Skin care and the microbiome

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The entirety of all living organisms on our skin is known as the skin microbiome and serves as a natural protective barrier against external influences. But how exactly do skin care products influence the skin microbiome and, above all, what influence does the skin microbiome have on cosmetic ingredients? These questions are closely linked to the effectiveness and tolerability of cosmetics. A close look at the skin microbiome and metabolic performance by substance group answers these questions.

Active ingredients are key components in cosmetic products when it comes to moisturising, smoothing, irritating or preventing skin ageing. Whether they remain on the surface of the skin or penetrate into the epidermis, they, as well as the unavoidable additives that are responsible for the stability, storage and consistency of products, come into contact with the skin microbiome, a varied community of microorganisms.

Something is happening...

You don't have to be a scientist or conduct a study to realise that something happens in the relationship between the epidermis and the microbiome when a substance is applied to the skin. Let's take a simple example of skin oiling and transepidermal water loss (TEWL). Paraffins, alias mineral oils, consisting of long-chain hydrocarbons, applied pure, reduce the TEWL more or less to zero and theoretically retain this effect until they are wiped off, which of course happens quickly in reality by touching objects. Paraffins therefore do not change and have a permanent occlusive effect.
For comparison, vegetable oils, for example avocado oil, are also applied pure. The primary effect is pretty much the same as with paraffins. The TEWL drops to almost zero. However, after a certain period of time, it becomes apparent that vegetable oils are slowly absorbed into the skin, i.e. they have a temporary occlusive effect.
If you look at the composition of avocado oil, it consists mainly of triglycerides, which are compounds (esters) of long-chain fatty acids with glycerol.
Paraffins may have even higher molecular masses than triglycerides, but for both substances it is clear that their molecular particle sizes are far too large to be absorbed by the epidermis. What is really happening here?

Working in a team

The explanation is relatively simple. If you look at the enzyme composition of the microbiome populations and the epidermis, the two work together like a team when they release their enzymes – in this case ester-cleaving esterases – onto the triglycerides. The result is glycerol and free fatty acids whose molecular mass is less than a third of the original compounds. They can now pass through the skin barrier and be absorbed by the epidermis. In contrast, there are no physiological enzymes for the breakdown or degradation of paraffins – which is also the reason why they have been stored as crude oil for millions of years.

Aerobes and anaerobes

But there is something else: paraffins are still not without effect on the skin microbiome. The populations change under the permanent occlusivity. This not only prevents water from leaving the skin, but also prevents oxygen from reaching the skin surface.
Among the microorganisms, there are specialists that work and multiply better in the absence of oxygen and those that thrive better in the presence of oxygen. The former are called anaerobes and the latter aerobes. Permanent (non-physiological) occlusivity favours the anaerobes and the ratio of microbiome populations changes. Anaerobes lead to inflammatory symptoms (irritation, reddening of the skin, comedones) within a few days in people suffering from rosacea or acne, which is why not only paraffins but also the daily use of products with a higher lipid content are counterproductive for them in particular.

Hygiene

The aerobes are not only, but also responsible for the low pH on the skin surface (acid mantle). With the help of oxidoreductases, they oxidise and break down the long-chain fatty

acids found in the skin barrier and in cosmetic products, for example, into shorter fatty acids.
However, this type of regeneration only works smoothly if the skin microbiome is not constantly decimated by harsh hygiene measures in the form of highly concentrated surfactants (detergents) and disinfectants.
It is advisable to use such products sparingly, especially for people who suffer from barrier disorders. Lukewarm water for adults and vegetable oil for small children, especially when wearing nappies, will prevent many problems from arising in the first place. Hygiene is good, but excessive cleanliness is harmful.

Natural protection

In this context, it should be noted that today's hunt for the strongest antioxidant may keep possible free radicals in check, but it makes the work and population of aerobes a challenge. Moderate physiological antioxidants such as vitamin E in low concentrations are the better choice.
Incidentally, the epidermis and skin flora work together in this area. Through their proteases, i.e. enzymes that can break down proteins, they form the amino acids of the NMF (Natural Moisturising Factor), the epidermis' own most important protective factor against radical influences from the environment, for example against nitrogen oxides. The reaction with them produces alpha hydroxy acids (AHAs).

Physiological balance

Speaking of proteases: Pathogenic bacteria and fungi use these enzymes to break down proteins, digest the metabolites and in this way break into epidermal structures and possibly infect the body. Under normal physiological conditions, there is a kind of demarcation line between the epidermis and the microbiome, i.e. a balance that utilises antimicrobial peptides (AMP) and also proteases on the epidermis side. This physiological balance formed after birth must be kept stable during skin care.
A good working hypothesis is therefore to choose cosmetic formulations that are well received by both the epidermis and the skin flora, i.e. that are as physiological as possible.

