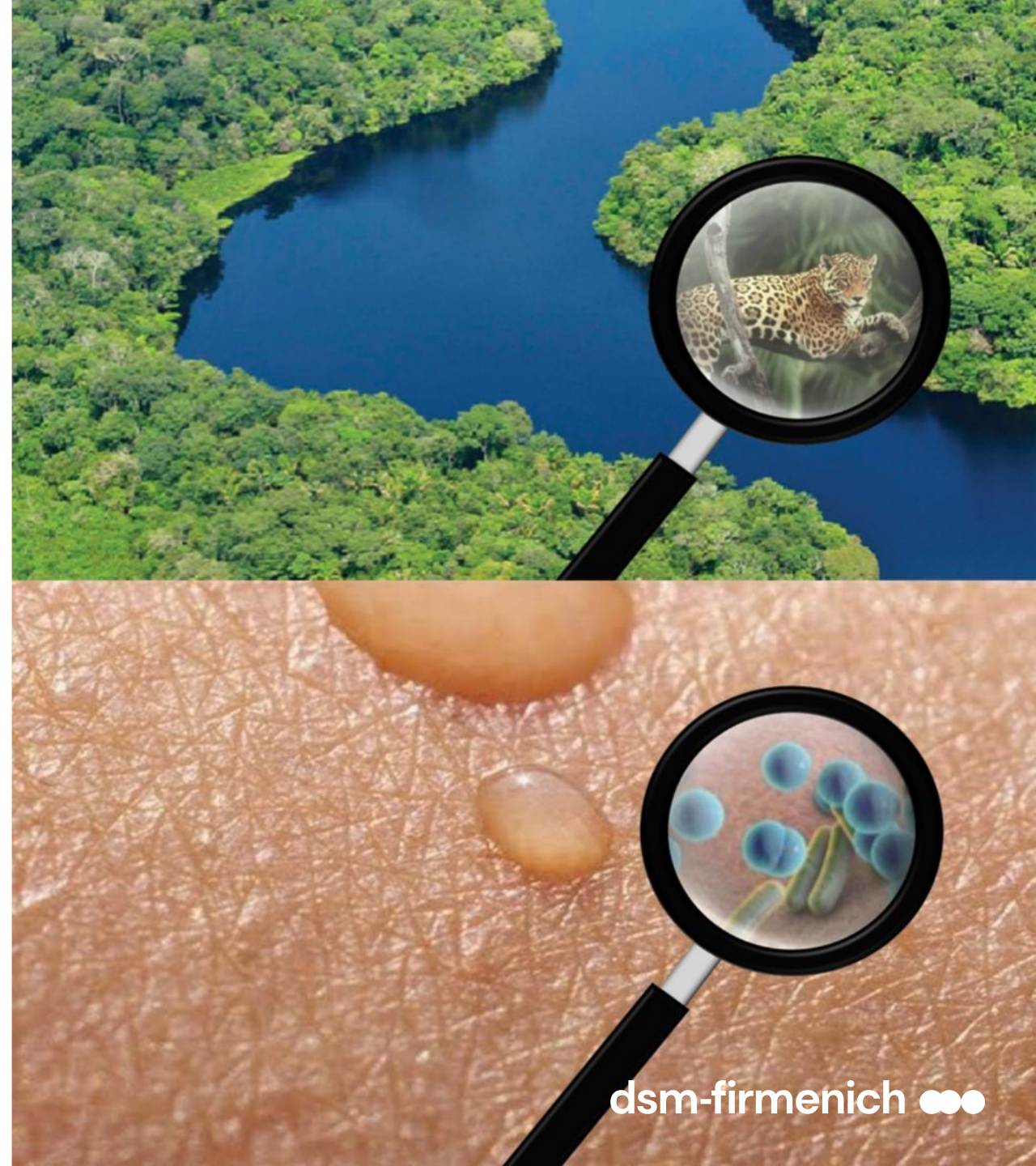
1. Berg et al (2020); 2. Byrd et al. (2018)

Micro(biome), but MEGA-important!

A diverse ecosystem

- An intra-individual and temporal diversity of the bacteria is observed on the skin.
- The Skin Microbiome is constantly adapting depending on age, gender, location, lifestyle (e.g., stress, Personal Care products) and environment (e.g., UV, pollution).
- Individual's Skin Microbiome composition may be as unique as a fingerprint.

