STRATEGIES FOR THE SKIN MICROBIOME

Active ingredients | The microbiome is a relatively new topic in cosmetics that still lacks uniform standards and definitions. This article focuses on three cosmetic active ingredients that target the microbiome with different strategies: “Prebiotics”, “biofilm control” and “natural antimicrobial agents”.

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A highly populated, balanced, and diversified microbiome builds a strong barrier that actively prevents normal skin from being colonised by adverse microbes. Healthy skin provides a remarkably good barrier against microbial disruption. Still, resident bacteria give raise to a substantial number of adverse skin conditions, including blemished skin, dandruff, or body odour that require cosmetic care.

There are various cosmetic strategies to target the skin microbiome: “Prebiotics”, for example, create a favourable environment for so-called good skin microbes by supplying nutrients. A second example is “biofilm

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control", where natural phytochemicals destabilise or dissolve bacterial biofilms of mixed bacterial populations for better access of antimicrobials. A third example are "natural anti-microbials", which selectively shift the microbial balance by repressing troublemaking microbes, while promoting beneficial, commensal populations.

Label for consumer orientation and trust

While the number of cosmetic products with microbiome claims is rising, no common standards exist, nor criteria for microbiome related claims. Many products selectively focus on either microbial balance, diversity, or growth behaviour. What is more, consumers know about the importance of the skin microbiome but often lack the scientific knowledge to make purchasing decisions. Thus, communication and substantiation of microbiome-related claims is difficult.

The independent, third-party certification label "microbiome-friendly" provides an approach to give consumers orientation and to build trust in cosmetic products with microbiome claims. As an independent expert organisation, "MyMicrobiome" issues certificates that make microbiome-related claims transparent and comparable in-between products. The standardised testing procedure covers all aspects of the microbiome, including:

- Microbial quality of the product
- Influence of the product on microbial diversity
- Influence of the product on the growth behaviour of specific microbes.

Finally, the standard uses a simple and transparent rating that makes products comparable for consumers[1]:

1 = microbiome-friendly
2 = microbiome neutral
3 = microbiome damaging

Prebiotic food for sensitive skin

The popularity of prebiotics is fuelled by scientific and public interest in the human microbiome. This trend has now expanded to the cosmetics industry, where cosmetic formulators incorporate prebiotics into cosmetic strategies.

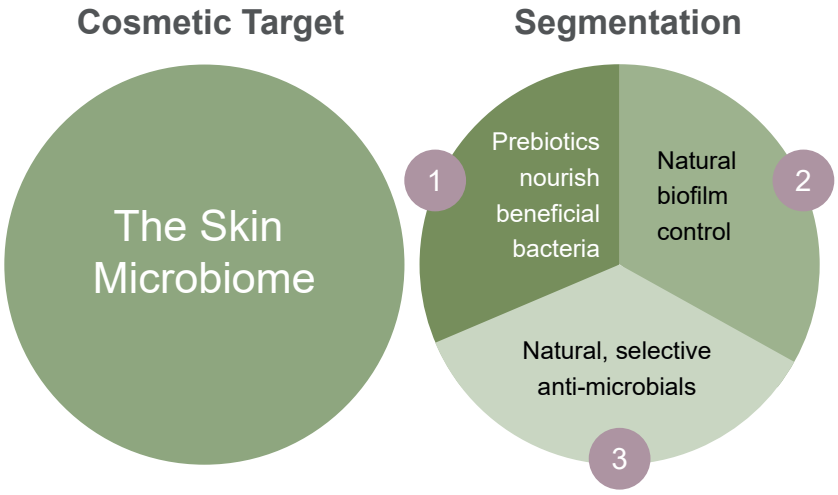


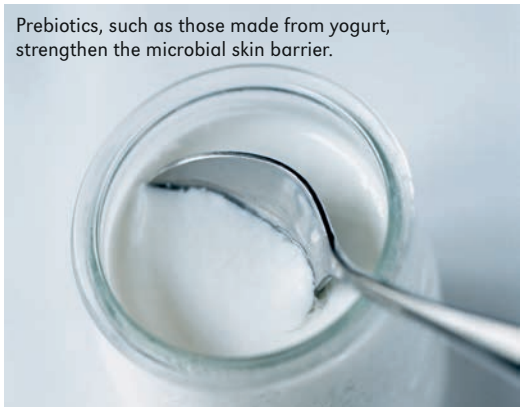
figure 1: Segmentation of cosmetic strategies that target the human skin microbiome. Product positioning of selected cosmetic actives that address each segment.

