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From Tradition to Biotechnology: The Global Landscape of Innovation in Kefir and Probiotics

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Abstract

The present study analyzes the technological evolution and the global panorama of patents related to kefir and probiotics, with the objective of identifying trends, strategic actors, and innovation dynamics in the sector. The research is characterized as documentary, with a qualitative and exploratory approach, with applications of bibliometric techniques and technological prospecting. The data were collected in scientific databases and on the Espacenet platform, using keywords, Boolean operators and International Patent Classification (IPC) codes. The results indicate significant growth in patents from 2014 onwards, with consolidation between 2020 and 2025, evidencing the transition of kefir from functional food to high-value therapeutic applications. There is a strong geographical concentration of innovation in the United States, Europe, and Asia, in addition to the predominance of large multinationals and biotechnology startups as the main applicants. The analysis of the legal situation demonstrates a mature portfolio, with high potential for innovation, especially in the pharmaceutical and nutraceutical areas, presenting opportunities for new entrants in specific niches and technologies in the public domain.

Keywords: *Biotechnology. Functional food. Nutraceuticals. Patent. Pharmaceutical.*

INTRODUCTION

In recent years, there has been an increase in demand for functional foods that play a key role in promoting healthy habits, as consumers are increasingly concerned about their health and well-being. In this context, there is a growing interest in these products as a source of probiotics and potential health benefits [1- 7].

Functional foods are those that contain a variety of components relevant to improving health or reducing health risks, without necessarily being directly associated with disease prevention. These foods also provide basic nutritional benefits [8 - 13].

Among functional foods, probiotics stand out. They use live microorganisms capable of exerting positive effects on the health of the host when administered in adequate quantities [14 - 19].

Probiotics have the ability to improve the balance of the gut microbiota, contributing to the maintenance of a healthy intestinal environment and the promotion of various beneficial health effects. Among the examples, kefir stands out [15 - 17, 20- 24].

In this context, there is a growing interest in its commercial use, due to benefits such as antimicrobial, hypocholesterolemic, and antiallergic properties; healing activity, β-galactosidase action, anti-inflammatory effects; antimutagens and antioxidants; in addition to stimulating the immune system [25 - 26].

Kefir is a fermented milk drink resulting from the symbiotic relationship between bacteria and yeast present in its grains. It is a polysaccharide that houses a microbial complex, which acts as an initiator culture in the fermentation of milk, originating a naturally carbonated drink with an acidic flavor and creamy consistency. These characteristics are due to the action of yeasts and the metabolism of lactic acid bacteria (LAB), such as *Lactobacillus, Lactococcus, Leuconostoc, Pediococcus,* and *Streptococcus* [27 - 36].

Kefir is defined by Normative Instruction No. 46 of October 23, 2007 as follows:

> Fermented milk, whether or not added to other food substances, obtained by coagulation and lowering of the pH of milk, or reconstituted, with or without addition of other dairy products, by lactic fermentation through the action of cultures of specific microorganisms. These specific microorganisms must be viable, active and abundant in the final product during its shelf life, whose fermentation is carried out with lactic acid cultures made with kefir grains, *Lactobacillus kefir*, species of the genera *Leuconostoc*. *Lactococcus*, and *Acetobacter* with lactic acid, ethanol and carbon dioxide production [37].

Therefore, kefir is a symbiotic, acid-alcoholic fermented dairy drink produced from kefir grains. The word derives from the Turkish "keif", which means "to feel good" after its consumption [38, 39]. The drink has a slightly acidic flavor and creamy consistency. It originates from the Balkans, Eastern Europe, and the Caucasus Mountains, but has spread throughout the world [29, 38 - 41].

Kefir is traditionally produced with different types of animal milk, such as cow, sheep, goat, or buffalo milk, but it can also be made with vegetable milks, such as coconut or almond milk, or with coconut or soy water [34, 42 - 45]. The fermentation process involves the production of lactic acid, ethanol, and CO_2, compounds that give the drink its viscosity, acidity, and low alcohol content [28, 34, 46]. In addition, diacetyl, acetaldehyde, ethyl alcohol, and amino acids, which contribute to the flavor, are also present [28, 40, 47]. Kefir grains are composed of microorganisms, such as lactic acid bacteria (LAB) and immobilized yeasts [28, 31, 34].

Kefir differs from other fermented dairy products in that its result is not due to the metabolic activity of a single microbial species [28, 40, 48].

For the production of the drink, kefir grains are used, which consist of gelatinous masses with dimensions ranging from 0.3 to 3.0 cm, with an irregular and multilobed surface, joined by a single central section. Their color varies from white to yellowish-white, resembling small cauliflower florets. To initiate fermentation, 2 to 10% of the grains are inoculated into the milk [49 - 52].

Traditionally, kefir grains are obtained through donations between families within a specific community, which promotes social integration and the transmission of traditional knowledge, since their commercialization does not usually occur [53 - 56].

The first patent related to kefir dates from May 12, 1900, having as inventor and applicant the German Samuel Proskauer, entitled "Improvements related to the manufacture of breads, cookies, and the like", number GB189912518A.

This study aims to analyze the technological development of kefir in order to identify trends, key players, and innovation dynamics in the sector.

METHODOLOGY

The present work was carried out through documentary research, with an exploratory and qualitative approach, using scientific works such as articles, dissertations, theses, and monographs, as well as specialized websites on the subject and search tools, with the objective of identifying relevant studies on the topic addressed.

The bibliometric search was conducted in the Capes, Google Scholar, Web of Science (WoS), Scopus, and Scientific Electronic Library Online (SciELO) databases, which bring together several academic works, including articles and course completion works (theses, dissertations, and monographs).

The search was carried out online, which enabled the creation of a database with academic works and recovered patents, later allowing the application of deductive and deterministic inference. Regarding the information retrieved, inductive and probabilistic inferences were also used.

The data processing consisted of the organization, analysis, and interpretation of the information obtained, with the objective of achieving consistent results, considering the high volume of data. Thus, careful screening was carried out to select the most relevant contents for the study, excluding duplicate records or those that did not fit the research objective. This process is a fundamental step for the analysis to be based, aiming at the identification of the technologies applied and their temporal evolution.

The methodological strategy adopted involved bibliographic survey, documentary analysis, and historical research, combined with technological prospecting at the European Patent Office (EPO) database, through the Espacenet platform, which allows free access to patent data from various industrial property offices.

The database used has high credibility and recognition in academic and scientific circles, especially for prior art verification. It is a public database that gathers information from more than 90 patent offices, with more than 130 million documents available, covering records from 1782 and updated daily.

The definition of keywords is an essential step for the success of the search, and terms directly related to the object of the study are selected in order to analyze the evolution of patents on kefir. To this end, combinations of keywords with Boolean operators (AND, OR), truncation operator (*), and the International Patent Classification (IPC) were used, especially with regard to applications aimed at human needs. During the analysis, duplicate patents were excluded. The survey was conducted on February 26, 2026, with a temporality from 2006 onwards. Based on the results obtained, the scope table (Table 1) was elaborated, which was later processed in Excel software.

In the next stage, the profile of the selected patents was identified, and only 97 were considered as the object of the study. For these, information such as patent title, temporality, IPC classification code, inventors, applicants, and country of publication were analyzed. The result are shown in Table 1.

Table 1 – Scope of the research

Search term	Database			
	Google patents	The Lens	Patentscope	Espacenet
C12N1/20 AND A23L33/135 AND kefir AND probiotic AND (microorganism* OR inorganic* OR microscopic organism) AND (leaven OR leavening OR fermentation OR ferment OR enzyme OR yeast)	297	274	119	106

Source: Authorship (2026)

Table 1 shows that the search strategic combines the IPC codes C12N1/20 and A23L33/135; the keywords “kefir” and “probiotic”; microorganism variations, such as “microorganism”, “microscopic”, “inorganic” and “organism”; terms related to fermentation, such as “leaven”, “leavening”, “fermentation”, “ferment”, “enzyme” and “yeas”t; Boolean operators, such as AND and OR; in addition to the truncation operator (*).

The best performance in terms of the number of results was obtained in Google Patents, which performs searches in full texts and metadata comprehensively, including documents from various offices, regardless of their relevance.

The second-best result was The Lens database, known for its comprehensive global coverage, similar to Google Patents, with a small difference (23 documents). This variation can be attributed to the filtering of some non-patent literature or a slightly more restrictive interpretation of Boolean operators (AND/OR) when aggregating data from multiple jurisdictions.

The third-best result was obtained in the WIPO global database (Patentscope), which has wide coverage, although it uses a search engine different from Google’s.

Espacenet, managed by the European Patent Office (EPO), showned results close to those of Patentscope, being one of the largest European and world databases.

