"Probiotics" In Skin Care Products- A Review

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ABSTRACT: **In the presented article, the definition of "probiotics" in cosmetics is proposed. Using a topical probiotic is beneficial, as it offers a protective shield and triggers the production of natural moisturizers in the skin. Therefore, some firms are already incorporating bacteria and/or their lysates into skin creams with the promise of rebalancing the community of bacteria that live in the human body and delivering healthier, more radiant-looking skin.**

Although probiotic bacteria have documented skin benefits, live cultures are generally not preferred in cosmetics. Rather than including live bacteria cultures, many of the probiotic skin care formulae use bacteria fragments or metabolites. The reason is that there is not currently any science developed to support the idea that live cells are any more effective when applied to the skin than these fragments. In near future, some brands using live bacteria might emerge. Recently there have also been an increasing number of skin care products entering the market touting probiotics. In this column, we will briefly review the science supporting the use of topical probiotics in skin care products.

KEYWORDS: **Natural Moisturizers, Probiotics, Probiotics in Skin Care Products, Topical Use of Probiotics.**

I. INTRODUCTION:

The skin is a complex barrier organ made of a symbiotic relationship between microbial communities and host tissue via complex signals provided by the innate and the adaptive immune systems. It is constantly exposed to various endogenous and exogenous factors – physical, chemical, bacterial and fungal, which affect this balanced system potentially leading to inflammatory skin conditions comprising infections, allergies or autoimmune diseases [3]. As an interface between internal organs and the outside environment, the skin is always in contact with different substances. Microorganisms including bacteria, fungi, and viruses found everywhere often colonize the skin. They can generally be categorized into three groups: 1) Transient microbes present intermittently, 2) Temporary organisms that persist over a short period of time, and 3) Residents that permanently inhabit the skin [4]. Therefore, the screening of effective means of correcting and/or maintaining the human normoflora for the preservation of healthy skin microbiome today is an urgent task [3].

So, in natural skin care products, probiotics help to deliver the good bacteria to our skin. This good bacteria can help to restore the natural balance of your skin, ensuring it functions the way it should and is replenished with the nutrients it needs in order to stay protected from the elements and fight the signs of aging and environmental damage. Probiotics are also a really effective anti-inflammatory, which makes them great for helping to soothe redness, irritation and skin conditions including acne, rosacea and dry skin [2].

This article provides an overview of probiotics use in skin care products. The discussion starts with a brief review of microbial communities in the skin. Their role in the health status of the host is further illustrated by examples of diseases associated with changes of microbial populations. The following section focuses on the potential of probiotics in skin care products.

II. SKIN MICROBIOME:

The skin is the largest organ in the human body. Its primary function is to protect our bodies from external harm by acting as a physical barrier, with additional roles that include regulation of body temperature, evaporation control, sensation, and storage of lipids and water [9, 10]. Skin continuously undergoes self-renewal, so resident microbial cells are shed in the process. Most of the microbes found on the skin are commensal organisms and harmless to healthy individuals; in fact, some are considered mutualistic organisms and confer health benefits to the skin by secreting antibacterial substances, preventing pathogen colonization, and influencing host immune responses [20]. Recent researches related to control of skin barrier functions prove close connection physical, immunological, and cell biological characteristics of skin and its bacterial population [11].

Joshua Lederberg suggested using the term "human microbiome" to describe the collective genome of our indigenous microorganisms (microflora) colonizing the whole body in 2001 [12,13]. Starting from this time, microbiologists and dermatologists joined their efforts to identify and describe different microorganisms colonizing human skin to estimate a number of each population and to understand, which microbial variety can cause one or another dermatological condition [14]. In general, the microbiome is defined as a collective genome of microorganisms [12]. Thus, skin microbiome is a genome of microorganisms present on skin, in which microorganisms support complex relations [3].

Most microorganisms found on human skin are not dangerous for human health. Some of them are even necessary for skin health. They release antibacterial substances, prevent pathogenic colonization of skin and effect its immunity [3].

