

Microbes in Cosmetics: Is it all things pretty?

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Being a 20-year-old female who is largely interested in the upkeep of my appearance, I have had a fair share of involvement with cosmetics from my time as a dancer and using it for performances to a daily basis for dolling up. I thought I was quite the expert, and I knew the good and bad for my skin.

I was wrong. It was only recently that I had a rather awful acne breakout on my forehead. I immediately combed the Internet to look for the possible causes and ways to help my skin get better and happened to stumble upon a few articles discussing the issue of contamination in makeup and it got me thinking, could this be why I am having a breakout? This may seem a tad bit dramatic, but it was at that moment that I could visualize the germs and bacteria just dancing at the top of my face powders, hiding among the pores of my sponges, and sliding through the bristles of my makeup brushes. With the interest to share my findings on my investigation of improving my skin condition, my topic of discussion is Microbes in Cosmetics: Is it all things pretty?

Makeup, or cosmetic products, are preparations applied on the body to beautify, promote attractiveness, preserve, or alter appearance. We usually use them for purposes such as cleansing, protecting, conditioning, and sometimes coloring [1]. L'OREAL, the largest cosmetic company to date, released the 2020 annual report stating that the cosmetic market has an estimated value of 200 billion euros. According to Statista [2] report analyzing the global cosmetic market growth from 2018 to 2025, the cosmetic market in 2018 was valued at 507.8 billion US dollars in 2018, and it is estimated to reach a value of about 758.4 billion by 2025. In Singapore, the beauty and personal care market was estimated to earn revenues of more than 1 billion US dollars in 2020 and is expected to grow again in 2021 as the economy is recovering

from COVID-19 [3]. Though there are many other statistics, these are enough to point towards the conclusion that cosmetics are extremely widely used across the world.

To some, applying makeup is perceived as a facade, deceiving others by hiding their true selves behind all that makeup and cosmetic alterations. But to most, cosmetics means making themselves feel a little better looking than before, more confident [4], less insecure, a little more ready to face what's to come which can be as simple as meeting a friend or as formal as a job interview. Cosmetic has also proved its significance for jobs [5] especially in the service industry. Service staff can be seen as the face of the brand, and they contribute to the consumers' first impression of the brand. A good example would be The Singapore Girl, the Singapore Airline air stewardess. These stewardesses are put through training and tests, needing to comply with strict guidelines to ensure that their presentation remains satisfactory. Stewardesses are usually assigned blue/brown eye shadow palettes, olive green/plum/brown for leading stewardess, and pulp/brown for the chief stewardess. The look is usually completed with a red lip.

Other than statistics related to the cosmetic market, another way to determine its relevance to the current society is to evaluate its usefulness [6]. Usefulness can be broken down into physiological, physicochemical, and psychological aspects. Firstly, physiological usefulness will include abilities to alleviate skin roughness, prevent hair loss, etc. Most of the research in this area revolves around dermatology, physiology, biochemistry, pharmacology, molecular biology, immunology, and other life sciences. Secondly, physicochemical usefulness includes aspects such as protecting skin from the effects of UV radiation using UV absorbing and scattering agents as well as utilizing the science of rheology, permanent waving, and creams to make hair more appealing. Lastly, psychological usefulness includes areas like aromacology of fragrances, psychology of makeup colors. Some of these products are effective in offering soothing and stimulating effects such as products with menthol odors or giving users more confidence, raising working efficacy, and many more.

