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PRELIMINARY STUDY ON THE INTERACTION OF SKIN MICROBES IN THE DEVELOPMENT OF COSMETIC AND TEXTILE PRODUCTS: A REVIEW

BY

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Abstract. This work, which aims at realizing a synthesis of the knowledge on cutaneous microbes, shows that the skin is made up of pathogenic microbes and commensal microbes. The resident or commensal microbes are defenders of the skin and are ready to compete for nutrients and available space. Therefore, pathogenic microorganisms will not be able to settle and grow. The textile designer, in his search for an antimicrobial textile, should not be satisfied with the ability to inhibit skin microbes. He should investigate whether his textile promotes the balance of the commensal flora before testing the inhibition of the transient flora. For this reason, it is desirable to know the skin flora before embarking on the implementation of antimicrobial textiles.

Keywords: textiles, antimicrobial, pathogenic microbes, commensal microbes.

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1. Introduction

The skin is the largest organ in the human body and covers the entire body (Pedrassi, 2019). With an average thickness of 1.5 mm, it represents 15% of our total weight (Pedrassi, 2019). It contains proteins, fats, minerals, water and trace elements (Kim and Yosipovitch 2020; Pedrassi, 2019). It is structured into 3 layers of tissue: the hypodermis (deepest), the dermis (intermediate) and the epidermis (most superficial) elements (Kim and Yosipovitch, 2020; Pedrassi, 2019). Nevertheless, the skin is a suitable environment for the development of micro-organisms (Pedrassi, 2019). The popular belief is that wearing clothes that are clean to the naked eye is the best way to ensure that our skin is hygienically clean. However, billions of micro-organisms live on the surface of our skin (Pedrassi, 2019; Wang *et al.*, 2018). Recent research has led to a better understanding of this collection of microorganisms, which is known as the skin microbiome. Research on the skin microbiome has been a real revolution for the textile industry, with the development of garments (wedges, socks, bras, panties, trousers, etc.) aimed at protecting, restoring or maintaining the balance of this skin microbiome.

The micro-organisms that form the skin microbiome are mainly present on the surface of the skin (mainly in the stratum corneum), on the upper part of the hair follicles and the sebaceous gland ducts (Mathieu, 2014; Wang *et al.*, 2018). Does the skin microbiome always alienate human health? Or does it always contribute to human flourishing? The aim of the study is to synthesise knowledge about skin microbes. Bacteria may need oxygen for their energy-producing metabolism, and these are called aerobes; or they can multiply in the absence of oxygen, these forms being anaerobic. Some species are active agents in fermentation, while others appear to be the cause of certain infectious diseases. Ultimately, the aim is to develop tools that will enable us to make better use of skin microbes to advance the textile sector and improve our health.

2. Background on the skin microbe

The term microbe is used to refer to all living microscopic organisms (Amartin, 2016; Kuska, 2008). They can be viruses, bacteria, fungi and protozoa (Di Domizio *et al.*, 2016; Kim and Yosipovitch, 2020). The skin contains billions of microbes. The most abundant are commensal bacteria (Sfriso *et al*., 2016) The commensal bacteria that make up part of the skin microbiota are present on the surface of the skin, in the epidermis and also in deeper layers such as the dermis (Pedrassi, 2019; Sfriso *et al*., 2016). They protect the host against colonisation by pathogenic microbes by competing for nutrients and secreting bacteriocins (Pedrassi, 2019). They also induce the

expression of IL-17 by T cells and antimicrobial peptides (AMPs) by keratinocytes, leading to the establishment of protective immunity against the risk of infection (Pedrassi, 2019; Sfriso *et al*., 2016). An increase or decrease in bacterial composition (dysbiosis) leads to skin inflammation and disease. This means that an increase or reduction in bacterial diversity, known as dysbiosis, promotes the emergence of pathogenic bacteria and/or a disruption of immune responses that can lead to the development of certain skin diseases such as acne, atopic dermatitis, hidradenitis suppurativa or perhaps even psoriasis (Sfriso *et al*., 2016). The skin is then made up of pathogenic microbes and commensal microbes that constitute a skin flora. This skin flora is divided into resident and transient flora (Di Domizio et *al*., 2016).

3. Resident skin flora

Resident skin microbes are also called commensal microbes, which means that they live off their host without causing disease (Pedrassi, 2019; Sfriso *et al*., 2016). These commensal microbes live in a balance between local conditions and their own metabolism (Kim and Yosipovitch, 2020; Pedrassi, 2019; Sfriso *et al*., 2016).

Their numbers and composition are stable over time. The most common are Gram-positive bacteria of the genera: Staphylococcus, Corynebacterium and Propionobacterium (Di Domizio *et al*., 2016; Pedrassi, 2019; Wang *et al*., 2018), (Table 1).

– Fungi in mycelial form of the genus Malassezia (appears at puberty).

– Gram-negative bacilli of the genus Acinetobacter, which are less present than Gram-positive strains because they are less resistant.

– Demodex folliculorum and Demodex brevis mites.

– Papillomavirus-type viruses (Kim and Yosipovitch, 2020; Sfriso *et al.*, 2016; Sariani, 2019).

