



Biodiversity of macrofungi: a scientometric review

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Abstract

Introduction: Fungi hold enormous potential across various industries, including the food, medical, and biotechnology sectors, and are particularly notable for their applications in the production of antibiotics, enzymes, and fermented foods. Their vast diversity suggests applications in various branches of the biological sciences, ranging from biodegradation to bioremediation. Although these organisms have significant scientific and social importance, studies in Colombia that adopt a scientometric approach to analyze their biological diversity remain scarce.

Methodology: This study conducts a scientometric review of fungal biodiversity at the global level, with a supplementary section highlighting some studies conducted in Colombia. **Results:** Three main approaches were identified: global fungal diversity, the adaptive capacity of fungi to adverse environmental conditions, and their application in innovative industries such as biotechnology. Furthermore, the importance of strengthening mycological research in key ecosystems, such as tropical dry forests and northern Colombia, which harbor a wealth of species not yet documented, is emphasized. **Conclusions:** It is proposed that researchers design action plans aimed at prioritizing studies according to local and international needs, thereby maximizing the scientific and social impact of their research.

Keywords: applications, fungal biodiversity, Colombia, macromycetes,

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scientometric review (source: *MeSH*).

Biodiversidad de macromicetos: una revisión cuantitativa

Resumen

Introducción: los hongos poseen un enorme potencial en diversas industrias, como los sectores alimentario, médico y biotecnológico, destacándose por sus aplicaciones en la producción de antibióticos, enzimas y alimentos fermentados. Su amplia diversidad sugiere aplicaciones en distintas ramas de las ciencias biológicas, desde la biodegradación hasta la biorremediación. Aunque estos organismos tienen una importancia científica y social significativa, en Colombia los estudios que adoptan un enfoque cuantitativo para analizar su diversidad biológica aún son escasos. **Metodología:** este estudio realiza una revisión cuantitativa de la biodiversidad fúngica a nivel global, con una sección complementaria que destaca algunos estudios desarrollados en Colombia. **Resultados:** se identificaron tres enfoques principales: la diversidad fúngica global, la capacidad adaptativa de los hongos frente a condiciones ambientales adversas y su aplicación en industrias innovadoras como la biotecnología. Asimismo, se subraya la importancia de fortalecer la investigación micológica en ecosistemas clave, como los bosques secos tropicales y la región norte de Colombia, que albergan una gran riqueza de especies aún no documentadas. **Conclusiones:** se propone que los investigadores diseñen planes de acción orientados a priorizar estudios según las necesidades locales e internacionales, maximizando así el impacto científico y social de sus investigaciones.

Palabras clave: aplicaciones, biodiversidad fúngica, Colombia, macromicetos, revisión cuantitativa (fuente: *MeSH*).

Biodiversidade de macromicetos: uma revisão quantitativa

Resumo

Introdução: os fungos possuem um enorme potencial em diversas indústrias, como os setores alimentar, médico e biotecnológico, destacando-se pelas suas aplicações na produção de antibióticos, enzimas e alimentos fermentados. A sua ampla diversidade sugere aplicações em diferentes ramos das ciências biológicas, desde a biodegradação até à biorremediação. Embora estes organismos tenham uma importância científica e social significativa, na Colômbia os estudos que adotam uma abordagem cienciométrica para analisar a sua diversidade biológica ainda são escassos. **Metodologia:** este estudo realiza uma revisão cienciométrica da biodiversidade fúngica a nível global, com uma secção complementar que destaca alguns estudos desenvolvidos na Colômbia. **Resultados:** foram identificadas três abordagens principais: a diversidade fúngica global, a capacidade adaptativa dos fungos face a condições ambientais adversas e a sua aplicação em indústrias inovadoras, como a biotecnologia. Além disso, sublinha-se a importância de reforçar a investigação micológica em ecossistemas-chave, como as florestas tropicais secas e a região norte da Colômbia, que abrigam uma grande riqueza de espécies ainda não documentadas. **Conclusões:** propõe-se que os investigadores elaborem planos de ação orientados para priorizar estudos de acordo com as necessidades locais e internacionais, maximizando assim o impacto científico e social das suas investigações.

Palavras-chave: aplicações, biodiversidade fúngica, Colômbia, macromicetos, revisão cienciométrica (fonte: MeSH)

Introduction

Mycology is a branch of biology that focuses on the study of organisms belonging to the kingdom of Fungi. This is an area of growing interest due to the high species diversity within this group (1), and the approaches that arise from this biological diversity. Applied mycology in the environmental sector, specifically using macromycetes as bioindicators of ecosystem health (2) and for soil bioremediation (3), represents some of the potential applied approaches. Macromycetes are a classification of fungi characterized by producing fruiting bodies, known for their potential in industries (4). In this regard, the exploration of macromycete biodiversity is essential for the use of these organisms in favor of the environmental sector and bioprospecting.

