ijlpr 2022; doi 10.22376/ijlpr.2023.13.1.SP1.L48-61

International Journal of Life science and Pharma Research

ISSN 2250-0480

Research Article

Probiotic in Cosmetics: A Patents Landscape Study

Narender Yadav[1&*], Gufran Ajmal[1], Mukesh Kumar Kumawat[1], and Anupama Diwan[1]

[1]School of Pharmaceutical Sciences, Apeejay Stya University, Sohna-Palwal Road, Sohna, Gurugram, Haryana-122001.

Abstract: Probiotics, described as "live microorganisms that impart a health benefit on the host," are gaining popularity and are also valuable in the personal care industry. Probiotic are used in various cosmeceutical formulations such as anti-wrinkle, anti-acne, and anti-ageing due to antimicrobial, antioxidant, anti-inflammatory, UV protection, and melanin synthesis inhibitor effects. In this work, a patent trend analysis of probiotic-based cosmetics patents is reported. In the last five years, patent filing has increased manifolds in this area. This study also discusses the inventions shown in the related patents with cosmeceutical compositions and their preparation methods. In conclusion, it has been found that probiotic in cosmetics still have numerous unexplored areas where innovation may flourish. The patent search was conducted using the commercially available CAS SciFinder database and the open-source patent database, The Lens. A total of 928 patents were found for search terms containing "probiotic" and "cosmetic" and retrieved from the database. After the initial screening, 38 patent documents were shortlisted for in-depth analysis. The analysis found that most of the top applicants come from the United States, the Republic of China, and the Republic of Korea, which shows market protection is more important in these countries. These countries lead the patent race in probiotic-based personal care products. The top applicants are related to private companies, universities, and people. The IPC code that has been recorded the most frequently (321 times) is A61K8/99, and it is related to cosmetics or similar toilet preparations from microorganisms other than algae or fungi. The research and development disclosed in most of the patents were focused on exploring or evaluating the mechanism of action of different probiotic strains and their application in skincare and beauty products. The most frequently used probiotic in topical formulations are *Lactobacillus* sp. and *Bafidobacterium sp.* Role of probiotics and mechanism of action for treating skin diseases such as skin whitening, skin moisturization, skin ageing, wrinkles, acne, psoriasis, rosacea, etc.

Keywords: Cosmetics, Probiotics, *Lactobacilli*, *Bifidobacterium*, Skin Microbiome, Probiotic In Cosmetic

***Corresponding Author**

Narender Yadav , School of Pharmaceutical Sciences, Apeejay Stya University, Sohna-Palwal Road, Sohna, Gurugram, Haryana-122001.

Received On 18 October 2022

Revised On 06 December 2022

Accepted On 13 December 2022

Published On 01 January 2023

This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation Narender Yadav, Gufran Ajmal, Mukesh Kumar Kumawat, and Anupama Diwan , Probiotic in Cosmetics: A Patents Landscape Study.(2023).Int. J. Life Sci. Pharma Res.13(1), L48-61 http://dx.doi.org/10.22376/ijlpr.2023.13.1.SP1.L48-61

1. INTRODUCTION

Probiotics are dietary supplements and meals that include live microbes identical to the beneficial microorganisms in the digestive tract and on the skin of a human. Maximum probiotics have microorganisms comparable to those found in the intestines naturally. In addition to being essential to human health, commensal bacteria maintain a healthy immune system.[1] These microorganisms perform various functions, including treating anxiety, depression, obesity, antidiabetic, arthritis, diabetes, Parkinson's disease, cancer, and other conditions.[2-3] Different types of microorganisms are present on the skin. An imbalance of these may cause various skin-related problems such as acne, wrinkles, atopic dermatitis, dryness, early ageing, psoriasis, skin whitening and rosacea.[4,5]In recent years, and the probiotics industry has expanded significantly due to the growing market of beneficial microorganisms in healthcare. The probiotic market in cosmetics is predicted to expand by 12% over the next ten years. Probiotics are made using many different microorganisms like *Lactobacillus acidophilus, Lactobacillus lactis, Bafidobacterium bifidum, Bafidobacterium thermophilum, Bacillus coagulans, Streptococcus thermophilus, Enterococcus faecium and Sacharomyces cerevisiae* (Figure 1).[6-8]In particular, *Lactobacillus*, *Bifidobacterium*, and *Streptococcus* have received a lot of attention. Therefore, these are extensively used and researched. Currently, the key market for probiotics-based cosmetics is in North America.[9] Two major North American cosmetics merchants, Ulta Beauty and Sephora, have at least fifty items claiming to contain probiotics.[10,11] Most are for skin care, but some are for deodorants and hair care products. All these products claim many things, but the most commonly used claim is "balancing" the skin microbiome, improving the skin barrier, and improving the skin's appearance.

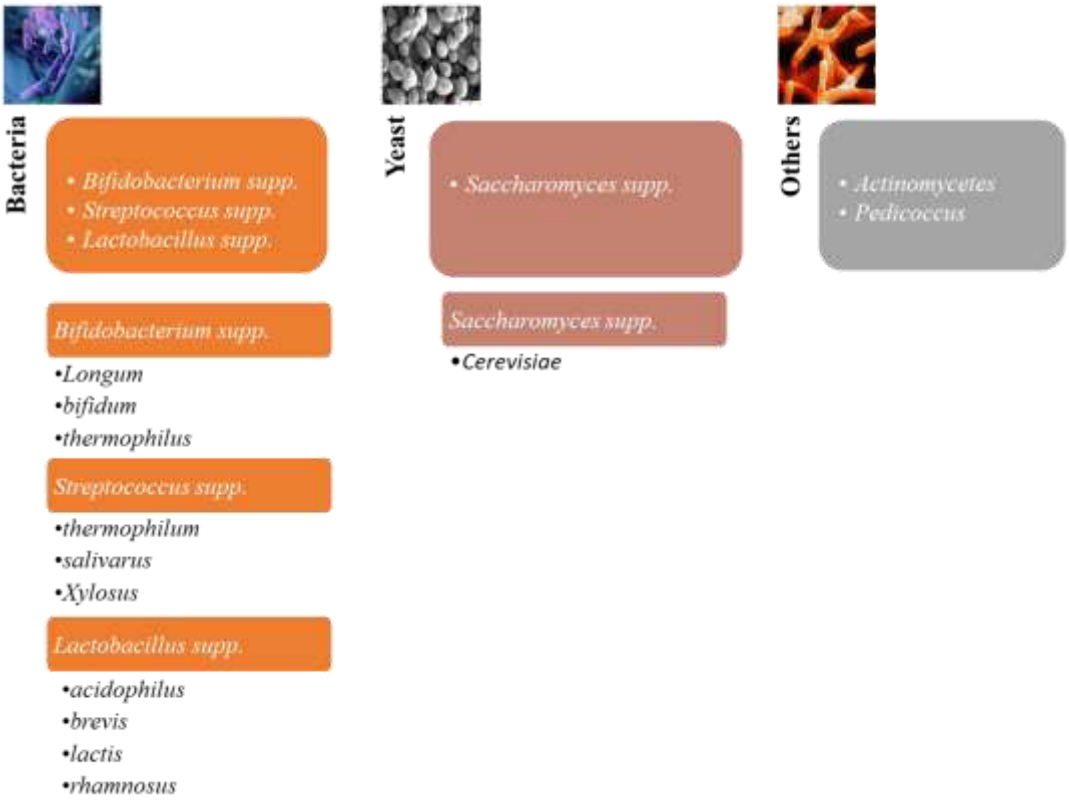


Fig 1: Various probiotics used in cosmeceuticals.

