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The World of Capers: A Scientometric Analysis

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Abstract

Capparis spinosa L. is a perennial plant adapted to hot, arid environments, commonly found among rocks and sandy soils across parts of Europe, Africa, and Asia. Despite its limited global distribution, its unopened flower buds hold the highest commercial value. This study aimed to identify publication metrics to provide a comprehensive overview of the evolution of research on this species. Scientometric tools, which assess scientific development over time based on quantitative indicators, were employed to track and analyze trends in the field. The Web of Science database and the Rayyan® application were used to conduct a bibliographic survey. Results indicate that *C. spinosa* has long been used in traditional medicine to treat various ailments, with different plant parts—stems, leaves, fruits, and flowers—studied in relation to the cultural and medicinal practices of specific regions. Research has also examined the plant's adaptation to harsh climates and its properties as a salted delicacy. Investigations have focused on taxonomy, chemical composition, and potential health benefits. Overall, findings suggest that while *C. spinosa* remains a relevant subject of scientific inquiry, the body of knowledge produced is still strongly concentrated in countries with historical and cultural ties to the species.

Keywords: scientometrics, bibliometrics, *Capparis spinosa*.

Practical Application: This is the first scientometric study on *Capparis spinosa* L. conducted in Brazil, mapping global research trends on the species. The plant's resilience to arid environments, nutritional value, and potential health benefits make it promising for regions of Brazil facing water scarcity. By consolidating existing knowledge, this work supports assessing the feasibility of introducing *C. spinosa* cultivation in the country, fostering agricultural diversification, and creating opportunities for the food and pharmaceutical sectors, as well as stimulating further national research.

1 INTRODUCTION

Capers (*Capparis spinosa* L) are perennial plants that grow in specific environments, such as rocky areas characterized by hot and dry conditions. Although the plant produces fruit, its most commonly consumed and commercially valued part is the flower bud (Alzahrani et al., 2021; Chedraoui et al., 2017).

The flower is commonly found in European countries such as Spain and Italy, particularly, as well as in parts of the Mediterranean region. However, its natural distribution extends as far as China, encompassing African countries like Egypt and Algeria, and Asian countries such as Iran (Inocencio et al., 2006; Stefanucci et al., 2018).

According to historical accounts, capers were already part of the local culture in northwestern China around 2800 BCE, having been uncovered in tombs located in Chinese districts. In parts of Europe, they were appreciated both as a culinary ingredient and for medicinal purposes, becoming integrated into distinct cultural practices even before being subject to exportation (El Finou et al., 2024; Jiang et al., 2007).

Due to its wide natural geographic distribution, capers have played an important historical role across various cultures. Their most common use has been in traditional medicine, targeting different ailments depending on the region. Moreover, different parts of the plant such as the stem, leaves, fruits, and flowers have been used in specific ways, according to the cultural and medicinal context of each area (Grimalt et al., 2018; Zhu et al., 2022).

Due to its consumption and production in various regions, a wide range of studies has been conducted, from food science research investigating the presence of specific compounds, to botanical studies aimed at understanding its taxonomy and medicinal applications, with the goal of evaluating the potential health benefits of its intake (Lo Bosco et al., 2019; Sun et al., 2023, 2024).

This diversity of knowledge generated through published articles over the years has contributed to reshaping and enhancing the scientific community's understanding of capers. As noted by Guerrero-Bote and Moya-Anegón (2015), the significant growth in research within the field of food science must be emphasized in order to fully grasp the importance of this raw material in that context.

One of the tools used to compile and analyze the evolution of research within a specific subject area is scientometrics.

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Developed by Russian scientists Nalimov and Mul'chenko (1969/1971), scientometrics emerged with the aim of evaluating the development of research conducted at the time, and was defined as an informational process.

Naturally, it is not possible to evaluate all studies on the same level, as they encompass different topics, varying degrees of depth, and a complex web of interrelated issues that form an intricate network of information. However, through this tool, it is entirely feasible to assess the evolution of research in central aspects, placing greater emphasis on general metrics rather than the intrinsic quality of the materials analyzed (Blázquez-Ruiz et al., 2016, p. 1041).

Thus, the objective of this study was to collect data and refine the search using tools such as the Web of Science (WOS), retaining in the database only content directly related to the main topic with the support of the Rayyan® application.

Additionally, efforts were directed toward characterizing and translating the dataset in order to understand the progress of research focused on the specific attributes of capers, identifying key elements such as countries, authors, and universities, along with other relevant information obtained through the R Studio® software.

1.1 Relevance of the work

This study provides a comprehensive scientometric assessment of research on *Capparis spinosa* L., a perennial species adapted to arid environments and culturally significant in various regions. Using the Web of Science database and Rayyan® application, we mapped publication trends, revealing its long-standing use in traditional medicine and as a valued culinary product. Analyses highlighted investigations into its taxonomy, chemical composition, and bioactive properties, alongside studies on its environmental resilience. The findings underscore that scientific output remains strongly linked to countries with historical ties to the plant, offering valuable insights for expanding research beyond traditional geographic and cultural boundaries.

2 MATERIAL AND METHODS

For the development of the study material, the WOS platform was used, a database managed by Clarivate and made available in Brazil through an agreement with the Coordination for the Improvement of Higher Education Personnel.

The research strategy for the bibliographic records was based on a keyword search using the terms "Capper AND *Capparis spinosa*." The time frame selected was from 1958 to 2024, with no language restrictions.

For the identification of relevant articles, an initial set of 1,340 documents was retrieved using the specified keywords and exported in ".bib" format. The raw data extracted from WOS were then uploaded to the Rayyan® platform for article screening. The inclusion criterion was based on the relevance of each document to the topic, and those not related to capers in any meaningful way were excluded.

From the selected documents, a new list was created within WOS, and the refined dataset was exported again in ".bib" format for further analysis in the statistical software RStudio® version 4.3.2 (2023).

3 RESULTS AND DISCUSSION

The infographic (Figure 1) illustrates how data extraction yielded information on publications, beginning with the earliest in 1958 and extending through 2024, encompassing a total of 483 documents, including original research articles and review papers, sourced from 312 distinct publications.