Image: Aerial view of the Amazon rainforest by Neil Palmer/CIAT



02 Agenda

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UV and Microbiome

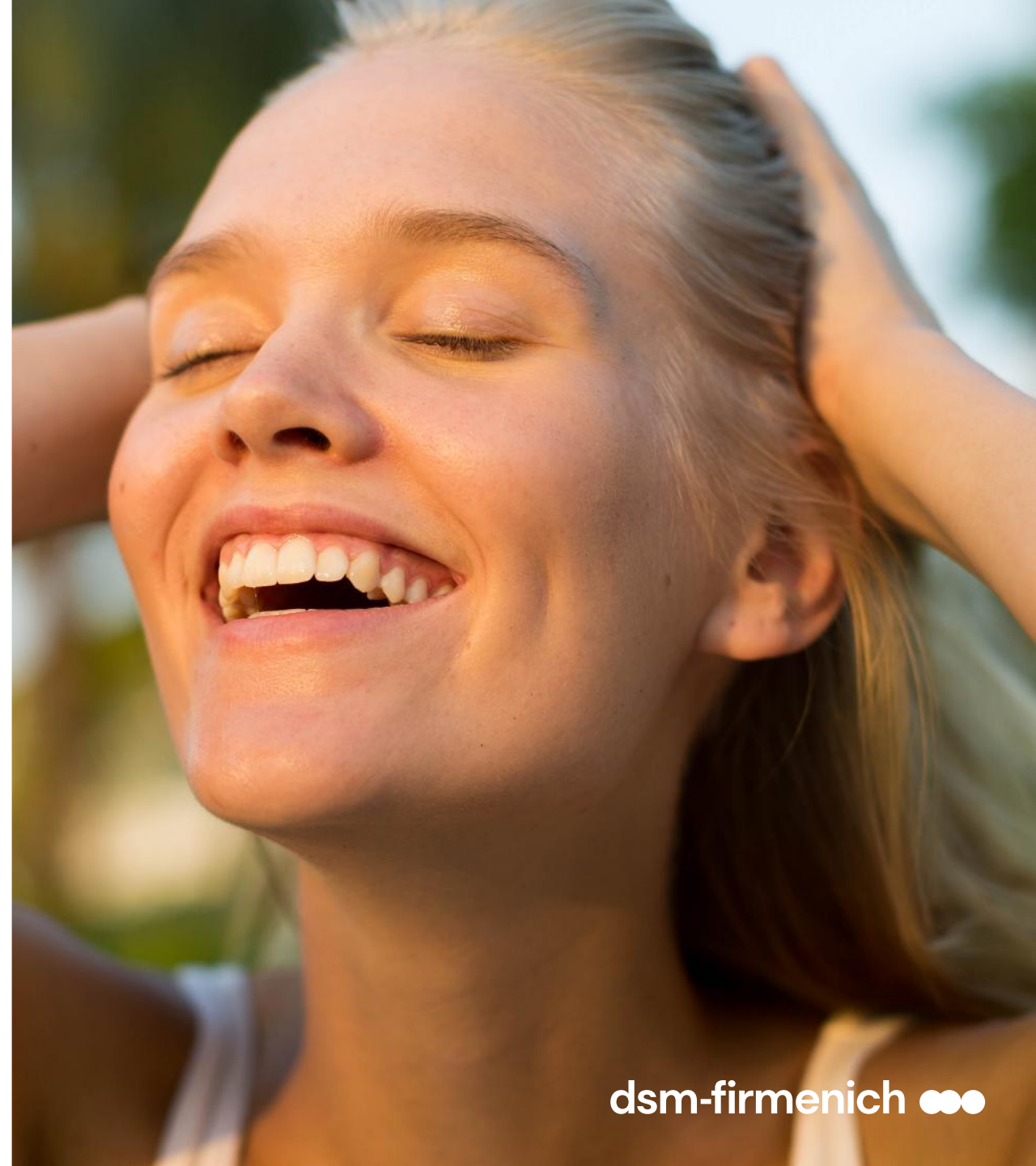


UV and Microbiome

dsm-firmenich placebo-controlled clinical pilot trial

1. Evaluate the impact of erythematous UV exposure on the Skin Microbiome.
2. Determine the protective effect of a SPF 20 sunscreen versus Placebo on the UV-exposed Skin Microbiome.

By investigating an active benefit of sunscreen for the Skin Microbiome, dsm-firmenich enters a new ground of research in the industry.



UV and Microbiome

dsm-firmenich clinical study outline

Test products:

- SPF 20 SUNSCREEN: light standard emulsion (no pigments)
- PLACEBO: chassis w/o UV filters

Study population:

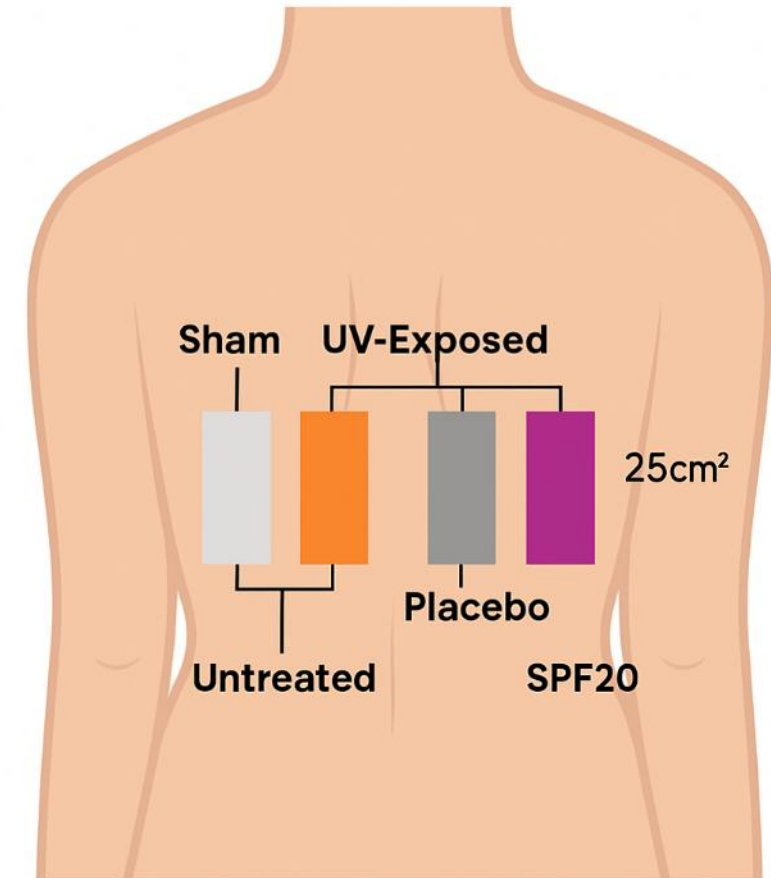
- 10 female volunteers between 25 and 45 years of age
- Skin type II-III (in vivo MED determination)

Overall study design:

- Wash-out phase gentle cleansing bar (Gallinée), 1x/day, 7 days
- Standardized application: Test products to be applied on upper middle back, 2 mg/cm² on 2.5 cm x 10 cm
- Exposure: 2 MED UVA/B from solar simulator
- Time Points: Baseline, 2-hour post-exposure
- Swabbing: 36 samples from 9 subjects in total

Skin microbiome and biophysical parameters:

