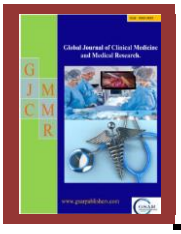

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A Decade of Research on *Amanita phalloides* Poisoning: Global Trends, Research Productivity, and Emerging Perspectives

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ABSTRACT

Background: *Amanita phalloides poisoning is one of the most clinically significant forms of mushroom intoxication because of its potential to cause severe hepatotoxicity, acute liver failure, and death. Despite continued scientific interest in its toxicology, diagnosis, and treatment, the structure and evolution of the global literature on A. phalloides have not been fully characterized. This study aimed to evaluate publication trends, leading contributors, geographical distribution, and major research characteristics of the literature on A. phalloides.*

Methods: *A bibliometric analysis was performed using publications indexed in the Scopus database. The search strategy was based on the terms "amanita" and "phalloides" within titles, abstracts, and keywords and covered publications from 2015 through 2026. The search identified 246 documents. Bibliometric parameters included annual publication output, document type, subject area, productive authors, institutions, countries, and funding organizations. Descriptive bibliometric indicators were used to characterize the development and geographical distribution of the research field.*

Results: *A total of 246 Scopus-indexed documents were identified. Publication activity fluctuated throughout the study period, with 27 publications in 2024 and 26 in 2025, indicating substantial recent scientific activity. Original articles constituted 74.4% of the literature, followed by reviews (15.9%) and book chapters (4.1%). Medicine was the leading subject area (30.3%), followed by pharmacology/toxicology-related research (17.0%) and environmental sciences (9.3%). Carvalho F., Kaya E., Arici M.A., Costa V.M., and Garcia J. were among the prominent authors. Universidade do Porto and Düzce University were among the leading institutions. The United States showed the greatest publication activity, followed by China and Türkiye, demonstrating contributions from geographically diverse research communities.*

Conclusion: *Research on A. phalloides has maintained substantial international activity over the past decade, with particularly strong contributions from the United States, China, and Türkiye. The predominance of original articles and substantial representation of medicine and pharmacology/toxicology demonstrate the clinical and toxicological importance of this field. Future bibliometric studies incorporating citation, keyword co-occurrence, co-authorship, and international collaboration network analyses may further identify influential publications, evolving research themes, and knowledge gaps in A. phalloides poisoning.*

Keywords: *Amanita phalloides; mushroom poisoning; amatoxin; hepatotoxicity; bibliometric analysis; Scopus; toxicology.*

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Introduction

Mushroom poisoning represents an important toxicological problem worldwide and encompasses a broad spectrum of clinical manifestations ranging from self-limiting gastrointestinal symptoms to severe multiorgan failure and death. Among poisonous mushrooms, *Amanita phalloides*, commonly known as the death cap mushroom, is particularly

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important because of its potentially fatal hepatotoxic effects [1,2]. Poisoning typically occurs following accidental ingestion, often because toxic mushrooms are mistaken for edible species. The potential for delayed clinical deterioration and severe hepatic injury makes *A. phalloides* poisoning an important challenge for emergency physicians, clinical toxicologists, hepatologists, and intensive care specialists. The principal toxicity of *A. phalloides* is associated with amatoxins, particularly α-amanitin [3]. These thermostable toxins inhibit RNA polymerase II, disrupting messenger RNA synthesis and protein production and ultimately resulting in cellular injury. Hepatocytes are particularly vulnerable, although renal and other organ involvement may also occur in severe poisoning. The clinical course is characteristically multiphasic. Following an initial latent period, patients commonly develop severe gastrointestinal symptoms, including abdominal pain, vomiting, and diarrhea [4,5]. An apparent period of clinical improvement may subsequently occur despite continuing hepatic injury. In severe cases, progressive elevations in aminotransferases, coagulopathy, hypoglycemia, hepatic encephalopathy, acute kidney injury, and fulminant hepatic failure may develop. This potentially deceptive clinical progression emphasizes the importance of early recognition and close monitoring [6].

Management remains challenging because no universally accepted single antidotal strategy exists. Initial treatment focuses on stabilization, appropriate gastrointestinal decontamination in selected circumstances, fluid and electrolyte management, and close monitoring of hepatic and renal function [7]. Several pharmacological approaches, including silibinin and N-acetylcysteine, have been investigated or incorporated into clinical practice, while patients who develop irreversible acute liver failure may require emergency liver transplantation. Consequently, early identification of patients at risk of severe toxicity and timely referral to specialized centers are important aspects of management. Despite this sustained research activity, a systematic characterization of the recent scientific landscape is valuable for identifying influential contributors, geographical patterns, research development, and potential knowledge gaps [8,9]. Bibliometric analysis provides quantitative methods for evaluating scientific productivity and the structural evolution of a research field. Therefore, the present study aimed to conduct a Scopus-based bibliometric analysis of *Amanita phalloides* research published between 2015 and 2026**,** examining temporal publication trends, leading authors, institutions, countries, document characteristics, subject areas, and other major bibliometric indicators [9,10]. By mapping the contemporary research landscape, this study seeks to provide a comprehensive overview of the development of *A. phalloides* research and to identify areas that may guide future toxicological and clinical investigations.