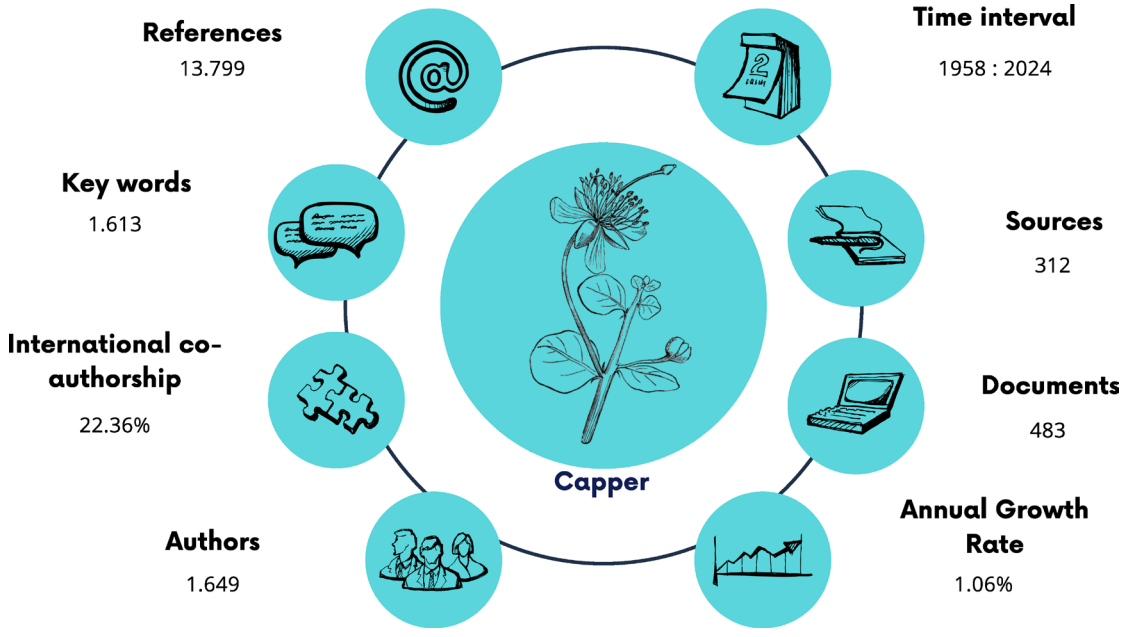


Figure 1. Infographic of general information extracted from the Web of Science database.

Despite involving over 1,600 authors and citing more than 13,000 references, the topic exhibits a modest annual growth rate of only 1.06%. Nevertheless, international co-authorship exceeds 20%, primarily due to the contributions of Mediterranean countries in collaboration with the broader global community, as this region is the leading producer of commercial capers.

Brazil is not among the countries contributing to research on capers and shows no collaborative ties with caper-producing nations. This can be partly attributed to Brazil's lack of significant caper cultivation, with its role limited to that of an importer of the product, primarily in the form of acidified preserves.

3.1 Sources

The analysis of Figure 2A reveals a growth trend in the number of publications over the past 25 years (1998–2023). Although the first publication appeared in 1958, with no subsequent records until 1976, it is possible to observe a clear upward trend in the volume of published material.

The peak of this growth was observed in 2023, with a total of 45 published articles. This increase may be correlated with the pandemic period, during which there was a rise not only in publications on capers but across a wide range of scientific topics. Although the number of publications in this specific field