Commensal microbes can be modified by the environment, pollution, but also by hygiene, but they quickly return to a normal elementary state (Pedrassi, 2019). An increase or decrease in bacterial composition (dysbiosis) leads to skin inflammation and disease. This means that an increase or decrease in bacterial diversity, known as dysbiosis, promotes the appearance of pathogenic bacteria and/or a disruption of immune responses that can lead to the development of certain skin diseases such as acne, atopic dermatitis, suppurative 12 hidradenitis or maybe even psoriasis (Sfriso *et al*., 2016). This indicates that antimicrobial textiles or cosmetics should take care of the balance of skin commensal microbes in order to provide good protection for humans.

Table 1
The different bacteria making up the resident skin flora (Pedrassi, 2019)

Genus Staphylococcus		Genus Corynebacterium		Genus Propionobacterium	
Species	Location	Species	Location	Species	Location
S.epidermidis +++	Everywhere but especially face, nostrils, axillae axillae	C.lipophiles	Especially in the nostrils spaces, interdigital spaces, perineum	Cutibacterium acnes (formerly known as named P.acnes)	Cutibacterium acnes (formerly known as named P.acnes)
S.hameolyticus	Wetlands	C.jeikeium	Especially in the area of hands, many found in hospital		
S.hominis	Axillary creases, inguinal folds, perineum				
S.aureus	Especially in the nostrils, axillae and axillae and folds inguinau				
S.hameolyticus S.hominus, S.simulans	Mainly in the hand level	C.urealyticum	Especially in the hands and interdigital spaces	P.avidum	

4. Transient skin flora

This flora is composed of micro-organisms that are not adapted to the living conditions of the human body, so they will mostly be present for a short time, hours or even days (Pedrassi, 2019).

This flora is used to be saprophytic, *i.e*. the micro-organisms will feed on decomposing organic matter in the body such as excreta, genitals, anus and feet from moisture and the head, hands and feet from the presence of oxygen in the air elements (Kim and Yosipovitch, 2020; Pedrassi, 2019). Most of these micro-organisms are harmless, but some will cause humans disease.

Table 2
Details the components of the transient flora (Pedrassi, 2019)

Bacteria		Fungi
Gram-positive bacteria	Gram-negative bacteria	Candida albicans Candida parapsilopsis
S. aureus Streptococci Bacillus Neisseria	Pseudomonas	

Table 2 shows two main types of transient skin microbes (bacteria and fungi). As these microbes are pathogenic, with the current trend towards the use of antimicrobial textiles, care should be taken to inhibit these pathogenic microbes by not damaging the skin. This work shows that pathogenic microbes are transitional microbes whose evolution is favoured by the presence of humidity, oxygen, ambient temperature on the host which is an organic medium (the skin). Residential or commensal microbes are defenders of the skin and are ready to compete for nutrients and available space.

Therefore, pathogenic microorganisms will not be able to settle or grow. The textile designer, in his search for an antimicrobial textile, should not be satisfied with the ability to inhibit skin microbes. He should look for the balance of the commensal or resident flora before testing the inhibition of the transient flora. It is therefore imperative to know the skin flora before embarking on the implementation of antimicrobial textiles. There are billions of skin microbes (Wang *et al.*, 2018). The fact that a textile does not inhibit a type of microbe does not mean that a textile is not antimicrobial (Nsangou *et al.*, 2021). This research aims at advancing the knowledge of skin microbes in order to not only promote sustainable development, but also to improve hygiene and the control of microbial infections that may come from textiles.

3. Conclusions

By studying the types of skin microbes, it turns out that the skin is made up of pathogenic microbes and commensal microbes. This cutaneous flora is divided into resident flora and transient flora. The microbiome of healthy skin protects against invasive pathogens. Therapeutic removal of the skin microbiome (*e.g.*, antibiotics, disinfection) then promotes pathogenic skin infections. Atopic dermatitis is characterized by a depletion of bacterial diversity (dysbiosis), which favours pathogenic Staphylococcus aureus infections. Restoration of the skin microbiome (*e.g.* by emollients) should be a long-term therapeutic goal.

Dysbiosis with increased diversity of the bacterial microbiota may underlie the pathogenesis of suppurative hidradenitis, acne and potentially psoriasis. Specific therapeutic strategies for microbiome recovery should be developed for these diseases. The textile designer in researching the implementation of antimicrobial textiles should not be satisfied with the inhibitory power of skin microbes. It should investigate whether the chosen textile material promotes the balance of commensal or resident flora before testing the inhibition of transient flora. Therefore, it is imperative to know the skin flora before starting to implement antimicrobial textiles. There are billions of skin microbes.

The fact that a textile does not inhibit a type of microbe does not mean that a textile is not antibacterial. This research aims to advance the knowledge of skin microbes to promote both sustainable development and to improve hygiene and control of microbial infections that can come from textiles.

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STUDIU PRELIMINAR PRIVIND INTERACȚIUNEA MICROBILOR CUTANAȚI ÎN DEZVOLTAREA PRODUSELOR COSMETICE ȘI TEXTILE

(Rezumat)

Această lucrare reprezintă o sinteză a datelor din literatura de specialitate care evidențiază faptul că pielea este formată din microbi patogeni și microbi comensali. Aceste concluzii vin în sprijinul celor care lucrează în domeniul cosmetic sau textil deoarece microbii rezidenți sau comensali sunt apărători ai pielii (utilizați drept gazdă dar și ca posibili nutrienți). Prin urmare, microorganismele patogene nu vor putea să se stabilească și să se dezvolte. Textilistul ar trebui să investigheze dacă materialul textil folosit sprijină echilibrul florei comensale înainte de a testa inhibarea florei tranzitorii. De aceleași avantaje trebuie să țină cont și cei din domeniul cosmetic.