Malfunctions

This in turn leads to the conclusion that substances that are not biodegradable or are difficult to biodegrade do not belong in cosmetic products. These include, for example, complexing agents such as EDTA (ethylenediaminetetraacetic acid and its salts). Complexing agents bind traces of heavy metals such as iron, which are involved in oxidation processes that shorten the shelf life of cosmetics. However, they also naturally bind endogenous heavy metals, which are vital for oxidoreductases in the epidermis and aerobes.
Routine peelings carried out at short intervals, for example with alpha hydroxy acids, as well as dermabrasion, have a damaging effect on the interaction between the epidermis and microbiome. Experience has shown that on sensitive skin, e.g. Celtic skin, they lead to an increased incidence of rosacea and perioral dermatitis (POD) in the long term. In acute cases, fatty substances are no longer tolerated at all, which is particularly unpleasant for those suffering from them.

Resistances

Preservatives are also harmful to the microbiome. They are explicitly directed against all types of microorganisms in order to prevent the destabilisation of preparations during storage and use and the associated degradation of individual components. Similar to antibiotics, they are effective to varying degrees with regard to the individual populations of microorganisms.
Mixtures are therefore often used in the preparations. For decades, the classic was a mixture of different parabens with phenoxyethanol – a combination of lipid and water-soluble preservatives.
The germs in the skin flora react with varying degrees of sensitivity. Some are more or less resistant and use the opportunity to decimate their colleagues for their own reproduction, similar to what we know from pharmaceutical antibiotics. The natural, physiological balance between the populations is thus disturbed. If this involves an increase in pathogenic representatives, this can lead to undesirable skin reactions, which is not uncommon with preservatives.
Without exception, all preservatives listed in the annex to the Cosmetics Regulation have allergenic potential. The extent to which the microbiome and/or direct reactions of the epidermis are involved in allergies can only be surmised due to the complexity of the matter.

Infections

The presence of emulsifiers, especially those that are not broken down after entering the epidermis, increases the penetration of preservatives and, conversely, the risk of infections caused by germs in the skin flora, but above all by external pathogenic germs, as the skin barrier is damaged. Examples include fungal infections in damp areas of domestic and communal bathrooms.

This situation is not limited to the feet. The occurrence of dandruff also correlates with the frequency with which hair is washed with products containing surfactants such as shampoo etc. Surfactant is the term for emulsifiers in cleansing products.

On the surface

The situation is different for consistency agents which, like emulsifiers, are amphiphilic (water- and lipid-loving) and stabilise emulsions, as they are usually polymeric compounds of natural or synthetic origin.
They remain on the skin and can at best have a positive effect on skin moisturisation. Examples are carbomers (synthetic) or xanthans, hyaluronic acid, cellulose and starch derivatives (natural). On the one hand they are relatively indifferent, on the other hand they are not occlusive and only slightly disturb the TEWL between the epidermis and the environment.
In general, polymers are more difficult to break down as they can only be metabolised by microorganisms step by step from the ends. The shorter they are, the easier they are to break down. This also applies to polysaccharides such as hyaluronic acid. This is the only way to explain the effect of short-chain hyaluronic acids compared to long-chain hyaluronic acids. Both are too large to penetrate the skin barrier. However, as the chain length decreases, the glycosidases of the microbiome release more N-acetylglucosamine and ultimately also glucosamine, both of which can easily penetrate the skin barrier due to their small molecular mass. The same applies to long and short-chain collagens. They are broken down to the amino acids by proteases.

The strength lies in the sum...

It is difficult to estimate how the metabolic performance of the epidermis and skin flora is divided. As described, this depends on the individual molecules that reach the skin. Therefore, the results of penetration, tolerability and efficacy studies carried out on Franz cells, artificial skin or in vivo will always differ.
The fact is that in vivo measurements never reflect the performance of the epidermis alone, but always only a sum together with the skin microbiome.

Paracelsus

Another important finding is that it is not only the chemical structure of a substance that is relevant when it comes to microbiome reactions, but also its physical behaviour and concentration. A typical example of this is the comedogenicity of stearic acid, which has an effect on microbial activity in the sebaceous glands. As with many other comedogenic substances, it depends on solubility, concentration and melting point. Taking Paracelsus' well-known guiding principle into account, cosmetics developers can avoid many problems in the subsequent application of preparations by lowering the concentrations.

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