Odovtos-International Journal of Dental Sciences (Odovtos-Int. J. Dent. Sc.), 27 (1): 52-63 (January-April), 2025. ISSN: 2215-3411
https://doi.org/10.15517/ijds.2024.60813

ODOVTOS
International Journal of Dental Sciences

UNIVERSIDAD DE COSTA RICA
FOd Facultad de Odontología

https://revistas.ucr.ac.cr/index.php/Odontos

BASIC RESEARCH:

Scientometric Analysis of Activated Carbon or Probiotics in Mouthwashes or Toothpastes: Dynamicity, Spatiotemporal Evolution and Trends

Análisis cienciométrico del carbón activado o los probióticos en enjuagues bucales o dentífricos: dinamicidad, evolución espaciotemporal y tendencias

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Received: 12-IV-2024 Accepted: 26-VI-2024

ABSTRACT: The use of activated charcoal and probiotics is a controversial topic nowadays due to their potential oral health benefits. Thus, the aim of this research was to perform a scientometric analysis of activated charcoal or probiotics in mouthwashes or dentifrices by means of dynamicity, spatiotemporal evolution, and trends. A study was carried out to look back at scientific publications between 2005 and 2022 using the Web of Science. To analyze the data, various bibliometric indicators were used. The process of retrieving information was completed on July 28, 2023. It was found that only 1 article was published in 1990. Furthermore, the highest co-citation occurred in cluster 9 (Dentistry, Dermatology, Surgery), indicating a higher relevance and frequency with cluster 8 (Molecular Biology, Genetics). In the cluster view, 15 large clusters were identified, with cluster 0 (Activated Carbon) being the largest and occupying the greatest centrality. On the other hand, the cross-country collaboration map showed active collaborations between Australia and New Zealand, Brazil, and Canada. We found a significant growth of scientific publications on probiotics and activated charcoal in the field of dentistry and related disciplines between 1990 and 2023.

KEYWORDS: Activated carbon; Probiotics; Scientometrics; Web of science.

RESUMEN: El uso de carbón activado y probióticos es un tema controvertido en la actualidad debido a sus potenciales beneficios para la salud bucodental. Por ello, el objetivo de esta investigación fue realizar un análisis cienciométrico del carbón activado o los probióticos en colutorios o dentífricos mediante su dinamicidad, evolución espaciotemporal y tendencias. Se realizó un estudio retrospectivo de las publicaciones científicas entre 2005 y 2022 utilizando la base de datos Web of Science. Los patrones de visualización, las relaciones temporales y las tendencias se evaluaron mediante mapas superpuestos, visualización de zonas horarias y tres parcelas de campo. El proceso de recuperación de información finalizó el 28 de julio de 2023. Se encontró que sólo 1 artículo fue publicado en 1990. Además, la mayor co-citación se produjo en el clúster 9 (Odontología, Dermatología, Cirugía), indicando una mayor relevancia y frecuencia con el clúster 8 (Biología Molecular, Genética). En la vista de clústeres, se identificaron 15 grandes clústeres, siendo el clúster 0 (Carbón Activado) el más grande y el que ocupa la mayor centralidad. Por otro lado, el mapa de colaboración entre países mostró colaboraciones activas entre Australia y Nueva Zelanda, Brasil y Canadá. Encontramos un crecimiento significativo de las publicaciones científicas sobre probióticos y carbón activado en el campo de la odontología y disciplinas relacionadas entre 1990 y 2023.

PALABRAS CLAVE: Carbón activado; Bibliometrix; Probióticos; Estudio cienciométrico; Web of science.

INTRODUCTION

In the field of dentistry, antiseptic mouth rinses have become a common and effective practice to reduce the population of microorganisms in the oral cavity (1). These rinses are especially recommended before undergoing any dental procedure, as they ensure a cleaner and pathogen-free mouth (1). Although there has been a growing interest in the use of these rinses as a preventive measure, it is important to mention that there is currently no concrete evidence to fully support their safety (2). Therefore, it is essential to carefully analyze both their advantages and disadvantages, considering the individual needs and characteristics of each patient and dental procedure. The discussion of mouth rinses and conventional antiseptics used in dentistry is crucial to evaluate their potential role as an adjunct in reducing the microbial load in the mouth during dental treatments (3). By thoroughly understanding the benefits and limitations of these options, dental professionals will be able to make informed decisions and tailor their use appropriately to optimize outcomes.