The discrepancy observed in the results, with wide variation between the databases (from 106 to 297), suggests that each platform uses different search algorithms; that the indexing and standardization of documents vary between offices; and that some databases may not adequately recognize more complex Boolean operators.

The terms used in the search proved to be effective, as they generated significant results in three of the five databases analyzed. Google Patents has proven to be the most comprehensive tool, retrieving the largest volume of data, and is therefore ideal for an initial scan.

The Patentscope and Espacenet databases validate the relevance of the strategy adopted, evidencing a consistent core of international patents on the subject.

The choice of Espacenet is in line with the objective of the research, as it presents a more accurate and up-to-date implementation of the Cooperative Patent Classification (CPC), allowing hierarchical navigation by class and its combination with high-precision Boolean operators, which makes it more reliable. In addition, the database makes it possible to group by patent families, eliminating duplications, and evidencing the real geographical extent of protection, covering more than 90 countries. It should be noted that kefir and probiotics have a strong industrial presence in Europe and Asia.

RESULTS AND DISCUSSION

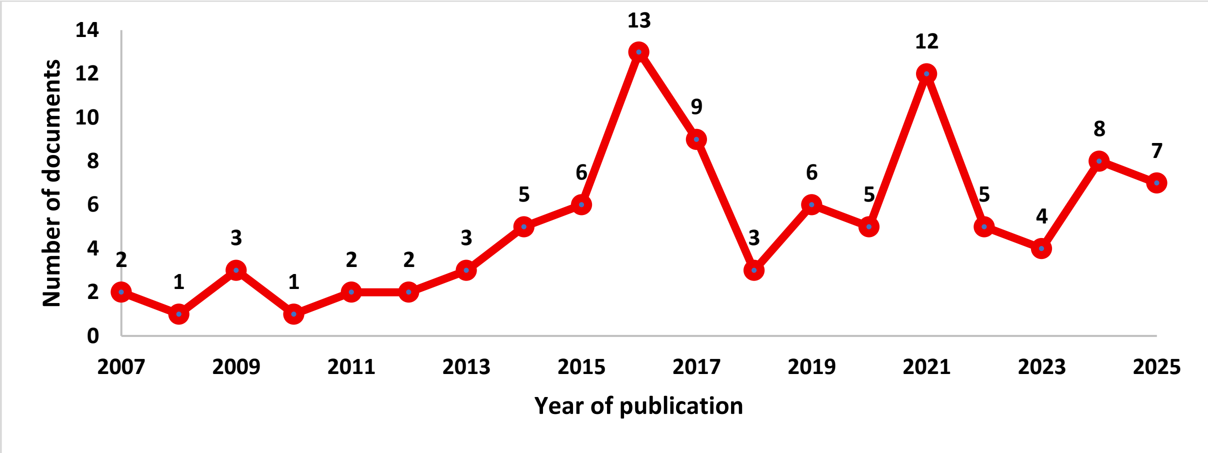
The titles analyzed indicate that the use of kefir is not limited to the area of functional foods but also extends to the pharmaceutical and precision nutraceutical fields, with applications focused on oncology, neurology, longevity, and metabolic syndrome.

Based on the data obtained, a graphical analysis was carried out, the results of which are presented below.

TEMPORALITY

The annual distribution of documents belonging to patent families published since 2006 is shown in Figure 1. Note that there were no publications in 2006.

Figure 1 – Temporality of published patents



Source: Authorship (2026)

Phase 1: Early or embryonic phase (2007-2013)

In this period, an average of two documents published per year is observed. The technology was still at an early stage, with a low number of patents, which may be related to the limited number of filing actors. Activity was low and relatively stable.

The main themes, according to the titles analyzed, are related to basic fermentation processes, use of bacteria in food, growth of *Bifidobacteria*, and freeze-drying methods. The characteristics of this period indicate low therapeutic sophistication, with a focus on basic technology centered on fundamental processes of strain isolation and generic applications.

Phase 2: Growth/Acceleration (2014-2017)

During this period, significant growth was observed, with an increase from five patents published in 2014 to 13 in 2016, indicating the maturation of the technology and the strengthening of the probiotics and kefir market. The peak in 2016 suggests the intensification of the search for intellectual protection, probably associated with the development of new fermentation methods, compositions, and specific applications of microorganisms.

In this phase, the strong presence of public-private partnerships stands out. Among the main characteristics, is the expansion of therapeutic applications, with probiotics targeting specific diseases, such as metabolic health (obesity and diabetes), cardiovascular health, irritable bowel syndrome (IBS), as well as advances in conservation methods (freeze-drying), microbiota recovery (dysbiosis), child health, genetic engineering, and programmable bacteria. Applications in oncology (cancer), neurodegenerative diseases (gut-brain axis), food allergies, and microbial consortia are also highlighted.

Phase 3: Maturation/Oscillation (2018-2022)

In this period, an oscillatory behavior is observed, with a reduction to three patents in 2018, increasing to 12 in 2021, followed by a further decrease to six published patents. The spike in 2021 may be associated with increased investments in the post-COVID-19 pandemic period, when there was greater interest in gut health and immunity to fight the virus.

These oscillations are typical of technologies in a state of maturity, in which the production of patents varies according to investments in Research and Development (R&D). The predominance of therapeutic startups is noted. The main characteristics include diversification and technological deepening, with the emergence of high-value niches, such as applications related to mitochondria, GLP-1 (metabolic regulation), skin health, and fatty acids.

Phase 4: Saturation/Stabilization (2023-2025)

In this period, relative stability is observed, with a variation between four and eight published documents. The market for probiotics and kefir seems to be entering a consolidation phase, in which fundamental patents have already been filed, and new applications tend to be incremental, involving new strains, combinations of ingredients, or the entry of new players in the sector.

The low number of publications in 2025 may be related to the 18-month secrecy period, since patents filed in the second half of 2024 are expected to be published only in 2026. Thus, although there are still no publications this year, an increase is expected in the coming months.

In general, the main cycle of technological expansion occurred between 2014 and 2017, consolidating the topic as an area of commercial interest. The peak observed in 2021 demonstrates the resilience of the kefir, probiotics, and fermentation sector. This scenario suggests that the space for radical innovations tends to be more restricted, directing efforts to specific niches or incremental process improvements.

In this more advanced phase, specific patents with high added value predominate, characterized by cutting-edge technologies applied to specialized niches, such as longevity, telomeres (cellular aging), GLP-1 and *Akkermansia* (bacteria associated with leanness and longevity).

The thematic evolution can be seen in Table 2.

Table 2 – Thematic evolution of patents

Phase	Central theme	Application example	Commercial value	Competitive differential
2007-2013	Processes and strains	"How to" – learning how to do it	Medium (industrial commodity)	Efficient process
2014-2017	Specific diseases	"What to Treat" (Obesity, IBS, and Allergies) – Figuring Out What It's For	Alto (entrance to the pharmacy)	Therapeutic efficacy
2018-2022	Advanced Mechanisms	"How it works" (mitochondria, SCFA, and skin) – understanding how it works	Very high (scientific differentiation)	Mechanism of action
2023-2025	Longevity and accuracy	"The Apex" (Telomeres, GLP-1 and Akkermansia) – using it to live longer	Very high ("anti-aging" market)	Long-lived and accurate

Source: Authorship (2026)

Table 2 summarizes the technological and commercial evolution of kefir, demonstrating how traditional knowledge can be transformed into high-value assets through scientific innovation and strategic direction.

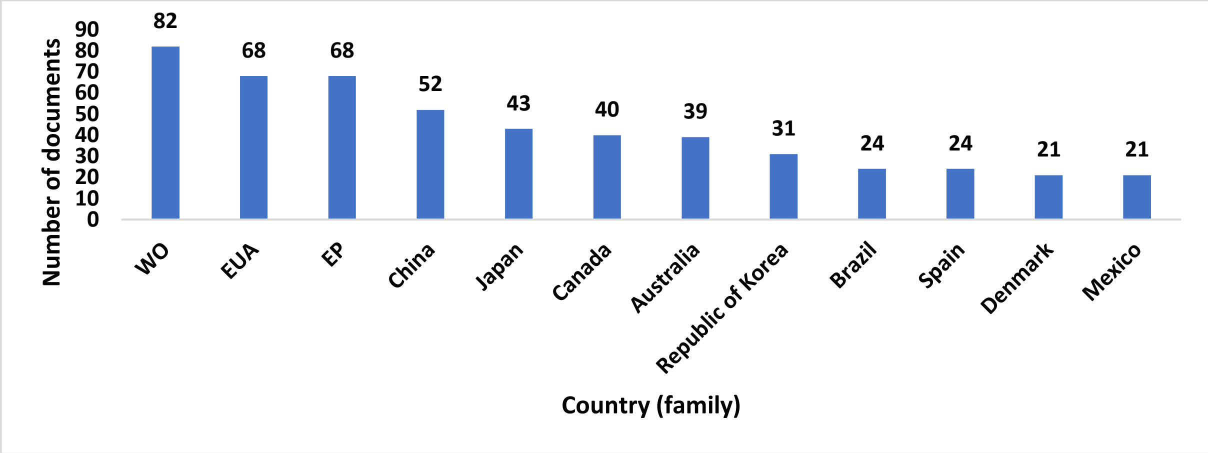
Kefir is present in all phases, starting as an artisanal product in Phase 1 and reaching its apex in Phase 4. Along the way, it has evolved from a rural-sourced product to clinical applications and, later, to advanced longevity research contexts. Thus, it transitions from traditional knowledge to an object of technological interest, with applications that go beyond functional food, reaching strategic areas such as precision health and pharmaceutical biotechnology.

