Article Title: Characteristics of the *Echinacea* Spp. research literature: A bibliometric analysis

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Abstract

Introduction: The herbaceous purple-petalled flowering plants of the genus Echinacea are from the aster family (Asteraceae). The majority of echinacea research is based on its purported ability to treat and prevent the common cold among many other upper respiratory tract infections. This bibliometric study aims to highlight the current landscape and impacts of available echinacea peer-reviewed publications.

Methods: Publication searches were conducted on August 10, 2022. To reduce discrepancies between daily database updates, results were exported on the same day. Publication search types were limited to only include "article" and "review." From this subset of publications, identified trends were used to construct bibliometric networks via the VOSviewer software.

Results: Between 1915 and 2022, a total of 3727 authors published 1267 publications across 638 journals. Since the late 1990s, there has been an exponential increase in the volume of published echinacea literature. Planta Medica (n=44) was identified to be the journal with the most publications. The countries with the highest number of publications are: the United States (n=290), Germany (n=142), and Canada (n=125). The majority of institutional affiliations and funding sponsors were also based in these three countries.

Conclusions: This bibliometric analysis provides insights into the characteristic features of echinacea research publications. Given echinacea's therapeutic potential and its growing popularity among consumers, future research should continue to investigate trends associated with this emerging field.

Abbreviations

COVID-19: Coronavirus disease 2019

1. Introduction

Widely referred to as coneflowers, the herbaceous purple-petalled flowering plants of the genus Echinacea are from the aster family (Asteraceae) [1]. These plants are native to North America, where they frequently grow in regions ranging from dry to wet prairies and open wooded areas. They have since been naturalised in Europe [1]. Out of nine echinacea species, only three have been used for medicinal purposes: Echinacea angustifolia, Echinacea purpurea, and Echinacea pallida [2,3]. The name "coneflower" is derived from its appearance, which consists of purple tubular florets surrounding a large cone-shaped centre. Inspired by its bristly leaves and cones, 'Echinacea' is named after the Greek word "echinos," meaning "sea urchin" or "hedgehog" [4].

As a traditional medicinal plant, Echinacea was historically used by North American indigenous groups to remedy diverse illnesses, such as toothaches, the common cold, sore throats, burns, and animal bites [5,6]. The demand for echinacea products grew rapidly in the early 1900s, when they became manufactured and sold by many large pharmaceutical firms. Between 1916 and 1950, Echinacea angustifolia and Echinacea pallida were formally added to the United States' National Formulary [5]. Presently, several factors make it complicated to accurately study the therapeutic and medicinal properties of echinacea. Firstly, the composition of commercially available echinacea products varies greatly with respect to the proportions of the three species used. In addition, the usage of different segments of the plant (e.g., roots, flowers, extracts) and different methods of preparation (e.g., extracts or expressed juice) may also lead to variations in the phytochemical profiles of echinacea products [7,8]. Despite these potential limitations, a growing body of literature has emerged surrounding echinacea's potential to treat and prevent the common cold among a host of other upper respiratory tract infections [9,10,11,12,13].

While preliminary findings appear positive, echinacea's prospect as a viable treatment method is hampered by a lack of robust and well-regulated clinical trials [3], thus this demands further investigation to evaluate the herb's safety and efficacy. In addition, studies have been conducted on echinacea's anti-cancer [14,15], anti-inflammatory [16], anti-bacterial [17,18], and anti-viral properties [19,20]. Due to its purported antiviral activity, one increasingly popular avenue of study is echinacea's potential in treating and/or preventing coronavirus disease 2019 (COVID-19) [21]. In one study, Echinacea purpurea's (Echinaforce®) antiviral properties against HCoV-229E were observed in two environments - one upon direct contact and the other within a cell culture model. In-vitro tests revealed that similar concentrations of Echinaforce inactivated both SARS-CoV-1 and SARS-CoV-2. Due to coronaviruses sharing similar structural features, the authors hypothesised that echinacea could be an effective prophylaxis for all coronaviruses [22], although more research is needed to validate this.

While oral ingestion of echinacea is usually well-tolerated, there is a risk of it negatively interacting with other common pharmaceutical medications [23]. Presently, there have been no significant reports of herb-drug interactions in the literature [23, 24]. The profile of side effects from echinacea include a wide array of gastrointestinal symptoms, including diarrhoea, heartburn, and nausea [25]. However, these symptoms are typically uncommon, mild, and reversible [26]. Other studies have associated echinacea with rare cases of allergic reactions such as asthma and anaphylaxis [26,27].

Given the multitude of studies suggesting the promising benefits of echinacea, there has been some growth in the number of publications on this topic over the past few decades. The

majority of echinacea research is likely funded by consumer popularity. HerbalGram reported that over $120 million was spent on echinacea products in the United States in 2019, which makes it the second most purchased herbal product that year [28]. During the COVID-19 pandemic, sales of echinacea increased sharply in the first half of the year 2020 [28].