Probiotic-containing formulations are used as food material, cosmetics, anti-acne, anti-wrinkle, anti-ageing, antimicrobial, antidiabetic, arthritis, etc.[12,13] Probiotic-based products are also studied in depression, diabetes, Parkinson's, cancer, etc.[14] About two decades earlier, probiotics, prebiotics and microbiome are not familiar terms for cosmetic industries. But, as a result of the extensive research on specific types of microorganisms to validate their various health benefits on the host. Multiple sectors have utilized these results effectively, and the personal care industry is one of the prominent in this domain. It creates a new area to develop new products in this domain that may boost the company's revenue in future. A range of probiotics containing personal care products like skin care, hair care, beauty products, deodorants, face mask, primers, etc., are marketed worldwide, as shown in Figures 2.[15,16]. Cosmetic formulations include creams, deodorants, primers, balms, soap bars, gels, skin cleansers, serums, foundation creams, moisturizers, toners, body wash, etc., are examples of probiotic-based cosmetics that are now available in the market. Different types of microorganisms present in various commercially available personal care products are listed in Figure 2.

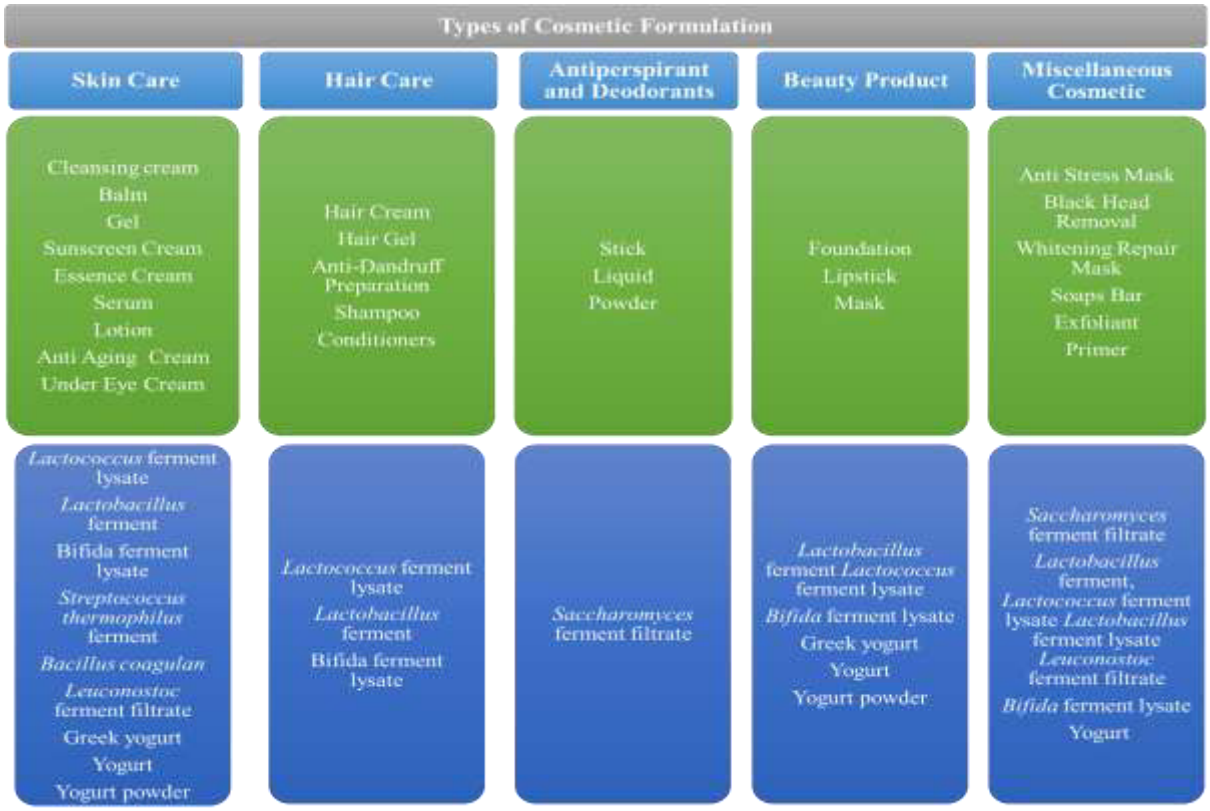


Fig 2: List of probiotic presents in a variety of commercially available skincare Products.

The aim of the study is to present a patent landscape analysis to give an overview of the uses of probiotics for cosmetic and cosmeceutical applications for the prevention and treatment of various skin-related disorders. This study also highlights the recent trends of probiotic application in cosmetics—the study describing probiotic-based cosmetics patented between 2000 and 2022. The study's objective is to present a detailed qualitative and quantitative analysis of retrieved patent documents. For quantitative analysis, detailed charts based on year-wise publication, patent technical characteristics using IPC classifications, inventors, applicants, geographical and jurisdictions are presented with technical insights. In addition, screening of extracted patent documents is done to find relevant patents. Further, qualitative analysis was done for relevant granted patents and patent applications demonstrating various cosmetic formulations' preparation methods. The study will give an idea about the prospects of probiotic use in personal care products.

2. MATERIALS AND METHODS

2.1 Research Methods and Resources Used

The patent search was conducted using two databases. One is CAS SciFinder, which is commercially available. The second is The Lens, an open-source patent database.[17] Patent documents were searched in title, abstract, and claims using keywords related to probiotics and cosmetics. There were 928 patents retrieved for search keywords containing "probiotic" and "cosmetic". The search results were then narrowed down to patent publications between January 1, 2000, and March 1, 2022.

2.2 *Patentability Analysis of Probiotic-Based Cosmetics*

Nine hundred twenty-eight patent documents (471 Simple INPADOC Family) were identified as a result of the search. This typically included patent applications and granted patents. Considering cosmetics containing probiotics, the retrieved patent documents include 720 patent applications and 208 granted patents. Following this, a review of the current state of the art will be presented, beginning with an overview of probiotic-based cosmetics that have been patented. A comprehensive study of patentability will be presented, with an emphasis on probiotics used in cosmetic formulations. Further, detailed charts based on publication year, patent classifications, inventors, applicants, and jurisdictions are also presented with clear insight.