Dentistry has constantly evolved and has achieved a lower prevalence of edentulism, this is due to a greater awareness of patients. This has increased the expectations regarding dental treatments. It is important to maintain and prevent the soft and hard tissues of the oral cavity in good condition (4, 5). Non-invasive methods are preferred in the prevention of certain pathologies to improve dental practice. This includes the indication of the use of toothbrushes, mouthwashes, and toothpastes to maintain oral health (6, 7).

Nowadays, dental esthetics has become increasingly important due to increased awareness of perfectionism and self-care, and tooth color has become a key aspect for the general public (8, 9). In this context, tooth whitening has been highlighted as a popular procedure, and it is important to note that it does not affect the hard tissues of the tooth, as the activated charcoal used in this process offers numerous benefits. Currently, many people opt for at-home whitening techniques due to their effective results (10). Among the available options, activated charcoal-based toothpastes have gained popularity, thanks to their promise of fast results. These products contain whitening and abrasive agents that effectively remove extrinsic stains from teeth, providing a convenient and economical solution to improve their appearance (11, 12).

Activated charcoal has generated interest in esthetic dentistry because of its ability to adsorb pigments and stains on the tooth surface. While numerous tooth-whitening products have begun to include activated charcoal in their recipes, the efficacy of this ingredient has yet to be scientifically confirmed (13). The use of high-concentration peroxides for tooth whitening has yielded unmatched outcomes, but it has also resulted in stricter regulations. Whitening toothpastes that contain oxidants or enzymes can chemically alter the pigments on the teeth, while those that contain optical modifiers, such as blue covarine, can alter the perceived tooth color. Activated charcoal has recently gained attention for its potential to absorb surface stains and pigments on teeth (14).

Evidence has shown that probiotics are microorganisms with a beneficial effect on health. In addition, they can improve oral health by maintaining a symbiosis in the bacterial flora (15). They can also potentially reduce the risk of periodontitis, dental caries, halitosis, and other disorders. In addition, their localized activity can have effects throughout the body, reducing the consequences of systemic inflammation (16).

Finally, it is important to mention that the use of activated charcoal or probiotics in toothpastes or mouthwashes is still a controversial issue. Although some companies claim that these products may have certain benefits in dentistry. Therefore, the objective of this research was to perform a scientometric analysis of activated charcoal or probiotics in mouthwashes or toothpastes by means of dynamicity, spatiotemporal evolution, and trends.

MATERIALS AND METHODS

STUDY DESIGN

An observational, descriptive, and cross-sectional study with a scientometric approach was carried out using the Web of Science (Core Collection) to analyze publications on the topic. The research focused on the period between 1990 and 2023.

SEARCH STRATEGY

On July 28, 2023, data were extracted from a total of 248 manuscripts using the Web of Science (WOS) database, which is a widely recognized database in the field of health. In addition, it was selected for its prestige and multidimensionality, which guarantees the quality of its contents and allows advanced analysis of metrics and advanced data search. To carry out the research, the thesauri available in the Mesh terms and the Emtree terms of Embase were used and a search strategy was defined using the logical operators "AND" and "OR". The details of the selected search strategy are presented in the following sections. TS=(“Mouth Rinse” OR “Mouth Rinses” OR “Rinse Mouth” OR “Rinses Mouth” OR “Mouth Bath” OR “Bath Mouth” OR “Baths Mouth” OR “Mouth Baths” OR “Mouth Wash” OR “Wash Mouth” OR “Toothpaste” OR “silicic acid-based toothpaste” OR “silica gel-based toothpaste” OR “Colgate Total Fresh Stripe Toothpaste” OR “Colgate Sparkling White with Tartar Control Toothpaste” OR “Colgate Tartar Control Plus Whitening Fluoride dentifrice” OR “CTPW toothpaste” OR “Colgate TCPWFT” OR “Colgate Total” OR “Colgate Total Plus Whitening Toothpaste” OR “Colgate Total toothpaste” OR “Colgate Simply White toothpaste” OR “Colgate Tartar Control Plus Whitening Fluoride Toothpaste” OR “RetarDENT toothpaste” OR “RetarDENT” OR