The objective of the present study is to perform a bibliometric analysis provide an overview of the current landscape surrounding research published about echinacea. This serves to provide a descriptive summary of the growth and distribution of literature on this subject. As a quantitative research methodology, a bibliometric analysis uses statistical methods to identify characteristics of existing scientific publications and determine their impact within their academic discipline [29,30,31]. There is a lack of bibliometric analyses on the topic of echinacea which this study aims to fill.

2. Methods

2.1. Publication Search and Characteristics

A single search was run on Scopus on August 10, 2022 using the following search terms: "(TITLE ("Echinacea" OR "Brauneria angustifolia" OR "Brauneria pallida" OR "Rudbeckia pallida" OR "Brauneria purpurea" OR "Helichroa purpurea" OR "Rudbeckia purpurea" OR "American Cone Flower" OR "Black Sampson" OR "Black Susans" OR "Comb Flower" OR "Coneflower" OR "Echinaceawurzel" OR "Échinacée" OR "Échinacée Angustifolia" OR "Échinacée Pallida" OR "Échinacée Pourpre" OR "Échinacée Purpurea" OR "Equinácea" OR "Fleur À Hérisson" OR "Igelkopfwurzel" OR "Kansas Snakeroot" OR "Narrow-Leaved Echinacea" OR "Narrow-Leaved Purple Coneflower" OR "Narrow-leaved Purple Cone Flower" OR "Pale Coneflower" OR "Pale Flower Echinacea" OR "Pale Purple Coneflower" OR "Purple Coneflower" OR "Purple Cone Flower" OR "Purpursonnenhutkraut" OR

“Purpursonnenhutwurzel” OR “Racine D'echininacea” OR “Roter Sonnenhut” OR “Rudbeckie Pourpre” OR “Schmallblaettrige Kegelblumenwurzel” OR “Schmallblaettriger Sonnenhut” OR “Scurvy Root” OR “Sonnenhutwurzel")) AND (LIMIT-TO (DOCTYPE,“ar”) OR LIMIT-TO (DOCTYPE,“re”))”. These terms were chosen based on the professional monograph of echinacea [25]. Since the total number of results did not exceed 2000 publications, results were exported in a single batch. Due to the potential for daily database updates, all publications were downloaded on the same day to prevent any discrepancies.

Searches were conducted solely on Scopus, as it is the largest abstract and citation database of peer-reviewed literature [32]. Comparatively, Web of Science contains a fewer number of indexed publications, while OVID databases lack certain metrics such as publication citation counts [33]. In terms of publication type, only “article” and “review” were included within the search and no additional search limits were applied. The bibliometric data that was collected were as follows: number of publications (in total and per year), open access status, publications per journal, journal names and impact factors, language of publication, document type, country of publication, author affiliations, funding sponsors, most highly published authors and most highly cited publications. Trends associated with this subset of publications were identified and presented. Bibliometric networks were constructed and visualized using the software tool VOSviewer (version 1.6.1) [34,35].

3. Results

From 1915 to August 2022, a total of 1267 publications (302 open access) were published by 3727 authors in 638 journals. Initially, publications on echinacea were limited. It was not until the late 1990s when an upward trend in the number of publications was observed, with

the volume of publications peaking in 2009. Following this initial increase, however, the number of publications plateaued up until 2020. Fig. 1 displays the number of publications published year over year from 1985 to 2022. The three journals with the highest number of echinacea publications were Planta Medica (n=44), Phytomedicine (n=27), and the Journal of Agricultural and Food Chemistry (n=26). In addition to the aforementioned three journals, the 16 journals with the highest number of echinacea publications were manually searched via InCites Journal Citation Reports to obtain relevant metric information. The 2021 impact factors of these journals ranged from 1.063 to 6.656; two journals did not have impact factors. Table 1 provides complete details of analysed journals, including full journal title, the number of publications published, and their impact factors.

The subject areas with the highest volume of publications were medicine (n=482), agricultural and biological sciences (n=414), and pharmacology, toxicology and pharmaceutics (n=410). By far, the most common publication language was English (n=1130). Trailing far behind was German (n=63) and Chinese (n=28). A similar observation was noted in document type, with the majority of publications being articles (n=1192) with a small number of reviews (n=75). The countries with the highest output of publications were the United States (n=290), Germany (n=142), and Canada (n=125). Reflecting this, the most common affiliations included Iowa State University (n=38), the University of British Columbia (n=31), and the University of Ottawa (n=29). In terms of funding sponsors, the most common were the National Institutes of Health (n=44), the National Center for Complementary and Integrative Health (n=41), and the National Natural Science Foundation of China (n=29). Table 2 outlines the general characteristics of eligible echinacea publications. Table 3 lists the 10 most highly published authors, while Table 4 lists the 10 most highly cited publications.