The literature review shows that the number of generally accepted species is 150,000, representing only 3.8% of an estimated total of 2.2–3.8 million species (5). In Colombia, the inventory of macrofungal biodiversity includes 4,606 species of Ascomycota and 2,386 of Basidiomycota (6,7), according to records compiled in databases such as ColFungi, which are based primarily on studies conducted in Andean regions. This article aims to contribute to fungal biodiversity studies, particularly macromycetes, from a scientometric review perspective due to the scarcity of studies of this kind. The intention is to provide a preliminary general approach to generate resources for future explorations.

To achieve this objective, an initial search on the topic of "macromycetes" was conducted using the Scopus and Web of Science (WoS) databases, which provides a factor that has been positioned as novel within academia (8,9). Many review articles rely solely on a single database, which can become a limitation when identifying significant studies in the field. A quantitative approach was applied using the Tree of Science (ToS) web platform (10). This resulted in three main branches: the first branch focused on fungal diversity with numerous studies from Europe and Eurasia, the second branch included studies from Colombia, and the third branch

highlighted applications and comparative contributions from other regions of the Americas.

This article continues with the methodological section, in which the process of focusing on the main articles is described in detail. It then presents the contributions in chronological order, leading to the different perspectives identified in the sheets. Finally, it concludes that fungal biodiversity has a knowledge gap worldwide regarding species acceptance, which suggests the need for exhaustive biodiversity studies to contribute to the field.

Materials and Methods

This study adopts a general approach to Colombian macromycete biodiversity, conducting a bibliographic search using the Scopus and WoS databases . This approach provides an advantage in mapping the research (11). Two search strings were used, one that allowed for a global overview of fungal biodiversity (Table 1).

Table 1. Search parameter used in both databases

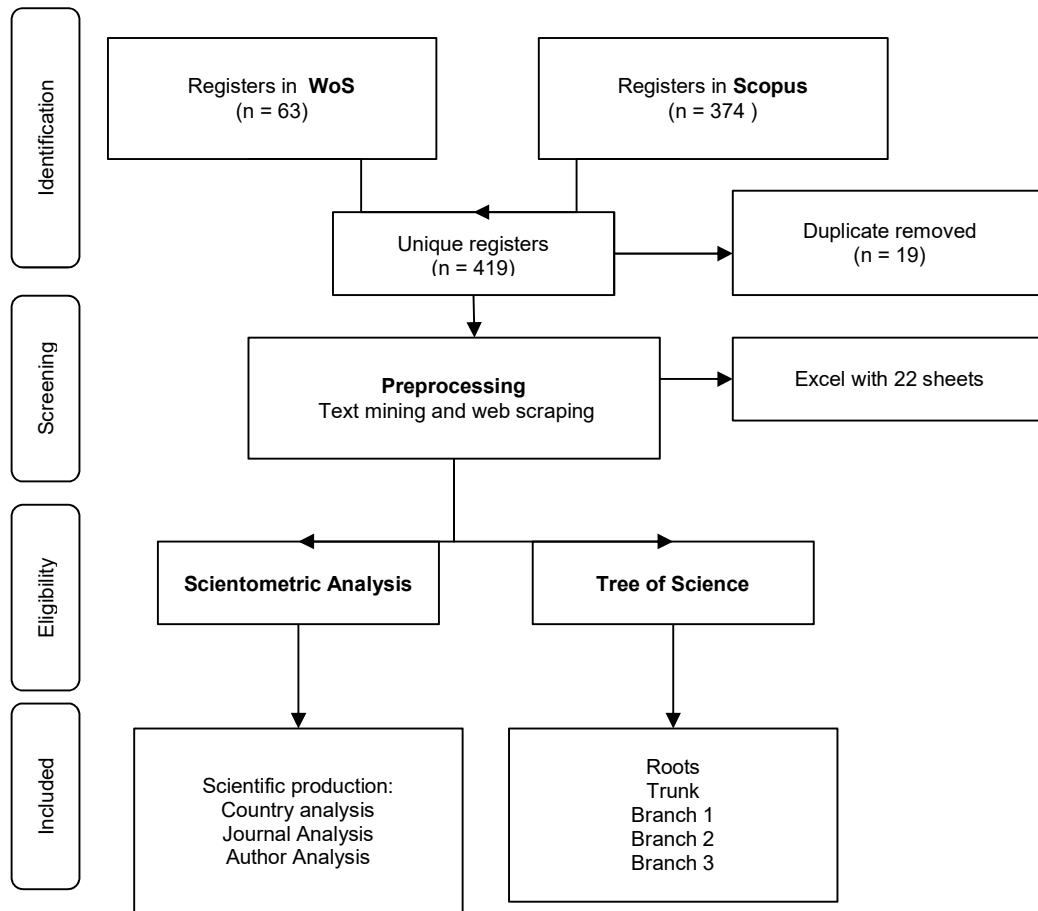
| Parameter | Web of Science | Scopus |
|---------------|--|--------|
| Range | 2012- 2024 | |
| Date | November 2024 | |
| Document Type | Paper, book, chapter, conference proceedings | |