- **Phase 1**: represents the technical-scientific learning period, in which patents focus on mastering the production process and characterizing the microorganisms involved. This technological base enabled subsequent advances, since the dominant players in this cycle established the necessary infrastructure for later applications.
- **Phase 2**: marks the transition of kefir from functional food to therapeutic agent. At this stage, patents start to protect not only the "how to do it" but also the "what it is for". Major players are able to associate specific strains with certain health conditions, creating barriers to entry for new entrants and generating higher-value assets.
- **Phase 3**: represents scientific maturity, in which patents begin to protect in-depth knowledge of the mechanisms of action. In this context, it is no longer enough to understand only the application in the treatment of diseases; it is also necessary to elucidate the biological processes involved. Patent applicants thus seek to expand technological protection, which can contribute to higher costs and increased competitive barriers.
- **Phase 4**: represents the state of the art and the apex of commercial value, focusing on the protection of applications related to healthy aging and longevity, considered some of the most relevant emerging markets today. Patent applicants seek to position themselves at the top of the value chain, with products with very high margins and strong emotional and aspirational appeal.

COUNTRY OF PUBLICATION

The geographical distribution of patent families, that is, the countries or offices in which applicants seek to protect their inventions, is shown in Figure 2.

Figure 2 – Main publishing offices



Source: Authorship (2026)

Figure 2 represents a strategic map, showing the markets considered most relevant by the applicants for the protection of their inventions.

The top of the table, which brings together the most expressive markets, is led by the WIPO office (82 documents published), followed by the USA (68) and the EPO (68), which are configured as references for pharmaceutical and biotechnology technologies with high added value.

The WIPO Office does not grant patents but facilitates international applications for protection through the Patent Cooperation Treaty (PCT). The high number of registrations indicates that most inventions are in the global protection phase, seeking to protect their rights in multiple markets simultaneously. The option for the PCT suggests a high commercial potential of the technologies, in addition to indicating that applicants have financial capacity and a strategic interest in ensuring protection on a global scale.

The U.S. and Europe are the largest, most strategic, and key target markets for functional foods, nutraceuticals, and pharmaceuticals, and are especially relevant in the gut health and probiotics segment. The strong presence in these markets reflects the high purchasing power of consumers, the robust regulatory infrastructure for pharmaceuticals and nutraceuticals, and the consolidation of the functional food sector.

The Asian market, led by China, Japan, and the Republic of Korea, also stands out as strategic for patent applicants.

China (52 documents) has a significant share, possibly associated with high investments in biotechnology and its large consumer market for fermented dairy products and supplements. Japan (43) has a consolidated tradition in research with probiotics, and the number of published patents reinforces the interest of the population, especially in applications aimed at aging and preventive health. In turn, the Republic of Korea (31) also stands out; including registrations in the local language, which shows the interest of applicants in protecting their inventions in the domestic market. The country has a strong tradition in fermented foods, such as kimchi, as well as relevant scientific production in *Lactobacillus* and a sophisticated consumer market in the health and beauty segments.

Canada (40 documents) and Australia (39) also stand out due to their relevance as agricultural and dairy producers, in addition to having high consumption of food supplements. Patent protection in these markets is associated with the control of production chains and the exploration of specific niches, also considering the high purchasing power of the population and regulatory convergence with the European and American markets.

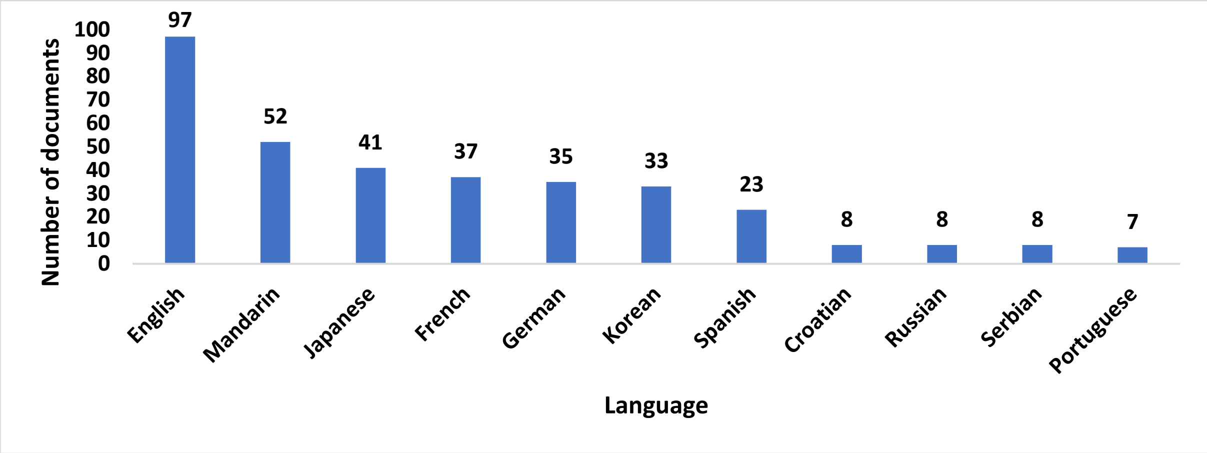
Brazil, as a relevant emerging market and the largest economy in Latin America, appears with 24 documents. This performance can be explained by its position as one of the largest milk producers and the growth of the market for yogurts and probiotic products, making it a strategic destination for applicants.

Finally, the countries with the lowest number of patents represent markets that are still little explored, setting up opportunities for new applicants to develop niches and expand their technological performance.

LANGUAGE OF PATENT DOCUMENTS

The predominant language of patent documents reveals filing strategies, as well as the origin of the inventions or the applicants' target market, as can be seen in Figure 3.

Figure 3 – Main languages of the documents



Source: Authorship (2026)

Figure 3 shows the predominance of the English language (97 documents), which was expected, as it is the lingua franca of science, technology, intellectual property, and global business. Practically all patents are published in English, especially those filed via PCT (WO), USPTO, or EPO (EP), which have high strategic value. Also included are patents filed in English-speaking countries, such as Australia and Canada. With a view to international protection, applicants often translate the texts of patents originally filed in other languages.

The hegemony of the English language confirms that technologies related to kefir are treated as global assets, with the potential to be protected in multiple markets.

The Asian market shows a significant alignment between the volume of filings in its offices and the language of the documents, since the filings made in China are mostly in Mandarin. This condition reflects the size of the Chinese consumer market for fermented dairy products and probiotics, the country's leading role as a patent applicant, and the local protection strategy adopted by Chinese inventors, who favor their native language. In this way, China is configured not only as a target market but also as an important source of innovation in kefir and probiotics.

Japan has a slight discrepancy: although there are 43 patents filed, 41 documents are in the Japanese language, which confirms the country's tradition in research on probiotics and functional foods. This scenario reflects the predominance of local filings by Japanese companies and inventors, the market's interest in preventive health and longevity, and the country's regulatory sophistication. Thus, Japan stands out both as a relevant market and as a source of innovation in kefir technologies.

In the Republic of Korea, the opposite movement to that of Japan can be observed: there are 31 documents filed, but 33 records in the Korean language. This reflects the country's dynamism, its tradition in fermented foods (kimchi), and the strong interest of the local industry in the health and beauty sectors. This market proves to be not only a consumer but also an important technology generator.

Despite its relevance as a market, the local production of technology in Brazil is still negligible, with only seven documents in Portuguese. This difference may be related to the fact that most filings are carried out via PCT, using English as the default language, due to the international nature of the protection process. In addition, there may be underrepresentation of the Portuguese language in international databases, although the country stands out as a relevant market, indicating that many patents are filed locally in other languages.

The languages organized by linguistic-geographic blocks can be seen in Table 3.