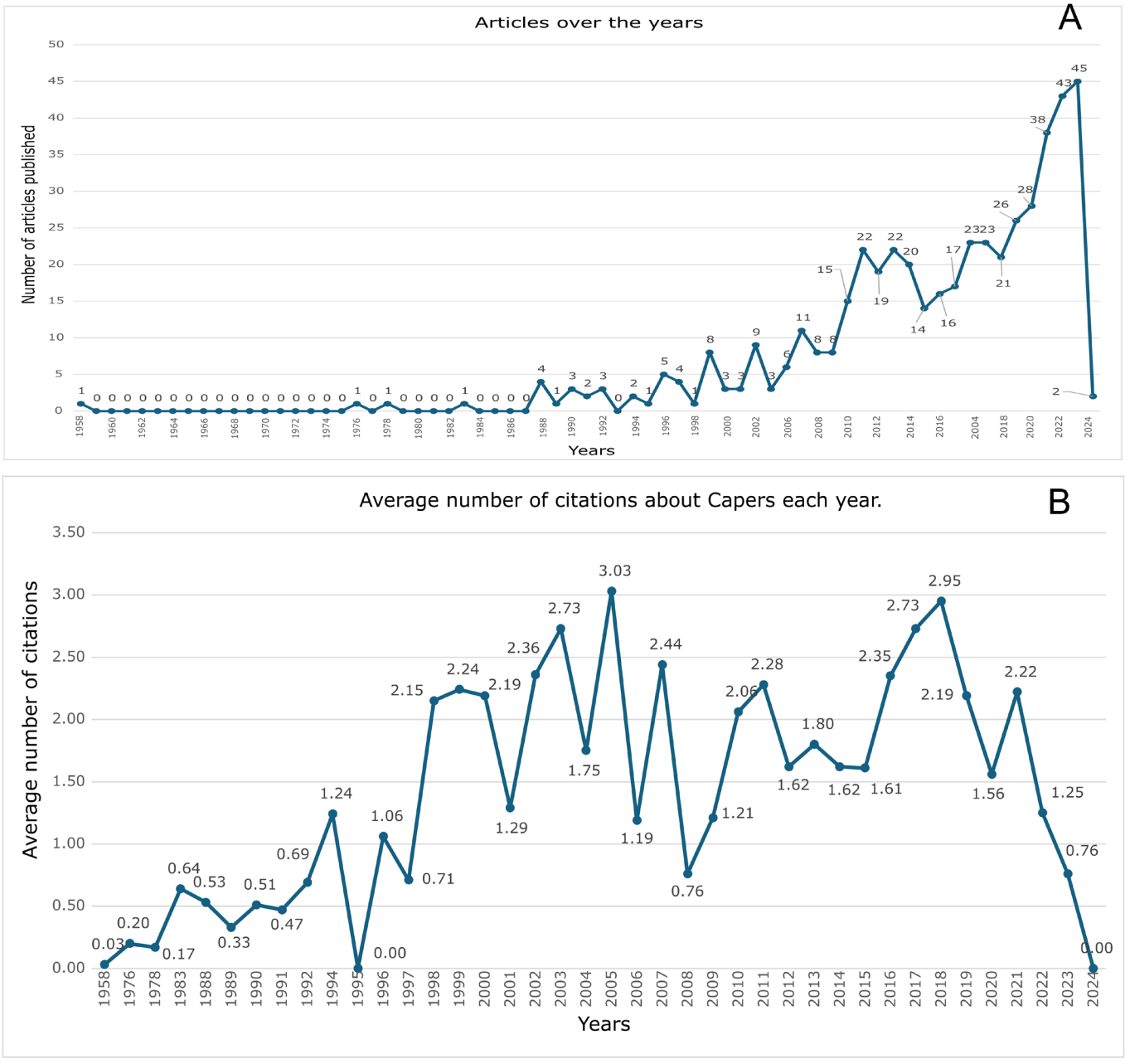


Figure 2. (A) List of the number of articles published on capers over the years. (B) Average number of citations involving capers over the years.

remains relatively low compared to other areas, the observed growth is considered significant (Else, 2020; Lee et al., 2023).

The average number of citations also reflects this trend, as illustrated in Figure 2B, which shows a consistent citation rate over the past 25 years (1999–2024), with a peak of three citations in 2005.

It is likely that this figure is lower than citation volumes observed in more commonly studied fields. However, direct comparison is not feasible, as there is no comparable dataset available, and there are no scientometric studies specifically focused on preserved products or edible flowers used as delicacies, such as capers.

Nonetheless, it is important to consider that the caper is native to a highly specific region and is not widely studied across different parts of the world due to factors related to its production, cultural relevance, and plant accessibility.

Among the countries involved in academic research on capers, Tunisia stands out through the University of Tunis El Manar, due to its direct connections with key authors in the field. Although not a major producer, the country has made significant contributions through researchers such as Tilili, Khaldi, Nasri, Triki, and Saadaoui, whose work has laid the foundation for the caper research field. These scholarly connections also extend to other countries, including Spain and Turkey.

The correlation analysis presented in Figure 3 reveals that some authors hold multiple affiliations, both with institutions in their home countries and with universities abroad. For instance, the author Fici, despite his strong association with the University of Palermo, Italy, also maintains a minor affiliation with the Islamic Azad University in Iran. This situation is likely the result of collaborations established during the publication of scientific articles.

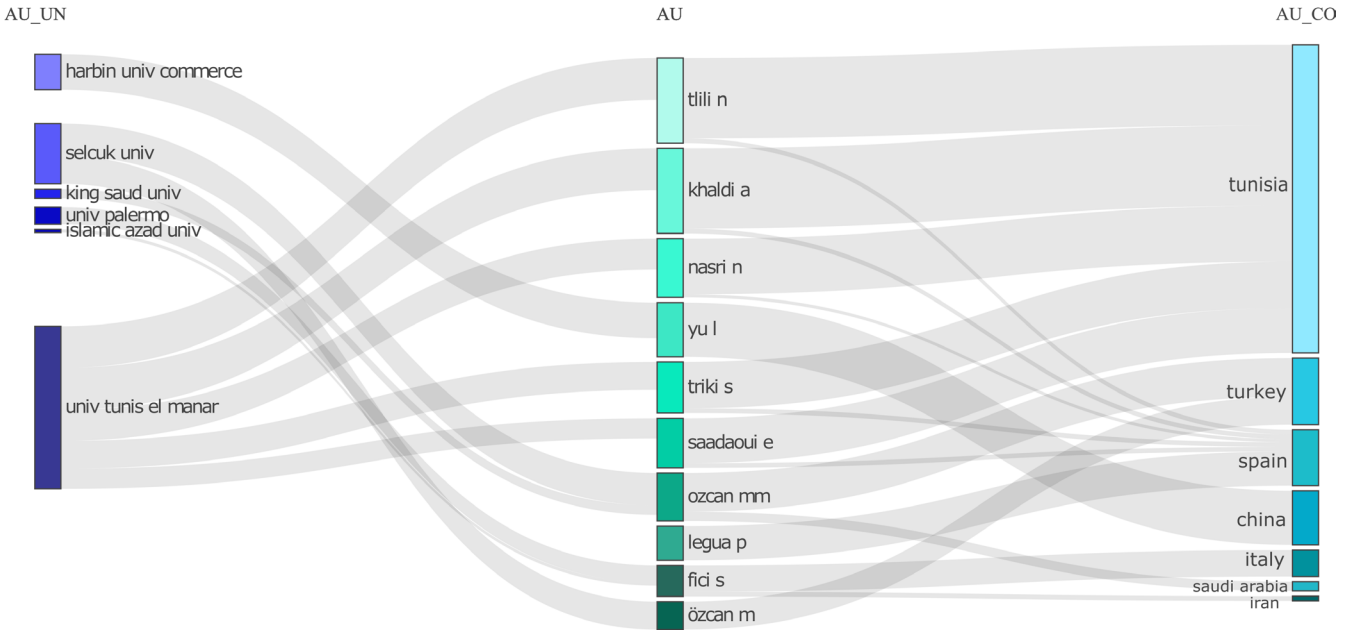
When examining the relationship between countries and authors, Tunisia stands out with strong connections to five authors—Tilili, Khaldi, Nasri, Triki, and Saadaoui—surpassing even more prominent caper-producing countries such as Italy and Spain.