According to held researches, three groups of microorganisms colonizing human skin are found (Fig. 1).

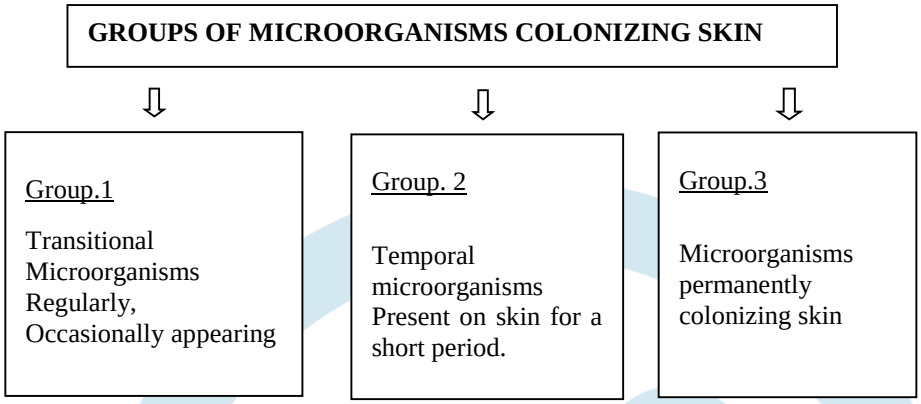

Fig. 1: Classification of microorganisms colonizing human skin [3].

There are various microflora i.e bacteria and microscopic algae and fungi, especially those living in a particular site or habitat. The following diagram shows the microflora present on skin [15].

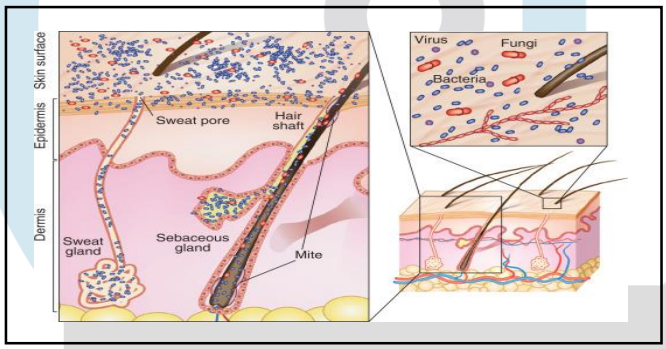

Fig.2: Skin Microflora [15]

In the context of bacteria, our skin can be viewed as a cultural environment composition of which is mainly a result of our genetics, diet, way of life and a region where we live. Therefore, human skin is unique and accordingly, skin microbiome of each person is also unique [3]. The skin microbiome is highly dependent on the microenvironment of sampled site, a reflection on the physiology of skin [16]. Sebaceous sites such as the forehead have the lowest diversity, and *Propionibacterium* species are the dominant organisms. On the other hand, moist areas (e.g., armpits, navel, groin) constitute higher diversity of microbiota, with *Staphylococcus* and *Corynebacterium* species as the predominant members [10,16]. Moreover, skin sites with greater bacterial diversity (e.g., forearm, hand, buttock) can harbor diversity as high as or higher than that of the gut microbiome. The acidic condition resulting from sebum degradation discourages pathogens from invading and establishing in the skin [16].

Personal hygiene is another environmental factor that has a direct effect on the skin's microbial flora. Soaps, makeup, and skincare products (e.g., moisturizers) alter skin conditions that in turn may influence the types of microbes residing on the skin [17]. On the contrary, in dry area, skin microbiome includes *β-Proteobacteria* and *Flavobacteriales* [18,19].