Table 3 – Linguistic-geographic blocks

Linguistic-Geographical Block	Total	%	Feature
East Asia (Mandarin, Japanese, and Korean)	126	34,90	Dominant origin of innovation
Anglo-Saxon (English)	97	26,87	Global lingua franca
Western Europe (Romanesque and Germanic)	97	26,87	Industrial and scientific tradition
Balkans/Eastern Europe (South and East Slavic)	32	8,86	Cultural origin of kefir
Lusophone (Portuguese)	7	1,94	Relevant market and incipient innovation
Baltic (Estonian)	2	0,55	Emerging niche

Source: Authorship (2026)

Table 3 shows that Asia is the center of gravity of kefir innovation, heavily influenced by China, Japan, and the Republic of Korea. Europe maintains relevance, but in a fragmented way: the western part is expressive, while the eastern part and the Balkans preserve the cultural tradition associated with the product.

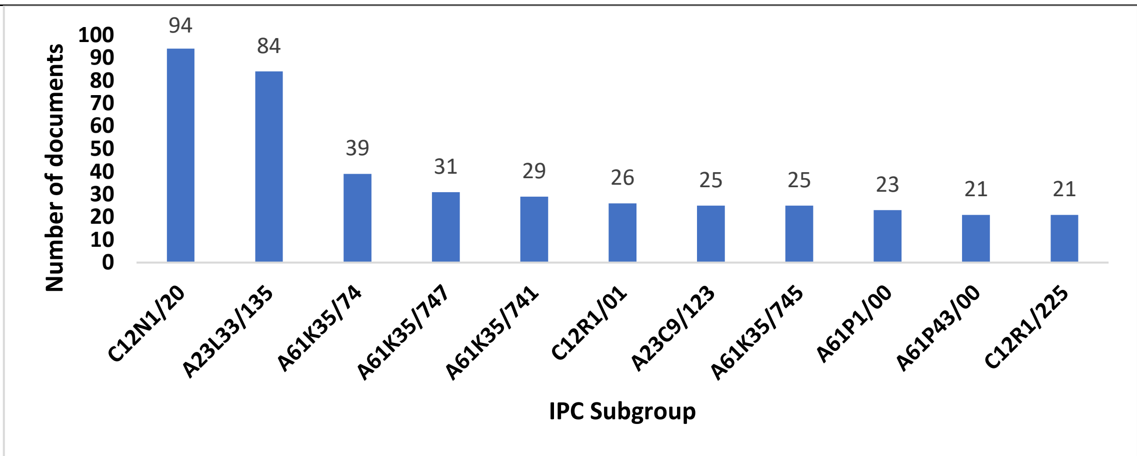
The English language connects all the blocks and enables the international protection of inventions. The region of origin of kefir continues to contribute to the generation of innovation, although in a smaller volume. Portuguese, in turn, contrasts with Brazil's economic relevance, suggesting opportunities to stimulate local innovation and increase filings in the national language. In addition, emerging niches, such as those represented by Estonian and Romanian languages, indicate the existence of small innovation ecosystems specializing in kefir and probiotics.

INTERNATIONAL PATENT CLASSIFICATION (IPC) SUBGROUP

The classification of patents can be organized according to the technology involved, constituting an effective search tool that helps interested parties to identify the area in which the invention is inserted, facilitating its analysis and searches in intellectual property offices. In addition, it allows the identification of areas of greater prominence, signaling the growth and interest of inventors and researchers in technological development.

The subgroup of the International Patent Classification (IPC) reveals, in terms of official classification, the object of the protected invention. It also highlights the technological and legal essence of patent documents, as can be seen in Figure 4.

Figure 4 – IPC Subgroup



Legend

C12N1/20: Microorganisms e.g. protozoa; His compositions; Processes of propagation, maintenance or conservation of microorganisms or their compositions; Processes of preparation or isolation of compositions containing a microorganism; Culture media for this; / Bacteria; Their means of culture;

A23L33/135: Bacteria or their derivatives, e.g. probiotics

A61K35/74: Medicinal preparations containing materials of indeterminate constitution or their reaction products; / Microorganisms or their materials; / Bacteria;

A61K35/747: Medicinal preparations containing materials of indeterminate constitution or their reaction products; / Microorganisms or their materials; / Bacteria; / Probiotics; / Lactic acid bacteria, e.g. enterococci, pediococci, lactococci, streptococci or leuconostocs; / Lactobacilli, e.g. L. acidophilus or L. brevis;

A61K35/741: Medicinal preparations containing materials of indeterminate constitution or their reaction products; / Microorganisms or their materials; / Bacteria; / Probiotics;

C12R1/01: Microorganisms; / Bacteria or acetinomycetes;

A23C9/123: Milk preparations; Milk powder or milk powder preparations; / Fermented milk preparations; Treatment using microorganisms or enzymes; / using only microorganisms of the genus Lactobacteriaceae; Yogurt;

A61K35/745: Medicinal preparations containing materials of indeterminate constitution or their reaction products; / Microorganisms or their materials; / Bacteria; / Probiotics; / Lactic acid bacteria, e.g. enterococci, pediococci, lactococci, streptococci or leuconostocs; / Bifidobacteria;

A61P1/00: Drugs for the treatment of disorders of the alimentary tract or digestive system;

A61P43/00: Drugs for special purposes, not provided for in groups ;

C12R1/225: Microorganisms; / Bacteria or acetinomycetes; / Lactobacillus;

Source: Authorship (2026)

Figure 4 presents an expected result, with the codes inserted in the search strategy leading in quantity. This is the most technical figure, since, while titles reflect marketing strategies and countries indicate the target market, IPC codes show the technological basis of the inventions.

The quantification presented in Figure 4 does not mean that the invention is restricted to a single technological field; on the contrary, it may be associated with multiple codes, given its multidisciplinary character and its insertion in different technological areas.

Category C12 refers to microorganisms and biotechnological processes and is represented by codes C12N1/20 (94 documents), C12R1/01 (26), and C12R1/225 (21). The last two codes represent the core of the technology, as they are related to the specification of bacterial genera.

Code C12N1/20 (94 documents): is the most frequent and is related to processes that use bacteria, confirming the main focus of the search: microorganisms. This result indicates that the technological basis is founded on the domain of microorganisms, including isolation, characterization, culture, and modification of bacterial strains.

The second relevant category refers to functional foods, represented by the code A23L.

Code A23L33/135 (84): is related to dietary or modified foods containing microorganisms (probiotics), being the second most frequent group and establishing a direct connection between the bacteria and the food application.

A relevant subgroup formed by medical preparations and pharmaceutical compositions (A61K) is also noteworthy, with emphasis on the following codes:

- A61K35/74 (39 documents): related to bacteria in general, it represents the umbrella for medicinal preparations;

- A61K35/747 (31): specific for *Lactobacillus*;

- A61K35/741 (29): concerning probiotic bacteria; and

- A61K35/745 (25): also related to probiotic bacteria.

These codes indicate that the technologies are being claimed as medicines and pharmaceutical inputs, transcending the food sector, and the last three detail the bacterial genera used.

Code A61P is specific for therapeutic activity, with the following standing out:

- A61P1/00 (23 documents): for diseases of the digestive tract or gastrointestinal diseases, constituting the most classic and consolidated application of probiotics;

- A61P43/00 (21): related to drugs for indications not provided for in other classes, generally used for diversified purposes or general effects;

- A61P29/00 (17): probiotic to reduce inflammation (anti-inflammatory);

- A61P25/00 (15): for diseases of the nervous system;

- A61P25/28 (13): specific for degenerative diseases of the nervous system, such as Alzheimer's, Parkinson's, dementia, among others;

- A61P3/04 (13): for obesity;

- A61P3/10 (13): for diabetes;

- A61P17/00 (13): for skin diseases;

- A61P35/00 (12): for oncological treatment (cancer);

- A61P37/02 (12) and A61P37/06 (12): related to autoimmune diseases, such as immunomodulation and immunosuppressants.

Other relevant groups include A23 (food), C12R (specific microorganisms), C12N and C12Q focused on process technology, among others.

The hierarchy of technological categories, as illustrated in Figure 5, can be seen in Table 4.

Table 4 – Hierarchies of technological categories

Category	Codes	Total	%
Microorganisms and processes (C12)	C12N1/20, C12R1/01, C12R1/225	141	33,73
Pharmaceutical Compositions (A61K)	A61K35/74, /747, /741, /745	124	29,67
Functional Foods (A23L)	A23L33/135	84	20,10
Therapeutic activities (A61P)	A61P1/00, A61P43/00	44	10,53
Dairy Products (A23C)	A23C9/123	25	5,98

Source: Authorship (2026)

The dominant category is that of processes and microorganisms, representing more than a third of all classifications. This result indicates that innovation starts from the domain of microbiology and that applicants in this category tend to control the essential raw material for later applications.

The second category demonstrates a strong presence in the pharmaceutical sector, indicating that kefir is not limited to a functional food but is also configured as a pharmaceutical ingredient of high commercial value. This segment has higher margins and greater regulatory rigor, contributing to the creation of entry barriers.