3. RESULTS AND DISCUSSION

3.1 *Application, Publication, Granted Patents Year-Based Trend Analysis*

The year a patent application was first published and made available to the general public is referred to as the "publication year".[18] Between 2000 and 2022, we found 928 patent documents relevant to probiotic-based cosmetics. There were 720 patent applications and 208 granted patents found in the results. Our search found a single registered patent document for the year 2000. On the other hand, the highest number of patent documents (88) was recorded in the year 2021. In 2020, the highest number of awarded patents (22) was reported. Moreover, 2020 recorded the highest number of patent applications and granted patents, with 88 and 22, respectively (Figure 3).

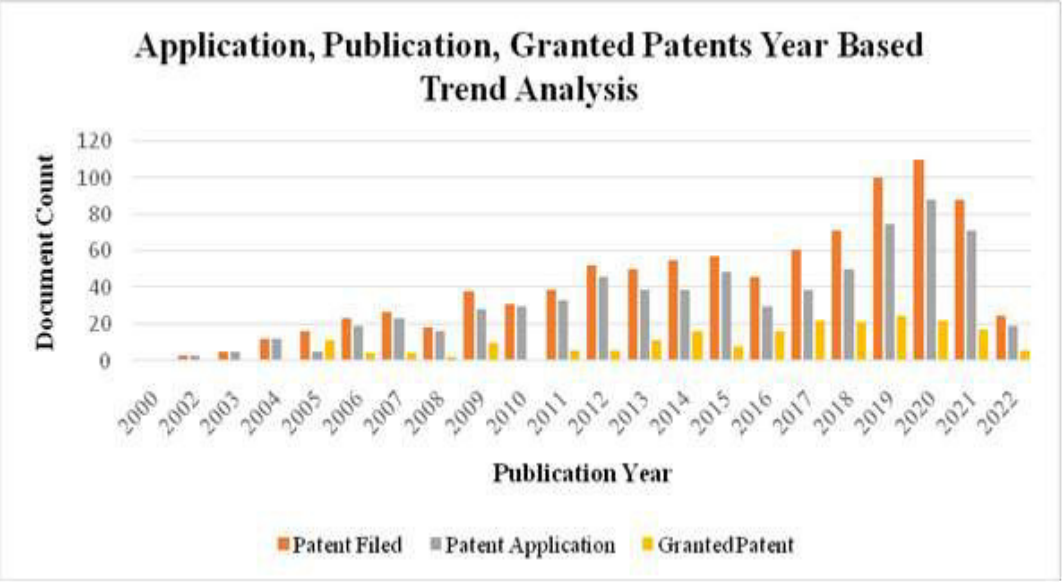


Fig 3: Application, Publication, Granted Patents Year Based Trend Analysis between 2000 and 2022.

3.2 International Patent Classification-Based Trend Analysis

The International Patent Classification (IPC) is a global hierarchical system based on codes that provide standard data for classifying inventions and evaluating their technological variations. The IPC classification is accepted worldwide.[19,20] Figure 4 shows the top 20 IPC codes for probiotic-based cosmetics between 2000 and 2022. The IPC code recorded the most frequently is A61K8/99. It is a subgroup of cosmetics or similar toilet preparations from microorganisms other than algae or fungi, e.g. protozoa or bacteria. This subgroup recorded the highest number of patent documents (321). A61Q19/00 and A61K35/74 are the second- and third-most-recorded IPC codes. A61Q19/00 is a group of preparations for skin care. A61K35/74 is concerned with the therapeutic use of a bacterial protein. These groups have 281 and 215 recorded patent documents. For more details concerning these top 20, a description of each IPC code is shown in Table 1.

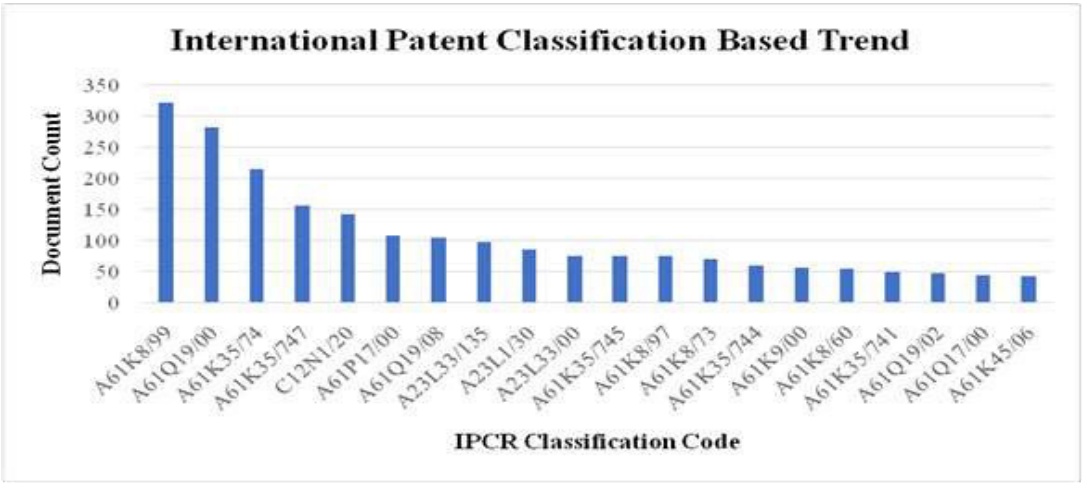


Fig 4: International Patent Classification (IPC) (Top 20) Based Trend between 2000 and 2022.

Table 1: Meaning of IPC codes concerning the resultant patents of probiotic-based cosmetics.[20]

IPC code	Description
A61K8/99	Cosmetics or similar toilet preparations from microorganisms other than algae or fungi, e.g. protozoa or bacteria
A61Q19/00	Preparations for care of the skin
A61K35/74	Therapeutic use of a bacterial protein
A61K35/747	Cover strains of *Lactobacilli*, e.g. *L. acidophilus* or *L. Brevis*
C12N1/20	Related to the preparation of bacteria culture media
A61P17/00	Drugs for dermatological disorders