Figs. 2-5 represent bibliometric networks constructed and visualised via the VOSviewer software tool. Fig. 2 describes a co-authorship analysis of the 30 most productive countries. Within a co-authorship analysis, the strength of a relationship between items is based on the number of co-authored publications. Fig. 3 describes a co-occurrence analysis of the 100 most frequent author keywords used across all publications. Within a co-occurrence analysis, the strength of a relationship between items is based on how many publications they occur in together. Figs. 4 and 5 describe a citation analysis of the 500 most cited authors and the 100 sources publishing the largest number of echinacea publications, respectively. Within a citation analysis, the strength of a relationship between items is based on how frequently they cite one another.

4. Discussion

The objective of this study is to perform a bibliometric analysis that provides an overview of the current landscape of peer-reviewed publications in the field of echinacea research. The Scopus database search retrieved 1267 peer-reviewed publications. To the best of the authors' knowledge, this represents the first and only bibliometric analysis of echinacea literature to date. Considerable growth in the volume of literature published occurred during the late 1990s; however, this was followed by a plateau in published research up until 2020. This plateau, along with a relatively lower total number of echinacea research compared to that of pharmacological treatments (e.g., for upper respiratory infections), is suggestive of government and nongovernment sectors providing comparatively little or lesser support and funding for herbal research [36]. A lack of funding may have hindered research opportunities to further investigating the herb's regulatory status, safety and efficacy profile, and quality control. This in turn may have contributed to insufficient knowledge about its merits or lack thereof within national drug regulatory bodies [37].

The present analysis determined that 290 publications originated from the United States, making it the country with the highest publication count in the field of echinacea, followed by Germany and Canada with 142 and 125 publications respectively. These results were expected due to both regions' past and current documented use of echinacea to treat upper respiratory infections. While the greatest proportion of publications were written in English, German was the second most common language. Among the top 9 affiliated institutions that were involved in the publication of echinacea research, 1 originated from the United States, 2 originated from Germany, and 2 originated from Canada. Additionally, 6 funding sponsors were based in the United States and 2 funding sponsors were based in Canada.

4.1. Comparative Literature

In terms of comparative literature, it is worth drawing attention to a few bibliometric analyses of a variety of topics relating to herbal and medicinal plants. Salmerón-Manzano et al. (2020) examined global research trends in medicinal plants, discovering that greater than 110 000 studies pertaining to medicinal plants had been published between 1960 and 2019. "Pharmacology, toxicology and pharmaceutics" and "medicine" were the two scientific categories on Scopus housing the highest volume of literature, in both the present analysis and that of Salmerón-Manzano et al. [38].

Ang et al. (2021) conducted a bibliometric analysis of randomised controlled trials of traditional and complementary medicine for the treatment of COVID-19 [39] . Both the present study and Ang's study revealed that Phytomedicine was among the journals that published the greatest number of articles. In terms of search strategy, Ang et al. had included six databases, half of which were Chinese databases, which in turn allowed the analysis of

articles that may not have been indexed in English databases. Within the present study, it was found that Chinese was among the top languages of publication. Ng (2020) conducted a bibliometric analysis of global research trends at the intersection of traditional, integrative, and complementary and alternative medicine (TICAM) and COVID-19, and found that a disproportionately large number of articles mentioned traditional Chinese medicine compared to any other type of TICAM [45]. These findings are unsurprising given the fact that China has heavily promoted the use of traditional medicines for the treatment/management of many diseases/conditions, including COVID-19 [40].

Musa et al. (2022) conducted a bibliometric analysis to study the characteristics of publications on the topic of traditional herbal medicine. The authors found that the number of publications increased steadily after 1990, which may have been due to increased public interest resulting from their affordability and reported efficacy in treating illnesses, among other reasons [41]. This is consistent with the findings in the present study, where an upward trend in the number of echinacea publications since the late 1990s was observed and could also be attributed to similar factors. In addition, the present study and the study conducted by Musa et al. share considerable overlap in the subject areas with the highest number of publications. Notably, medicine, as well as pharmacology, toxicology, and pharmaceutics, were the two fields containing the most publications about both echinacea and traditional herbal medicine [41]. Unlike the present study, however, Musa et al. found that China was by far, the most productive country with respect to the number of publications.