"Crest Intelliclean liquid toothpaste" OR "Crest Regular Dentifrice" OR "Crest Regular" OR "Crest regular cavity protection" OR "Colgate regular dentifrice" OR "Aquafresh Whitening Toothpaste" OR "Aquafresh Whitening dentifrice" OR "Crest Cavity Fighting Toothpaste with Fluoristat")AND TS=("Liqui-Char" OR "Actidose" OR "Actidose-Aqua" OR "Activated Charcoal" OR "Charcoal Activated" OR "Adsorba" OR "Carbomix" OR "Charbon" OR "CharcoAid" OR "CharcoCaps" OR "Charcodote" OR "Formocarbine" OR "Insta-Char" OR "Kohle-Compretten" OR "Kohle-Hevert" OR "Kohle-Pulvis" OR "Kohle-Tabletten Boxo-Pharm" OR "Ultracarbon" OR "Norit" OR "activated charcoal - colloidal silver - dimethicone - liquorice - silicone dioxide" OR "adsorgan"OR "Probiotic" OR "Beneficial microorganisms" OR "Friendly bacteria" OR "Gut flora" OR "Microbiota" OR "Live cultures" OR "Lactobacilli" OR "Bifidobacteria" OR "Lactic ferments" OR "Probiotic supplements" OR "Probiotic foods" OR "Bacteria cultures" OR "Beneficial bacteria" OR "Good bacteria" OR "Microbial supplements" OR "Live microorganisms" OR "Gut-friendly bacteria" OR "Intestinal flora" OR "Friendly flora" OR "Microbiotic agents" OR "Probiotic strains" OR "Digestive health supplements" OR "Beneficial microorganisms" OR "Microbiome boosters" OR "Probiotic microorganisms" OR "Probiotic bacteria" OR "Synbiotics (combination of prebiotics and probiotics)" OR "Biotics" OR "Bifidobacteria" OR "Lactobacillus" OR "Fermented foods").

BIBLIOMETRIC INDICATORS

The study used various indicators of production, collaboration, and impact, as well as document contents, Authors collaboration, document types, annual growth, Lotka's law, Bradford's law and the annual scientific & train Topic, Overlay map, Timezone visualization, Clustering virew, and Timeline view cluster graphs. In addition, thematic maps were used to visualize the relationships and collaborations between authors and countries.

DATA ANALYSIS

After the metadata was retrieved, it underwent analysis, which included elements such as the author's name, the number of citations, the journal, and the country. The analyzed data was then exported to CiteSpace 6.2 R2 [2003-2023 Chaomei Chen] and R Studio software, specifically Bibliometrix 3.0.

RESULTS

The results of the bibliometric analysis revealed that the data cover a period from 1990 to 2023 and include 150 sources, such as journals and books. A total of 248 documents were analyzed, with an annual growth rate of 9.97% and an average age of 7.49 years. The average number of citations per document was 18.55, with a total of 8206 references. As for the content of the documents, 755 Plus Keywords and 664 Author Keywords were identified. A total of 1176 authors contributed to the papers, and only 5 authors produced single-authored papers. In terms of inter-author collaboration, there were only 5 single-author papers, with an average of 5.36 co-authors per paper. International collaborations accounted for 25% of the total. Regarding document type, most were articles (214), with some classified as article; data paper (1), article; early access (6), article; proceedings paper (2), correction (1), and editorial material (2) (Table 1).

It was found that, in 1990, only 1 article was published, while in 1991, 3 were published. In addition, it could be seen that between 1992 and 2010 there was a sustained growth of less than 10 articles. However, it could be visualized that from the year 2016 onwards there was the greatest increase exceeding 20 manuscripts published over time (Figure 1.A). The analysis evidenced that the most frequent terms in the analyzed papers include "*mutans streptococci*" (7 times), "plaque" (5 times), "lactobacilli" (8 times), among others. In addition, a detailed representation of the most representative terms was found in relation to the distribution (Figure 1.B).