| | |
|-------------------------|---|
| Words | ("macromycetes") AND ("Biodiversity" OR "Species Diversity") / ("Colombian") AND ("macromycetes") AND ("Biodiversity" OR "Species Diversity"). |
| Result | 64 |
| Total (WoS + Scopus) | 374 |
| | 419 |

Source: own elaboration.

Once the results were obtained, they were uploaded to the ToS platform, enabling the practical development and understanding of the theoretical framework based on the database search. The ToS algorithm is based on graph theory (12); the articles at the root are the most cited in the field of fungal species identification, and the studies located on the trunk cite the root and are in turn the most cited by the leaves (Figure 1). Finally, the leaves are novel contributions to science that cite both the trunk and the root. In this way, it was possible to visualize the scientific information in the form of a tree.

Figure 1: Workflow for scientometric analysis and the construction of the tree of science



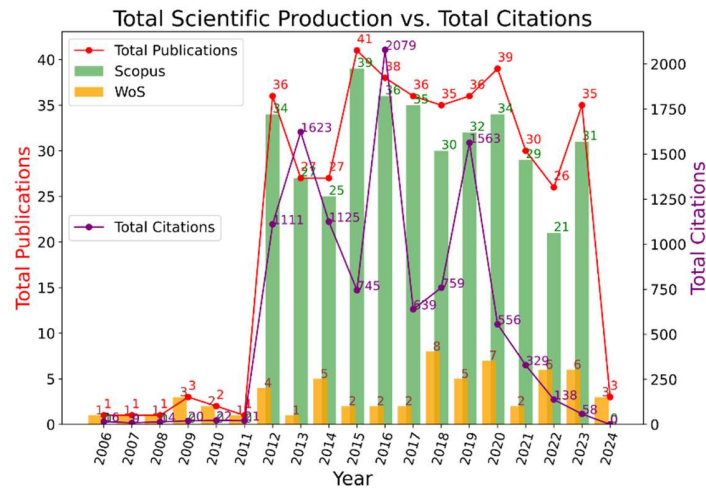
Source: own elaboration

Results

Scientometric analysis

Figure 2 illustrates the annual production of studies on fungal diversity over the past 18 years. Since 2006, WoS (yellow bar) began publishing articles; however, Scopus (green bar) showed a significant increase starting in 2012 compared to WoS. It is important to note that the total production growth was 6.3%, highlighting this as a nascent area of knowledge with ample room for contributions.

Figure 2: Annual output of studies on fungal diversity in the WoS and Scopus databases (2006–2024)



Source: own elaboration

Three periods were defined based on scientific output. The first spans from 2006 to 2013, a period during which scientific output increased by 60.1%, reflecting a growing interest in the field of mycology. Notable studies from this period include that by Tedersoo et al. (13), which analyzes the phylogenetic relationships between plant biodiversity and the diversity of mycorrhizal fungi, and that by van der Wal et al. (14), which examines the relationship between fungal diversity and decomposition processes in terrestrial soils.

The second period, spanning 2014–2019, showed a growth rate of 5.9%, reflecting a lower production of scientific research. The graph also reveals fluctuating production during this period, with activity declining but experiencing significant peaks at two points within this timeframe. Among the studies from this period, Saldarriaga-Hernández et al. (15) analyze the biotransformation of lignocellulosic biomass into products of industrial interest through the use of fungal lignocellulolytic enzymes, highlighting the biotechnological potential of fungi in applied enzymatic processes.

In the most recent period, from 2020 to 2024, the production percentage was 2.9%. This time frame coincides with the years when much of the world experienced lockdowns due to the COVID-19 pandemic. Consequently, it is estimated that scientific research on fungi was significantly impacted by this phenomenon, resulting in a notable decline in production compared to previous periods. References (16) and (17) specifically highlight the impact of COVID-19 on scientific research.

Analysis by country

The analysis of scientific production by country is essential to recognize individual nations' efforts toward fungal biodiversity. Table 2 presents three variables used to analyze academic productivity by country. The first is output, measured by the number of articles published per country. The second is impact, quantified by the number of citations received by all articles from a given country. The third is quality, assessed by the quartiles of the journals published according to Scimago. Poland leads scientific production (31 articles, representing 8.1% of the total). However, it is surpassed by countries like the USA and Germany, which, despite lower production numbers, lead in high-impact articles with 1,331 and 599 citations (12.9% and 5.9%), respectively, and with publications in the highest quartiles (Q1).