Bacterial populations that live on our skin source nutrients from skin hydration, natural sebum production, epidermal proteins, and lipids – these are important factors enabling colonisation of human skin by microorganisms. Still, **many factors can reduce the skin's microbial barrier**: from certain skin care products, washing habits, pollution, UV radiation, and lifestyle factors such as diet and stress.

Prebiotics are naturally occurring nutrients that act like fertilisers – creating an ideal environment to thrive for a strong and balanced skin microbiome. **Prebiotics strengthen the microbial skin barrier**, thereby supporting the physical skin barrier[2,3,4]. In cosmetics, prebiotic skin care helps to stabilise and restore a balanced skin microbiome – one example is yogurt.

Although yogurt has been part of the human diet for several millennia, the raise of conscious living, healthy nutrition, and active lifestyle has given yogurt's popularity a boost. Now, the beneficial properties for sensitive skin were rediscovered. Yogurt Powder[5] is a natural, prebiotic ferment derived from Swiss milk. As a yogurt concentrate, it creates a favourable environment for a balanced skin microbiome. It ▶

figure: Lipoid Kosmetik



Prebiotics, such as those made from yogurt, strengthen the microbial skin barrier.

Cranberry produces phytochemicals that prevent bacteria from adhering to surfaces such as the skin.

re-establishes the microbial barrier, soothes and calms irritated skin (data not shown). Recommended applications include sensitive face care, calming hand care, soothing body care and prebiotic concepts.

Natural biofilm control

Bacteria attach to surfaces (skin) by forming biofilms. **Biofilms are large complex communities of microbes encapsulated in a thick protective matrix**[6]. Inside biofilms, microorganisms hide and can become resistant to antimicrobial agents[7].

To build a biofilm, individual, free floating (planktonic) bacteria assemble and produce sticky polysaccharides that help them adhere to surfaces. When attached, these bacteria proliferate and enmesh in a slimy, protective matrix composed of extracellular biopolymers, finally forming a mature biofilm[8]. Biofilms spread to new places by releasing individual, planktonic bacteria – a process that is triggered by biochemical messengers, such as nitric oxide or 10-hydroxy-2-decenoic acid[6]. This way, released individual cells can disperse and adhere to new surfaces, extending the biofilm.

Traditional cosmetic antimicrobials eliminate individual bacteria. Yet bacteria hiding inside biofilms are less accessible to anti-microbial agents. In fact, cutaneous biofilms are now recognised as the principal virulence factor in many inflammatory skin conditions[7]. A complementary cosmetic strategy in targeting the skin microbiome tends to disrupt bacterial biofilms. Weakening the protective matrix, or causing structural dissolution of biofilms, makes bacteria vulnerable to cosmetic actives, or biocidal treatments.

Natural biofilm-balancing agents from cranberry

Cranberry fits perfectly into this stra-tegy. Its metabolites have anti-adhesive and anti-biofilm forming activity[12]. Without being directly biocidal, cranberry's unique phytochemicals help to selectively obstruct the formation of undesirable biofilms, while supporting beneficial biofilms of the resident skin flora.

Cranberry produces phytochemicals that prevent bacteria from adhering to surfaces: so-called procyanidins of type A inhibit bacterial enzymes responsible for producing sticky polysaccharides[8]. This way, cranberry directly intercepts in the initial step of biofilm formation. Other cranberry metabolites, such as myricetin, or 10-hydroxy-2-decenoic acid (also known as "queen bee acid") interfere into biofilm adhesion or act as messengers to induce premature biofilm dissolution. For its anti-biofilm activity, cranberry has been successfully tested in the treatment of infectious diseases[9] or the dissolution of dental plaques[10,11].

Vaccinium Macrocarpon (Cranberry) Fruit Extract[12] was designed to prevent adhesion, assembly, and maturation of biofilms from trouble-making bacteria, while selectively supporting biofilms of beneficial skin bacteria. It presents a novel cosmetic tool to tackle skin blemishes and to control the skin microbiome. Recommended applications include face care for blemished and acne-prone skin, cleansers, intimate care, body care and deodorants.

Natural, selective antibacterial

Depending on the specific skin condition, antimicrobial strategies are found in all cosmetic categories: They have applications in deodorants and antiperspirants, in anti-dandruff shampoos, in skin care against blemishes, as well as toothpaste and mouthwashes.

Traditional biocides such as triclosan disrupt bacterial cell walls and although they provide broad-spectrum bactericidal action, they also have nonspecific targets, **killing both unfavourable and favourable bacteria**, leaving the skin defenceless against new destructive microorganisms[13]. This has a negative impact on commensal microflora and skin barrier function. In addition, some of the traditional biocides are associated with the emergence of antimicrobial resistance of certain pathogens[14].