The Dual Map Overlay plot allowed comparison and analysis of the relationship between two data sets. It was observed that the highest co-citation occurred in cluster 9 (Dentistry, Dermatology, Surgery), indicating a higher relevance and frequency with cluster 8 (Molecular Biology, Genetics). This can be seen through the larger nodes and links that are formed in this field of knowledge (Figure 2).

Figure 3.A, which corresponds to the Time Zone Visualization, shows temporal patterns and trends. In particular, the largest nodes correspond to authors Brooks JK (2017), Vaz VTP (2019), and Franco MC (2020), who had high linking activity among the citations of the other nodes. Larger nodes indicated higher relevance, while thicker links indicated a higher amount of inter-document citations. Figure 3.B shows how citation patterns among scientific journals have evolved over the years evaluated. It was identified that in 2013 there was the highest number of nodes, represented by journals such as Plos One, J Dent Res and Oral Health Prev Dent, among others. However, a lower citation frequency was observed between the years 2021 and 2022.

In the cluster view, 15 large clusters were identified, of which cluster 0 (Activated carbon) had the largest size and a central position. This was followed by cluster 1 (Subgingival plaque) in which a great deal of research activity on these topics was evident. Finally, there were 13 other clusters of lesser relevance (Figure 4).

According to Bradford's Law, it was found that the most representative journals were "Caries Reserach" (12 articles), "BMC Oral Health" (8 articles), and the "International Journal of Dental Hygiene" (7 articles), finding that these journals corresponded mainly to zone 1, while in zone 2 the "Journal of Dental Reserach" (3 articles), and "Scientific Reports" (3 articles) were found, which shows an unequal distribution in the concentration of journals (Figure 5.A). According to Lotka's law, it was found that the majority of authors (1074 or 91.3% of the total) wrote only 1 scientific article. While 5.4% wrote only 2 papers. This indicates that the authors generally had only 1 paper written (Figure 5.B).

The cluster timeline view revealed 10 major clusters, with cluster 0 (Dental enamel) being the most prominent because it presented an increase in the number of horizontally arranged nodes over time. In particular, during 2020, high citation activity was observed with authors Vaz VTP (2019) and Greenwall LH (2019) (Figure 6).

The map of collaboration between countries evidenced that collaborations were observed between Australia and New Zealand, Brazil and Canada, Brazil and France, Brazil and Germany, Brazil and Italy, and Brazil and Spain, each with 1 article. Brazil also collaborated with Switzerland on 2 articles. Other collaborations included China and Australia, China and Germany, China and Malaysia, China and New Zealand, and China and Singapore, each with 1 article. Collaborations were also noted between Denmark and Greece, Finland and Kuwait, and France and Portugal, each with 1 article. In summary, our analysis shows a wide range of international collaborations in the production of scientific articles (Figure 7).

Table 1. Scholarly Output.

Description	Results
Main information about data	
Timespan	1990:2023
Sources (Journals, Books, etc)	150
Documents	248
Annual Growth Rate %	9.97
Document Average Age	7.49
Average citations per doc	18.55
References	8206
Document contents	
Keywords Plus (ID)	755
Author's Keywords (DE)	664
Authors	
Authors	1176
Authors of single-authored docs	5
Authors collaboration	
Single-authored docs	5
Co-Authors per Doc	5.36
International co-authorships %	25
Document types	
article	214
article; data paper	1
article; early access	6
article; proceedings paper	2
correction	1
editorial material	2

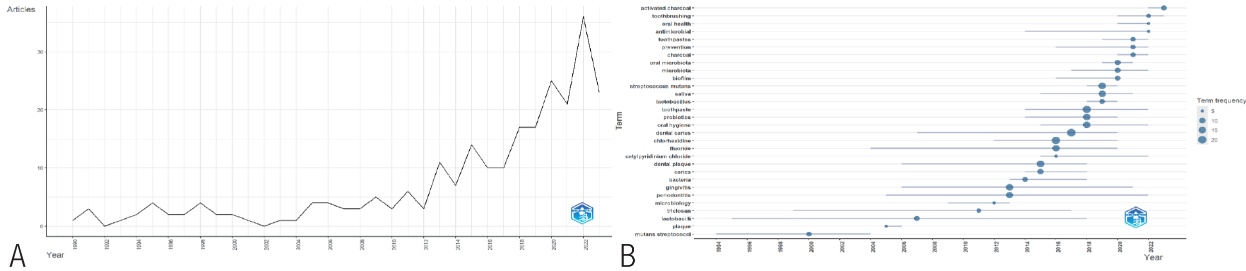

Figure 1. Annual scientific production & Trend topics.