- Skin Microbiome analysis: 16S rRNA sequencing
- Skin tone: Spectrometer (L* a* values). DSRL camera (back photos)



Body map of back applications

03 Agenda

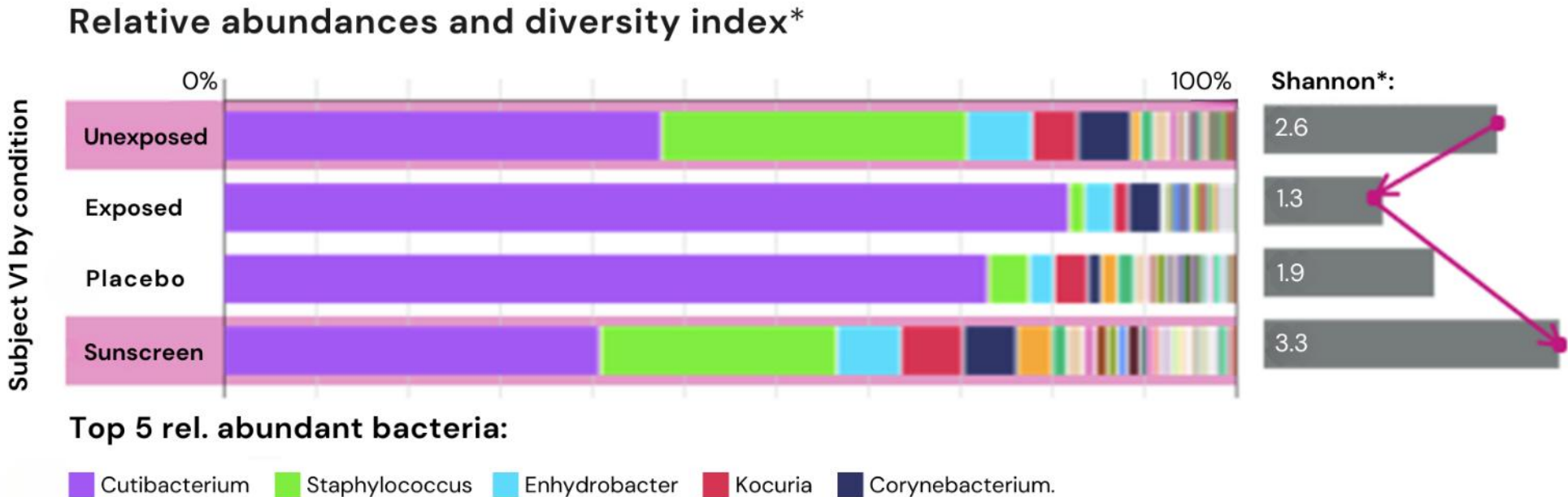
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Study results at a glance



Key results in vivo I/II

UV irradiation and treatment showed an impact on bacterial composition



→ Cutibacterium was found most abundant genus

Did you know?
Cutibacterium acnes is a major component of the Skin Microbiome, especially of oily ecosystems such as back skin.

We observed distinct changes in the global diversity within the Skin Microbiome.

Key results in vivo II/II

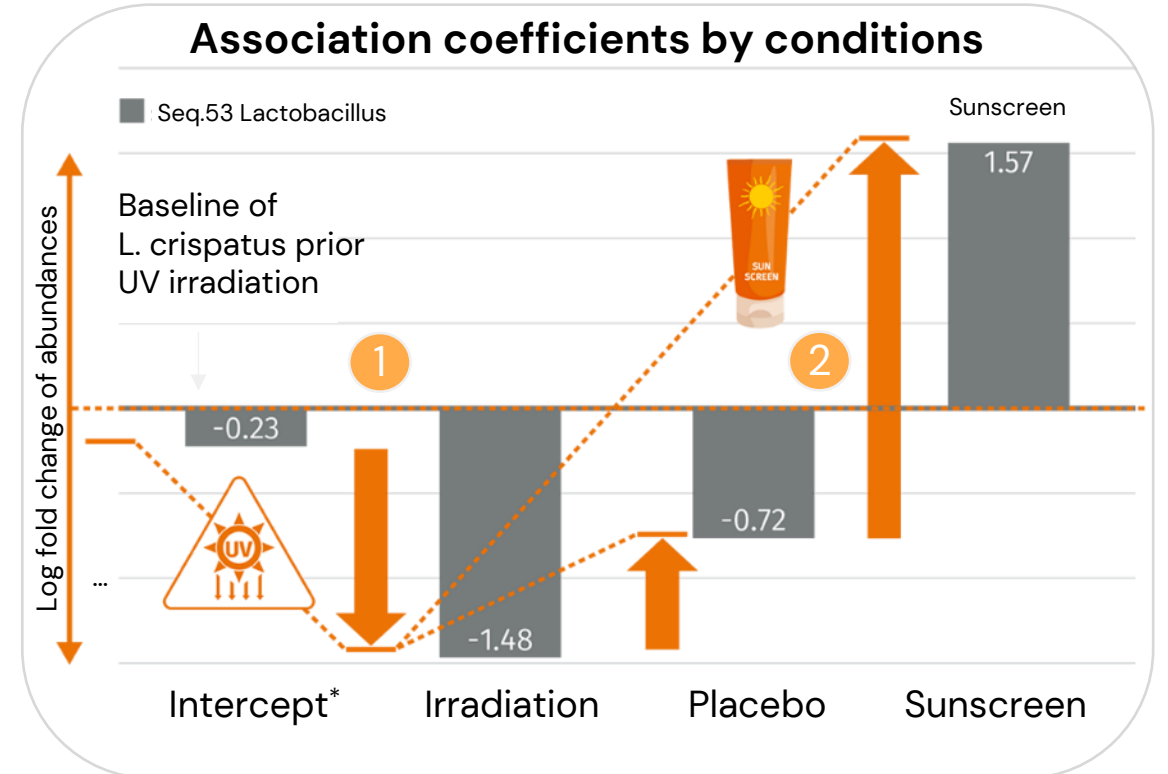
SPF 20 Sunscreen prevented UV-induced reduction of *Lactobacillus crispatus*