Various factors affect the microbial flora of the skin and they can be generally categorized into host and environmental factors [10].

i. Host Factors:

Among the host factors are age, sex, and anatomic sites. Skin microflora differ among various age groups, with significantly different bacterial communities between the youngest and the oldest groups [17]. A newborn acquires resident bacteria on the skin soon after birth, and their composition is affected by birth delivery methods [9,20]. Unlike vaginally delivered infants, who are colonized by bacteria from the vaginal community, infants born by C-section are dominantly colonized by *Staphylococcus* and other taxa reflecting maternal skin flora [24].

Hormonal changes during puberty stimulate the growth of lipophilic (or lipid-loving) bacteria due to sebum production [17]. Altered lipid composition and organization can cause skin diseases when commensal bacteria become infectious agents. One such example is acne [21].The change of lipid composition during puberty encourages lipophilic organisms, such as *Propionibacterium* acnes, to proliferate [22]. As these bacteria derive energy from metabolizing fatty acids in the sebum, a variety of enzymes are secreted that injure the tissue lining of sebaceous glands.

In conjunction with activated immune responses, this results in a skin condition termed acne vulgaris [10]. In addition, the investigators noticed younger children had a higher abundance of *Staphylococcus (S.) aureus*, which were later replaced by lipophilic and other bacteria.This finding may have important implications for skin disorders, such as atopic dermatitis (or eczema), which are most common among children but often resolves by adolescence and adulthood [23].

ii. Environmental Factors:

Skin barrier and microbiota act like a shield protecting the organism against harmful effect of exterior environment. There is well-balanced interaction between permanent and temporary populations on skin. This balance continuously depends on internal and external (including environmental) factors that change composition of microbial population on skin.Change of this balance is characterized as *dysbacteriosis* occurrence of which can worsen such chronic skin diseases as atopic dermatitis and psoriasis or acne . The skin microbiome is essentially influenced with factors such as the climate, including temperature and ultraviolet rays. Ultraviolet rays are known to be bactericidal [3].

The skin microbiome is also affected by lifestyle, including alcoholism or nutrition. The excessive consumption of alcohol and meals' vitamins deficiency render effects the skin microbiotic balance decreasing its resistance to infections [25].

Therefore, the following figure shows factors leading to dysbiosis and innate immunity response of the skin.

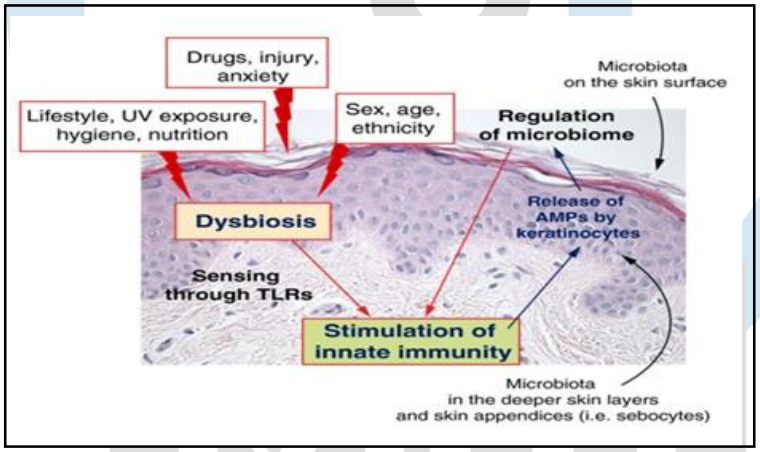

Fig.3: Factors leading to dysbiosis and innate immunity response of the skin [3]

Most of researches are aimed at study of bacterial composition of the microbiome, but viruses, fungi, and arthropods also make an important part of the skin microflora. Researches have established that a prevailing genus of fungi in skin is *Malassezia*, specifically *M. globosa, M. Restricta* and *M. Sympodialis* [26,27,28]. *Malassezia* fungi are lipophile, often connected with skin areas rich with sebum [29]. As in case of bacteria, distribution of *Malassezia* depends on features of each particular life area. For example, *M. Globosa* prevails on the back, hindhead, and inguinal folds, while *M. Restricta* is found in hairy part of the head [30], external acoustic meatus, postaural folds, and glabellar area [25]. Other skin areas, for example feet, are colonized by a great variety of microorganisms (for example, *Aspergillus, Rhodotorula, Cryptococcus* and *Epicoccum*) [26].