Table 2. Scientific output, impact, and quality of fungal research by country

| Country | WoS | | Scopus | | Q1 | Q2 | Q3 | Q4 |
|---------|-------|-----|--------|-----|----|----|----|----|
| | Count | % | Count | % | | | | |
| Poland | 31 | 8.1 | 469 | 4.5 | 1 | 6 | 9 | 4 |
| Turkey | 23 | | 176 | | | 5 | 1 | 3 |

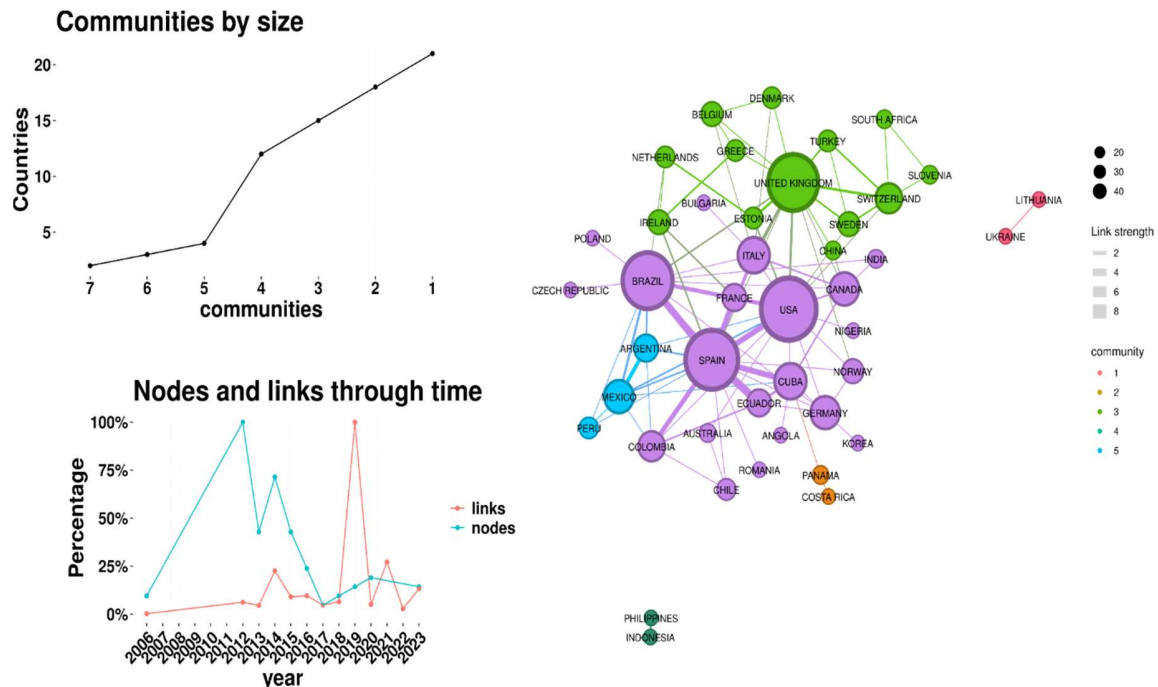
| | | | | | | | | |
|---------|----|----|-----|----|---|---|----|---|
| | | 6. | | 1. | 1 | | | |
| USA | 23 | 2 | 131 | 7 | | 3 | 2 | 1 |
| | | | 1 | | 1 | | | |
| Brazil | 22 | 6. | | 13 | 5 | 4 | 11 | 2 |
| | | 2 | 186 | | | | | |
| Germa | 20 | | | 1. | 3 | 4 | 0 | 0 |
| ny | | 5. | 599 | 8 | | | | |
| | 20 | 7 | | | 1 | 2 | 6 | 1 |
| México | | | 302 | 5. | 5 | | | |
| | 17 | 5. | | 8 | | 0 | 2 | 0 |
| Slovaki | | 2 | 109 | | 8 | | | |
| a | 16 | | | 2. | | 2 | 2 | 0 |
| | | 5. | 407 | 9 | 7 | | | |
| China | | 2 | | | | | | |
| | 15 | | | 1. | 1 | 2 | 0 | 1 |
| Czech | | 4. | 209 | 1 | 2 | | | |
| Republ | 14 | 4 | | | | 5 | 1 | 0 |
| ic | | | 237 | 3. | | | | |
| | | 4. | | 9 | 1 | | | |
| Italy | | 1 | | | 0 | | | |
| | | | | 2. | 7 | | | |
| | | 3. | | 0 | | | | |
| | | 9 | | | | | | |
| | | | | 2. | | | | |
| | | 3. | | 3 | | | | |
| | | 6 | | | | | | |