L. crispatus identified as a key player in UV-irradiated Skin Microbiome:

1. Relative abundance of *L. crispatus* decreased by irradiation
2. Active benefit of SPF 20 sunscreen by preventing UV-induced reduction of *L. crispatus* vs. placebo and by supporting its propagation

→ *Lactobacillus (crispatus)* is known to preserve balance of microbe populations.¹⁻⁵

Sunscreen supports the abundance of *L. crispatus* and may lead to a higher skin resilience



*averaged log abundance of the control population

1. Bouslimani et al. (2015) 2. Lebeer et al. (2022) 3. Kim et al. (2022) 4. Lepargneur et al. (2016) 5. Wang et al. (2017)

Key results in vitro I/II

Smart filter combination stimulated *Lactobacillus crispatus* abundance upon UV exposure

In vitro UV test: survival rate of isolated *L. crispatus* and *S. epidermidis* (reference strain) ± UV filters/combinations

- 1. UV filters differ in their positive impact on *L. crispatus* abundance: effective protection by OC, ZnO, BMDBM and EHT
- 2. UV filter combinations including effective UV filters support growth of beneficial bacteria:

Sample 8 – protection confirmed with same combination as in study (SPF 20)
Sample 9 – similar effects with EHT/Shield/1789

A smart PARSOL® filter combination allows maximizing SPF while maintaining protection of symbiotic bacterial species to strengthen UV-exposed skin resilience

1. Bouslimani et al. (2015) 2. Lebeer et al. (2022) 3. Kim et al. (2022) 4. Lepargneur et al. (2016) 5. Wang et al. (2017)

Survival rates of bacterial species upon UV irradiation vs. control

SAMPLE	UV FILTERS		Wt*-%	Survival (Protection) [%]	
	Abbrev.	Trade Name		<i>L. crispatus</i>	<i>S. epidermidis</i>
1	OC	PARSOL® 340	5	50 (+300)	63 (+59)
2	ZnO Tecs	PARSOL® ZX	3	31 (+152)	50 (+26)
3	BMDBM	PARSOL® 1789	5	25 (+100)	63 (+59)
4	EHT	PARSOL® EHT	2.3	25 (+100)	63 (+59)
5	EHS	PARSOL® EHS	10	20 (+59)	79 (+100)
6	BEMT	PARSOL® Shield	2.3	20 (+59)	79 (+100)
7	TiO ₂ /SiO ₂ /D	PARSOL® TX	3	20 (+59)	50 (+26)
8	OC/EHS/BE MT/ BMDBM	PARSOL® 340/EHS/Shield/ 1789	7/4/2/ 4.5	31 (+152)	63 (+59)
9	EHT/BEMT/ BMDBM	PARSOL® EHT/Shield/1789	3/3/3	331 (+152)	50 (+26)
Control	Vehicle	n.d.	n.d.	12.5 (0)	40 (0)

*The use level of single UV filters and combinations in the test formulations was calculated to obtain predicted *in vitro* SPF values of 6 and 23-24, respectively.

Abbreviations	INCI Name
OC	Octocrylene
BMDBM	Butyl Methoxydibenzoylmethane
ZnO Tecs	Zinc Oxide, Triethoxycaprylsilane
EHT	Ethylhexyl Triazone
BEMT	Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine
EHS	Ethylhexyl Salicylate
TiO ₂ /SiO ₂ /D	Titanium Dioxide, Silica, Dimethicone

Key results in vitro II/II

Specific UV filters and combinations reduced *Cutibacterium acnes* upon UV exposure

Cutibacterium acnes is a major component of the Skin Microbiome and an opportunistic pathogen known to trigger inflammation in *acne vulgaris*.

1. In vitro test showed that specific UV filter reduced abundance of *C. acnes* while maintaining the commensal bacteria *S. epidermidis*: **BMDBM, EHS, and OC**
2. UV filter combinations considering the needs for acne prone skin allows maximizing the SPF while reducing the *C. acnes* population

Smart selection of PARSOL® filters in sunscreens might prevent inflammatory acne breakouts triggered by imbalance in the skin microbiota associated with specific types of *Cutibacterium acnes*.¹

Survival rates of bacterial species upon UV irradiation vs. control

SAMPLE	UV FILTERS		Wt*-%	Survival (Protection) [%]	
	Abbrev.	Trade Name		<i>C. acnes</i>	<i>S. epidermidis</i>
1	BMDBM	PARSOL® 1789	5	20 (-70)	63 (+59)
2	EHS	PARSOL® EHS	10	46 (-30)	79 (+100)
3	OC	PARSOL® 340	5	56 (-15)	63 (+59)
4	BEMT	PARSOL® Shield	2.3	74 (+13)	79 (+100)
5	ZnO Tecs	PARSOL® ZX	3	74 (+13)	50 (+26)
6	TiO ₂ /SiO ₂ /D	PARSOL® TX	3	81 (+23)	50 (+26)
7	EHT	PARSOL® EHT	2.3	92 (+40)	63 (+59)
8	OC/EHS/EHT	PARSOL® 340/EHS/EHT	10/5/5	23 (-65)	31 (-21)
9	EHT/BEMT/BMDBM	PARSOL® EHT/Shield/1789	3/3/3	58 (-13)	50 (+26)
Control	Vehicle	n.d.	-	66 (0)	40 (0)

*The use level of single UV filters and combinations in the test formulations was calculated to obtain predicted in vitro SPF values of 6 and 23-24, respectively.