Although multiple author-to-author connections exist, universities tend to maintain strong ties with their national affiliates. These are not considered international partnerships, as their collaborations remain primarily with researchers from their own countries. This is evident, for example, in the University of Tunis El Manar, which is closely linked to Tunisia through its researchers.

3.2 Journals and authors

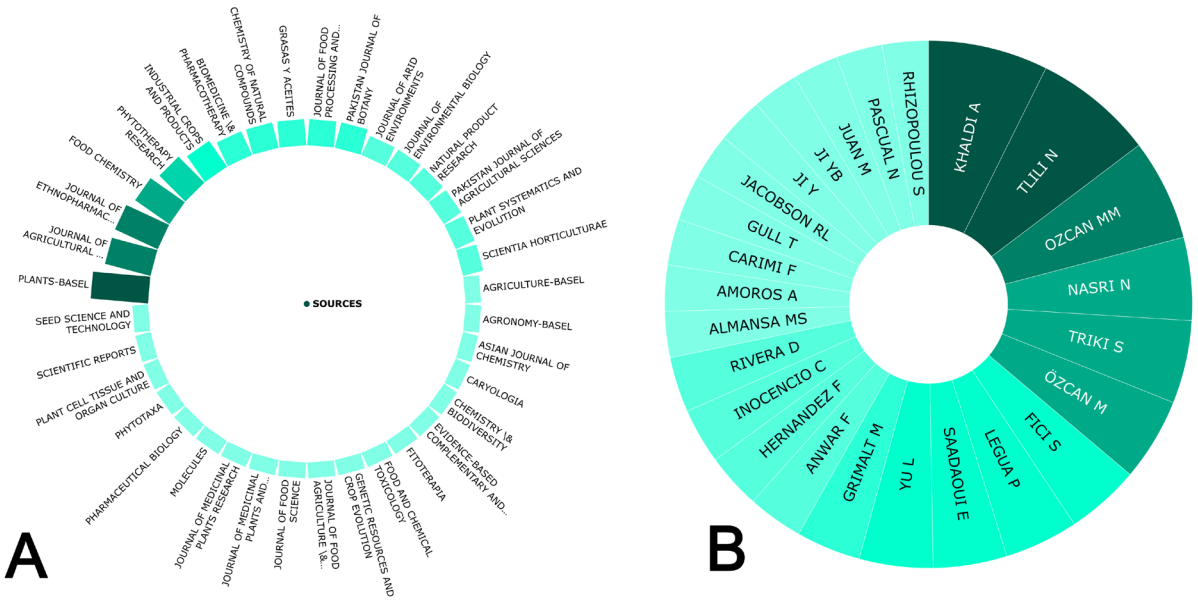
Among the main journals, we can see in Figure 4A that *Plants-Basel* stands out with 11 documents, and *Journal of Agricultural and Food Chemistry* and *Journal of Ethnopharmacology* have 9 documents. It is possible to identify that different strands of research can study capers, demonstrating a certain variety of uses, even if there are few publications.

In addition to scopes aimed at agronomy and chemistry, it is possible to identify important journals in the field of natural compounds, aimed at medicine, biology, botany, and pharmacology.



AU_UN: correlating universities; AU: authors (AU); AU_CO: countries of origin of publications.

Figure 3. 3-point graph correlating Universities, authors, and countries of origin of publications studying capers.