Another bibliometric study conducted by García-García et al. (2008) reviewed the scientific literature that lie at the nexus of phytotherapy and psychiatry. They revealed that with respect to the number of publications, the top three most productive countries were the United States,

followed by Germany, and Canada [42], as in the present study. Yeung et al. (2018) conducted two bibliometric analyses of the top 100 most-cited scientific papers in the research field of nutraceuticals and functional foods [43] and ethnopharmacology [44], respectively. Despite the different research objectives held by the authors of the present study compared to that of these authors, both bibliometric analyses contained a number of shared journals that published the highest number of publications (within the top 15 for each study). This included the Journal of Agricultural and Food Chemistry and Phytochemistry with Yeung et al.'s nutraceuticals and functional foods bibliometric analysis [43]. The present study and Yeung et al. 's ethnopharmacology bibliometric analysis also shared the two aforementioned journals, in addition to Phytotherapy Research [44]. Altogether, this suggests that many of the journals having published the highest number of echinacea publications are also the same journals that publish much of the research about other herbal medicine topics.

4.2. Strengths and Limitations

The present bibliometric study has several notable strengths. Firstly, the characteristics of 1267 publications published in 638 journals were captured. Compared to other notable academic databases such as Web of Science, Scopus was chosen for its larger coverage of publications. However, despite its leverage, it may have failed to capture all existing literature that would have otherwise been found had we expanded our search to include other databases. Attempts to mitigate this limitation would have introduced additional complexities that hinder the ability to efficiently analyse the search results (e.g., deduplication of such a large number of publications). Another potential limitation stems from the lack of manual screening for the search results, which was mitigated by the chosen search strategy. Publications on the subject of echinacea tend to include one of the following search strings containing the term "echinacea," and these same search strings rarely refer to a non-echinacea

publication. Although the search strategy included many terms that are commonly used to refer to echinacea, observations from preliminary searches have demonstrated that it is rare for authors to incorporate these terms in the titles of their articles.

5. Conclusion

This present study identified the characteristics of 1267 publications and represents the first bibliometric analysis published on the topic of echinacea research. Countries with the highest number of publications were found to be the United States, Germany, and Canada. As expected, these three respective countries also produced the most institutional affiliations and funding agencies related to this subset of echinacea publications. Although the volume of echinacea publication has plateaued between 2009 and 2020, the steep growth trajectory of echinacea research in the late 1990s up until the late 2000s can likely be attributed to increased funding opportunities. Future research directions point towards investigating changes in the publication characteristics of emerging echinacea research. As the existing literature demonstrates, echinacea displays therapeutic promise in treating a range of infections such as the common cold and COVID-19. Therefore, it is likely that the global demand for this popular herbal medicine will only continue to grow, making it necessary to further investigate its effects on human health.

Authors' Contributions

JYN: Designed and conceptualised the study, collected the data, interpreted and analysed the data, drafted the manuscript, and gave final approval of the version to be submitted.

JDC: collected, interpreted and analysed the data, critically revised the manuscript, and gave final approval of the version to be submitted.

MYML: collected, interpreted, and analysed the data, critically revised the manuscript, and gave final approval of the version to be submitted.

KKYP: collected, interpreted, and analysed the data, critically revised the manuscript, and gave final approval of the version to be submitted.

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Declaration of Competing Interests

The authors declare that they have no competing interests.

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Data Availability

All data generated or analysed during this study are included in this published article.

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Figure Legends

Figure 1: Number of Echinacea Publications per Year from 1985-2022

Figure 2: Co-Authorship Analysis of the 30 Most Productive Countries/Regions

Figure 3: Co-Occurrence Analysis of the 100 Most Frequent Author Keywords

Figure 4: Citation Analysis of the 500 Most Cited Authors

Figure 5: Citation Analysis of the 100 Journals Publishing the Largest Number of Echinacea Publications

Table Legends

Table 1: Characteristics of the 16 Journals Having Published the Highest Number of Echinacea Publications