A61Q19/08	Topical preparations for affording protection against sunlight or other radiation; Topical sun tanning preparations
A23L33/135	Bacteria or derivatives thereof, e.g. probiotics
A23L1/30	Foods, foodstuffs, or non-alcoholic beverages, not covered by subclasses or; their preparation or treatment, e.g. Cooking, modification of nutritional qualities, physical therapy; preservation of foods or foodstuffs, in general, containing additives
A23L33/00	Modifying nutritive qualities of foods; Dietetic products; Preparation or treatment thereof
A61K35/745	Medicinal preparations containing materials or reaction products thereof with *Bifidobacteria*
A61K8/97	Cosmetics or similar toilet preparations algae, fungi, lichens or plants; from derivatives thereof
A61K8/73	Cosmetics or similar toilet preparations containing polysaccharides
A61K35/744	Medicinal preparations containing materials or reaction products from Lactic acid bacteria, e.g. *enterococci*, *pneumococci*, *lactococci*, *streptococci* or *leuconostocs*
A61K9/00	Medicinal preparations characterized by special physical form
A61K8/60	Cosmetics or similar toilet preparations containing sugars, Derivatives thereof
A61K35/741	Medicinal preparations containing materials or reaction products from Probiotics (probiotic yeast, e.g. *saccharomyces*)
A61Q19/02	Preparations for care of the skin for chemically bleaching or whitening the skin
A61Q17/00	Barrier preparations; Preparations brought into direct contact with the skin for affording protection against external influences, e.g. sunlight, X-rays or other harmful rays, corrosive materials, bacteria or insect stings
A61K45/06	Mixtures of active ingredients without chemical characterization, e.g. antiphlogistics and cardiac

3.3 Inventors-Based Trend Analysis

An inventor is an individual named in a patent application which discovers the technology.[18] Figure 5 shows the top 20 inventors who came up with probiotic-based cosmetics between 2000 and 2022. Gueniche A. from France is ranked as the first inventor to record 80 patent documents. The inventor Castiel I. from France, for second place with 57 patent documents. The inventors Breton L., Dionisi F. and Guitard M. from France and Switzerland tied for third place with 24 patent documents each. All of the patents found by the above five inventors are for healthcare companies L'Oréal SA (Paris, France) and Nestec SA (Vevey, Switzerland) (Figure 6). L'Oréal S.A. is one of the largest beauty companies in the world. The company's main products include makeup (lipstick, mascara, foundation, eye shadow, nail polish, face powder, etc.), skincare, hair care, and body-care products.[21] Nestec SA is a multinational company that makes and sells a wide range of packaged food items. The company produces food products like milk, chocolate, candy, bottled water, coffee, creamer, food seasonings, and food for pets. It also makes dietetic products, diets, and pharmaceutical specialities, especially in Nestlé products.[22]

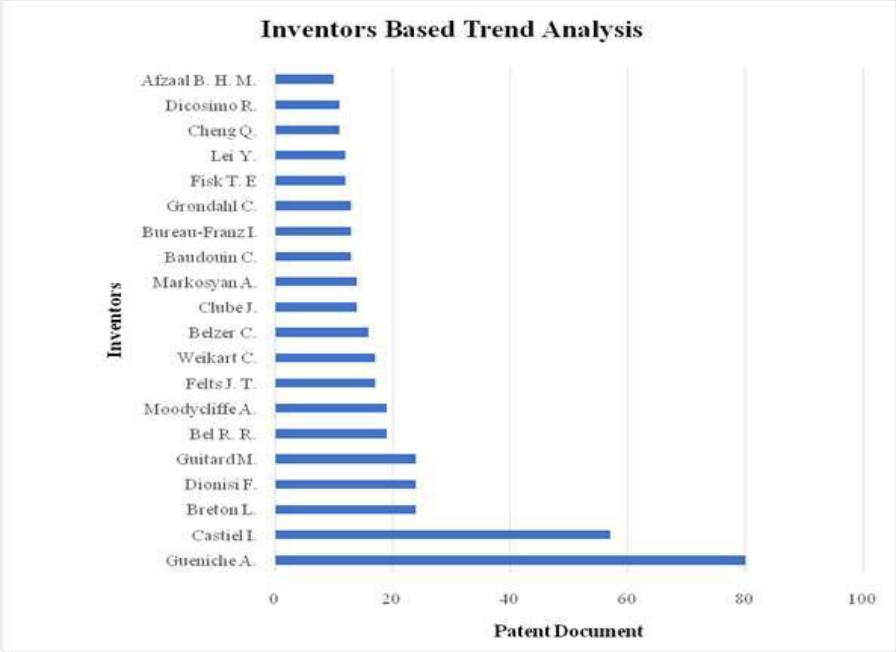


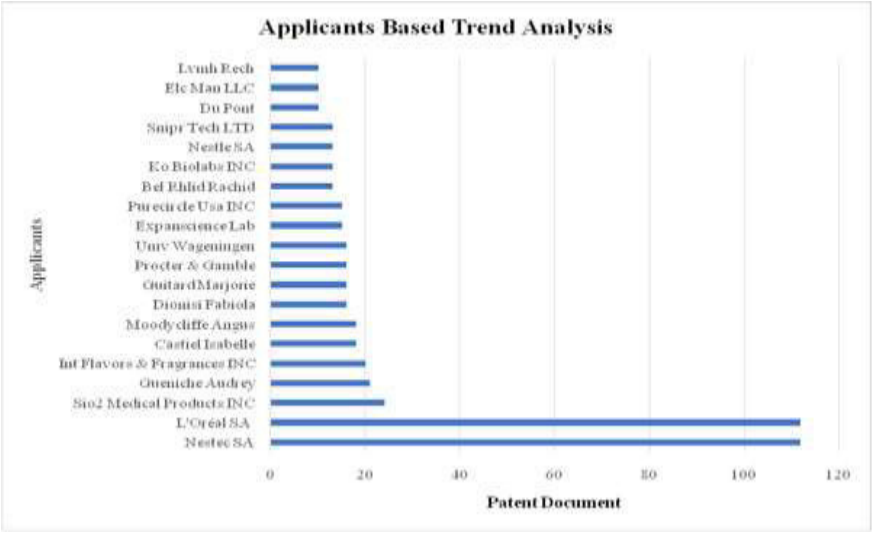
Fig 5: Inventors Based Trend Analysis for the top 20 inventors between 2000 and 2022.

3.4 Applicants-Based Trend Analysis

An applicant is, in the context of patent applications, the individual/organization/ legal entity that has applied.[18]

Regarding probiotics in cosmetics, the top 20 applicants between 2000 and 2022 in terms of the number of patent families are presented in Figure 4 and Table 2. Most of the top applicants come from the United States, Switzerland and

France, which shows that market protection is more critical in these two countries. The top applicants come from private companies, universities, and people. Amongst the top twenty applicants, twelve are from the United States alone, which implies that the US pays more attention to international patent portfolio strategy in this field. The top assignees among companies possessed a few patent families except a few, e.g. L'Oréal SA (France), but they have many patent documents. And six are individual persons that indicate researchers as an individual also contribute equally to probiotic research. Figure 6 illustrates 20 applicants for probiotic-based cosmetics from 2000 to 2022. Regarding the top 20, all candidates are considered, be they individuals or organizations (companies and universities). Nestec SA (Vevey, Switzerland), a health care company, and L'Oréal SA (Paris, France), a personal care company, are tied for being the first applicant with 112 patent documents.



By contrast, representative players of academic institutions from India have a small patent family size, which implies that India pays less attention to international patent portfolio strategy.