Source: own elaboration

Among the scientific output generated in Poland, it is known that review studies have been conducted on the chemical profile and biological activity of secondary metabolites derived from organisms, including some of fungal origin (18). Furthermore, the United States has also conducted research in the field of biochemistry and, additionally, in the ecology of soil fungi, focusing on their diverse and rich functions in these environments (19). This analysis is relevant, as it complements the information presented in Table 2, which shows that Poland leads in terms of total production (31 articles in WoS and 469 in Scopus), while the United States, despite having a lower number of publications (23 in WoS and 1,311 total citations), stands out significantly in terms of impact and quality, with a notable concentration of publications in Q1 journals (15 articles). In contrast, countries such as Italy, the Czech Republic, and China show a lower proportion of articles published in top quartiles, which may reflect challenges in positioning their research in high-impact journals. This information highlights not only the volume of scientific output but also the depth and academic recognition of the knowledge generated in each country.

Figure 3 illustrates scientific collaboration between countries, along with the number of communities by size and the nodes and links over time. Two main communities related to scientific production can be distinguished in the network. The first is led by Brazil, Spain, and the United States, while the United Kingdom leads the second, which is also of great importance. Both communities have collaborated, albeit not primarily, with countries such as Italy and Greece (20), for example, in the identification of macrofungi in the Mediterranean maquis along the coast and across altitudinal transects.

Figure 3. Network for scientific collaboration among countries and communities in the field of fungal research



Source: own elaboration

A more detailed analysis of the network reveals that Colombia, although part of a smaller community (blue cluster), maintains visible scientific connections with countries such as Mexico, Spain, and Argentina. These collaborations demonstrate a growing integration of Colombia into the international landscape of fungal research, particularly through its links with Latin American and Ibero-American networks. This highlights Colombia's potential role in strengthening regional research agendas and advancing biodiversity studies in tropical mycology.

Journal analysis

Table 3 lists the journals with the highest scientific output on the topic. It shows that most belong to the highest impact quartile (4 journals in Q1), followed by those in the second-

highest impact quartile (3 journals in Q2). Finally, there are also top journals but with lower impact (1 journal in Q3 and 2 in Q4).

The list of journals is headed by Turkish Journal of Botany, with 17 publications in the Q2 quartile. Although it is the journal with the highest output, it is not the most influential, as Forest Ecology and Management has six more publications than the former but far surpasses it in the H-index. A similar situation is observed with Biodiversity and Conservation, which has seven more publications than the Turkish Journal of Botany.

Table 3. Journals with the highest scientific output on fungal diversity: country (C), impact factor (IF), distribution by Scimago quartiles (Q), and H-index (H)

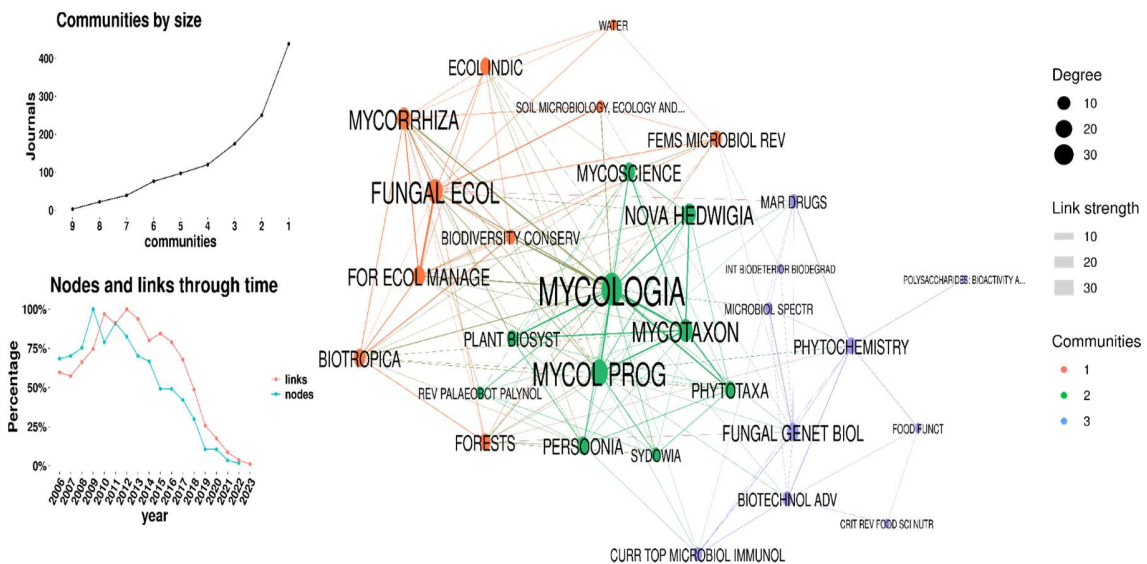
| Journal | N. o | % | C | IF | Q | H |
|--|---------|---|-----------------|------|----|----|
| Turkish Journal Of Botany | 17 | 4 | Turkey | 0.36 | Q2 | 47 |
| Forest Ecology And Manageme nt | 1 | 3 | Netherla nds | 1.19 | Q1 | 20 |
| Biodiversity And Conservati on | 1 | 2 | Netherla nds | 0.95 | Q1 | 15 |