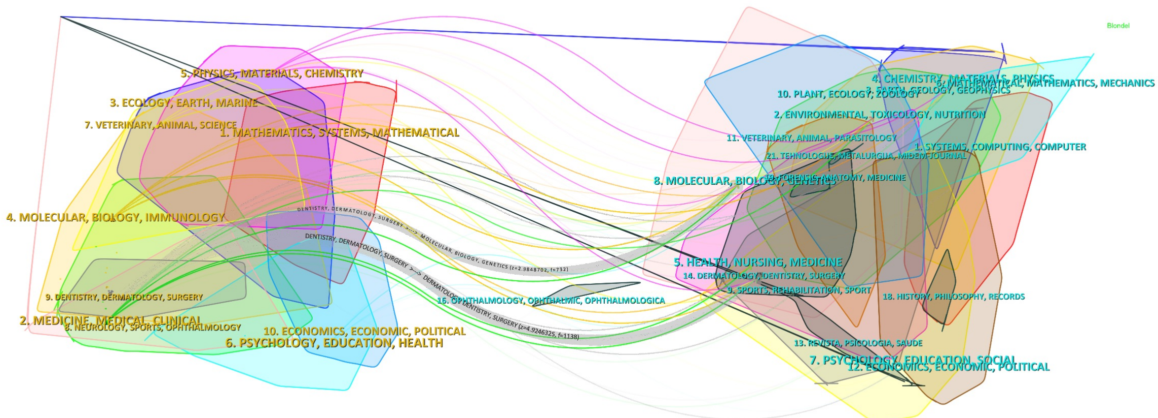

Figure 2. Overlay maps.

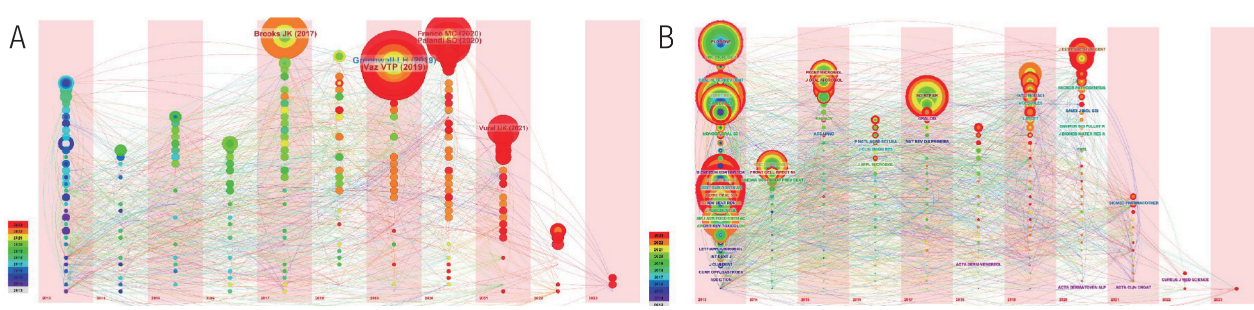

Figure 3. Timezone visualization.