Let us first understand the relationship between microbes and cosmetics before discussing microbes in cosmetics. We are familiar with common microbes, like bacteria, fungi (yeast and mold), algae, and viruses but not so much about their associated use in cosmetic products [7]. First, bacteria's major plus point would be its biocompatibility, the ability to contribute to or deliver an intended effect in the cosmetic product effectively without largely impairing the skin's physiology and causing skin irritations and reactions. Another notable characteristic is bacteria's ability to secrete an abundance of biologically active compounds like oligosaccharides, exopolysaccharides, biosurfactants, enzymes, peptides, vitamins, etc. Focusing on biosurfactants, one commonly used biosurfactant is Mannosylerythritol lipid (MEL) which is produced by Basidiomycetous yeast of *Pseudozyma* spp. They are used in cosmetic products like lipsticks, eyeshadows, soap, nail care, etc. Second, fungi and specifically a species called the Rhizopus genera can produce lactic acid as a product of the aerobic fermentation process of glucose. They have low substrate cost compared to bacterial sources Lactobacillus that are commonly used in cosmetic products for known purposes such as inhibiting skin pathogens [8]. Lactic acid helps to retain skin moisture, enhance smoothness and suppleness of the skin, high concentrations of this acid offer exfoliating properties which are prominent in products like skin peeling creams. Lastly, algae give rise to many bioactive compounds that can then be easily manipulated and adjusted with the change of physiological culturing conditions. Mycosporine-like amino acids (MAAs) are one of the many photo-protective compounds found in algae. They have a high molar coefficient which aids MAAs in absorbing UV light and scatter radiation without generating free radicals. From this bulk of information, it is obvious that microbes have so much to offer, and it is no wonder that there is an increasing consumer demand for biological ingredients to be integrated into cosmetic products. This pushes the industry to delve further into microbial sources and get a better understanding of the possible side or adverse effects that these biologically derived products may cause.

So, is everything related to cosmetics pretty? In my time scouring the Internet, I realized that some microbes are a source of risk for contamination, which probably explains the cause of my

acne breakout as shared early. I will be using the classic 5W1H, Who, what, when, why, where, and how to dissect the issue of contamination in cosmetics contributed by microbes.

Who is involved? The actual microbes involved in the issue of contamination include the common ones such as *P.aeruginosa*, *S.aureus*, *E. coli* & *Bacillus* species. Bacteria, mold, and yeasts. Some bacteria & molds that cause human infections are *S.epidermidis*, *B. cereus*, *B. circulans* & *A.versicolor*. They have a direct or indirect effect on people who are immunocompromised and more susceptible to infection, people sharing makeup, usage of makeup near the eyes, mouth, cuts, or grazes that have open wounds or large areas of mucus membranes, or just people who simply have sensitive skin. However, these microbes can be introduced by the manufacturers and consumers, which brings me to the next W.

When does contamination occur? It usually occurs in two instances [9]. First, during manufacturing or/and placed into a container during packaging. Second, when the consumers use the product.

Where are these microbes usually found? They can proliferate and grow in abundance in cosmetic products with high water content such as eyeliners, mascara, and foundations. Make-up accessories such as make-up sponges which are often found damp for an easier application are not spared from the proliferation of these harmful pathogens.

What do these microbes cause? When exposed to skin, especially if sensitive, build-up of bacteria on the face can cause acne flare-ups in usual cases. There can also be instances of skin or eye infections, and viral conjunctivitis if cosmetic products are shared among users. Though rare, serious skin reactions like irritant-induced contact dermatitis [10], worsen atopic dermatitis that can further escalate existing health issues like asthma, allergic rhinitis, etc.

Why do such reactions occur? With irritant contact dermatitis, they are reactions resembling allergy reactions that arise due to the sensitivity of the skin or certain parts of the skin to a

specific product. Skin sensitivity can be contributed by dry or injured skin. However, for acne, which is a common problem that people who wear makeup all face, makeup is not the actual and direct cause of acne [11]. Instead, certain ingredients or circumstances such as using contaminated makeup can cause clogged pores and follicles, creating the optimal environment for acne-causing bacteria *Propionibacterium acnes* to proliferate. These bacteria can then result in non-inflammatory acne lesions such as open comedones, better known as blackheads or closed comedones, known as whiteheads, as well as inflammatory acne that can present as papules, pus-filled pustules, or nodules that are large and painful lesions lodged deep in the skin.

How do these microbes lead to such reactions? Cosmetic product compounds can remain on the skin for a prolonged period despite being washed off [12]. Also, microbes shape specific skin microbial communities and affect molecular as well as bacterial diversity. Microbes change the chemical environment hence altering the diversity of bacteria and the structure of molecules on the skin. Lastly, the temporal variability of molecules & bacteria is specific to product, site, and person. The changes are visible from the first week of use.