Abbreviations	INCI Name
OC	Octocrylene
BMDBM	Butyl Methoxydibenzoylmethane
ZnO Tecs	Zinc Oxide, Triethoxycaprylylsilane
EHT	Ethylhexyl Triazone
BEMT	Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine
EHS	Ethylhexyl Salicylate
TiO ₂ /SiO ₂ /D	Titanium Dioxide, Silica, Dimethicone

1. Conforti et al. (2021)

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Customer benefits & recommendations



Customer benefits I/III

Study supports patent filings



Study results were translated into two patent applications (filed June 2022):

1. Specific protection of *genus Lactobacillus* from harmful effects of UV radiation by selected UV filters¹
2. Reducing *C. acnes* in Skin Microbiome of person in need by selected UV filters²

1. Method of protecting bacteria of the genus *Lactobacillus* from the detrimental effects of UV radiation, said method comprising the step of applying to an external surface of the human body with a Skin Microbiome comprising said bacteria an effective amount of a sunscreen composition comprising one or more UV-filters selected from the group consisting of Octocrylene, Butyl Methoxydibenzoylmethane, Ethylhexyl Triazone and Zinc Oxide prior to exposing said external surface to UV radiation.
2. Method of reducing *C. acnes* in a Skin Microbiome of a person in need thereof, said method comprising the step of applying to an external surface of the human body with a skin microbiome comprising *C. acnes* and optionally *S. epidermidis* an effective amount of a sunscreen composition comprising one or more UV filters selected from the group consisting of Octocrylene, Ethylhexyl Salicylate and Butyl Methoxydibenzoylmethane prior to exposing said external surface to UV radiation.



Customer benefits II/III

Study supports consumer benefits

dsm-firmenich innovative study results may support consumer relevant benefits:

- 1. Specific protection of *Lactobacillus crispatus* by selected UV filters:

"Extra skin strengthening properties"

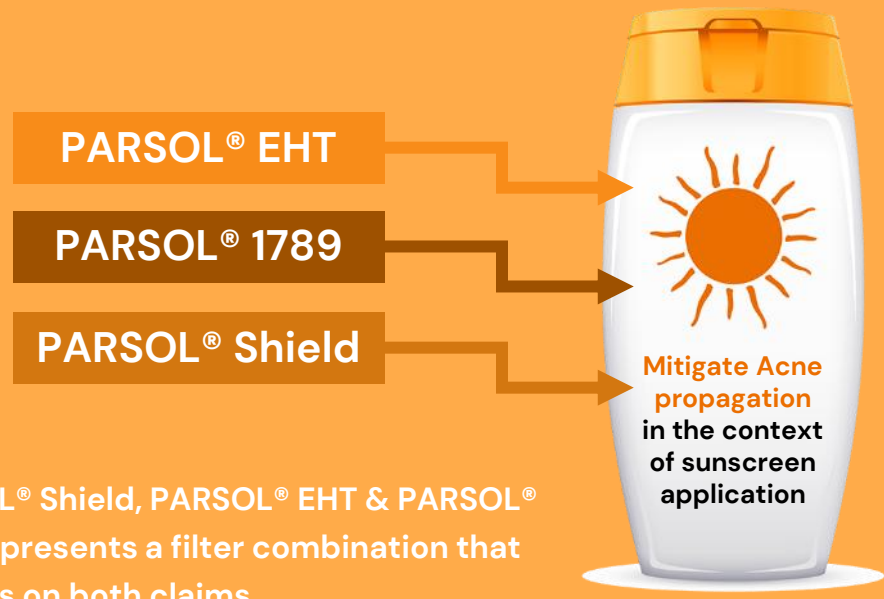
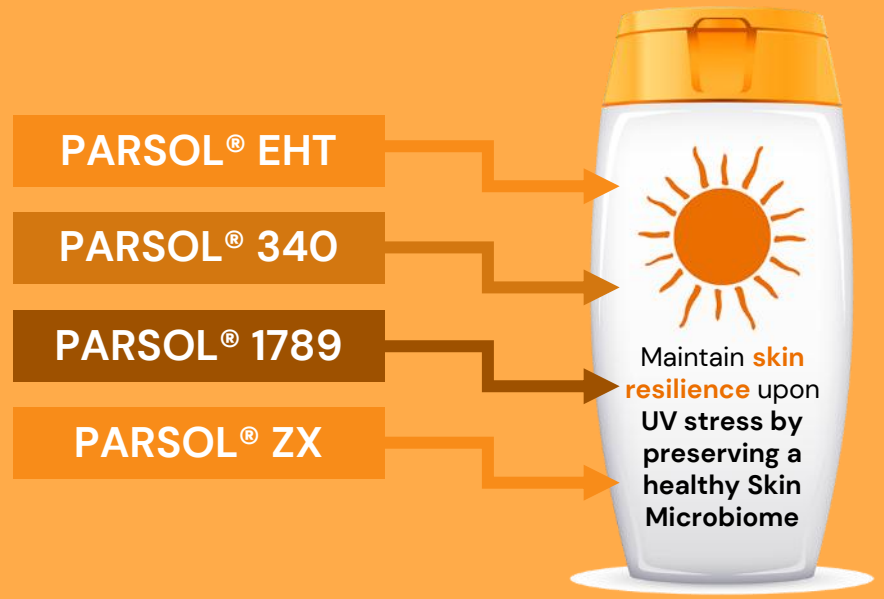
"Strengthening the skin barrier"

"Strengthening skin's natural defense/ immune response"

- 2. Specific reduction of *Cutibacterium acnes* by selective UV filters:

"(...) specially tailored for acne prone skin"

"supports an even complexion"¹



PARSOL® Shield, PARSOL® EHT & PARSOL® 1789 represents a filter combination that delivers on both claims.