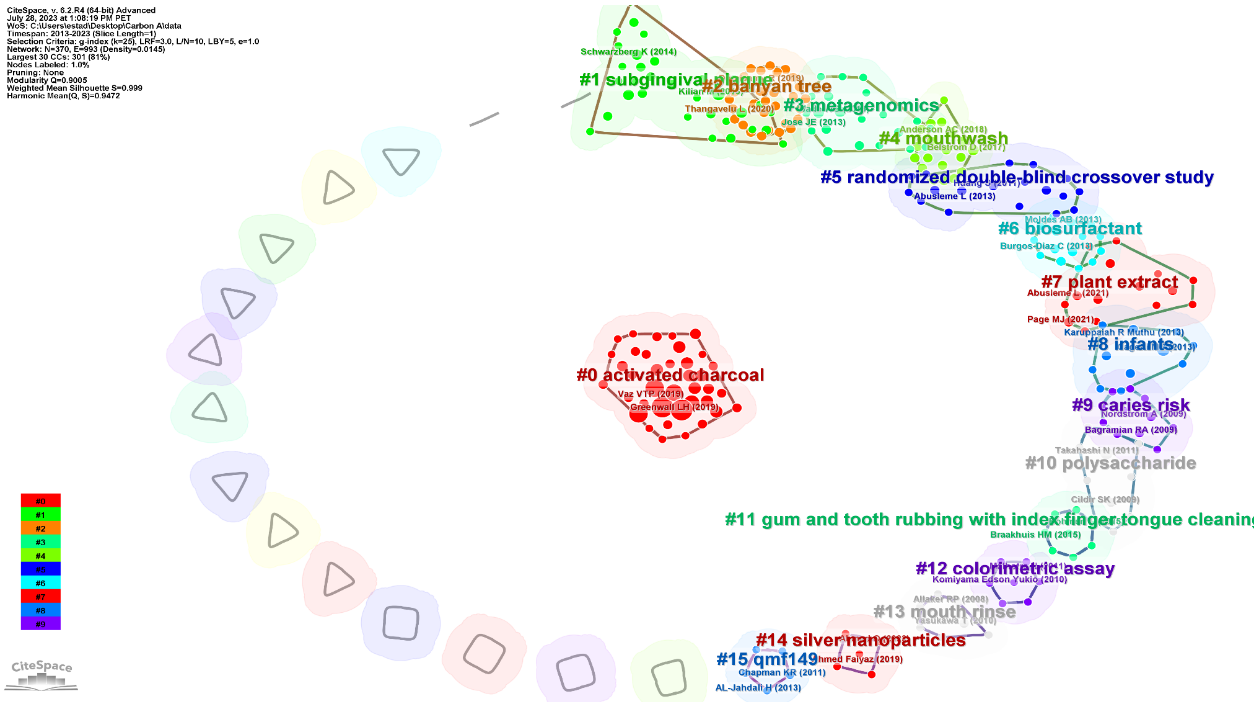

Figure 4. Clustering view.

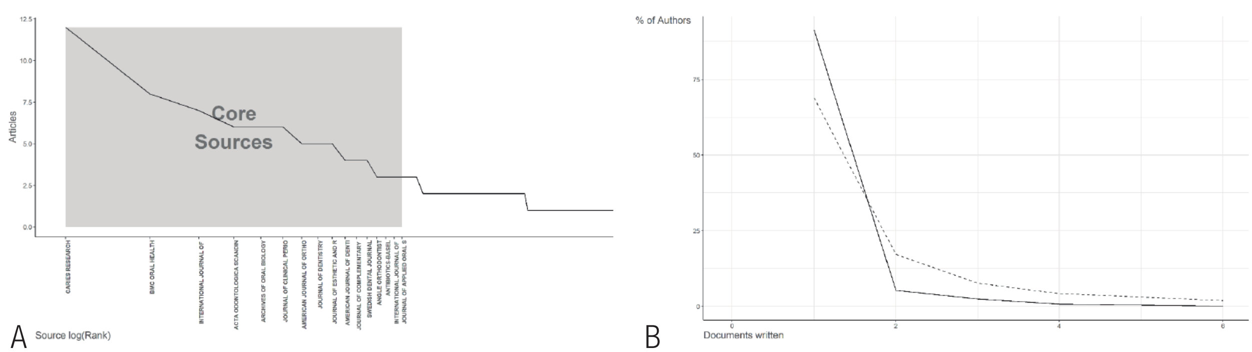

Figure 5. Bradford & Lotka´s Law.