But does this mean that we must avoid using makeup? Not at all, there are some ways to use them safely and some good in using cosmetics as well. We can contribute to lowering the risk of contamination with a few steps. Cleaning all cosmetic accessories like sponges and brushes, thoroughly regularly. Note that this must be done properly, to effectively remove the germs that are the primary cause of contamination. Another suggestion is that the services providing cosmetic procedures like salons, shift to use disposable, single-use applicators. This will most definitely reduce the risk of cross-contamination. But this must be executed with much consideration because this bleeds into another issue of increasing carbon footprint, plastics not being biodegradable, generally a not so environmentally sustainable method.

To alleviate our main issue, which is contamination, the most effective way is to adopt the opposite concept, which is preservation [13]. Effective protection against microbial

contamination can be achieved in 2 stages of preservation, primary and secondary. Primary prevention is based on Good Manufacturing (GMP) and occurs during manufacturing. This means that GMP is to be strictly followed during the cosmetic product production processes such as adhering to aseptic conditions, water treatment, microbial control of raw materials, proper equipment disinfection, and qualified staff to oversee the production process. Secondary prevention occurs after manufacturing, with strategies including physical, physicochemical, and chemical preservation methods to attain protection.

First, physical preservation includes the primary packaging which is the physical barrier, providing protection against most of the contamination during use and accumulated in the distribution system. Some examples include the physical configuration of packaging like a bottle, or/and closed system configurations like airless pumps. In recent times, technologies such as the Pylote technology [14], Pyclear protection can also be applied. This technology is a natural solution that targets bacterial and viral contamination. Its unique green tech synthesis process only uses water as a vector and chemical reactor without an organic solvent. It does not generate any waste but small bead-like mineral microspheres. It is nano-free, silver-free, and can also be integrated directly into plastic as a colorant masterbatch which means it can be integrated into cosmetic accessories like makeup brushes to aid the reduction in contamination. Usage of Pylote removes the need to use preservatives which is beneficial since some like parabens can cause health issues while still providing microbial protection. Second, physicochemical prevention focuses on aspects such as water activity that can be solved with the usage of substances like salts that reduce water activity. Emulsion forms like water-in-oil emulsions are preferred over oil-in-water emulsions as they minimize the risk of microbial contamination. Also, pH control is vital. An optimal pH for microorganisms' growth is between 5-8, compounds like salicylic acid and aluminum compounds create a low and acidic pH environment favorable for inhibition of microorganism growth. Third, chemical preservation focuses more on the usage of microorganisms. Other than natural chemical preservatives, multifunctional ingredients such as chelating agents that are used for specific functions also add to another effect such as antimicrobial activity, hence helping to preserve cosmetic products.

Current good in makeup includes players such as sunscreens. These products are essential in our routines because they help us prevent sunburn and premature aging. This is contributed by the ability to absorb ultraviolet (UV) A and/or B and convert it into heat or scatter it. Extended benefits of proper sunscreen usage include reduced risk of skin cancer, sun sensitivity. But what about a future good? Regarding an article written as part of research innovation, L'OREAL expressed their stance on the usefulness of microbiome in the future of cosmetic products. Other than the trillions of microbes found in the gut that we already know of a comparable and substantial number of microbes are also found on the skin. They form the skin microbiome, which refers to the complex ecosystem attained since birth and changes as we mature, containing different types of microorganisms like bacteria, fungi, etc that contribute to protecting the skin against harmful environmental factors and invasion of pathogens. Proving a role in skin protection, there are a few ways that the cosmetic industries are approaching the skin microbiome [15]. With probiotics [16], the “good bacteria” boost beneficial bacteria on the skin while prebiotics nourishes existing good bacteria to grow, examples include short-chain oligosaccharides. Finally, postbiotics are usually combined with pre- or probiotic treatments such as adding byproducts of probiotics. Cosmetic companies are looking to tap into the skin microbiome potential to create individualized cosmetic care and routines, which will fulfill the specific and exact needs of the consumers largely based on the microbe ecosystem living on their skins and their personal skin goals.

Microbes are all around us. From the most intimate area of our body, our gut, skin, and other body parts, to the food we eat and the environment around us. These “too small to be seen by the naked eye” microorganisms play an important role in our lives, good or bad. Often, microorganisms are portrayed in a negative light which is justifiable. A few examples will include the microbes causing human disease such as *Vibrio cholerae* causing cholera, *Plasmodium falciparum* causing malaria, and microbes causing issues such as the one I raised previously of contamination. However, this does not mean that microbes are only bad that can be evidenced by mine and other research on how cosmetic products can benefit us.