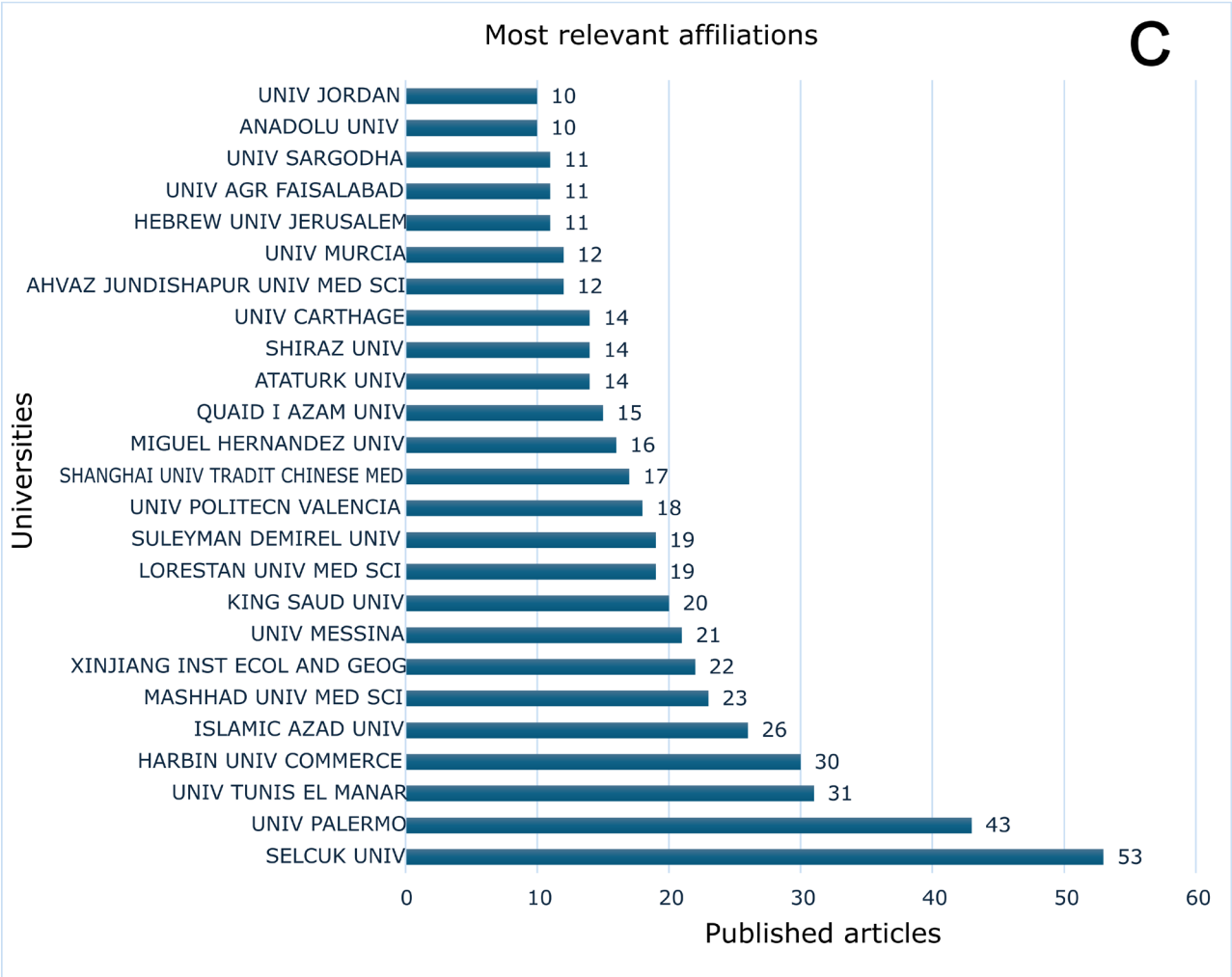


Figure 4. (A) Spiral of the main journals that have published on capers, (B) most relevant authors within the database analyzed, and (C) most relevant affiliations in terms of number of publications.

As mentioned above, the five authors linked to the University of El Manar in Tunis are also the most important authors in the field. Khaldi and Tlili have 13 documents, followed by Özcan with 11, and the others with 9 documents, as can be seen in Figure 4B.

In quantitative terms, Selcuk University, located in Konya, Turkey, stands out for its number of academic publications, surpassing more traditional institutions such as the University of Palermo in Italy.

Moreover, Turkey demonstrates a significant presence in the scientific literature on capers, being the country of origin for the majority of contributing authors, as illustrated in Figure 4C. Additionally, Turkey has amassed an impressive total of 84 publications related to the topic of capers.

Other universities also emerge in this field, primarily associated with regions where caper cultivation occurs, such as areas in the Mediterranean, Europe, and Asia.

An analysis of citation counts within the selected database in relation to the contributing authors (Figure 5A) reveals the recurrence of several highly influential authors who also rank among the most frequently cited locally. Notable examples include Khaldi and Tlili, each with 226 citations, followed by Triki with 166 citations and Nasri with 118.

Although Fici is not among the most prominent authors in terms of relevance, he has accumulated a considerable number of citations, totaling 102 in the local database. Conversely, Hernandez is regarded as more relevant than Rivera, despite having only 19 citations, whereas Rivera has 85 local citations.

These differences can be attributed to the fact that the topics addressed vary, and although they all concern the same product, capers, they are approached from different perspectives. Depending on the subject matter, one author may be cited more frequently than another, based on the specific focus of the publication.

It is important to note that the relevance data presented here are based solely on the number of local citations an author has received, without considering the content of the article in which the author is cited or contributes as a co-author.

Analyzing Figure 5B, it becomes evident that Özcan has established himself as a key reference in the field, primarily due to publications released between 1999 and 2005. Fici also has earlier publications, although the majority of his work has been published since 2014, with a relatively consistent output in subsequent years.

Triki stands out for his publication volume between 2009 and 2011, while Tlili is notable for having published every 2 years between 2015 and 2019. The period from 2007 to 2023 was undoubtedly the most prolific for the topic, with contributions from prominent authors such as Khaldi and Ozcan M.M.

3.3 Countries

As shown in Figure 6A, caper-producing countries tend to publish more articles independently, reflecting a higher level of direct involvement and a self-sufficient academic output on the topic.

In contrast, non-caper-producing countries, such as the USA and Algeria, often form partnerships with producing countries to conduct related research. These collaborations result in joint publications that are counted for both countries, highlighting the presence of international cooperation.

In such cases of international collaboration, research resources, particularly analytical equipment, are frequently provided by non-producing countries, aiming to offset the lack of domestic production with the expertise and specialized knowledge offered by producing nations.

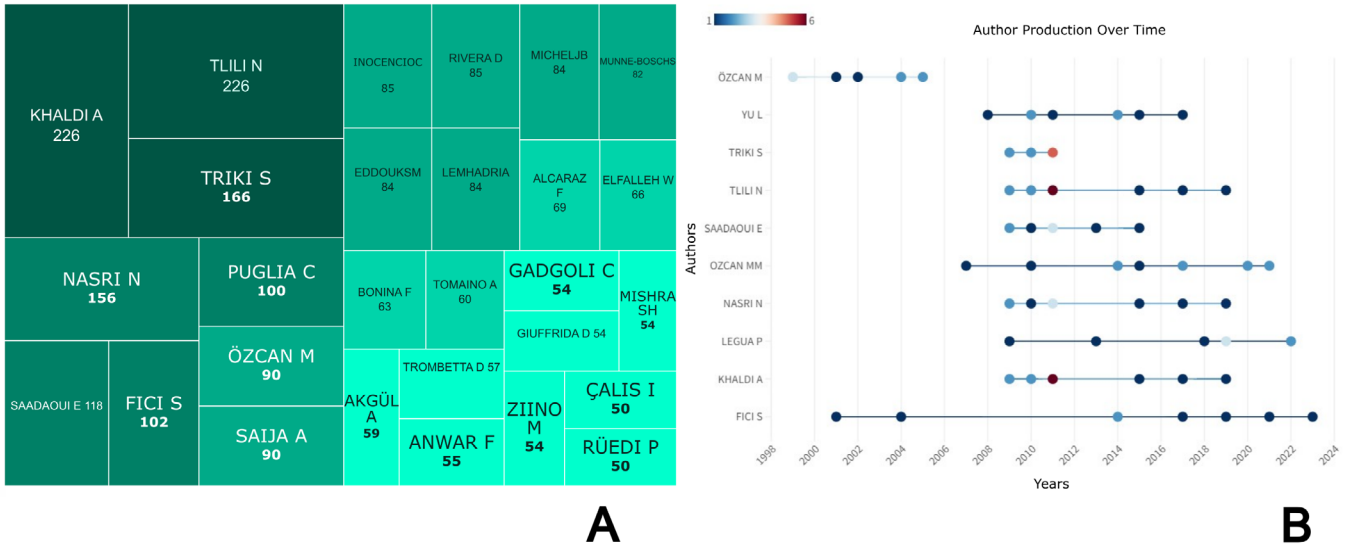


Figure 5. (A) Most cited authors in the Web of Science database. (B) Authors' output over the years with a color scale from blue to purple indicating 1–6 publications per year.