Fig 6: Applicants Based Trend Analysis for the top 20 applicants between 2000 and 2022.

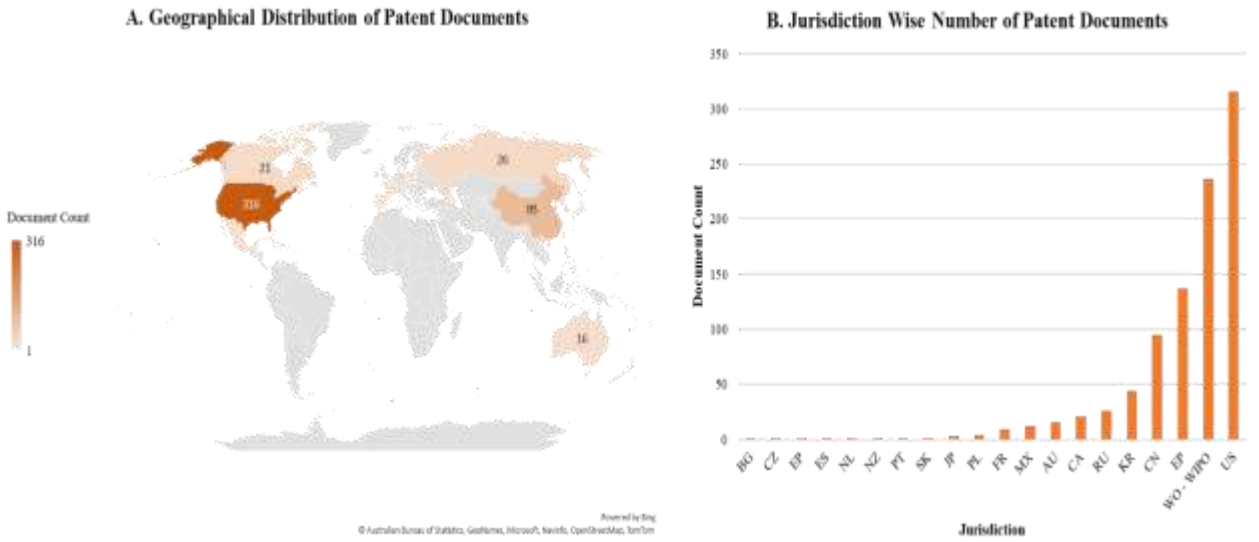
Table 2. Top assignees for probiotic cosmetics.

Rank	Assignee	Patent Documents	Patent Family	Average Number of Patents per family	Assignee Type
1	Nestec SA (Switzerland)	112	32	3.5	C
2	L'Oréal SA (France)	112	52	2.2	C
3	Sio2 Medical Products INC (US)	24	11	2.2	C
4	Gueniche Audrey (US)	21	4	5.3	I
5	Int Flavors & Fragrances INC (US)	20	10	2.0	C
6	Castiel Isabelle (US)	18	4	4.5	I
7	Moodycliffe Angus (US)	18	4	4.5	I
8	Dionisi Fabiola (US)	16	3	5.3	I
9	Guitard Marjorie (US)	16	3	5.3	I
10	Procter & Gamble (US)	16	4	4.0	C
11	Wageningen University & Research (Netherlands)	16	4	4.0	A&G
12	Expanscience Lab (France)	15	6	2.5	C
13	Purecircle USA INC (US)	15	10	1.5	C
14	Bel Rhlid Rachid (US)	13	1	13.0	I
15	Ko Biolabs INC (South Korea)	13	2	6.5	C
16	Nestle SA (Switzerland)	13	8	1.6	C
17	Sniper Tech LTD (Scotland)	13	1	13.0	C
18	Du Pont (US)	10	4	2.5	C
19	Elc Man LLC (US)	10	2	5.0	C
20	Lvmh Rech (France)	10	5	2.0	C

Abbreviations: I: Individual; C: Company; A&G: Academia and Government; PPP: Public-Private Partnership. The average number of patents per family = the number of patent documents / the number of patent families

3.5 *Jurisdictions-Based Trend Analysis*

A patent application can be submitted to the appropriate patent office within the jurisdiction of which the applicant typically resides, has his domicile, or maintains a place of business; alternatively, it can be submitted to the office in the location from which the invention was conceived. Depending on the case, related patent applications may be presented in several different jurisdictions.[23,24] We then analyzed the nationalities of patent inventors. We looked at the inventors rather than the applications to trace the locus of knowledge production, a common approach in innovation studies. As shown in Figure 7, countries with the most inventors include the United States (316 patents), EPO (European Patent Office (137 patents), The Republic of China (95 patents), The Republic of Korea (44 patents) and Canada (21 patents).



The colour intensity denotes the frequency of patent families. B. Geographic distribution by nationalities of jurisdictions (based on patent documents).

Fig 7: A. Geographic distribution by nationalities of patent inventors.

Figure 8 shows the top 20 jurisdictions in terms of probiotic-based cosmetics between the years 2000 and 2022. The highest number of patent documents counts 316 filled in through the USPTO (the United States Patent and Trademark Office) with a total contribution of ~34%. The second highest number of patent documents counts 237 filled in through a global system known as the Patent Cooperation Treaty (PCT) and administered by WIPO with a contribution of ~25%. The EPO (European Patent Office), through which patent applications are filed regionally (Europe), encompassed 137 patent documents with the contribution of ~15%; The Republic of China, through the CNIPA (China National Intellectual Property Administration), encompassed 95 patent documents with the assistance of ~10%; finally, The Republic of Korea, KIPRIS (Korea Intellectual Property Rights Information Service) encompassed 44 patent documents with the contribution of ~4%. The chart also demonstrates that patent filed through the USPTO is maximum throughout the years, followed by WIPO, EPO, CNIPA and KIPRIS. The geographical distribution of patent year-wise application filings shown in Figure 7 also indicates a vast surge in a patent filing in the probiotic-based cosmetics domain. That means probiotic-based cosmetics formulations may have excellent commercialization value in the coming years.