Table 2: General Characteristics of Echinacea Publications

Table 3: 10 Most Productive Authors Across Echinacea Publications

Table 4: 10 Highest Cited Echinacea Publications

Figures

Figure 1: Number of Echinacea Publications per Year from 1985-2022

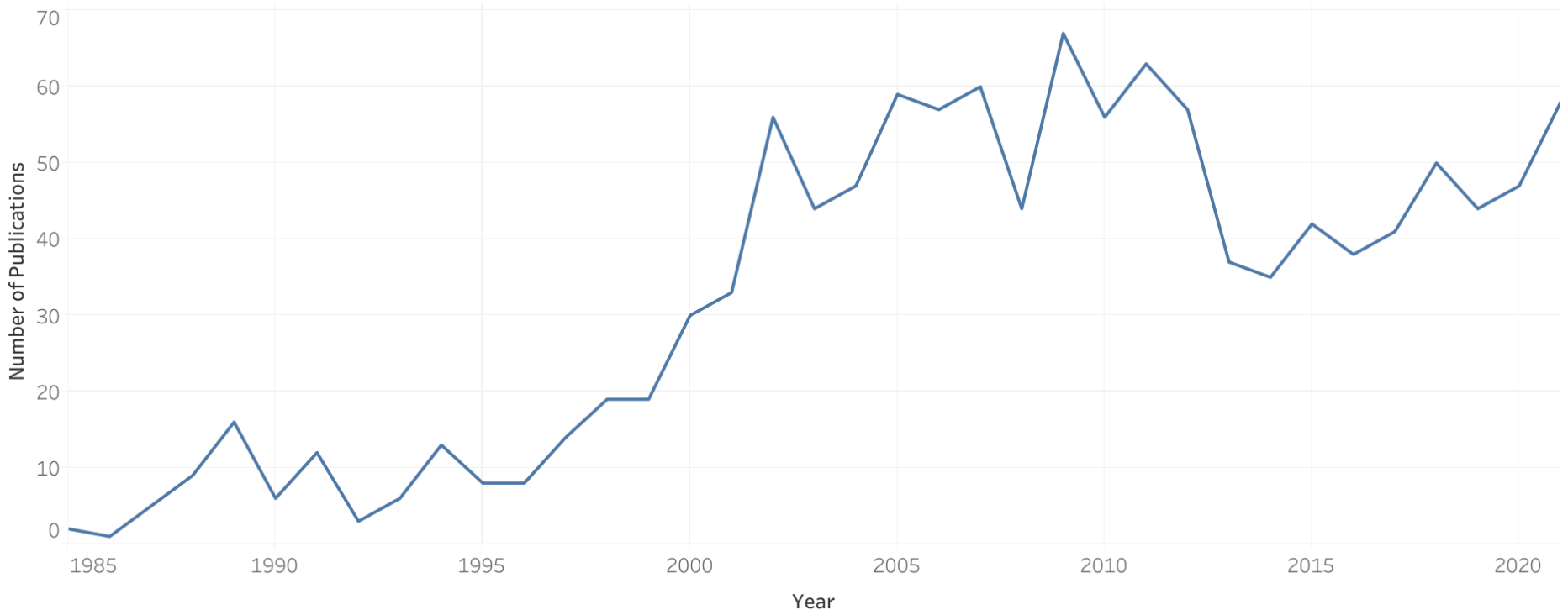


Figure 2: Co-Authorship Analysis of the 30 Most Productive Countries/Regions