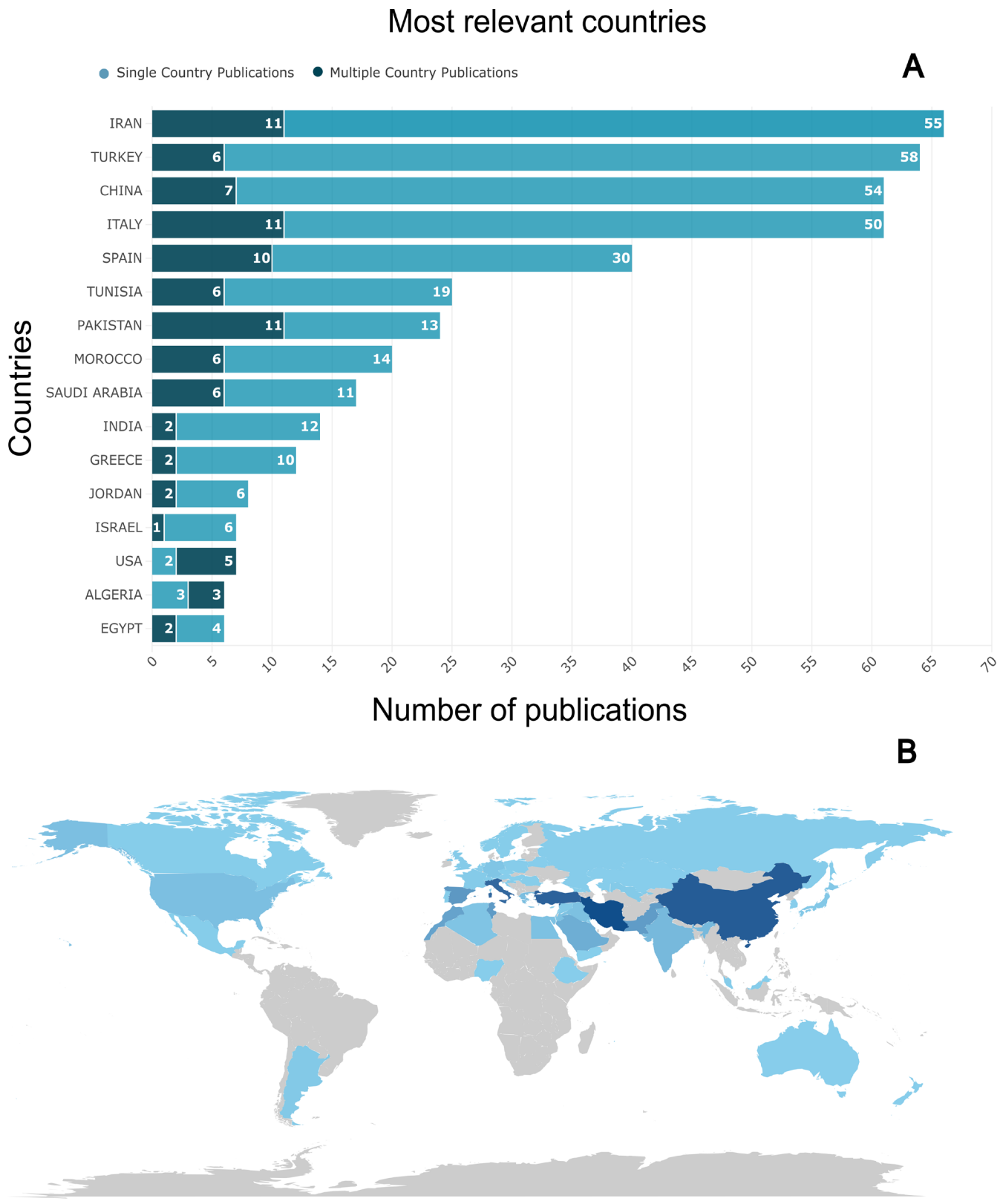


Figure 6. (A) Most relevant countries in terms of number of publications with a strong blue color scale for publications from multiple countries and light blue for publications from only one country involved. (B) World map with the geographical distribution and frequency of scientific production on capers.

According to the scientific output by country (Figure 6B), the topic appears to be concentrated in a few key nations, particularly Iran, China, Turkey, Italy, and Spain.

Once again, factors such as academic interest in the subject and the availability of the product for study contribute to this distribution. Other countries, such as Canada, Australia, the USA, and Mexico, have also published research on the topic.

In South America, only Argentina appears as a country that both studies and cultivates capers. This includes private enterprises such as Alcaparras Argentinas, a company dedicated to supporting local producers and maintaining the cultivation of capers in the country (González et al., 2010).

Brazil, by contrast, does not present any publications focused on this topic, likely reflecting the absence of caper cultivation within the country and the limited popularity of preserved capers in Brazilian popular culture.

Figure 7A shows that the analyzed studies contain specific keywords that provide insights into the research area to which they belong. It is possible to observe terms related to biochemical analysis processes for the identification of specific compounds, such as extracts and antioxidant activity, as well as words indicating studies focused solely on the plant's botanical nature, such as the term "plants" or its scientific name, which appears in various forms: "spinosa" and "*Capparis spinosa* L."

Given that this plant presents interesting characteristics across multiple research domains, there is a blend of keywords from different academic fields, as previously discussed, reflecting its publication across diverse scientific journals.

Additionally, keywords related to compounds of interest, such as quercetin and polyphenols, and specific functions, including antioxidant capacity and antibacterial activity, are also observed.