Jurisdiction→ Publication Year ↓	AU	BG	CA	CN	CZ	EA	EP	ES	FR	JP	KR	MX	NL	NZ	PL	PT	Ru	SK	US	WO	Grand Total
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	3
2003	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	2	5
2004	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	5	5	12
2005	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	8	0	2	3	16
2006	0	1	0	0	0	0	3	0	1	0	0	0	0	0	0	0	3	0	6	9	23
2007	0	0	1	0	0	0	3	0	0	0	2	1	0	0	0	0	2	0	9	9	27
2008	0	0	1	4	0	0	4	0	0	0	0	1	0	0	0	0	1	0	3	4	18
2009	0	0	1	1	0	0	4	0	2	0	2	1	0	0	0	0	7	0	14	6	38
2010	0	0	0	2	0	0	4	0	2	0	0	1	0	0	0	0	0	0	11	11	31
2011	2	0	1	3	0	0	7	0	2	0	0	0	0	0	0	0	0	0	14	10	39
2012	1	0	1	1	0	0	5	0	1	0	1	0	0	0	0	0	0	0	16	26	52
2013	3	0	2	4	1	0	6	0	0	0	1	1	0	0	1	0	0	0	21	10	50
2014	1	0	2	1	0	0	9	0	0	0	6	0	0	0	0	0	1	0	19	14	55
2015	1	0	0	7	0	0	7	0	0	1	2	1	0	0	3	0	0	0	25	10	57
2016	0	0	1	10	0	0	10	0	0	0	4	0	0	0	0	0	1	0	14	6	46
2017	1	0	3	5	0	0	10	0	0	1	1	0	0	0	0	0	0	0	28	12	61
2018	2	0	1	5	0	0	11	1	0	1	3	1	1	1	0	1	2	0	25	14	71
2019	1	0	3	11	0	0	12	0	0	0	8	5	0	0	0	0	0	0	24	14	100
2020	2	0	3	14	0	0	10	0	0	0	8	0	0	0	0	0	0	1	29	14	110
2021	0	0	0	22	0	0	12	0	0	0	2	0	0	0	0	0	1	0	39	12	88
2022	2	0	1	1	0	0	4	0	0	0	1	0	0	0	0	0	0	0	10	4	25
Grand Total	16	1	21	95	1	1	137	1	9	3	44	12	1	1	4	1	26	1	316	237	928

Fig 8: Jurisdictions-Based Trend Analysis for the top 20 jurisdictions between 2000 and 2022.

3.6 Scientific Implications

An analysis of patent documents discloses *in-vivo* and *in-vitro* studies on experimental animals and humans to investigate the effect of various probiotics-based cosmetic formulations in maintaining microbial balance in skin-related diseases. Different probiotics that have shown therapeutic benefits in treating a wide range of skin diseases are shown in Figure 9. Due to the wide application of probiotics in the maintenance of skin health, recent years have seen an increase in cosmetic formulations with microorganisms. Various probiotic-containing skin care products are available worldwide. There are several potential uses for probiotics in treating skin-related illnesses; thus, suitable labelling and marketing regulations are necessary. Almost all topical formulations containing probiotics have not yet expanded beyond the category of personal care products. In addition, these topical care products are non-sterile. They may include antimicrobial preservatives that may impact the survival of probiotic strains and further modify the microbiota of an already ill host. Therefore, the first focus of probiotics regulation must be safety. There are currently no criteria for the commercialization of probiotics; instead, items are controlled based on their intended purpose as medication, medical device, food, dietary supplement, or cosmetic. Products made with probiotics that claim to be good for your health could be called pharmaceuticals or medicines. It will be regarded as a medical device if the product includes non-viable microorganisms. Probiotic-based cosmetics products are a new concept, and there is little clinical evidence of their effectiveness and safety. In addition, the clear distinction between foods, pharmaceuticals, and cosmetics complicates the development and disclosure of probiotic cosmetic products.

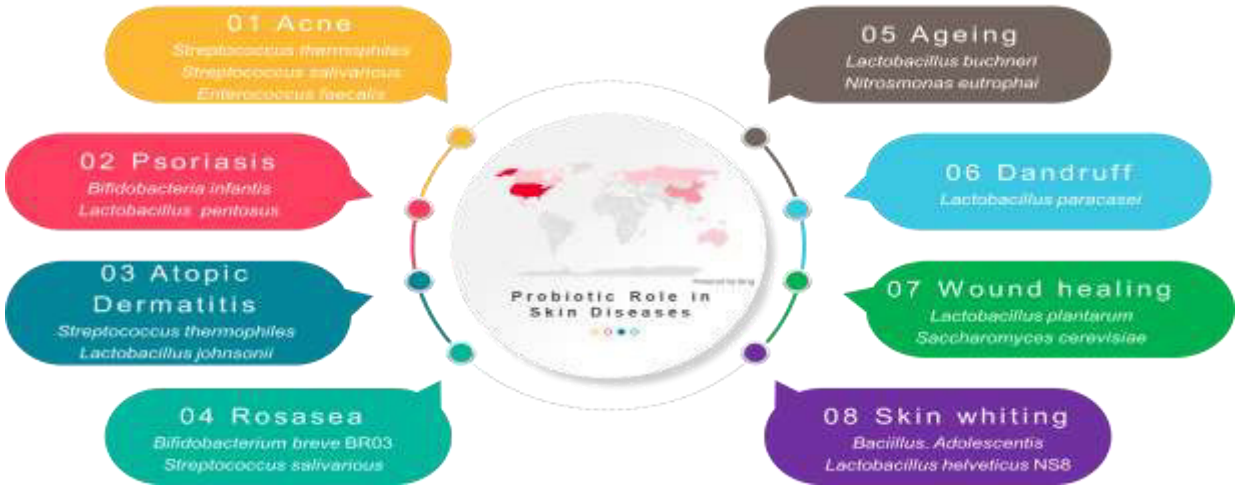


Fig 9: Role of probiotic for the treatment of skin diseases.

3.7 Analysis of Relevant Patents

The topical use of cosmetics containing probiotics is a novel technique for treating skin disorders. Numerous varieties of probiotics are employed in the production of skin care products; they serve an essential function in cosmetics. Multiple innovative probiotic-based cosmetic patents have flooded the personal care market due to the exceptional research results and registrations of countless probiotic strains. The study of probiotic compositions in patented personal care products can provide a comprehensive understanding of its current application. In this work, a patent trend analysis for probiotic-based cosmetic formulations is reported. Table 3 presents examples of innovation and application of probiotics in cosmetic formulation as disclosed in most cited patents. To clarify the actual status of these patents in this area, the ones listed here are the most important ones that focus on probiotic-based cosmetic compositions from 2000 to 2022. The selection of these relevant patent documents was based on the countries that patent probiotic-based cosmetics the most and the patenting rates in those countries. Most relevant patents are discussed in detail. Berkes E. A. *et al.* invented materials and procedures for treating disorders caused by pathogenic biofilm. The patent also discloses anti-biofilm formulations containing probiotics and honey as antimicrobial agents. Other prebiotics such as green tea-derived compounds, vitamin D3, hive products, etc.[25] O'Neill C. *et al.* invented a probiotic bacteria lysate derived from a strain of *Lactobacillus rhamnosus*, *Lactobacillus reuteri*, or *Bifidobacterium longum*, and the lysate that can be applied to the skin of the subject for regeneration and repair of the skin barrier.[26] Leser T. D. *et al.*, describe probiotic bacteria that modulate satiety markers in the GIT and minimize fat deposition to achieve healthy body weight. The patent further discloses a composition containing such a probiotic strain of bacteria and the preparation of a composition to be administered to a mammal to promote optimal body weight.[27] Breton L., *et al.*, invented a skin care topical composition that helps prevent or treat skin problems such as sensitivity and dryness. Composition for the skin with at least one probiotic microorganism and at least one polyunsaturated fatty acid or derivatives in a physiologically-acceptable vehicle.[28,29] Dondi G., *et al.*, invented probiotic bacteria (*L. crispatus P17631*) to protect the skin against pathogenic microorganisms. The patent also discloses topical compositions containing such bacteria for the treatment of skin illnesses, particularly recurrent infections, such as atopic dermatitis, Pityriasis Versicolor, dandruff, etc.[30] Patron A. P., *et al.*, invented the formulation that is composed of probiotics with cooling agents, and their substance such as corticosteroids, antimicrobials, etc. and compounds commonly used in the preparation of personal care and pet