Materials and Methods

Study Design

This study was designed as a descriptive bibliometric analysis to evaluate the characteristics and temporal development of scientific literature related to *Amanita phalloides*. Bibliometric methods were used to assess publication productivity and the distribution of research according to authors, institutions, countries, document types, subject areas, and funding organizations. The Scopus database was selected as the source of bibliographic data because of its broad coverage of peer-reviewed scientific literature across medicine, toxicology, pharmacology, and related disciplines.

Data Source and Search Strategy

The literature search was conducted using the Scopus database. The search strategy applied to the title, abstract, and keyword fields was: The publication period was restricted to **2015–2026**. The search identified a total of **246 documents** for bibliometric evaluation. No additional databases were included in the present analysis; therefore, all bibliometric findings reported in this study represent Scopus-indexed literature retrieved using the predefined search strategy.

Eligibility and Data Collection

Documents retrieved by the predefined Scopus query within the selected publication period were included in the bibliometric dataset. The analysis incorporated the document categories available in the Scopus results, including original articles, reviews, book chapters, letters, conference papers, notes, short surveys, and errata. Original research articles represented the largest document category in the retrieved dataset (74.4%), followed by review articles (15.9%). Bibliometric information available through the Scopus "Analyze search results" function was evaluated. The extracted parameters included publication year, document type, subject area, author, institutional affiliation, country or territory, and funding sponsor.

Bibliometric Indicators

Annual publication output was examined to characterize changes in scientific productivity over the study period. Author-level analysis was used to identify the most productive researchers, while institutional analysis was performed to determine the affiliations contributing most frequently to the literature. Geographical research productivity was assessed according to the country or territory information provided by Scopus. The multidisciplinary characteristics of the literature were evaluated using Scopus subject classifications. The principal subject categories included Medicine, pharmacology/toxicology-related disciplines, Environmental Science, biochemistry/genetics-related disciplines, Agricultural and Biological Sciences, Chemistry, Immunology, Chemical Engineering, Engineering, and other fields. Funding information was also evaluated to identify organizations contributing financial support to research within the field.

Data Analysis and Visualization

Descriptive bibliometric analysis was used to summarize the retrieved literature. Publication frequencies and distributions were evaluated according to year, author, institution, country, document type, subject area, and funding sponsor. Results were expressed as absolute numbers and, where available, percentages. The Scopus analytical interface was used to

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visualize temporal publication trends and the distributions of authors, affiliations, countries, document types, subject areas, and funding sponsors. For example, the dataset demonstrates variation in annual research output and identifies 2024 and 2025 as particularly productive recent years. Because the uploaded dataset contains only the Scopus "Analyze search results" output, **citation-network, co-authorship-network, keyword co-occurrence, and VOSviewer analyses should not yet be claimed in the Methods** unless you actually performed/exported those analyses.

Statistical Analysis

The study was primarily descriptive. Categorical bibliometric variables were summarized using frequencies and percentages, whereas annual publication counts were used to evaluate temporal changes in research productivity. No patient-level data or inferential clinical comparisons were included in the analysis.

Results

A total of **246 documents** related to *Amanita phalloides* were identified in the Scopus database for the period **2015–2026** using the predefined title-abstract-keyword search strategy. Annual scientific production demonstrated fluctuations throughout the study period rather than a continuous linear increase. Recent years showed substantial research activity, with **27 publications in 2024 and 26 in 2025**. The dataset also recorded 20 publications in 2023, 18 in 2022, 21 in 2021, 17 in 2020, 19 in 2019, and 21 in 2018. Eleven publications were indexed for 2026 at the time represented by the dataset [Figure 1.] Analysis by document type demonstrated a strong predominance of original research. **Articles accounted for 74.4%** of all publications, followed by **reviews (15.9%)** and book chapters (4.1%). Letters represented 2.4%, conference papers 1.2%, while notes, short surveys, and errata each constituted less than 1% of the retrieved literatüre [Figure 2]. These findings indicate that the literature on *A. phalloides* during the investigated period was primarily composed of original scientific studies.