In addition to searching for its compounds, the use of words such as "rats," "in vitro," and "growth" suggests research aimed at understanding the mechanisms related to the absorption of the plant's compounds, how they are modified in different organisms, and how these compounds behave.

Through the construction of the dendrogram in Figure 7B, three major clusters can be identified. Despite some overlapping or related terms, they form distinct groups concerning the thematic focus of the analyzed studies.

The first cluster, which is the smallest, comprises four terms: "Antioxidant activity," "Flavonoids," "Medicinal plants," and "Oxidative stress." Analyzing the relationships among these terms, this group can be interpreted as representing biochemical factors associated with research on the plant's potential as a medicinal resource.

The second cluster includes terms such as "Extracts," "Plant," "Size," "Spinosa," and "Diversity." This group is more closely associated with botanical characteristics, as caper plants (*C. spinosa*) exhibit significant and diverse variability. Different forms of the species can be found adapted to dry and rocky environments.

The third and final cluster represents a combination of the previous two, encompassing terms associated with both. For example, "Wild," "Extracts," "Plants," "Buds," and "Leaves" relate to the botanical aspects highlighted in the second cluster, while terms like "Profile," "Acid," "Antioxidant," and "Aqueous extract" reflect biochemical characteristics aligned with the first cluster.

Reinforcing the keywords previously discussed in Figure 7A, this grouping further illustrates the plant's wide-ranging diversity and utility, offering valuable data for research across multiple scientific fields.

4 CONCLUSIONS

Following the collection of scientometric data and the corresponding statistical analyses, covering publication data, research trends, and the evolution of topics over the years, it was observed that research on capers spans fields such as medicine, pharmacology, agronomy, and plant chemistry. However, a noticeable gap remains regarding the plant's role as a food item, particularly in terms of sensory attributes, commercial applications, and culinary uses.

The charts also indicate that the countries with the highest levels of caper production and consumption are those that invest the most in scientific publications and studies on its specific characteristics. This investment is often linked to a long-standing cultural relationship with the plant, which has been used in traditional medicine in various regions.

The data further reveal a significant increase in research activity over the past 25 years. Despite relatively low citation rates, academic interest in certain aspects of the plant, such as its resilience, adaptability, and antioxidant compounds, has been evident.

The leading authors and universities publishing on the topic are primarily based in countries where capers are commonly consumed, particularly across Europe, North Africa, and the Eurasian region extending to Japan.

Other regions, such as the United States and Argentina, have also emerged as contributors to scientific research on capers. In contrast, Brazil does not appear to have made notable contributions in this field, despite its productive potential.

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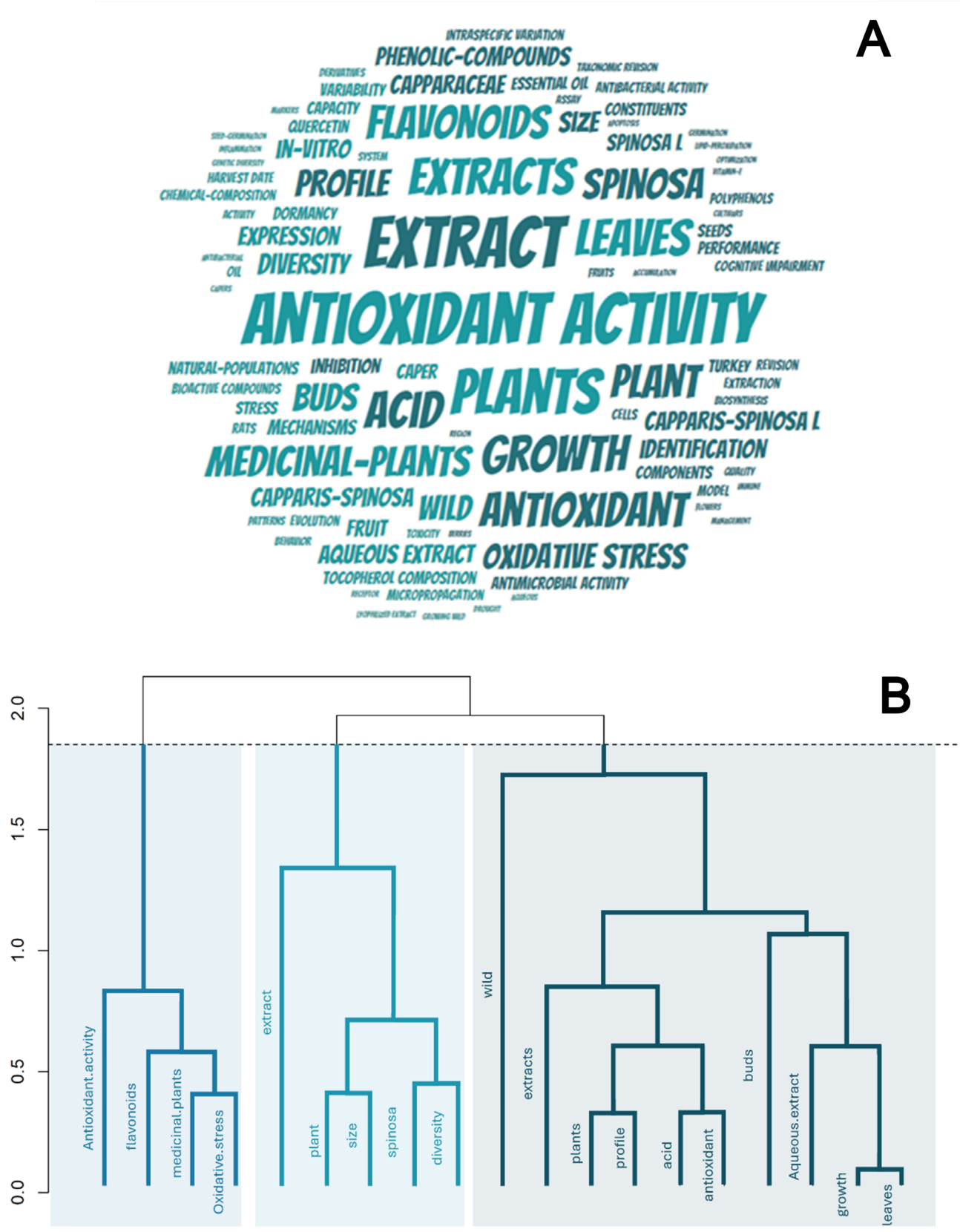

Figure 7. (A) Cloud of most frequent keywords. (B) Dissimilarity dendrogram of frequently used words.