The third category is related to the traditional commercial application of kefir, with significant economic relevance, although it potentially has lower margins than those of the pharmaceutical sector. It is a segment more suitable for companies focused on the production of functional foods and the wellness market.

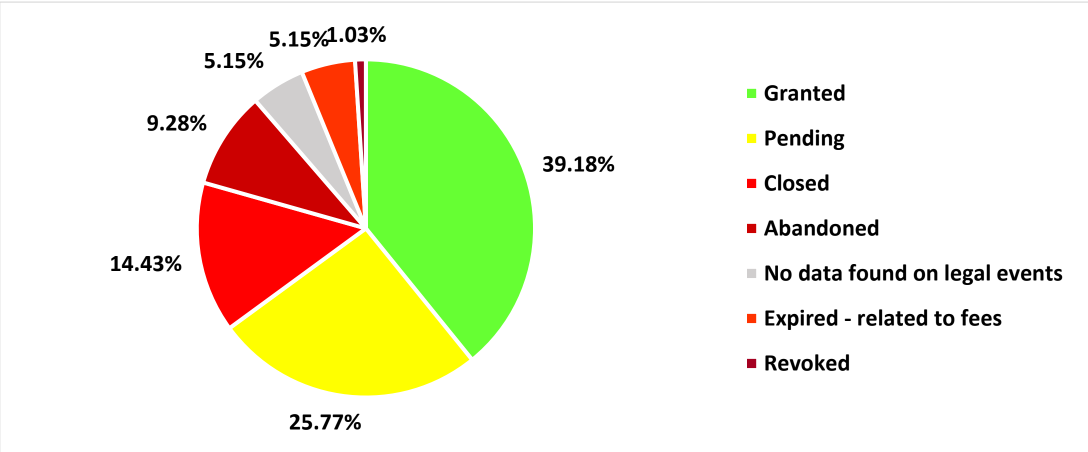
The fourth category refers to the therapeutic purpose of protected compositions, mainly aimed at applications in the gastrointestinal tract. This category reveals the potential for kefir to expand to new therapeutic frontiers, in addition to the applications already consolidated in the gastrointestinal tract.

The fifth category is related to the more traditional application of kefir, mainly linked to the dairy industry, representing innovation in fermented dairy products, such as cheeses, yogurts, and dairy drinks. It is a consolidated niche with room for incremental innovations, but with less potential for disruptive growth compared to pharmaceutical categories.

LEGAL SITUATION OF PATENTS

The legal status of the kefir-related patent portfolio, i.e., the legal protection stage, reveals the applicants' strategy and demonstrates the maturity of the technological portfolio, as can be seen in Figure 5.

Figure 5 – Legal situation of patents



Source: Authorship (2026)

Figure 5 shows a high percentage of active patents (granted and pending), totaling 63 documents, meaning that this field of study is dynamic and protected sector, generating legal barriers to the entry of new competitors.

More than a third of the portfolio (39.18% - 38 documents) has already been granted a patent, that is, it has already passed through the scrutiny of the patent offices, surpassing the examinations of novelty, inventive step, and industrial application in the offices where they were filed. The owners of these patents effectively have consolidated property rights. In this context, any competitor wishing to operate in the markets where these patents are consolidated must carry out a careful analysis to avoid infringing these rights, carefully mapping such patents. They represent market niches and constitute barriers for new entrants. Therefore, this condition reflects high technological maturity: applicants can exercise exclusive rights over their inventions, license or commercialize safely, and patents represent legal obstacles for competitors.

Approximately a quarter of the patents (25.77% - 25 documents) are in the analysis phase, awaiting the decision of the patent offices, and may become future grants, increasing the density of technological protection. For now, these inventions still do not have a guaranteed right. Competitors should monitor these documents closely to keep track of the outcome. This condition means that there is temporary uncertainty, in which the scope of protection may change during examination. Regarding market strategy, applicants have already initiated protection, indicating confidence in the commercial value of the technology.

Patents classified as "no data" (5.15% - 5 documents) indicate a lack of transparency in national patent offices. This condition can occur due to incomplete databases for certain offices, very recent patents whose status has not yet been updated, or documents from certain jurisdictions with less transparency. These cases require additional consultation of official sources from the patent offices.

Patents that are in the public domain (29.90% - 29 documents) represent almost a third of the portfolio, meaning for startups and researchers the possibility of developing products without risk of infringement and without licensing costs. This group is composed of:

- **Abandoned** (9.28% - 9 documents): refer to the withdrawal of the process by the applicant before grant, which may be related to patent obsolescence, lack of response to requirements, or costs that do not justify the continuity of the process. It may also indicate a change in the applicant's strategy, technical problems that made the grant unfeasible, or financial difficulties in paying fees. These conditions generate opportunities for competitors, serving as a basis for the development of new products.
- **Expired** (5.15% - 5 documents): indicate that the patent was granted but lost its validity due to non-payment of annuity fees. This situation differs from abandonment, because here the patent was granted, but the owner decided not to maintain its validity. As implications, there is a loss of rights, in which the patent applicant has stopped investing in maintenance for reasons such as low commercial return, change of strategic focus, or high maintenance costs in multiple countries. This condition creates opportunities for competitors, as the technology falls into the public domain before the normal deadline.
- **Closed** (14.43% - 14 documents): may be related to the end of the term of validity in a patent office or have been filed for other reasons. In general, they represent technologies that have already fulfilled their protection cycle and are now in the public domain. Therefore, these technologies are available and can be used freely by any interested party; that is, competitors can exploit them without restrictions as a result of the end of the monopoly. The presence of closed patents is an indicator of the maturity of the field and shows that the technology is not recent.
- **Revoked** (1.03% - 1 document): the only revoked patent occurs due to opposition from third parties after it was granted, redering it invalid by judicial decision (nullity action) or by administrative reexamination that concluded that the requirements were not met. As implications of this legal status, there is a weakness, indicating that a patent did not resist challenges because the competitor was successful in the challenge, possibly due to similarity with another patent.

In general, the legal situation demonstrates that the portfolio of patents related to kefir is mature, strategically protected, and presents a low risk of invalidation, characterizing a consolidated technological field with good prospects for commercial exploitation.

The portfolio overview can be seen in Table 5.

Table 5 – Portfolio summary

Situation	Quantity	%	Strategic significance
Active (granted and pending)	63	65,0	Living core of the portfolio, with rights in place or seeking protection
Effective protection (granted)	38	39,2	Technologies with Exclusive Rights Granted
Under review (pending)	25	25,8	Depositors' Future Bets
Extinguished (terminated, expired and revoked)	20	20,6	Technologies that have lost protection (public domain or invalidated)
Abandoned	9	9,3	Withdrawal during the process
No information	5	5,2	Incomplete data

Source: Authorship (2026)

Table 5 shows that the portfolio is robust and mature, since about 65% of the patents are active (granted or pending), indicating a dynamic and continuously developing technological field. This scenario is consistent with the growth of the probiotics and kefir market, driven by the demand for functional foods and health-oriented solutions.

The high percentage of patents granted (39,18%) shows that the technologies analyzed meet the patentability criteria, such as novelty, inventive step, and industrial application. In addition, a low revocation rate is observed, which suggests that the granted patents are legally sound and resistant to challenge.

The abandonment rate is moderate and consistent with what is expected for technology portfolios, indicating that applicants adopt selective strategies and give up on protecting lower-value technologies.

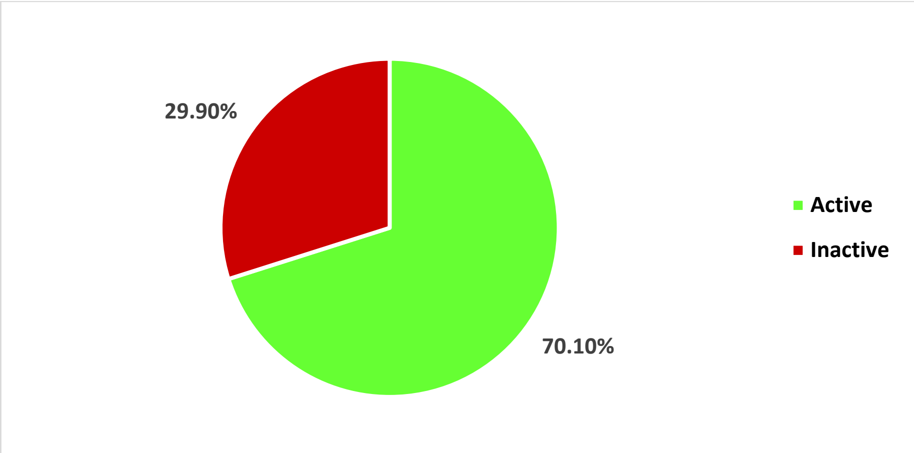
Expired patents represent a relevant set of technologies available for free exploitation by competitors, researchers, and startups, creating opportunities for incremental innovation and new product development.