Customer benefit III/III

Microbiome friendliness

Formulator tools to support a microbiome-friendly claim on active ingredient (1) or formulation (3):

1. Usage of one or more “Microbiome-friendly” certified* PARSOL® filter:
 - PARSOL® 1789
 - PARSOL® Shield
 - PARSOL® EHT
1. dsm-firmenich formulation guidance
2. Full “microbiome-friendly” certified** sunscreen formulation

→ **Flor'Active Defense
Hydrating Cream SPF 30**



*Logo usage for final formulation to be requested by customer at MyMicrobiome
**www.microbiome-friendly.com – Worldwide leading and only registered certification mark for Microbiome-friendly cosmetics and care products



Customer benefit III/III

Flor'Active Defense¹

Hydrating cream SPF 30 UVA

- Extra mild preservatives
- Specifically tailored for acne prone
- Supports an even complexion

Outstanding sensory
panel test results!



1: Name for non-commercial purpose only



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Key takeaways

- dsm-firmenich provides the 1st exploratory study showing a beneficial effect on UV-irradiated Skin Microbiome by UV protection.
- *Lactobacillus crispatus* identified as a key player for skin's natural defense.
- dsm-firmenich provides various tools to promote a beneficial UV protection on Skin Microbiome in final formulations: PARSOL® filter selection, formulation concept, microbiome-friendly certificates, patent-pending claim options.



dsm-firmenich, a Partner of Choice in Photoprotection

dsm-firmenich capabilities and expertise to best serve our customers



UV task force

- dsm-firmenich internal group of experts
- Monitoring concerns and challenges related to UV-filters
- Defines strategies to provide best solutions



Sensory

- Trained expert panelists (bi-weekly evaluations)
- Objective assessments of 28 sensory parameters
- Market mapping and concept improvement



Product stewardship

- Product quality and safety
- Regulatory compliance
- Toxicology and ecotoxicology



Science & application

- New claim substantiation (e.g. blue light)
- Compatibilities of ingredients in various chassis
- Inspirational formulations/issue solving



Advocacy

- Defense of ingredients
- Presence at REACH consortium
- Involvement in industry associations (IKW, FEBEA, ISO, EffCI etc.)



Sunscreen Optimizer™

- Online simulation tool
- Direct comparison of customized combinations
- Archived searches and additional parameters (eco-profile, blue light, solvent calculator, etc)



Consumer and market insights

- Proprietary consumer surveys
- Analysis of global and local trends
- dsm-firmenich consumer insights hub



Intellectual property

- Oral assistance on specific patent questions (no FTO)



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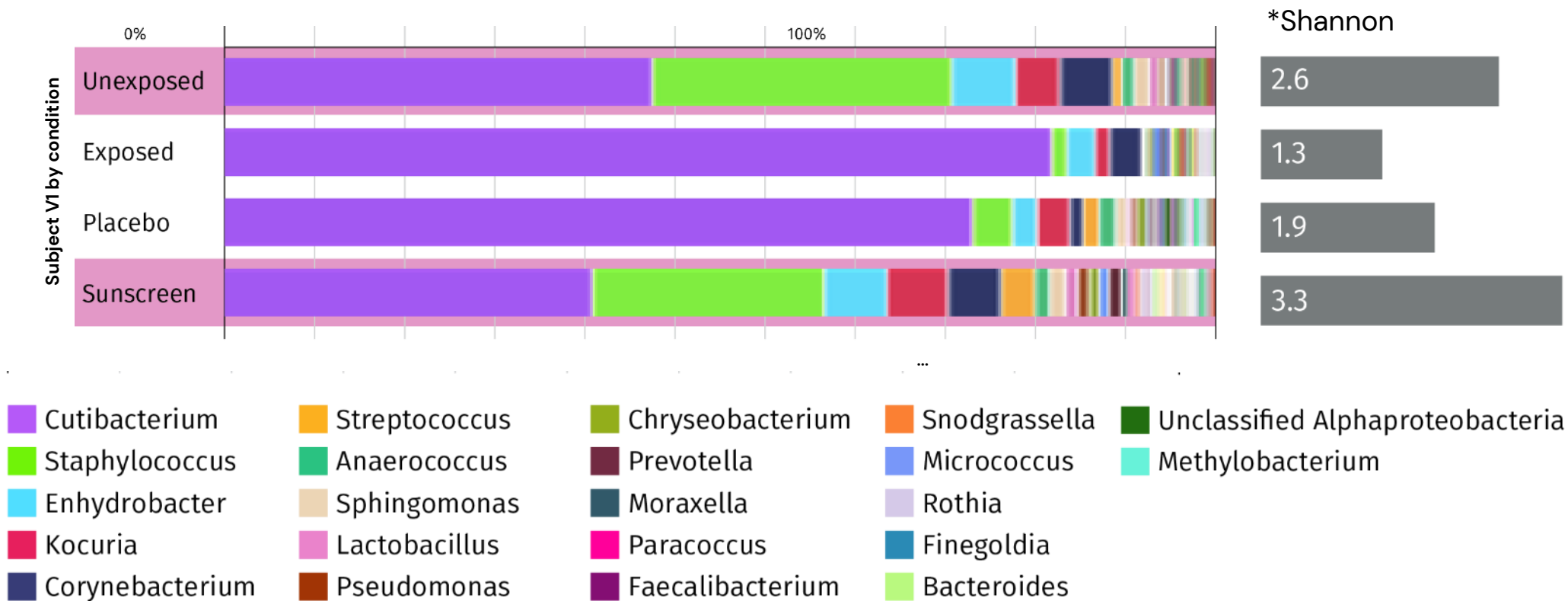
Appendix