The subject-area distribution revealed the multidisciplinary nature of *A. phalloides* research. **Medicine was the largest subject category, accounting for 30.3%**, followed by pharmacology/toxicology-related disciplines (17.0%), Environmental Science (9.3%), biochemistry/genetics-related fields (9.0%), and Agricultural and Biological Sciences (8.8%). Chemistry accounted for 4.8%, Immunology for 3.7%, Chemical Engineering for 2.9%, Engineering for 2.1%, and Physics and Astronomy for 1.9%. Other subject areas collectively represented 10.1% [Figure 3]. Author analysis identified **Carvalho F.** as the most prominent contributor in the displayed Scopus analysis, followed by researchers including **Costa V.M., Garcia J., Dekkers B.G.J., Kaya E., Touw D.J., Baptista P., Pringle A., Arici M.A., and Bayram R.** At the institutional level, **Universidade do Porto** ranked prominently, while **Düzce University** and **UCIBIO-REQUIMTE** were also among the leading affiliations. Other contributing institutions originated from several European, North American, and Asian research environments. Geographical analysis demonstrated broad international participation. The **United States** showed the highest publication activity in the displayed country analysis, followed by **China and Türkiye**. Germany, France, Portugal, Canada, India, Poland, and the Netherlands were also among the leading contributing countries. Overall, the findings demonstrate sustained and geographically diverse scientific interest in *A. phalloides*, with particularly strong representation from clinical medicine and toxicology-related research.

Discussion

The present bibliometric analysis provides an overview of the scientific literature on Amanita phalloides indexed in Scopus between 2015 and 2026. A total of 246 publications were identified, demonstrating sustained international scientific interest in this highly relevant toxic mushroom. Publication output fluctuated across the study period, with particularly high productivity in recent years, including 27 documents in 2024 and 26 in 2025. This pattern suggests that A. phalloides continues to represent an active research topic rather than a mature field characterized by declining scientific attention. One of the most notable findings was the predominance of original research articles, which accounted for 74.4% of the retrieved documents. Reviews constituted an additional 15.9%, whereas book chapters, letters, conference papers, notes, and other publication types represented relatively small proportions. The high proportion of original articles indicates continued generation of primary scientific evidence. Nevertheless, the substantial presence of reviews also suggests an ongoing need to synthesize accumulated knowledge within this field.

Amanita phalloides is commonly known as a deadly mushroom species and contains three main toxin groups such as amatoxins, virotoxins, and phallotoxins[11]. This mushroom is responsible for 90-95% of deaths due to mushroom poisoning worldwide[12-15]. Amanita phalloides poisoning usually begins with a delay period of 8-24 hours, during which the toxins spread throughout the body[16]. Poisoning symptoms usually start with gastrointestinal symptoms and can lead to liver necrosis[17]. The mortality rate in poisoning cases is 20-30% in adults and over 50% in children[18]. Treatment may include supportive care, gastric lavage, chemotherapy, and liver transplantation[19]. Liver transplantation may be necessary, especially when liver failure develops[20]. The toxic effects of Amanita phalloides are primarily triggered by an RNA polymerase II inhibitor called α-amanitin, which inhibits cellular protein synthesis[21,22]. In a study conducted in Portugal, amatoxin and phallotoxin contents in different tissues of the mushroom were analyzed, and it was found that the cap is the richest in terms of amatoxins[23]. The spread of Amanita phalloides shows a wide distribution in various geographical regions, and the presence of this mushroom is particularly common in Europe[24]. The management of poisoning cases can reduce mortality rates with early diagnosis and appropriate treatment[21]. Further research on the dangers of Amanita

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phalloides and treatment methods may contribute to the more effective management of poisoning cases[22].

The multidisciplinary nature of A. phalloides research was another important finding. Medicine represented the largest subject area at 30.3%, followed by pharmacology/toxicology-related disciplines at 17.0%. Environmental Science, biochemistry/genetics-related fields, and Agricultural and Biological Sciences also contributed considerably to the literature. This distribution demonstrates that research concerning A. phalloides extends considerably beyond the clinical management of mushroom poisoning. The topic involves multiple scientific perspectives, including toxicology, biological sciences, environmental research, and biochemical investigation. Such multidisciplinary involvement may be particularly valuable for connecting fundamental toxin-related research with clinically relevant applications.

The geographical distribution of publications further demonstrates the international character of the field. The United States showed the greatest publication activity in the displayed Scopus analysis, followed by China and Türkiye, while Germany, France, Portugal, Canada, India, Poland, and the Netherlands were also represented among the leading countries [24-27]. The relatively prominent position of Türkiye is noteworthy and indicates substantial national research activity related to A. phalloides. However, publication productivity alone should not be interpreted as research impact; citation-based indicators would be required to determine whether the countries producing the largest number of publications also generated the most influential research.