| | | | | | | |
|--------------|---|----|----------|------|---|----|
| | | | UK | | | 12 |
| Mycologia | 1 | .0 | | 0.81 | Q | 8 |
| | 0 | 2 | | 5 | 1 | |
| | | | Germany | | | |
| Mycological | | | | | | 49 |
| Progress | 1 | .0 | | 0.75 | Q | |
| | 0 | 2 | USA | 9 | 1 | |
| Mycotaxon | | | | | | 48 |
| | 1 | .0 | Netherla | 0.21 | Q | |
| Fungal | 0 | 2 | nds | 6 | 4 | 73 |
| Ecology | | | | | | |
| Nova | 8 | .0 | Germany | 0.66 | Q | 46 |
| Hedwigia | | 2 | | 5 | 2 | |
| Plant | 8 | | UK | | | 60 |
| Biosystems | | .0 | | 0.32 | Q | |
| | | 2 | | 3 | 3 | |
| Mikologiya | 7 | | Russian | | | 15 |
| I | | | | | | |
| Fitopatologi | | .0 | | 0.45 | Q | |
| ya | 7 | 2 | | 2 | 2 | |
| | | .0 | | 0.21 | Q | |
| | | 2 | | 6 | 4 | |

Source: own elaboration

Figure 4 shows a citation network among the journals. This network thematically groups the journals by topic. The first theme is led by Fungal Ecology, which focuses on agriculture and biological sciences (21). The second theme revolves around the ecology, systematics, and evolution of fungi (22). The last topic is led by Fungal Genetics and Biology, which a focuses on molecular biology applied to fungal organisms (23).

Figure 4. Citation network of journals on fungal research by topic



Source: own elaboration

Network of collaborating authors

Table 4 describes the authors with the highest number of contributions, measured by total publications, and also outlines their H-index and current affiliations. The affiliations of these researchers are mainly located in Turkey, Russia, Italy, and Brazil, across various institutions in these countries.

Table 4. Authors with the highest number of contributions: publications, h-index, and current affiliations

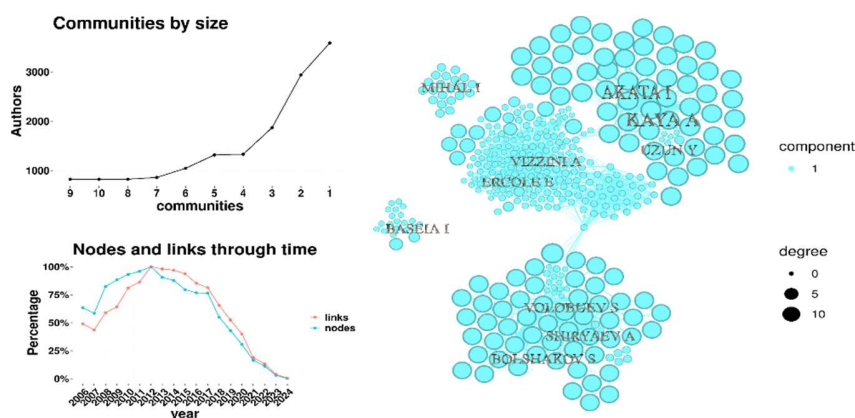
| Authors | Total Publications | H-index | Affiliation |
|------------|--------------------|---------|--|
| Kaya A | 14 | 31 | Gazi University, Science Faculty, Department of Biology, 06560 Ankara, Türkiye |
| Vizzini A | 13 | 47 | Department of Life Sciences and Systems Biology, University of Torino, Viale P.A. Mattioli 25, I-10125 Torino, Italy |
| Volobuev S | 13 | 16 | Komarov Botanical Institute, Russian Academy of Sciences, 2, Professora Popova St., RU-197376, Saint Petersburg, Russia |
| Uzun Y | 10 | 20 | Karamanoğlu Mehmetbey University, Ermenek Uysal and Hasan Kalan Health Services Vocational School, Department of Pharmacy Services, 70400 Karaman, Türkiye |
| Shiryaev A | 9 | | |