Key results in vivo I/II

Different relative abundance of bacteria by condition – Complete bacteria legend

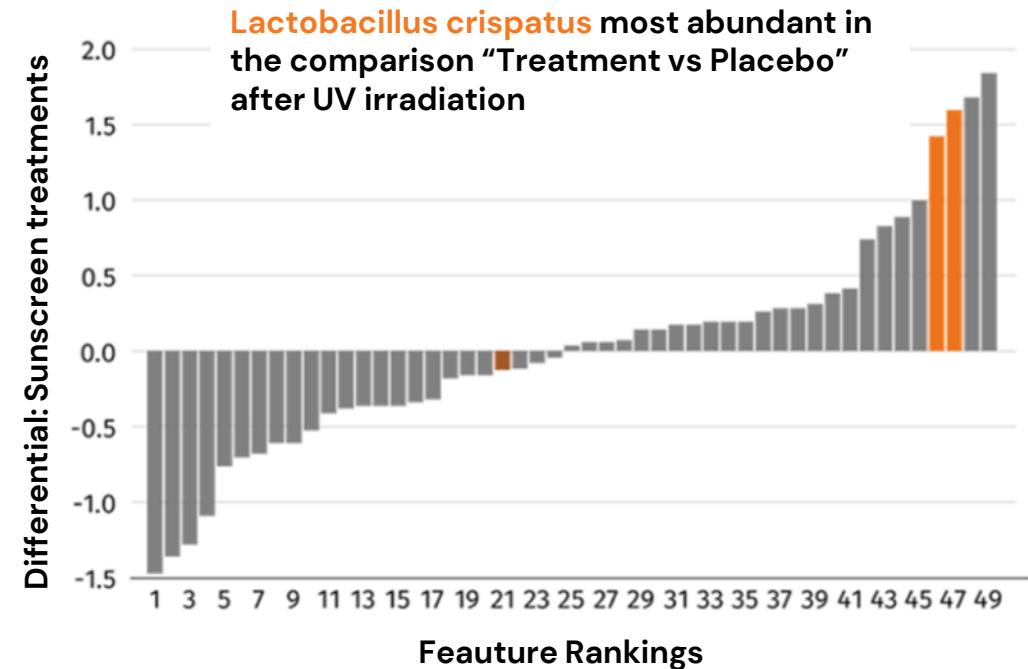
Relative abundances and **diversity index*** (Shannon)



Specific bacteria of interest

Lactobacillus crispatus and Cutibacterium acnes

- **Lactobacillus** genus known to be beneficial bacteria for the skin.^{1, 2,3}
 - It preserves the **balance of microbe populations**, prevents skin pathogens and infections, by lactic acid production creating an acidic environment.^{1,4}
- Songbird analysis has proven **L. crispatus** to be most abundant Lactobacillus species in our study with a change in test-situation vs. **Cutibacterium acnes**.
 - **Cutibacterium acnes** species is a major component of the skin microbiome and an **opportunistic pathogen** known to trigger inflammation in **acne vulgaris** but is also found in healthy, oily skin.^{5, 6}



Songbird analysis Log-Ratio Classification:

■ None ■ Numerator ■ Denominator

1. Delanghe, Lize et al. (2021) 2 Bouslimani et al. (2015) 3. Lebeer et al. (2022)

4 Wang et al. (2017) 5 Dagnelie et al. (2018), 6 Spittaels et al. (2020)

UV and Microbiome

Ingredient list of the SPF 20* and Placebo formulations

Trade name	INCI Name	Phase	SPF20 Weight-%	Placebo Weight-%
PARSOL® 340	OCTOCRYLENE	A	7	0
PARSOL® EHS	ETHYLHEXYL SALICYLATE	A	4	0
PARSOL® Shield	BIS-ETHYLHEXYLOXYPHENOL METHOXYPHENYL TRIAZINE	A	2	0
PARSOL® 1789	BUTYL METHOXYDIBENZOYLMETHANE	A	4.5	0
AMPHISOL® K	POTASSIUM CETYL PHOSPHATE	A	1	1
Cetiol B	DIBUTYL ADIPATE	A	9	15
Cetiol® CC	DICAPRYLYL CARBONATE	A	6	17.5
Lanette 18	STEARYL ALCOHOL	A	0.5	0.5
Pemulen TR-2	ACRYLATES/C10-30 ALKYL ACRYLATE CROSSPOLYMER	A	0.2	0.2
VALVANCE® Touch 210	SILICA	A	1	1
Euxyl PE 9010	PHENOXYETHANOL; ETHYLHEXYLGLYCERIN	A	0.3	0.3
Water Dem	AQUA	B	56.38	56.38
Edeta BD	DISODIUM EDTA	B	0.1	0.1
Sodium Hydroxide Pellets Emprove	SODIUM HYDROXIDE	B	0.02	0.02
Ethanol abs.	ALCOHOL	C	8	8
Total			100	100

* SPF calculated from dsm-firmenich Sunscreen Optimizer™ (www.sunscreen-optimizer.com)

Microbiome friendly certified sunscreen

Flor'Active Defense Hydrating Cream SPF 30*

Phase	Ingredients	INCI Name	% w / w	Supplier
A	PARSOL® 1789	BUTYL METHOXYDIBENZOYLMETHANE	3,00	100288
	PARSOL® Shield	BIS-ETHYLHEXYLOXYPHENOL METHOXYPHENYL TRIAZINE	3,00	100288
	Dermol IDSA	ISODECYL SALICYLATE	10,00	101029
	PARSOL® EHS	ETHYLHEXYL SALICYLATE	5,00	100288
	PARSOL® EHT	ETHYLHEXYL TRIAZONE	5,00	100288
	Lanette® 22	BEHENYL ALCOHOL	1,00	100037
	Emulium Dolce MB	CETEARYL ALCOHOL, GLYCERYL STEARATE, JOJOBA ESTERS, HELIANTHUS ANNUUS SEED CERA, SODIUM STEAROYL GLUTAMATE, AQUA, POLYGLYCERIN-3	5,00	100413
	Eldew SL-205	ISOPROPYL LAUROYL SARCOSINATE	5,50	100383
	Dermosoft® Octiol	CAPRYLYL GLYCOL	0,20	100491
	VALVANCE® Touch 210	SILICA	2,00	100288
B	Sensiva SC 50	ETHYLHEXYLGLYCERIN	0,20	100444
	Water Dem	AQUA	53,60	999999
	Keltrol® CG-T	XANTHAN GUM	0,30	100400
	TILAMAR® PDO with NØØVISTA TM	PROPANEDIOL	3,00	100288
	Dermofeel® PA-3	SODIUM PHYTATE, AQUA, ALCOHOL	0,10	100491
	HYDROLITE 5 green	PENTYLENE GLYCOL	2,00	100106
C	HYA-ACT TM M	SODIUM HYALURONATE	0,10	100288
	SYN-UP®	AMIDINO BENZYL BENZYL SULFONYL D-SERYL HOMOPHENYLALANINAMIDE ACETATE, GLYCERIN, AQUA, CITRIC ACID	1,00	100288