care products.[31] Bockmuhl D., *et al.*, invented substances with a probiotic action used in deodorants. The patent document also discloses a method for promoting probiotic activity on the skin using plant extracts like tea extract.[32] Pridmore Raymond-David., *et al.*, invented probiotic bacteria strain deficient in D-lactic acid production. The patent discloses natural derivatives of the well-known probiotic *Lactobacillus johnsonii* CNCM I-1225 that have this property.[33,34] Giuliani G., *et al.*, invented *Lactobacillus rhamnosus* probiotic strain and its nutritional, aesthetic, and medicinal applications. The *Lactobacillus rhamnosus* strain of the invention possesses anti-inflammatory properties. It is an application for treating skin conditions like inflammation and allergic infections, such as eczema, acne, seborrheic, and atopic dermatitis, and the treatment of sensitive skin.[35] Dejmek P., *et al.*, invented particle-stabilized emulsion or foam containing starch granules. This particle-stabilized emulsion or foam encapsulates biopharmaceuticals, proteins, probiotics, enzymes, etc., in food products, cosmetic products, skin creams, and pharmaceutical formulations.[36] Matar C., *et al.*, invented bacterial strains obtained from *Vaccinium angustifolium*, which can enhance the antioxidant content of culture media. In addition, the antioxidant-rich mixture may be used for cosmetics and dietary supplement formulation.[37]

Table 3. Most cited patents mentioning probiotic and cosmetics between 2000 and 2022.

S. No.	Publication number	Title	Assignees	Inventors	Publication Date	Citations
1	WO2012118535A1	Materials and methods for treating conditions associated with pathogenic biofilm	Quorum Innovations LLC	Berkes E. A., Monsul N. T.	07-09-2012	71
2	EP3888628A1	Cosmetic use of a probiotic bacteria lysate	Skinbiotherapeutics PLC	O'Neill C., Mcbain A.	06-10-2021	69
3	WO2010108950A1	Use of a probiotic to regulate body weight	CHR Hansen AS	Leser T. D., Gunnarsson T., Kildsgaard J., Pedersen J. W., F. B.	30-09-2010	48
4	US20090232785A1	Cosmetic and dermatological composition for prevention and treatment of sensitive or dry skin	L'Oréal, Nestec SA	Breton L., Jourdain R., Gueniche A., Bureau-Franz I., Fleith M., Malnoe A.	17-09-2009	43
5	WO2006013441A2	Use of probiotic bacteria for the preparation of topical compositions for skin protection	Page Farm SRL	Dondi G., Malfa P.	09-02-2006	42
6	US20170087199A1	Compositions for delivering a cooling sensation	Senomyx INC	Patron A. P., Ditschun T.	30-03-2017	42
7	WO2006000992A1	Method and compositions helpful in preventing and treating sensitive and dry skin	L'Oréal, Nestec SA	Breton L., Jourdain R., Gueniche A., Bureau-Franz I., Blum-Sperisen S.	05-01-2006	41
8	US20070190004A1	Substances with a probiotic action used in deodorants	An assignee is a natural person	Bockmuhl D., Hohne Heide-Marie, Jassoy C., Scholtyssek R., Banowski B., Wadle A., Sattler A., Breves R., Nieveler S.	16-08-2007	34
9	WO2012130965A1	A natural derivative of a well-known and successful probiotic strain deficient in D-lactic acid production	Nestec SA	Pridmore Raymond-David, Foata F., Delley M., Jankovic I.	04-10-2012	32
10	WO2012022773A1	Probiotic composition for oral health	AB Biotics SA	Cune C. J.	23-02-2012	29
11	WO2011029784A1	Probiotic *Lactobacillus rhamnosus* strain and oral and topical uses thereof	Giuliani SPA	Giuliani G., Benedusi A., Mascolo A.	17-03-2011	28
12	WO2012082065A1	New particle-stabilized emulsions and foams	Specimen AB	Dejmek P., Timgren A., Sjoeoe M., Rayner M.	21-06-2012	27

13	WO2004101770A1	Antioxidant-producing bacterium and uses thereof	Univ Moncton Bureau De Soutien	Matar C., Martin L. J.	25-11-2004	25
14	WO2006048457A1	Probiotics and polyphenol	DSM IP Assets BV	Henriksson K. A. O.	11-05-2006	19
15	US8679786B2	Copper-enriched biomass, a method for the preparation thereof and pro-biotic, cosmetic, dietary and nutraceuticproducts comprising the same	Bioman SRL	Manzoni M., Rollini M. S., Benedetti A.	25-03-2014	19
16	WO 2012/062895 A1	Extruded non-replicating probiotic micro-organisms and their health benefits	Nestec SA	Mercenier A., Wermeille A., Demont A., Prioult G.	18-05-2012	18
17	EP2149368A1	Cosmetic and dermatological use of probiotic *Lactobacillus paracasei* microorganisms for the treatment of greasy scalp disorders	L'Oréal, Nestec SA	Castiel I., Gueniche A.	03-02-2010	18
18	WO2012104025A2	Balneotherapeutic lipid-containing probiotic preparations and their applications	Merz Pharma GMBH& Co KGAA	Ebinger J., Holzem M.	09-08-2012	17
19	CN101254163A	Beauty treatment health care combination containing traditional Chinese herbs effective ingredient microorganism product	An assignee is a natural person*	Hengming C., Hongyan S., Jianzhong L.	03-09-2008	16
20	WO20090311O6A2	Use of a combination of hesperidin and a microorganism to influence the barrier function of the skin	L'Oréal, Nestec SA	Gueniche A., Castiel I.	12-03-2009	15
21	WO2010020639A1	Arabinoxylans for modulating the barrier function of the intestinal surface	Bioactor BVBA	Ekhart P. F., Van Der S. H., Possemiers S., Van Den A. P., Van De W. T.	25-02-2010	15
22	US20150202136A1	Topical use of a skin-commensal prebiotic agent and compositions containing the same	Procter & Gamble	Lanzalaco A. C., Charbonneau D. L., Howard B. W.	23-07-2015	15
23	EP2364712A1	A topical cosmetic or pharmaceutical composition comprising probiotic *Lactobacillus* strains and the use of the same	Kloarys Investment Ltd, Kloarys Development	Lopes A., Lheritier A. M., Mielcarek C., Malard P.	14-09-2011	15
24	CN105231444A	Meal replacement combined enzyme and preparation method thereof	Qingdao Guohai Biological Pharmaceutical Co. Ltd	Zuo S., Sun X., Zhu Y.	13-01-2016	15
25	US20090022700A1	Cosmetic water-soluble film	L'Oréal	Cassin G., Simonnet Jean-Thierry	22-01-2009	14
26	WO2018083212A1	Microbiome-safe cosmetic cleaning compositions	Yun NV, Univ Antwerpen	Henkens T., Kiekens F., Lebeer S., Claes I.	11-05-2018	13
27	WO2017191093A1	Method for coating microorganisms,	Lacto Res SPRL	Timmermans S., Fonteyn F., Thonart P.	09-11-2017	13