| | | |
|-----------------|-------------|--|
| Baseia I | 8 36 | Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences, Yekaterinburg, 620144 Russia |
| Akata I | 7 37 | Universidade Federal do Rio Grande do Norte, Centro de Biociências, Departamento de Botânica e Zoologia, Avenida Senador Salgado Filho, 3000, Lagoa Nova, 59064-741 Natal, RN, Brazil |
| Bolshako v S | 7 15 | Department of Biology, Faculty of Science, Ankara University, Ankara 06100, Türkiye |
| Ercole E | 7 26 | Komarov Botanical Institute RAS, St. Petersburg, Russia Department of Life Sciences and Systems Biology, University of Torino, Viale P.A. Mattioli, 25, 10125 Torino, Italy |

Source: own elaboration

The scientific collaboration network illustrates the academic communities that are being formed. Figure 5 was created using the personal networks (ego networks) of the prominent authors described in Table 4. For example, in Turkey, Abdullah Kaya has collaborated with Yasin et al. (24), contributing to the understanding of fungi from the *Pyronemataceae* family. On the other hand, in Italy, authors like Alfredo Vizzini and Enrique Ercole have collaborated in describing macrofungi species from the *Cortinarius* genus (25).

Figure 5. A scientific collaboration network of leading researchers in the field of mycology



Source: own elaboration

Tree of Science

Root

The roots of the tree refer to the classification of fungi, which is a challenging task, particularly the identification of macrofungi. This has traditionally relied on taxonomic characteristics (26). However, this approach has many limitations when identifying

the biodiversity of this kingdom due to the morphological variability they exhibit. For this reason, White et al. (27) lay the foundation for the phylogenetic research of fungi, specifically in the identification and classification of species using ribosomal DNA sequencing techniques. Furthermore, Gardes and Bruns (28) introduced a set of specific primers for amplifying fungal ribosomal DNA, which has had an impact on species classification, contributing knowledge in areas such as nomenclature, taxonomy, biology, and ecology, which are the focus of the study by CABI (29).

Macrofungi exhibit a wide range of classification (30), with a review of some forms such as Agaricoides, Boletoides, and Cyphelloides in the Nordic region. However, the taxonomy of these organisms is not limited solely to their morphological traits; it also relies on ecological roles such as mycorrhizae (31); Tedersoo et al. (32) explore and delve into the mutualism between fungi and plants, biodiversity, evolution, and their global distribution.

Trunk

In addition to all the morphological and ecological traits, the cosmopolitan habit of fungi makes them attractive as subjects of study, as there is a wide range of research worldwide highlighting the versatility of these organisms in being found in different environments. Biodiversity studies span areas from the Atlantic part of the Northern/Western Hemisphere in Ireland (33). Also, the work of Abrego et al. (34) investigated the implications of reserve size and forest connectivity for the conservation of fungi inhabiting wood in both Northern Europe and Central Europe, including countries such as Germany, Sweden, and Denmark.

In the Euroasian region, data from studies contributing to the mycological inventory of this area are taken into account, specifically those from Turkey (35-39). Likewise, in this same geographic area, other contributions by Uzun and Kaya (40) are recognized, with new records of *Hydnobolites* and *Pachyphlodes*, as well as the

studies by Shakhova and Volobuev (41) on the cultural and enzymatic activity of *Fomitiporia hippophaeicola*.

In Figure 6 the scientometric analysis revealed three notable trends, which are visualized in the network of nodes. The largest community (green) with 44.28% focuses on the medicinal, genomic, and metabolomic areas. The second community (orange) with 30.38% covers biodiversity from the molecular, phylogenetic, and evolutionary perspectives. Finally, the (blue) community with 25.34% works on the diversity of mycorrhizal and ectomycorrhizal species.

Figure 6. A scientometric analysis of research trends in mycological diversity and its applications



Source: own elaboration

Branch 1

Biodiversity is a topic that has been worked on globally. As previously mentioned, the studies located in the trunk focus on the northern part of Europe and the Eurasian region. As an approach to the diversity of fungi in the northern part of the American continent, there are contributions through monographs of genera such as *Suillus* and *Lactarius* (42,43), studies on the composition of fungi in soils (44), and works that provide an introduction to mycology in the tropics. Thus, biodiversity and conservation are recognized as the main focus of this area of study.

The group's study offers some insights into the environmental resilience of these organisms, as they are believed to possess both psychrophilic (45) and thermophilic (46) adaptations. Thanks to this and other physiological processes in fungi, studies have been conducted in applied mycology, such as the one by Vašutová et al. (47), which analyzes how fungi can serve as ecological indicators in ecosystem restoration efforts. Additionally, they have other uses, such as secondary metabolites in the biotechnology industry (48).