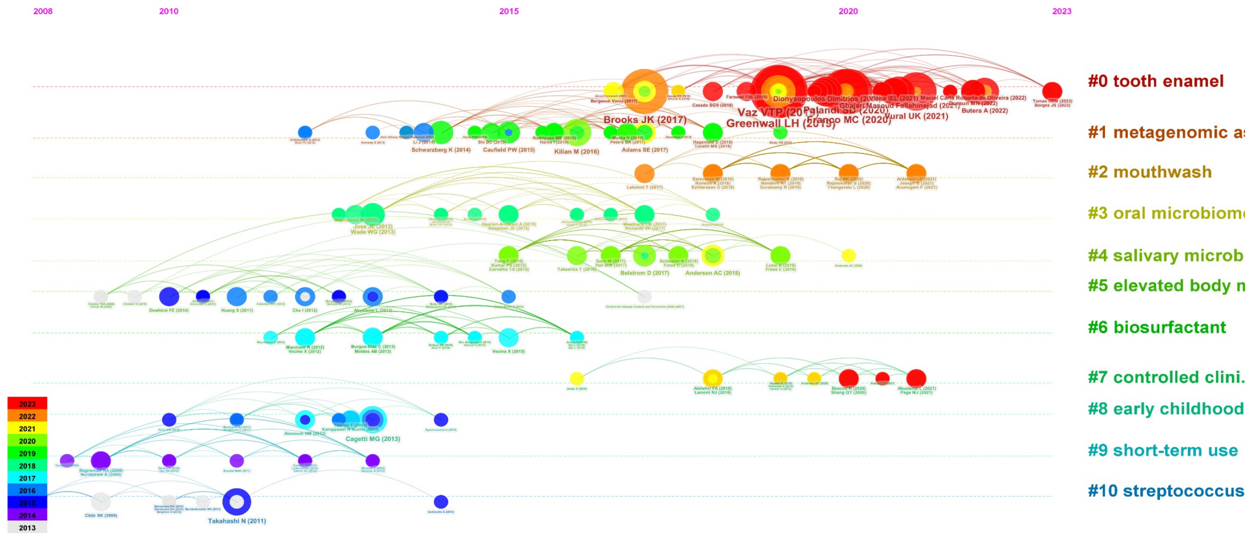

Figure 6. The timeline view clusters.

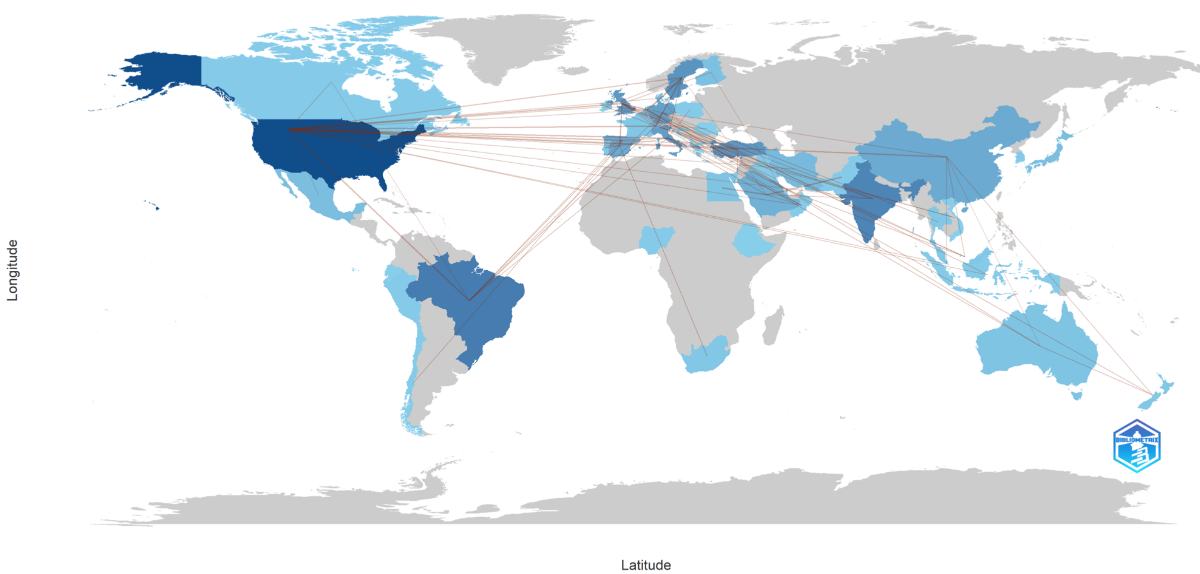

Figure 7. Country collaboration map.