The following table shows the presence of fungi on various skin areas.

Table no.1: Presence of Fungi upon Skin areas.

Sr.no.	**Fungi**	**Skin Areas**
1.	*M. Globosa*	back, hindhead, and inguinal folds.
2.	*M. Restricta*	hairy part of the head , external acoustic meatus, postaural folds, and glabellar area..
3.	*Aspergillus, Rhodotorula, Cryptococcus and Epicoccum*	Feet.

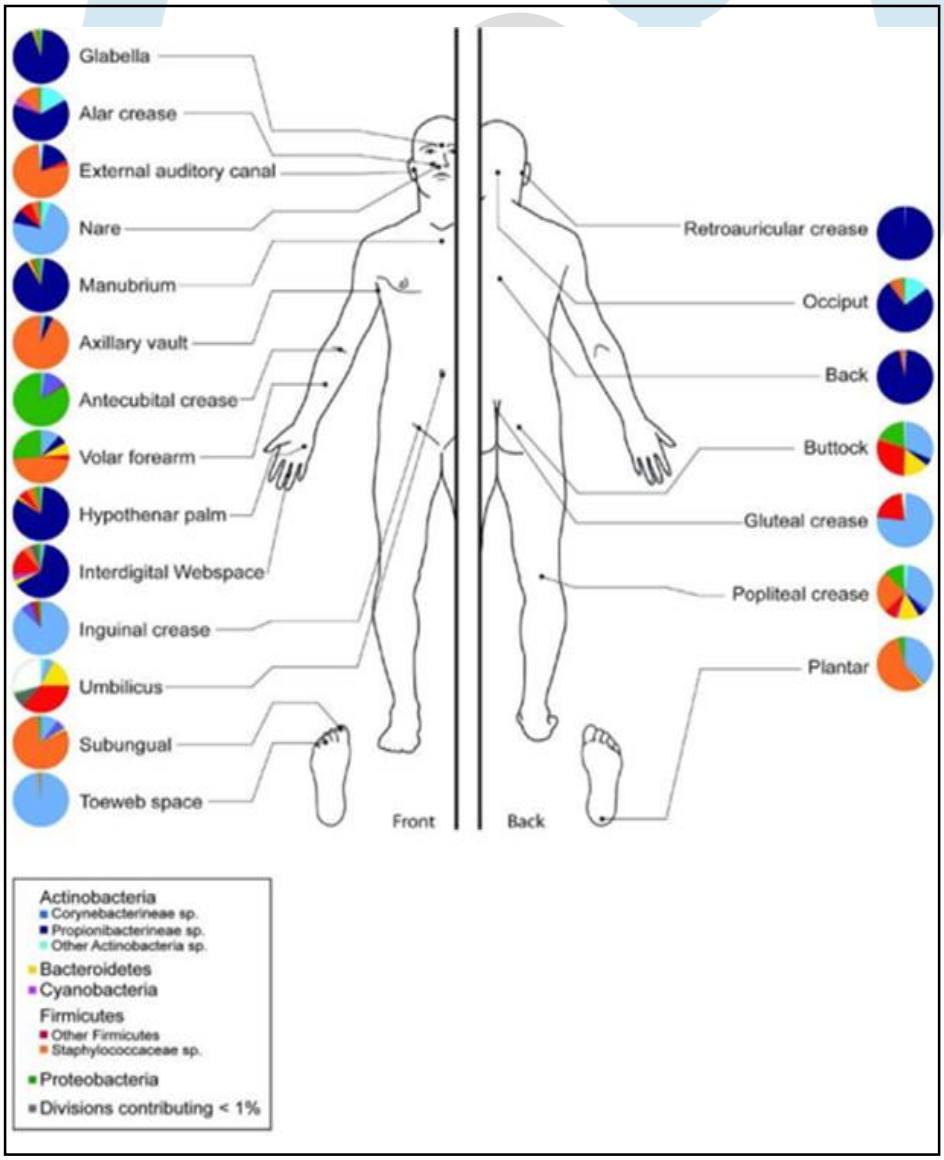

Fig.4: Topographical distribution of bacteria on skin sites. Sebaceous sites are labelled in blue, moist sites are labelled in green and dry surfaces are labelled in red [10]

However, not only external factors contribute to microbial population, both pH and body skin various areas temperature also can play their role at microorganisms' growth or progress deceleration. The human body pH varies between 4.2 and 7.9. Therefore, an excessive use of detergents involves alternation in skin pH, thus involving the irritation with changes in microbiome especially at hand's skin. Cosmetology and hygienic purpose products, soaps, makeup for e.g. foundation, compact powders, lipsticks, eye products and moisturizing products like creams and lotions alter skin conditions that in turn may influence the types of microbes residing on the skin [3].

III. PROBIOTICS:

The concept of probiotics was proposed in the early 20th century by Elie Metchnikoff who postulated that ingested microorganisms could confer health benefits for humans [6]. The World Health Organization has defined probiotics as live microorganisms that, when administered in adequate amounts, confer a health benefit [7].

Probiotics are "body-friendly" bacteria that help balance our "good" and "bad" bacteria to help strengthen the immune system and support the body's ability to remain healthy. Probiotics are live bacterial culture that, when applied topically, influence the composition of skin microflora [1]. Probiotics can be digested too and are a really key element for keeping our gut health in check. Gut health can have a huge impact on the appearance of our skin too, so it's important to care for your skin from the inside out as well as topically [2]. Probiotics have the rather clever ability to rebuild and strengthen the skin's barrier. Sensitive skin may take a while to repair itself after damage but incorporating probiotics into your skincare regime helps speed up the process for rejuvenating skin [5].