Branch 2

Colombia is a megadiverse country due to the wide variety of ecosystems found within its borders, which has made the study of biodiversity a central focus of scientific research. In this context, mycology has experienced significant development thanks to the contributions of the Fungal Taxonomy and Ecology Group (TEHO) at the University of Antioquia. Vasco-Palacios et al. (49) and López-Quintero et al. (50) have studied macrofungal diversity in regions such as Caquetá and the Colombian Amazon, revealing patterns associated with environmental heterogeneity and disturbance regimes. Likewise, Vasco-Palacios et al. (51), expanded the records of macrofungi in Colombia, constituting a valuable source for understanding the country's fungal biodiversity. (52) contributed to the inventory by recording a new species (*Austroboletus amazonicus*) and a new variety (*Fistulinella campinaranae* var. *scrobiculata*) in the Colombian Amazon. Studies with ecological implications have also been conducted in Colombia, such as the case of the invasion of *Amanita muscaria* in forests of *Quercus humboldtii*, a native oak species. This phenomenon has been documented primarily in the Andean region of Colombia, particularly in departments such as Santander, Boyacá, Cundinamarca, and Antioquia, where the spread of this exotic fungus has been observed in montane forests and commercial tree plantations (53).

Fungi in Colombia are closely associated with ecosystems dynamics. Royal Botanic Gardens Kew (54) highlights the challenges and strategies in the protecting fungal species, especially regarding the diversity and ecological role of fungi in vulnerable ecosystems. Furthermore, the biodiversity of fungi has an applied focus in Colombia; Charria-Girón et al. (55) focuses on the potential of Colombian macromycetes for various significant applications in biotechnology.

Branch 3

The last branch focuses on the chemical analysis of macromycetes, a growing subfield that explores the structure, function, and bioactivity of fungal secondary metabolites. This line of research is essential in the context of natural product discovery, drug development, and environmental biotechnology. It encompasses the isolation and structural characterization of bioactive compounds such as terpenoids, alkaloids, phenolics, as well as fungal enzymes and pigments, many of which exhibit antimicrobial, cytotoxic, enzymatic, or antioxidant properties. Fungal enzymes, in particular, play a key role in biotransformation processes and biodegradation, while fungal pigments are gaining attention for their potential in natural dyes, pharmaceuticals, and cosmetics.

For example, the study by Aqueveque et al. (56) reports the discovery of a new triterpenoid isolated from a Chilean *Mycena* species. Similarly, Castañeda-Ramírez et al. (57) explore the insecticidal activity of macro- and microfungi, highlighting their potential use in biological pest control. In addition to *Mycena* sp., *Xylaria* sp. has also been studied for its secondary metabolites and their effects on microorganisms (58). These findings demonstrate the scientific innovation that fungal biodiversity brings to core scientific disciplines such as chemistry, giving rise to new interdisciplinary approaches like mycochemistry, which have applications in bioremediation, pharmaceutical development, and industrial biotechnology (59).

Conclusions

This paper presents a scientometric review of fungal biodiversity globally, with a section focused on Colombia, using the ToS algorithm from searches in Scopus and WoS. The results showed that this topic has been studied from a Taxonomy and molecular biology approach for identifying biological diversity. Then, from the trunk, an emphasis on conservation and species inventory expansion in several parts of Europe emerges.

Three major trends were identified. The first addresses fungal diversity at a global scale; the second focuses on the physiological capacity of fungi to adapt to adverse environmental conditions; and the third highlights the application of these organisms in innovative industries, such as biotechnology.

The second trend includes studies from the Neotropical region of the Americas, particularly highlighting contributions from Colombia, mostly in the Andean and Amazonian zones. Although older studies detail contributions to fungal diversity and new species records, they focus mainly on the Andean and Amazonian zones. Furthermore, it highlights the potential of native organisms in applied fields across various industries.

The third trend contrasts the direct application of fungal biodiversity in the bioindustry. It showcases some applications of mycology in mycochemistry, such as enzyme production, insecticidal activity, and the use of pigments.

As with any research, limitations were encountered, such as the study being based on data from 2012 onwards. While ToS helps reduce bias by grouping references and allowing earlier dates to be found, references from expeditions in the Caribbean region of Colombia were not included. It is hoped that these limitations do not present significant obstacles to the final results.

Future research should include keywords focusing on studies in the Caribbean region. Additionally, beyond the scientometric search, the intent of this review is to recognize the national landscape regarding studies of this type in order to carry out an expedition in the Caribbean region of Colombia, specifically in Cesar, to contribute to mycological research on biodiversity in Colombia.

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