DISCUSSION

Activated charcoal is a fine black powder obtained by superheating charcoal and other natural products, resulting in a very porous substance. It has long been used in emergency departments for the treatment of drug overdoses (17-19). In dentistry, activated charcoal is used in products such as toothpaste. Although it may sound strange, manufacturers claim that it can be very beneficial for oral health. The alleged benefits of charcoal-based dental antimicrobial and antifungal. However, researchers have found that there is insufficient clinical evidence to support these claims (20).

Although there is little research evaluating the clinical efficacy of organic dentifrices, there appears to be a growing trend in their use. It is important to obtain scientific evidence on their ability to remove external discoloration, their abrasive action, and their possible effects on enamel (21). Given this, questions arise about the remineralizing effects of organic toothpastes. It is essential to answer these questions to promote their use and provide evidence-based clinical recommendations to both practitioners and patients. None of the studied formulations included ozonated olive oil. The additional database can be accessed from the corresponding author upon a reasonable request, and it's possible to search all the individual ingredients listed (22).

Regular use of fluoride toothpastes is an important measure to prevent caries or other dental diseases. However, toothpastes with high concentrations can cause alterations in developing teeth (23). Activated charcoal is a popular component in dental products, such as toothpastes and mouthwashes, due to its adsorption and impurity removal properties. Although further research is needed to confirm its efficiency in these types of products, it should be noted that not all dental products with activated charcoal contain fluoride, an essential component for combating dental caries. Therefore, it is advised to opt for products with activated charcoal that also contain fluoride for better oral outcomes (24).

The bibliometric analysis of activated charcoal and probiotics provides a detailed overview of research and development in the field of dental products containing these ingredients. This analysis allows researchers and practitioners to better understand current and future trends in the use of activated charcoal and probiotics in dental products, as well as their efficacy and safety. By examining the dynamicity, spatio-temporal evolution and trends in this field, promising areas of research can be identified, and more effective products can be developed to improve oral health. In our research, we conducted a comprehensive bibliometric analysis of activated charcoal applications in dentistry, identifying trends and topics explored and evaluating available research. This analysis allows us to integrate entire fields of research or specific areas of scientific application to gain a more complete understanding of the potential of activated charcoal in improving oral health.

Potential limitations could include the need to look at data from other databases besides Scopus, such as Embase and PubMed. This could provide a broader and more in-depth view of scientific papers related to the topic. Although Scopus is among the largest databases for dental-related content, it's important to carefully consider the findings from it, as they might not encompass the entirety of worldwide research.

CONCLUSIONS

In conclusion, the scientometric analysis revealed that the data covers a period from 1990 to 2023 and includes 150 sources such as journals and books. A total of 248 documents were analyzed, with an annual growth rate of 9.97% and an average age of 7.49 years. The average number of citations per document was 18.55, with a total of 8206 references. The most frequent terms in the analyzed papers included "mutans streptococci" (7 times), "plaque" (5 times) and "lactobacilli" (8 times). The highest co-citation occurred in cluster 9 (Dentistry, Dermatology, Surgery), indicating a higher relevance and frequency with cluster 8 (Molecular Biology, Genetics). The most representative journals were "Caries Research" (12 articles), "BMC Oral Health" (8 articles) and "International Journal of Dental Hygiene" (7 articles).

CONFLICT OF INTEREST

No conflict of interest.

FUNDING

This research did not receive grants.

AUTHOR CONTRIBUTION STATEMENT

Conceptualization and design: F.M., C.M.V., F.E.C., and F.M.T.
Literature review: L.V., D.G.V and D.A.T.
Methodology and validation: F.M.T .and F.E.C.
Formal analysis: F.M., F.M.T., and C.M.V
Investigation and data collection: F.E.C. and D.G.V.
Resources: F.E.C. and L.V.
Data analysis and interpretation: F.M.T., F.E.C., D.G.V., F.M.
Writing-review and editing: L.V. C.M.V., and F.M.
Supervision: F.M.T.
Project administration: F.M. F.E.C. and L.V.

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