SU-E-100111-93

Key benefits:

- SPF 30 (simulated, in-vivo results pending)
- UVA acc. to ISO 24443
- Microbiome friendly (certified)
- Locks in moisture (HYA-ACT™ M)
- Boost of hydration (HYA-ACT™ M)
- Calming reddened skin (SYN-UP®)
- Strengthened skin barrier function for a more resilient skin (SYN-UP®) / PARSOL® Shield/ PARSOL® EHT

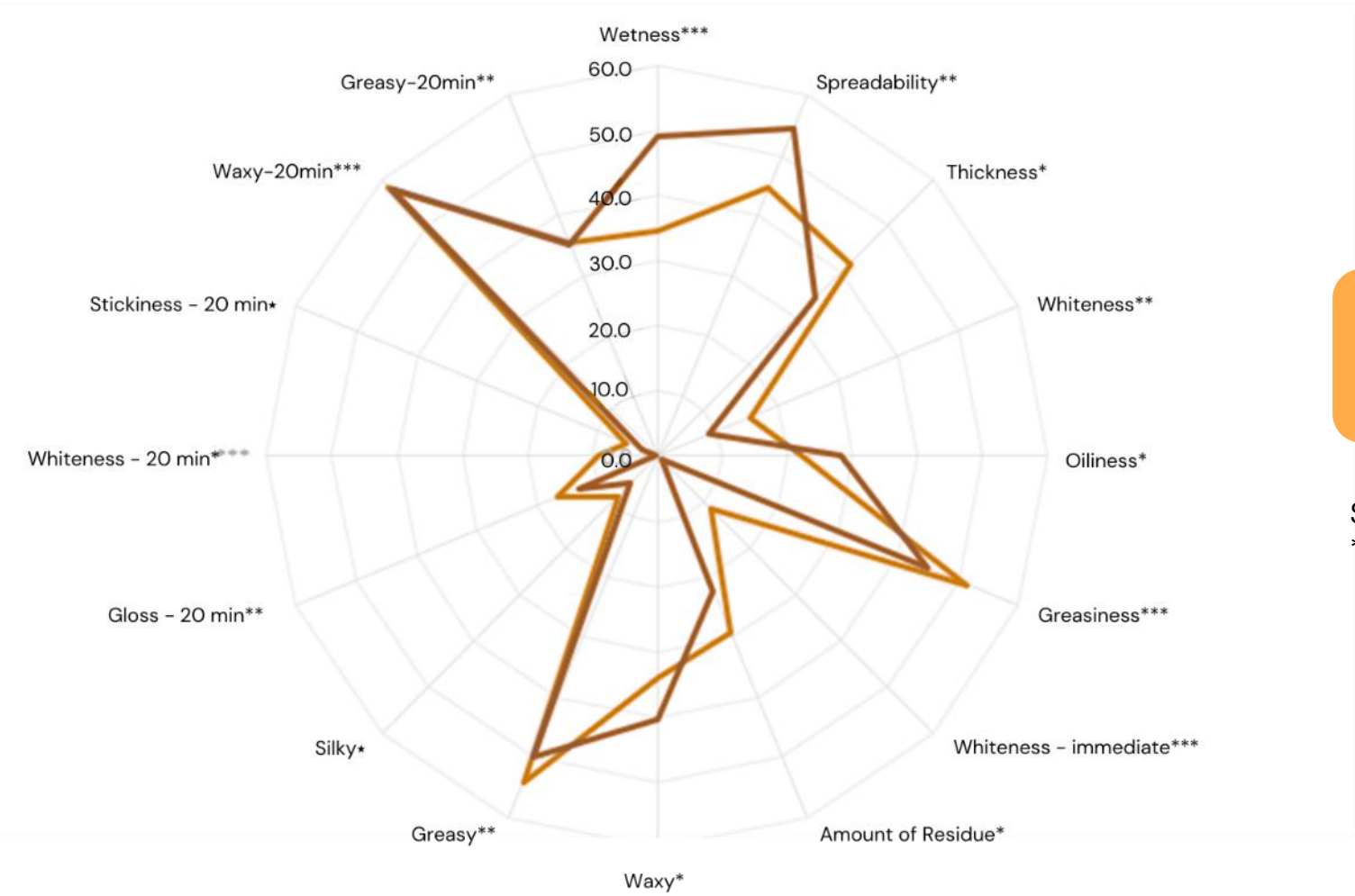
New:

- > Extra mild preservatives
- > Specifically tailored for acne prone skin / Extra skin strengthening properties
- > Supports an even complexion

*simulated SPF, in-vivo SPF results 03/23

Microbiome friendly sunscreen

Flor'Active SPF 30 / Sensory panel test results 02-2023



Means per attribute dsm-Firmenich test formulation SU E 100111-93 SPF 30 mattifying sun protection "face"

Star-rating identifies levels of significance: ***<1%; **<5%; *<10%

Glossary

Key definitions

Relative abundance: The percent composition of an organism of a particular kind relative to the total number of organisms in the area

Richness: The total number of species in a microbiome

Evenness: How well represented each species is relative to others (relative abundance)

Diversity: How many different species are present in a microbiome and to what extend (richness + evenness)

Shannon Index: A popular metric used in ecology and estimates species diversity. The index considers the number of species living in a habitat (richness) and their relative abundance (evenness).

Chao 1: Is an estimator based on abundance (richness)