Therefore, some firms are already incorporating bacteria and/or their lysates into skin creams with the promise of "rebalancing" the community of bacteria that live in the human body and delivering healthier, more radiant-looking skin [3]. Although people often think of bacteria and other microorganisms as harmful "germs," many microorganisms help our bodies function properly. For example, bacteria that are normally present in our intestines help digest food, destroy disease-causing microorganisms, and produce vitamins. Large numbers of microorganisms live on and in our bodies. Many of the microorganisms in probiotic products are the same as or similar to microorganisms that naturally live in our bodies [6].

Clinical studies have already reported that probiotics may exert other health-promoting effects beyond the gut well-being such as improving atopic eczema, atopic dermatitis, healing of burn and scars, treating acne, preventing premature aging, rejuvenating the skin and also improving the skin's innate immunity [8].

IV. PROBIOTICS IN SKIN CARE PRODUCTS:

In recent years, numerous products containing probiotics have entered the marketplace; these include naturally fermented and not-fermented food products, dietary supplements, approved pharmaceutical products, cosmetics, hygiene items, and other products, such as household cleaners. Until recently, the beneficial effects of probiotics have been mostly focused on the Gastro Intestinal (GI) system. In the last few years, however, there have been reports on the potential use of probiotics on the skin care products [31, 32].

Studies and clinical trials have been conducted to determine the effect of probiotics and the mechanisms of action in the GI system; these include strengthening and maintaining the intestinal barrier, modulating immune responses, enhancing microbial flora, producing antimicrobial substances, degrading toxins, and resisting pathogen colonization [21]. Most of the probiotics are lactic bacteria belonging to *Lactobacillus* and *Bifidobacterium*, as well as other bacterial genera and yeasts (e.g., *Saccharomyces*) [31].