REFERENCES

Alzahrani, D., Albokhari, E., Yaradua, S., & Abba, A. (2021). The complete plastome sequence for the medicinal species Capparis spinosa L. (Capparaceae). *Gene Reports*, *23*, Article 101059. https://doi.org/10.1016/j.genrep.2021.101059

Blázquez-Ruiz, J., Guerrero-Bote, V. P., & Moya-Anegón, F. (2016). New scientometric-based knowledge map of food science research (2003 to 2014). *Comprehensive Reviews in Food Science and Food Safety*, *15*(6), 1040–1055. https://doi.org/10.1111/1541-4337.12223

Chedraoui, S., Abi-Rizk, A., El-Beyrouthy, M., Chalak, L., Ouaini, N., & Rajjou, L. (2017). Capparis spinosa L. in A systematic review: A xerophilous species of multi values and promising potentialities for agrosystems under the threat of global warming. *Frontiers in Plant Science*, *8*, Article 1845. https://doi.org/10.3389/fpls.2017.01845

El Finou, H., Salhi, N., Zaid, A., & El Rhaffari, L. (2024). Phytotoxicity, antioxidant activity and chemical profile of aqueous extracts from Moroccan caper (Capparis spinosa L.). *Scientific African*, *24*, Article e02176. https://doi.org/10.1016/j.sciaf.2024.e02176

Else, H. (2020). How a torrent of COVID science changed research publishing - in seven charts. *Nature*, *588*(7839), Article 553. https://doi.org/10.1038/d41586-020-03564-y

González, E. A., Coria Cayupán, Y. S., & Nazareno, M. A. (2010). Efecto de distintos tratamientos de conservación en la actividad antirradicalaria de alcaparras (Capparis spinosa L.) cultivadas en Santiago del Estero, Argentina. *Revista Venezolana de Ciencia y Tecnología de Alimentos*, *1*(1), 47–57. http://hdl.handle.net/11336/186606

Grimalt, M., Hernández, F., Legua, P., Almansa, M. S., & Amorós, A. (2018). Physicochemical composition and antioxidant activity of three Spanish caper (*Capparis spinosa* L.) fruit cultivars in three stages of development. *Scientia Horticulturae*, *240*, 509–515. https://doi.org/10.1016/j.scienta.2018.06.061

Guerrero-Bote, V. P., & Moya-Anegón, F. (2015). Analysis of scientific production in food science from 2003 to 2013. *Journal of Food Science*, *80*(12), R2619–R2626. https://doi.org/10.1111/1750-3841.13108

Inocencio, C., Rivera, D., Obón, M. C., Alcaraz, F., & Barrena, J.-A. (2006). A systematic revision of capparis section Capparis (Capparaceae). *Anais Do Jardim Botânico Do Missouri*, *93*(1), 122–149. https://doi.org/10.3417/0026-6493(2006)93[122:asrocs]2.0.co;2

Jiang, H.-E., Li, X., Ferguson, D. K., Wang, Y.-F., Liu, C.-J., & Li, C.-S. (2007). The discovery of Capparis spinosa L. (Capparidaceae) in the Yanghai Tombs (2800 years b.p.), NW China, and its medicinal implications. *Journal of Ethnopharmacology*, *113*(3), 409–420. https://doi.org/10.1016/j.jep.2007.06.020

Lee, K. G. L., Mennerat, A., Lukas, D., Dugdale, H. L., & Culina, A. (2023). Meta-Research: The effect of the COVID-19 pandemic on the gender gap in research productivity within academia. *eLife*, *12*, Article e85427. https://doi.org/10.7554/eLife.85427

Lo Bosco, F., Guarrasi, V., Moschetti, M., Germanà, M. A., Butera, D., Corana, F., & Papetti, A. (2019). Nutraceutical Value of Pantelleria Capers (*Capparis spinosa* L.). *Journal of Food Science*, *84*(8), 2337–2346. https://doi.org/10.1111/1750-3841.14718

Nalimov, V. V., & Mul'chenko, Z. M. (1971). *Measurement of science: Study of the development of science as an information process* (R. D. Hill, Trans.). National Technical Information Service. (Original work published 1969 in Russian)

Stefanucci, A., Zengin, G., Locatelli, M., Macedonio, G., Wang, C.-K., Novellino, E., Mahomoodally, M. F., & Mollica, A. (2018). Impact of different geographical locations on varying profile of bioactives and associated functionalities of caper (*Capparis spinosa* L.). *Food and Chemical Toxicology*, *118*, 181–189. https://doi.org/10.1016/j.fct.2018.05.003

Sun, Y., Chen, Q., Dang, R., Xie, Y., Cheng, X., Huang, X., Zhou, S., & Wang, C. (2024). Skin irritation assessment and potential mechanism of Capparis spinosa L. fruits. *Journal of Ethnopharmacology*, *321*, Article 117510. https://doi.org/10.1016/j.jep.2023.117510

Sun, Y., Yang, T., & Wang, C. (2023). *Capparis spinosa* L. as a potential source of nutrition and its health benefits in foods: A comprehensive review of its phytochemistry, bioactivities, safety, and application. *Food Chemistry*, *409*, Article 135258. https://doi.org/10.1016/j.foodchem.2022.135258

Zhu, P., Wang, Y., & Zhang, X. (2022). Preparation and characterization of electrospun nanofibre membranes incorporated with an ethanol extract of Capparis spinosa L. as a potential packaging material. *Food Packaging and Shelf Life*, *32*, Article 100851. https://doi.org/10.1016/j.fpsl.2022.10085