Finally, uncertainty is reduced since only five documents have no data, indicating that the databases consulted are relatively complete for most patents.

LEGAL STATUS OF PATENTS

The legal status of patents condenses all the complexities of the legal situation into just two categories - active and non-active - representing a strategic simplification that allows a quick overview of the protection landscape, as can be seen in Figure 6.

Figure 6 – Legal status of patents



Source: Authorship (2026)

Figure 6 shows a relationship of forces in a ratio of approximately 70% active vs. 30% non-active, demonstrating a mature and well-protected sector, in which most applicants invest to maintain their valid rights. This simplification into just two categories is extremely useful for an executive view of the portfolio, allowing for quick decisions on go-to-market strategies, licensing, R&D, and competitive positioning.

Active patents include granted patents (38 documents), pending patents (25), and those without information (5), whose general status is undetermined. This scenario indicates that the portfolio is extremely healthy and defensive, generating exclusive rights or being in the process of generating them, which shows a highly protected and competitive technological field. Applicants keep their patents valid through the payment of annuities and continue to seek new protections through pending patents, which characterizes a competitive and mature market.

Non-active patents (29 documents) correspond to those that can be replicated without the need to pay for licensing, as they no longer generate exclusive rights.

For new entrants, active patents represent barriers to innovation, while inactive patents are an easier path to follow, also serving to acquire knowledge contained in these documents, which can be freely used to develop new products, without paying licensing fees and without risk of global infringement.

Regarding the period of publication of patents, between 2020 and 2025, there was a concentration of granted patents (12 documents), pending patents (22), and those without information (1), which indicates maximum activity in this technology. There were only eight patents that were not active in the same period, four of which were abandoned and four closed.

Pending patents refer to filed applications that are still in the analysis phase or whose examination has not yet been concluded, occurring massively between 2020 and 2025, distributed as follows: 2020 (1 document), 2021 (7), 2022 (4), 2023 (2), 2024 (3), and 2025 (5). This behavior reinforces the global growing trend in patent filings related to probiotics and functional foods, driven by increased scientific and commercial interest in the sector.

In general, the patents that are in the public domain zone were distributed as follows:

Abandoned: 2009, 2013, 2015, 2018, 2021, 2022, and 2024;

Expired: 2007, 2016, and 2017;

Revoked: 2014;

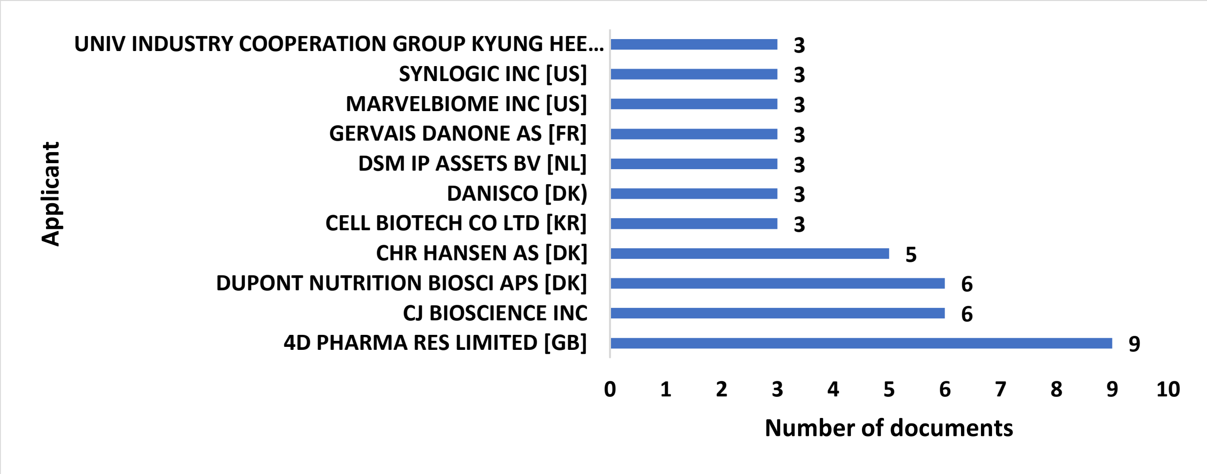
Closed: 2009, 2011, 2012, 2016, 2017, 2020, and 2024.

APPLICANTS

Consumers' preference for healthy products rich in bioactive compounds aimed at disease prevention has motivated the food industry to invest in this segment, due to users' perception of the benefits generated by this type of food [57].

The patent holders or applicants are the owners of the technologies and the legal rights associated with them, as can be seen in Figure 7.

Figure 7 – Main patent applicant



Source: Authorship (2026)

The largest industrial players in the ingredients, dairy, and biotechnology sectors are the dominant ones in patents, appearing in multiple documents, which indicates the existence of robust portfolios. The categories of applicants are composed of:

- **Ingredients and food multinationals (industrial giants),** such as Dupont, Danisco, Chr. Hansen A/S, DSM IP Assets BV, Danone, Ajinomoto, Yakult, Procter & Gamble, among others, that supply cultures to the food industries or produce fermented foods with probiotics. Anyone who needs to sell ingredients or finished products will have to negotiate with these giants.
- **Therapeutic startups**, such as 4D Pharma, Marvelbiome, Synlogic, Pendulum, among others, that develop drugs based on live microorganisms. These companies hold advanced patents and are often targets for acquisition by pharmaceutical giants or enter into strategic partnerships for the development of new products. This is a group that shapes the future.
- **Universities and research centers**, such as South China Agricultural University, Tianjin University of Science and Technology, Columbia University, University of California, Consejo Superior de Investigaciones Científicas, Korea Food Research Institute, among others, which work in the generation of scientific knowledge and in the establishment of partnerships with the productive sector. These institutions have relevance in basic research and technological advancement.
- **Individual inventors**, such as Majeed Muhammed (IN), Arumugam Sivakumar (IN), Beede Kirankumar (IN), among others, who control specific niches. They own their own intellectual property.

The absolute leader is 4D Pharma Research Limited (UK), with nine documents. The nature of the company's activity is experimental research and development in biotechnology, focusing on areas such as oncology, neurology, and inflammation, as well as therapies based on live microbiota (LBP). This leadership means that it is the most active player in the kefir and probiotics sector, with a focus entirely on pharmaceutical and non-food applications, confirming the trend of migration of kefir to high value-added therapeutic applications.

In second place is the Korean CJ Bioscience Inc., with six documents, whose specialty is the development of biopharmaceuticals, food and biotechnology. It is a conglomerate that operates in several sectors, including food and food services, pharmaceutical and biotechnology, entertainment and media, e-commerce, and logistics. "CJ" derives from Cheil Jeding, which means "first sugar factory", the sector in which the company started.

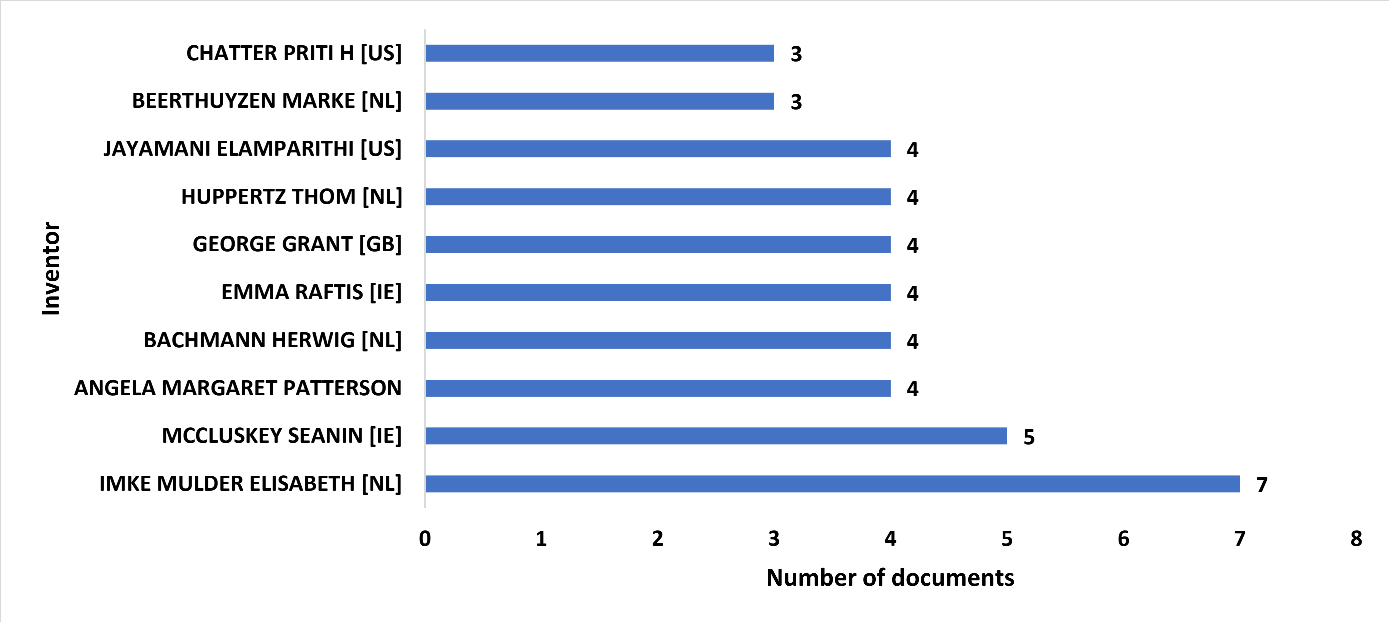
The presence of Kyung Hee University (3 documents) indicates strong university-company interaction, evidencing the protection of technologies developed in the academic environment.