To conclude all my points and findings, choosing to write about cosmetics is important to me because makeup plays a vital role in my personal life, boosting positive emotions, giving me encouragement and confidence that nothing else can offer. Being a frequent user of cosmetic products, I realized the need to understand how they work, not about the application but the way they interact with my skin and body such as how its content can help me or how this product can be detrimental to me if not used properly. This allows me to make informed decisions for myself as I will be able to narrow down options and stick to a few products that will show guaranteed benefits when I use them on my skin. This is much safer as compared to the continuous cycle of trying out new products which may irritate and sensitize my skin in the process. An additional benefit will be helping my friends and close ones around me make informed decisions about what they decide to put on their faces by sharing the knowledge that I obtained from writing about this topic.

References

- [1] Augustine, R. & Hasan, A. Multimodal applications of phytonanoparticles. *Phytonanotechnology* 195–219 (2020). doi:10.1016/b978-0-12-822348-2.00011-5
- [2] Petruzzi, D. Cosmetic Market Value Worldwide, 2018-2025. Statista (2022). Available at: <https://www.statista.com/statistics/585522/global-value-cosmetics-market/>. (Accessed: 9th December 2022)
- [3] Hirschmann, R. Topic: Cosmetics market in Singapore. Statista Available at: <https://www.statista.com/topics/7542/cosmetics-market-in-singapore/>. (Accessed: 9th December 2022)
- [4] Miller, L. C. & Cox, C. L. For appearances' sake. *Personality and Social Psychology Bulletin* 8, 748–751 (1982).
- [5] DELLINGER, KIRSTEN. & WILLIAMS, CHRISTINEL. Makeup at work. *Gender & Society* 11, 151–177 (1997).
- [6] Mitsui, T. *New cosmetic science*. (Elsevier Science, 1998).
- [7] Gupta, P. L., Rajput, M., Oza, T., Trivedi, U. & Sanghvi, G. Eminence of microbial products in cosmetic industry. *Natural Products and Bioprospecting* 9, 267–278 (2019).
- [8] Delanghe, L. et al. The role of lactobacilli in inhibiting skin pathogens. *Biochemical Society Transactions* 49, 617–627 (2021).
- [9] Jairoun, A. A., Al-Hemyari, S. S., Shahwan, M. & Zyoud, S. H. An investigation into incidences of microbial contamination in cosmeceuticals in the UAE: Imbalances between preservation and microbial contamination. *Cosmetics* 7, 92 (2020).
- [10] Skin disorders caused by cosmetics. HealthHub Available at: https://www.healthhub.sg/a-z/diseases-and-conditions/406/skin_disorders_cosmetics_i. (Accessed: 9th December 2022)
- [11] McLintock, K. Can makeup actually cause acne? we get to the bottom of it. *Byrdie* (2021). Available at: <https://www.byrdie.com/does-makeup-cause-acne>. (Accessed: 9th December 2022)

- [12] Bouslimani, A. et al. The impact of skin care products on skin chemistry and Microbiome Dynamics. *BMC Biology* 17, (2019).
- [13] Halla, N. et al. Cosmetics preservation: A review on present strategies. *Molecules* 23, 1571 (2018).
- [14] Feuillolay, C., & Roques, C. (2016). Unpreserved ophthalmic formula: PYCLEAR® Protection fully controlled risk of contamination with common 3 parts eye dropper. *Investigative Ophthalmology & Visual Science*, 57(12), 768-768.
- [15] Bhaskar, B. Innovations in skin microbiome products: Saying yes to good bacteria! prescouter - custom intelligence from a global network of experts. *PreScouter* (2019). Available at: <https://www.prescouter.com/2019/05/innovations-skin-microbiome-cosmetics/>. (Accessed: 9th December 2022)
- [16] Lukic, J. et al. Probiotics or pro-healers: The role of beneficial bacteria in tissue repair. *Wound Repair and Regeneration* 25, 912–922 (2017).