		powder of said coated microorganisms, and pharmaceutical, nutraceutical, cosmetic, food or sanitary composition comprising said powder				
28	US 8465731B2	Probiotic colour cosmetic compositions and methods	ELC Man LLC	Dao K. N., Mercado C. G., Logalbo J. F.	18-06-2013	13
29	US2010/0226892A1	Use of probiotic microorganisms to limit skin irritation	L'Oréal, Nestec SA	Gueniche A.	09-09-2010	13
30	CN103461982A	Special diet for people in need of acne removal	Zhejiang Healing Health Science Co Ltd	Hu A., Wang H., Xia M., Jiang L., Xia D.	25-12-2013	13
31	US2003/0219456A1	Method of the utilization of *Zygosaccharomyces rouxii*	Ok Taing	Ok T.	27-11-2003	12
32	WO2013188626A2	Probiotic-containing particles have improved probiotic stability when in aqueous formulations.	Dow Global Technologies LLC	Hong L., Madduri K., Pressler K., Tucker C. J., Woelfle-Gupta C.	19-12-2013	11
33	US20110182861A1	Cosmetic use of microorganisms for the treatment of oily skin	An assignee is a natural person*	Castiel I., Gueniche A.	28-07-2011	11
34	US20130089524A1	L. johnsonii LA1, B. Longum NCC2705 and immune disorders	Nestec SA	Petit V., Garcia-Rodenas C. L., Julita M.	11-04-2013	11
35	EP1840205A1	*Bifidobacterium lactis 668*strain is used as a component for food products, starters, and medicinal and cosmetic agents.	Wimm Bill Dann JSC	Vustina T. F., Perminov Sergey I., Mozgovaya I. N.	03-10-2007	11
36	CN110384650A	Probiotic composition for skin moisturizing and barrier protection and application of probiotic composition in cosmetics	Hubei Maishite Biotechnology Co Ltd	Zheng T., Zhou Z., Guo M., Zhang J., He K.	29-10-2019	11
37	CN108653059A	Method for preparing seaweed fermentation solution by probiotics fermentation and application of seaweed fermentation solution in cosmetics	Shandong Furida Biological Co. Ltd.	Wang T., Zhao L., Li K., Liang Y., Yue Q.	16-10-2018	10
38	CN104257598A	Chinese wolfberry fermented raw stock cosmetic and preparation method thereof	Hanghai Dai Cosmetics Instrument Ltd, Beijing Technology and Business University	Li M., Wang C., Lin A., Fang X., Wang D., Fang X.	07-01-2015	10

Castiel I., *et al*., disclosed the application of probiotics to prevent or treat scalp disorders like dandruff. [38] Castiel I. *et al.* also discussed the practical application of probiotics in cosmetic formulation to treat or prevent skin-related disorders like oily skin and associated symptoms.[39] Gueniche A. *et al.* invented the cosmetic use of a composition containing hesperidin and probiotics for the regeneration of the skin barrier.[40] In 2010, Gueniche A. *et al.* also disclosed the effective application of probiotics, *Lactobacillus sp*. and *Bifido bacterium sp*., in a cosmetic formulation as an active agent for the prevention and treatment of skin disorders like irritation and related symptoms.[41] Lanzalaco A. C. *et al.* disclosed The use of skin prebiotics to enhance the health of the skin microbes for skin care. It's potentially improving the condition, like the appearance of the skin. The patent document also discloses topical cosmetic compositions, including the skin commensal

prebiotic.[42] Lopes A. *et al.* invented a topical composition containing *lactobacillus* strain that is suitable for treating or preventing skin or mucosal infectious disorders. The topical composition is particularly used for treating or preventing urinary tract infections and lower vaginal tract infections in females.[43] Cassin G. *et al.* invented a cosmetic water-soluble anhydrous film containing probiotic microorganisms.[44] Henkens T. *et al.* invented microbiome-safe cosmetic cleaning soaps for preserving the natural microflora of the human or animal skin/vagina. It was found that soap has typical characteristics without negative effects on the natural microflora of the skin/vagin.[45] Dao K. N. *et al.* invented a probiotic colour cosmetic composition containing one extract from a probiotic microorganism (*Lactobacillus*). The disclosed colour cosmetic composition is a foundation makeup or concealer.[46] Zheng T. *et al.* invented the probiotic composition of barrier protection and its application in cosmetics to maintain optimum skin moisture. The probiotic composition has excellent moisturizing and repairs the skin barrier, effectively inhibits the survival of harmful bacteria, prevents skin infection, and helps the body's self-healing system recover rapidly from skin problems.[47]

4. CONCLUSIONS

The patent analysis of cosmetics containing probiotics was provided in this study. The period from 2000 to 2022 was the focus of the in-depth analysis. With 88 patent publications, 2020 was the year with the most patent registrations. With 316 patent documents, the United States was placed in the top position. Based on the IPC classification, all filed patents are relevant to probiotic containing cosmetic formulations and applications for the prevention and treatment of skin-related diseases. Many patents also disclose the development of new probiotic strains for topical formulations and personal care products. The majority of the research and development was focused on exploring or evaluating the mechanism of action of different probiotic strains and their application in skin disorders and beauty products. This study also indicated that the inventions shown in the patents are relevant to cosmeceutical composition and the method for preparing it. In addition, research has found numerous unexplored areas where innovation may flourish.

5. ACKNOWLEDGMENTS

The author acknowledges the Apeejay Stya University for access to the commercially available CAS SciFinder database and The Lens patent data set (The Cambia Institute) used in this study.

6. AUTHOR CONTRIBUTION STATEMENT

N.Y. conceived and planned the study. N.Y., M.K.K., G.A. and A.D. were responsible for data collection, model analysis and manuscript writing. N.Y. took the lead in writing the manuscript. N.Y. and G.A. were responsible for research design, manuscript revision and project management. All authors provided critical feedback and helped shape the research, analysis and manuscript.

7. CONFLICT OF INTEREST

Conflict of interest declared none.

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