In the case of psoriasis where dysbiosis (microbial imbalance) was associated with skin inflammation, probiotics have been suggested to restore commonly occurring resident microbes that were diminished when the disorder was present [20]. Other reported benefits to the skin from the ingestion of probiotics include the healing of burns and scars, rejuvenating skin tissues, protection against ultraviolet rays, and improving innate immunity of the skin [31].

The most widely used and recognized probiotics are [33]:

- Enterococcus (typical representative E. faecium);
- Lactobacillus (L. acidophilus, L. casei, L. paracasei);
- Bifidobacterium (B. bifidum, B. longum, B. breve, B. infantis, B. adolescentis).

The probiotics' functions in the human body [34]:

- to maintain the normal macrobiotic balance (both digestive and dermal);
- to produce short-chain acids – acetic, lactic, formic, which can act in peristaltic stimulators assisting the large colon health function with decreasing the environment pH that makes the colon immune against the potential pathogens' growth, such microbes

as coliforms, clostridia etc. (cosmetology application as components of skin tonifying lotions and for pH correction after alkali-containing skin washing products; also used as peeling composition components);

• to lower the potentially risky content of nitrogen in blood;

• to produce the metabolic factors, bacteriocins, immediately inhibiting the pathogenic bacteria vital activity (that reduces the inflammation and skin disease

Industries involved in skin care products have determined the significance of probiotics as "bioactive ingredients" to help enhance the beauty as well as the function of the skin [35,36]. These products range from topical applications (e.g., body lotion, anti-aging serum, soap, aftershave, wipe) to ingestible products (e.g., probiotic drinks) [37,38]. *Lactobacillus* is the most common bacterial genus listed in the ingredients [4]; others with less specific descriptions (e.g., probiotic enzyme, ferment lysate, probiotic proteins) have implied association with some type of beneficial organisms. In a few cases bacterial metabolites (e.g., lactic acid, hyaluronic acid) are listed as ingredients [31].

Safety limits for viable organisms in products other than food are usually very low. For example, the current FDA acceptable limits for total (not pathogenic) microorganisms in cosmetics are 500 colony forming units (cfu) per gram in eye-area products and 1000 cfu/g for other area products [39].

The cosmetic formulas are usually complex containing a number of ingredients, including preservatives to discourage microbial growth. Typically, preservatives having broad-spectrum antimicrobial efficacy are combined with one or more compounds of more selective efficacy in order to deliver a broad antimicrobial effect against a wide range of potential contaminating microorganisms; and at the same time establish some degree of synergic activity [40].

Even if the safety limits are relaxed, concentrating cells and maintaining their long term viability in personal care products pose technical challenges for industries. Because incorporating viable beneficial microorganisms adds complexity to the formulation and manufacturing processes, some cosmetic companies are addressing these issues by taking an alternative approach to probiotics. Instead of live microorganisms, only their "bio-active" molecules or metabolites may be used in cosmetic products. These so called "novel technologies" draw from research on various fermentation-based proteins, filtrates, and lysates that reportedly retain beauty benefits without the presence of whole or live bacteria [41].

Lactobacillus rhamnosus (L. rhamnosus) has been shown to produce lactic acid as the only carbohydrate metabolism product [42,43]. Lactic acid was first manufactured on a commercial scale in the United States in 1883 by lactic acid bacterial fermentation of sugar substrates [44]. Lactic acid bacteria of the genus *Lactobacillus* have been employed in manufacturing lactic acid. A natural organic acid with a long history of application in the food, leather, cosmetic, and pharmaceutical industries [45], lactic acid has also been described as a very effective exfoliating and moisturizing agent [46]. Its application at low concentration (5% v/v) decreases inter corneocyte cohesion and induces skin peeling [47]. Therefore, different concentrations of lactic acid produce different cosmetic results in the epidermis and dermis [48].