INVENTORS

Innovation in kefir is driven by highly productive researchers, concentrated in centers of excellence such as the Netherlands, Ireland, USA, and UK, and strongly linked to the leading companies in the sector.

Inventors are the brains behind technological innovations and those responsible for creation, constituting the intellectual capital related to patents, as can be seen in Figure 8.

Figure 8 – Main inventors



Source: Authorship (2026)

Figure 8 shows that, among the most productive inventors, the geographic region is led by the Netherlands, with 11 documents, associated with the companies 4D Pharma Research Limited and DSM IP Assets BV, to which their inventors are linked. In second place, Ireland stands out with five documents, whose inventors are also associated with 4D Pharma Research Limited. In third place, with four documents each, are the United Kingdom, also linked to 4D Pharma Research Limited; and the USA, with inventors associated with Marvelbiome.

The most productive inventor is the Dutch Imke Mulder Elisabeth (7 documents), linked to the English giant 4D Pharma Research Limited. Inventors Seanin McCluskey (5), Angela Patterson (4), George Grant (4), Emma Raftis (4), and Alex Stevenson (1) are also part of this development team, constituting the company's most productive R&D core, especially in patents related to the composition of bacterial strains.

Also noteworthy is the Dutch inventor Herwig Bachmann (4 documents), associated with the Dutch giant DSM IP Assets BV. The development team includes Thom Huppertz (4), Mariya Tarazanova (3), Jan Kok (3), and Marke Beerthuyzen (3). The patents developed by this group are related to gene transfer by conjugation and methods of producing dairy foods.

Another prominente inventor is Elamparithi Jayamani (4 documents), from the company Marvelbiome (USA). Also part of the development team are inventors Chatter Priti H (3), Govindan Jothi Amaranath (3), and Chatter Mukesh (2).

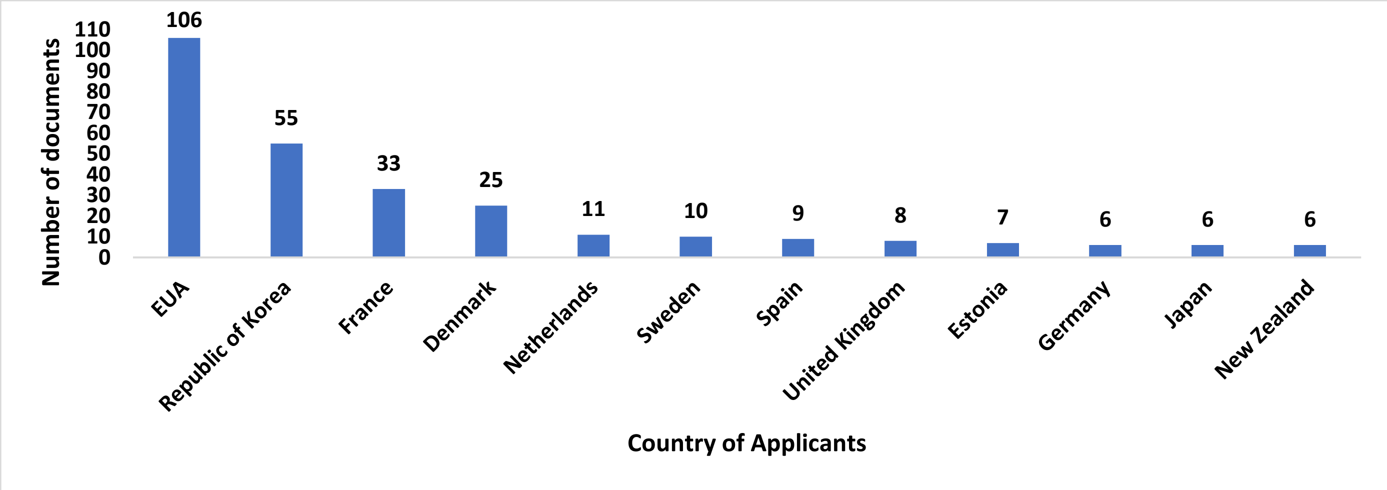
There is also a significant presence of women inventors, especially in leadership positions in development teams, such as Imke Mulder Elisabeth (4D Pharma), with seven documents; Mariya Tarazanova (DSM), with three documents; Angela Patterson (4D Pharma), with four documents, among others.

COUNTRIES OF THE APPLICANTS

Kefir innovation is a global and multipolar phenomenon, with leadership from the US and Europe, but with the Republic of Korea emerging as a new power and countries such as Denmark and Estonia demonstrating their strength and relevance in the technological scenario.

The distribution of applicants by country of origin reveals, in aggregate form, which nations lead innovation in kefir and probiotics, offering a strategic view of the main poles of technological development, as can be seen in Figure 9.

Figure 9 – Main countries of the applicants



Source: Authorship (2026)

Figure 9 shows an absolute dominance of the USA (106 documents), establishing itself as the main intellectual property center in this sector, with a volume almost twice as high as that of the second place, the Republic of Korea (55). This leadership reflects the size of the U.S. market for functional foods, nutraceuticals, and pharmaceuticals.

US companies and universities are the biggest filers of patents, demonstrating the robustness of the R&D system. This scenario reflects: a significant consumer market for supplements and functional foods; a favorable innovation ecosystem with access to robust venture capital for biotechnology startups; and cutting-edge academic research connected to the needs of industry. In this context, any global strategy in kefir and probiotics needs to consider the US as the main market and also as the main source of competition and partnerships.

The second largest global applicant is the Republic of Korea (55 documents), surpassing traditional powers such as France (33) and Denmark (25). This performance suggests that there is investment in biotechnology and innovation; a strong tradition in fermented foods (kimchi), which directly dialogues with probiotics; intense university-company interaction; and the presence of large conglomerates.

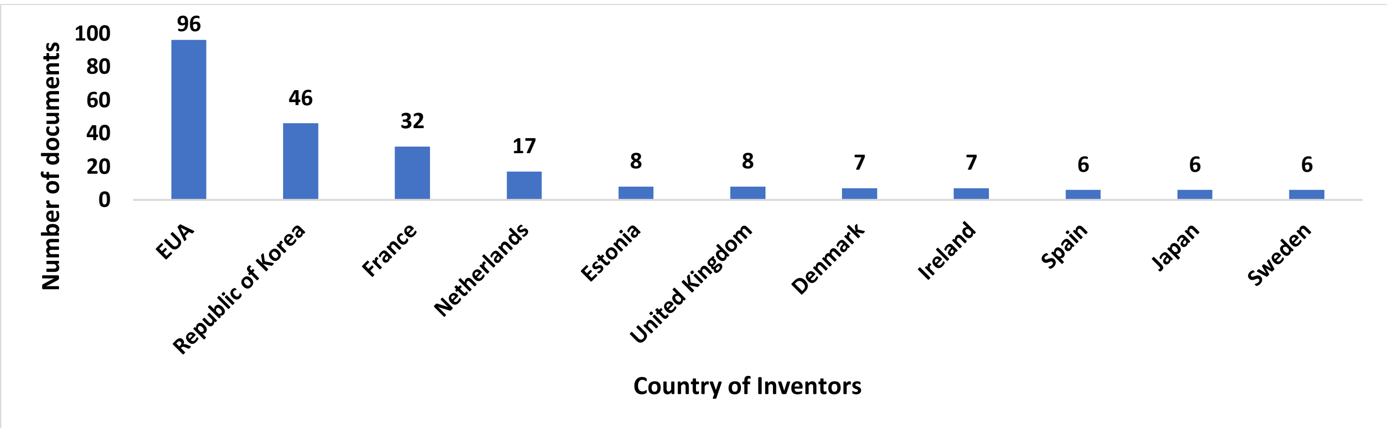
There is an Asian belt formed by the Republic of Korea (55 documents) and Japan (6). Although China does not appear on the list, there are local companies that stand out, such as Tianjin University, South China University, Bright Dairy, and Moon Guangzhou.