Usnic acid is effective against gram-positive bacteria, but nonetheless, it only has limited activity against other microorganisms such as gram-negative bacteria, fungi, or yeasts.

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Besides, the shift from synthetic to natural ingredients is a long-term trend in cosmetics. This also applies to antimicrobial agents. Consumers have more confidence in natural ingredients and less environmental concerns (e.g., biodegradation). **Currently, natural compounds from plants with complementary antibacterial properties are considered as alternatives to conventional, synthetic antimicrobials.** Particularly natural alternatives that shift the equilibrium of beneficial and trouble-making bacteria while maintaining the microbiome intact. Cosmetic applications include care for blemished skin, dandruff, or body odour.

Usnic acid

Usnic acid is a secondary metabolite uniquely found in lichens. With its bitter taste and antimicrobial activity, it protects the lichen from sunlight exposure, it rejects predators, parasites, and fights pathogens. **In medical applications, usnic acid is a natural, selective, and fast-acting antibiotic against gram-positive bacteria and some fungi**[15,16].

Usnea Barbata (Lichen) Extract[17] is part of a plant-derived, cosmetic active based on usnic acid extracted from the alpine lichen Usnea barbata. The active is effective against gram-positive bacteria – those that cause body odour, blemished skin, and dandruff. Nonetheless, it has only limited activity against other microorganisms such as gram-negative bacteria, fungi, or yeasts. This selectivity keeps the skin microbiome intact and makes it a suitable cosmetic ingredient against body odour, skin blemishes, or dandruff. □

References

1 www.mymicrobiome.info

2 R. Ashraf, N. P. Shah, Immune system stimulation by probiotic microorganisms. Crit Rev Food Sci Nutr 54, 938-9 56 (2014).

3 M. A. Fernandez, A. Marette, Potential Health Benefits of Combining Yogurt and Fruits Based on Their Probiotic and Prebiotic Properties. Adv Nutr 8, 155S-164S (2017).

4 C. R. Kok, R. Hutkins, Yogurt and other fermented foods as sources of health-promoting bacteria. Nutr Rev 76, 4-15 (2018).

5 INCI for Yogurtolin

6 Sauer, K., The War on Slime. Sci Am, 2017. 317(5): p. 64-69.

7 Koo, H., et al., Targeting microbial biofilms: current and prospective therapeutic strategies. Nat Rev Microbiol, 2017. 15(12): p. 740-755.

8 Ulrey, R.K., et al., Cranberry proanthocyanidins have anti-biofilm properties against Pseudomonas aeruginosa. BMC Complement Altern Med, 2014. 14: p. 499.

9 Steinberg, D., et al., Cranberry high molecular weight constituents promote Streptococcus sobrinus desorption from artificial biofilm. Int J Antimicrob Agents, 2005. 25(3): p. 247-51.

10 Steinberg, D., et al., Effect of a high-molecular-weight component of cranberry on constituents of dental biofilm. J Antimicrob Chemother, 2004. 54(1): p. 86-9.

11 Kim, D., et al., Cranberry Flavonoids Modulate Cariogenic Properties of Mixed-Species Biofilm through Exopolysaccharides-Matrix Disruption. PLoS One, 2015. 10(12): p. e0145844.

12 INCI of Cranberry Pro: Aqua (Water), Glycerin, Vaccinium Macrocarpon (Cranberry) Fruit Extract, Potassium Sorbate, Sodium Benzoate, Sodium Hydroxide

13 Lisa M. Weatherly A. Gosse Triclosan exposure, transformation, and human health effects Journal of Toxicology and Environmental Health, Part B Critical Reviews Volume 20, 2017 - Issue 8

14 Siamak P., Triclosan and Antimicrobial Resistance in Bacteria: An Overview Microbial Drug Resistance 2006 Vol. 12, No. 2 Mechanisms

15 Francolini I, et al., Usnic acid, a natural antimicrobial agent able to inhibit bacterial biofilm formation on polymer surfaces. Antimicrob Agents Chemother. 2004;48(11):4360-4365.

16 Cocchietto M, et al., A review on usnic acid, an interesting natural compound. Naturwissenschaften. 2002;89(4):137-146.

17 INCI for usNeo: Propanediol, Usnea Barbata (Lichen) Extract, Tromethamine, Tetrasodium Glutamate Diacetate, Aqua (Water), Sodium Hydroxide