The researchers created a cosmetic products line that perfectly moistures the skin together with age-protection, skin nourishment and anti-wrinkles effect due to the presence of lactic acid. Use of these products increases the skin's resistivity to environmental factors; it restores the condition much faster after a continued solar irradiation or peeling and scrubbing. Several cosmetic companies initiated the hair care products with probiotics that enriched hair with vitamins, better clean and replenish its condition with nutrients [49].

Several metabolites of probiotic bacteria demonstrate the antimicrobial features, particularly, *Lactobacillus acidophilus* produces the Acidocin B*; Bifidobacterium sp*. produces the Bacteriocins N5; *Lactobacillus casei* produces the Caseicin; *Enterococcus faecium* – Enterocin A, Enterococcin; *Lactobacillus plantarum* – Plantaricin A and C, Pediocin AcH. Therefore, the probiotics can assist in elimination of harmful, pathogenic microorganisms that involve skin inflammation and diseases [50].

The cosmetic companies develop creams, douche gels, shampoos, and other skin care products on probiotics basis. Most often, such products contain the bacteria DNA fragments, parts of their cell wall, ferments and non-living bacteria [50]. The researches mark a positive effect of lysates of probiotic cultures *Lactobacillus delbreuckii, Lactobacillus rhamnosus, Lactobacillus salivarius, Lactobacillus paracasei, Bacillus subtilis* in the composition of cosmetic products for atopic dermatitis curing. It is noted that the lysates *of Lactobacillus delbreuckii* cultures enabled the atopic dermatitis' progress inhibition [52], and the *Bacillus subtilis* lysates are used to the atopic diseases' prophylactic [51], the *Lactobacillus salivarius, Lactobacillus rhamnosus, Lactobacillus paracasei* lysates were used at the atopic dermatitis therapy [53,54].

The following table represents the properties of the probiotics, and their possible incorporation of lysates in various cosmetic products.

Table no.2: Properties of probiotics and incorporation of their lysates in cosmetic products.

Sr.No.	Probiotics	Properties	Cosmetic Products
1.	***Lactobacillus acidophilus, Lactobacillus bulgaricus*** **lysates** ***and Lactobacillus plantarum***	**Antiacne and antimicrobial properties [50,55]**	**Anti-acne creams, Anti-acne facewash.**
2.	***Lactobacillus delbreuckii and Lactobacillus casei*** **lysates**	**Anti-inflammatory, soothing properties [56].**	**Anti-acne cream, Anti-acne gels, Skin toner.**
3.	***Lactobacillus rhamnosus*** **lysates**	**Prevent skin damage from UV radiation [57]. Lactic acid has also been described as a very effective exfoliating and moisturizing agent [46].**	**Sunscreen creams, lotions and gels, Exfoliating scrubs, Moisturizing creams and lotions.**
4.	***Streptococcus thermophilus***	**Enables skin hydration, rendering an antioxidant effect and pH control [58]**	**Moisturising creams and lotions, Anti-aging creams and serums, Anti-wrinkle creams, Under eye creams.**
5.	***Bifidobacterium longum sp. lysates***	**Showed positive effect for reactive skin at in vivo experiment, decreasing skin sensitivity [59].**	**Skin hydrating gels and serums, soaps.**
6.	***Lactobacillus paracasei***	**Imparts antibacterial properties reducing dandruff [60].**	**Antidandruff shampoos.**
7.	***Streptococcus thermophilus YIT 2084***	**It is capable to produce the hyaluronic acid by itself, this increases skin moisture and reduces the appearance of fine lines and wrinkles [58].**	**Moisturizing creams, serums and Anti-wrinkle creams.**

V. CONCLUSION:

It can be concluded from the article that probiotics will continue to expand in applications and market share, and this exponential growth is not likely to subside. It has been observed that existing cosmetic products and their ingredients make use of viable cultures of probiotics and/or their lysates for their production to maintain good skin health. Also based on the properties of some probiotics or their lysates, their incorporation in certain cosmetics have been proposed in order to achieve more radiant looking skin.

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