Europe surpasses the US, with 109 documents, proving to be the leading continent in generating innovation in kefir and probiotics. France (33) leads the way in the region, driven by its tradition in fermented dairy products (Danone) and research into probiotics.

COUNTRIES OF INVENTORS

The talent to innovate in kefir is concentrated in a few global hubs, especially the USA, the Republic of Korea, and France, as well as emerging niches such as the Netherlands, Ireland, and Estonia. The distribution of inventors by country of origin reveals the main breeding grounds for talent and creativity in this segment, as seen in Figure 10.

Figure 10 – Country of Inventors



Source: Authorship (2026)

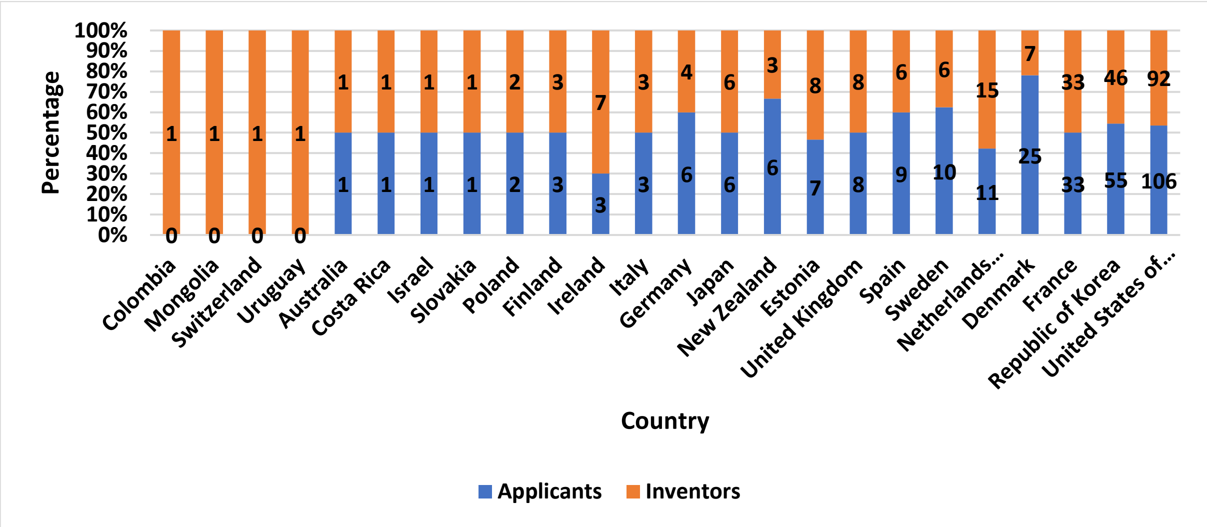
The absolute leadership is the USA, which has twice as many documents as the second-placed Republic of Korea. This position reflects the size of the country's R&D ecosystem, made up of hundreds of universities, research centers, and biotechnology companies. It also shows the potential to attract global talent, in addition to having an innovative culture, a mature patent system, and robust investment in research. Any company that wants to be at the forefront of this technology needs to monitor US inventors and consider establishing partnerships or hiring an expert in this market.

In second place is the Republic of Korea, which is ahead even of traditional European powers, reflecting the country's investment in education and research, especially in biotechnology; it has a tradition in fermented foods (kimchi) that generates applied knowledge in this technological segment; there is strong interaction between universities and companies, in addition to the dynamism of its industry. It is the main Asian talent hub, surpassing Japan and China in the number of inventors, representing a strategic source of knowledge and an opportunity for partnerships.

GEOGRAPHY OF KEFIR INNOVATION

The present analysis reveals the complex geography of kefir innovation, where capital, talent, and intellectual property are unevenly distributed, creating opportunities and challenges for different actors. The distribution of applicants and inventors by country reveals the relationship between the origin of capital/investment (applicants) and the origin of knowledge/creation (inventors), offering valuable information on the dynamics of innovation in kefir, as can be seen in Figure 11.

Figure 11 – Geography of kefir innovation



Source: Authorship (2026)

Countries such as the USA (106 applicants / 92 inventors), Denmark (25/7), the Republic of Korea (55/46), Sweden (10/6), Spain (9/6), Germany (6/4), and New Zealand (6/3) represent those that have more applicants than inventors, indicating that they are investment and capital hubs, where companies and institutions hold ownership of patents, even if part of the invention has been developed elsewhere.

The largest proportional difference is in Denmark (18): many patents are held by Danish applicants (Chr. Hansen, DuPont), but inventors are distributed in other countries, probably as a result of the global operations of companies and partnerships between inventors.

In second place is the USA (14), showing a strong concentration of capital and a high capacity to attract inventors from all over the world to work in US companies, but with intellectual property retained in the country.

This scenario suggests that these countries are centers of decision and control of innovation, and the companies installed in their territory coordinate global R&D activities and hold the rights to the inventions.

Countries such as the Netherlands (11 applicants / 15 inventors), Estonia (7/8), Ireland (3/7), Switzerland (0/1), Colombia (0/1), Mongolia (0/1), and Uruguay (0/1) have more inventors than applicants, indicating that they are hubs of talent and creation, where researchers develop innovations, but intellectual property is held by companies from other countries.

The largest proportional differences occur in the Netherlands (4) and Ireland (4), which stand out for having excellent research centers (Wageningen, APC Microbiome) and productive inventors, but patents are often held by foreign owners (4D Pharma, DSM). Therefore, these countries are sources of knowledge and talent, but they depend on foreign capital to transform invention into protected assets. They represent opportunities for partnerships and talent acquisition.

On the other hand, countries such as France (33 applicants / 33 inventors), the United Kingdom (8/8), Japan (6/6), Finland (3/3), Italy (3/3), Poland (2/2), Australia (1/1), Costa Rica (1/1), Israel (1/1), and Slovakia (1/1) show a perfect balance between applicants and inventors, indicating that innovation is developed and appropriated locally.

France represents the most emblematic case: French companies (Danone, among others) employ French inventors, generating a complete innovation ecosystem.

In general, these countries have mature and self-sufficient innovation ecosystems, where local talent is absorbed by local companies, generating retention of intellectual property.

As a general result, companies that want to find talent should look for it in the Netherlands, Ireland, and Estonia. To protect inventions, they should look to countries such as the Republic of Korea, Denmark, and the USA. In turn, R&D establishment can be done in countries such as France and the United Kingdom.

CONCLUSION

The present research showed that kefir is no longer just a traditional food and has consolidate itself as a strategic technological asset, inserted in a global context of innovation focused on health, nutrition, and biotechnology. The analysis of patents showed significant growth from 2014 onwards, with greater intensification between 2020 and 2025, indicating the maturity and consolidation of this technological field.

The results revealed a strong concentration of innovation in countries such as the United States of America and the Republic of Korea, as well as the predominance of large multinational corporations and biotechnology startups as the main patent applicants. A geographical division was also observed between countries that concentrate capital and intellectual property and those that stand out for the generation of knowledge and talent, evidencing the global dynamics of innovation based on the articulation between investment, research, and technological development.

From a legal point of view, the portfolio analyzed has a high degree of maturity, with a predominance of active patents and a low revocation rate, which indicates a competitive environment with significant barriers to entry. On the other hand, the presence of patents in the public domain reveals strategic opportunities for new entrants, especially in technological niches and incremental innovations.

However, the study has some limitations. The analysis focused on specific databases, especially Espacenet, which may not fully cover all existing patent documents, especially those that are not indexed or that are limited in terms of updating. In addition, the use of keywords and IPC codes, while judicious, may not capture all the terminological variations associated with kefir and probiotics. Another point refers to the temporal nature of patents, considering the 18-months secrecy period, which may imply underrepresentation of more recent filings. Furthermore, qualitative analysis, even if in-depth, may involve a certain degree of interpretative subjectivity.

As future perspectives, it is recommended to expand the analysis to other international databases, as well as to incorporate more advanced quantitative methods, such as analysis of co-authorship and co-citation networks. It is also suggested to investigate the economic impact of patents, the transfer of technology between universities and companies, and the relationship with public innovation policies. In the Brazilian context, the need for studies aimed at strengthening local innovation capacity, encouraging patents filings, and valuing traditional products with technological potential, such as kefir, is highlighted.

The technological field of kefir has high potential for growth and diversification, being promising for both industrial and therapeutic applications. Understanding its global dynamics contributes to scientific advancement and the development of innovative strategies, especially in a scenario that is increasingly health- and sustainability-oriented.

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