The funding profile also indicates participation by diverse national and international organizations. Among the funding bodies displayed by Scopus were the National Natural Science Foundation, European Regional Development-related funding, European Commission, National Institutes of Health, National Science Foundation, and Deutsche Forschungsgemeinschaft. This diversity may reflect the multidisciplinary and international nature of research on A. phalloides.

Several limitations should be considered. First, the analysis was restricted to the Scopus database; therefore, publications indexed exclusively in Web of Science, PubMed, or other databases may not have been captured. Second, the search strategy was limited to the terms “amanita” and “phalloides” in titles, abstracts, and keywords, potentially excluding relevant studies indexed using alternative terminology. Third, the 2026 publication count represents an incomplete year and should not be directly compared with completed calendar years. Finally, the supplied Scopus analysis does not contain citation-network, keyword co-occurrence, bibliographic coupling, or co-authorship network data. Consequently, conclusions regarding intellectual structure, emerging research themes, collaboration networks, or the most influential publications cannot be drawn from the present dataset.

Conclusion

This Scopus-based bibliometric analysis demonstrates sustained and internationally distributed research activity on Amanita phalloides between 2015 and 2026. Among the 246 identified publications, original articles constituted the dominant document type, while Medicine and pharmacology/toxicology-related disciplines represented the major subject areas. The United States, China, and Türkiye were prominent contributors, and several established authors and institutions demonstrated repeated research activity. The relatively high publication output observed in 2024 and 2025 further indicates continuing scientific interest in the field. Future studies incorporating citation analysis, keyword co-occurrence mapping, co-authorship networks, and international collaboration analyses could provide a more comprehensive understanding of the intellectual structure and evolving research priorities in A. phalloides research.

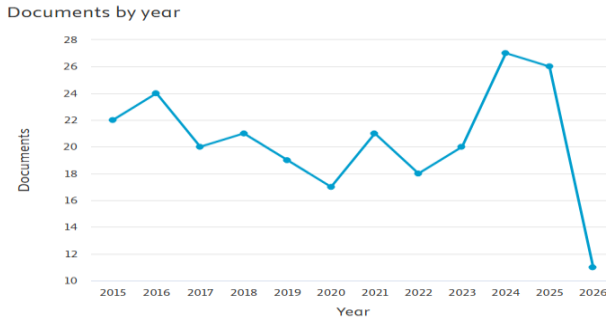

Figure 1. Documents by year

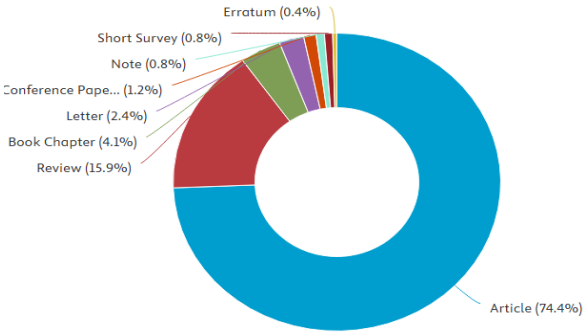

Figure 2. Documents by type

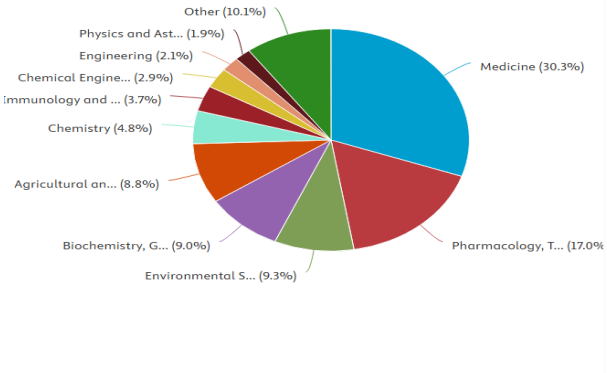

Figure 3. Documents by subject area

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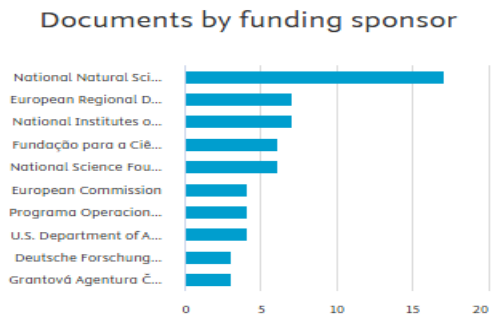

Figure 4. Documents by funding sponsor

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