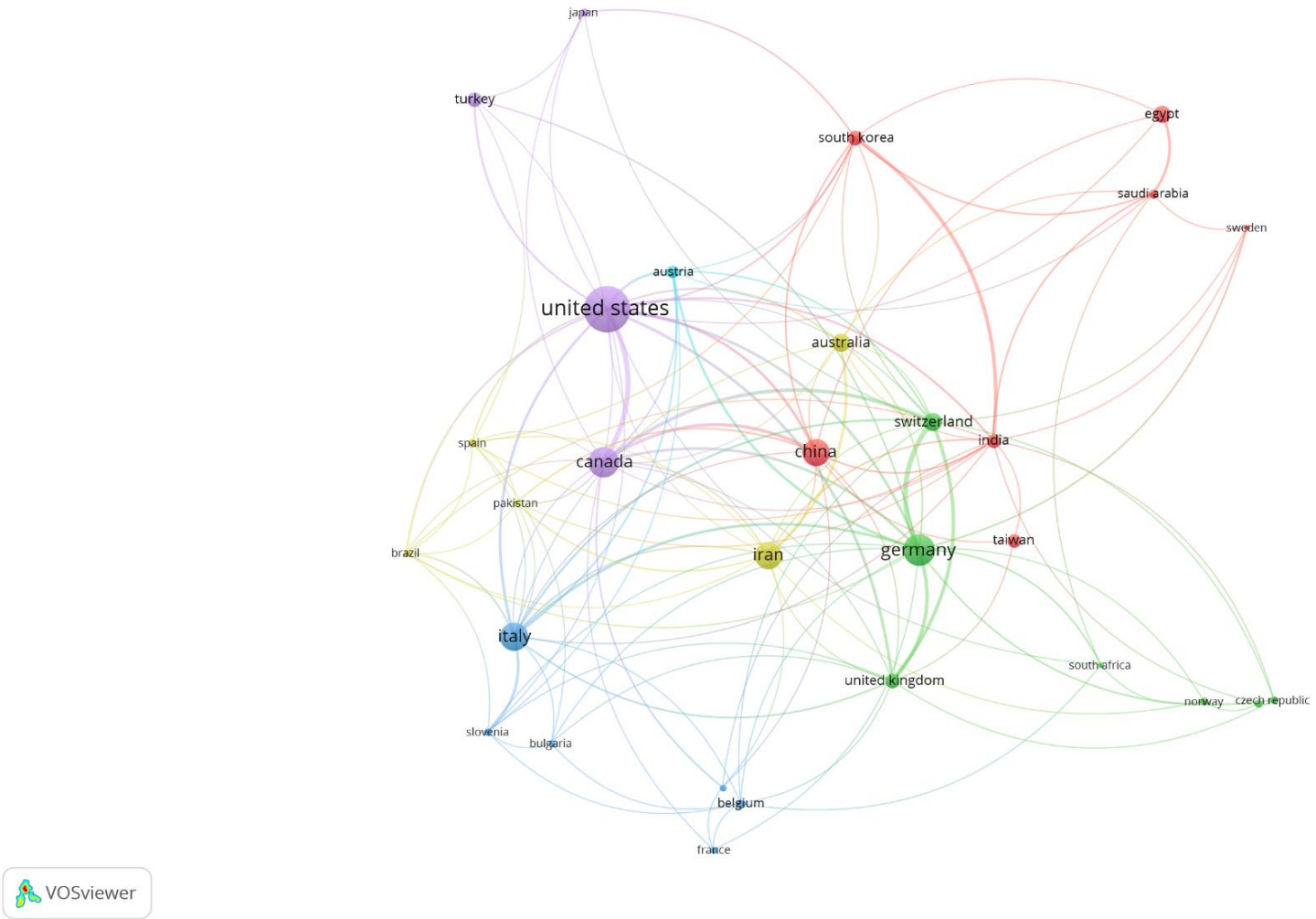


Figure 3: Co-Occurrence Analysis of the 100 Most Frequent Author Keywords

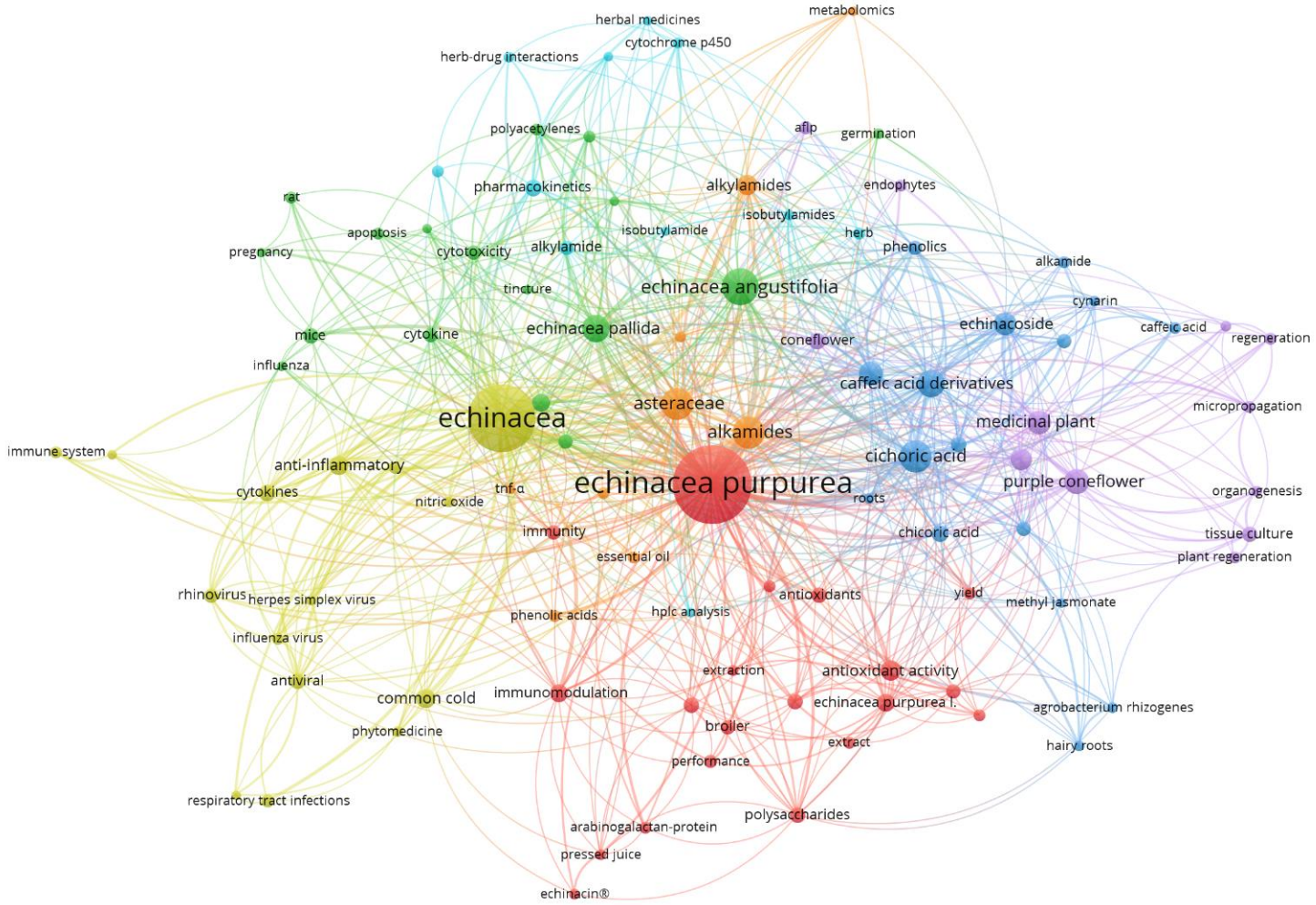


Figure 4: Citation Analysis of the 500 Most Cited Authors

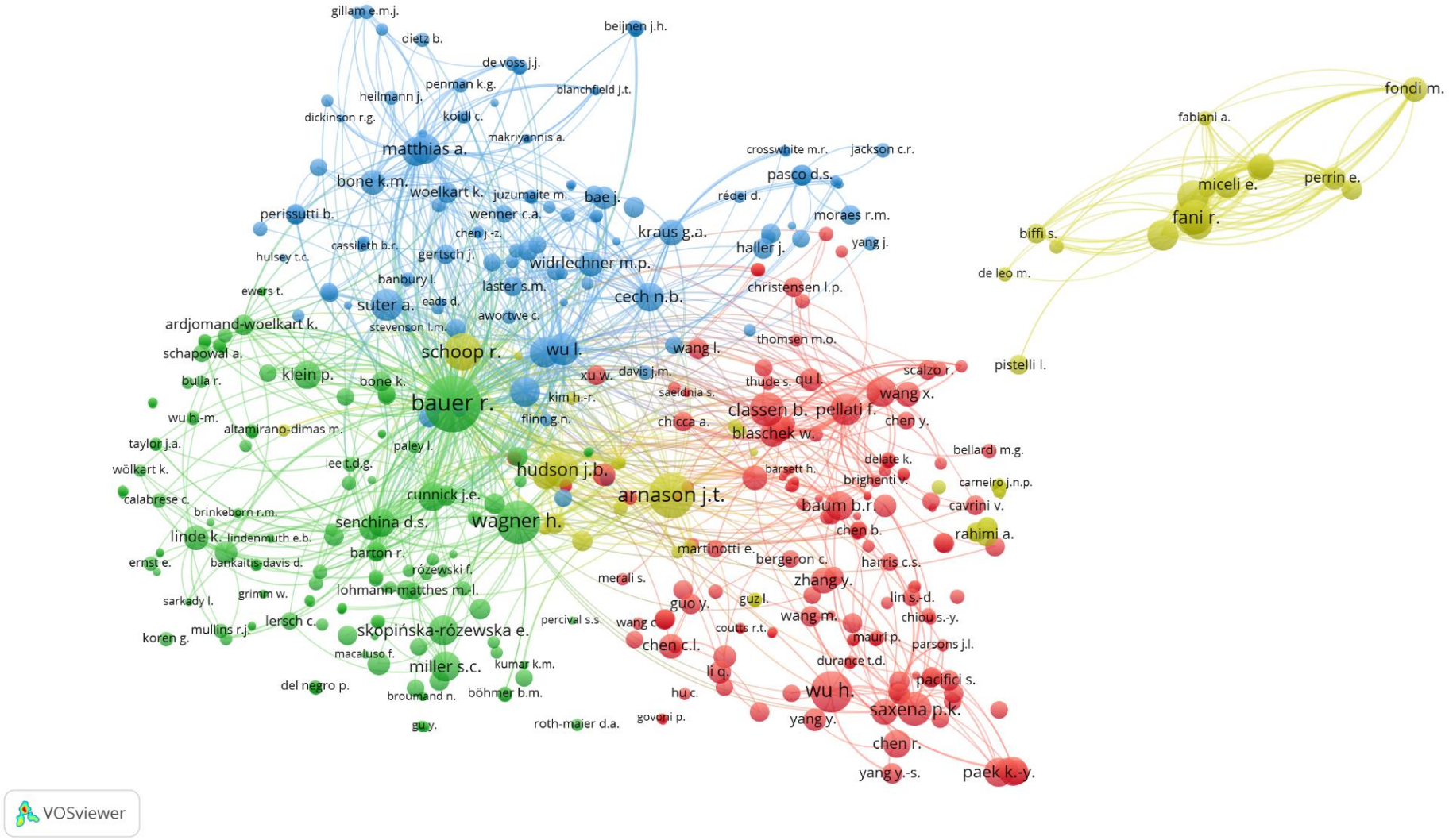
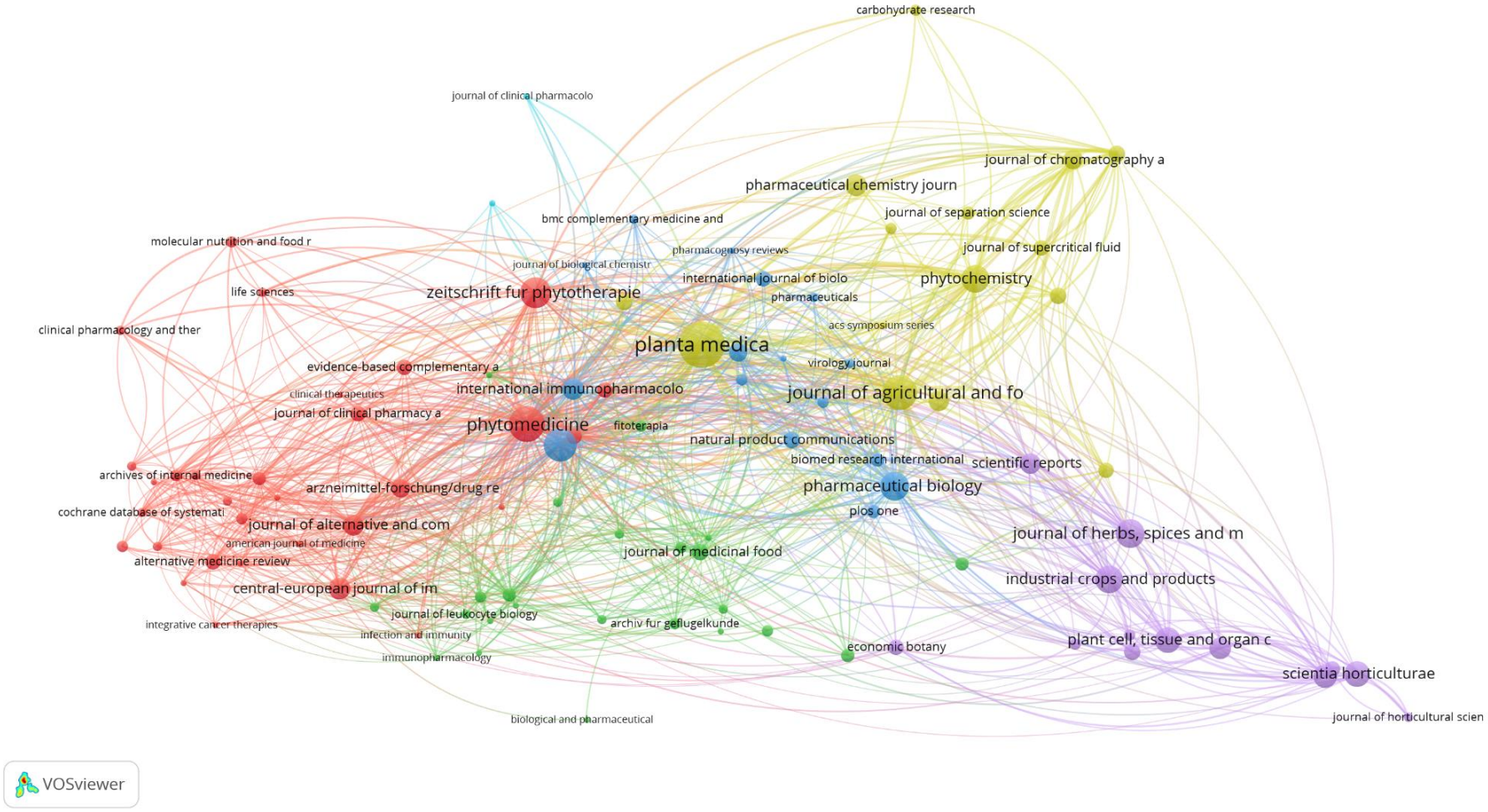


Figure 5: Citation Analysis of the 100 Journals Publishing the Largest Number of Echinacea Publications



Tables

Table 1: Characteristics of the 16 Journals Having Published the Highest Number of Echinacea Publications

Journal Name	Number of Publications	2021 Impact Factor	Name of the Publisher	Subject Area (Scopus)	CiteScore 2021
Planta Medica	44	3.007	Thieme	Medicine: Complementary and Alternative Medicine; Pharmacology, Toxicology and Pharmaceutics: Pharmaceutical Science; Chemistry: Analytical Chemistry; Chemistry: Organic Chemistry; Pharmacology, Toxicology and Pharmaceutics: Drug Discovery; Pharmacology, Toxicology and Pharmaceutics: Pharmacology; Biochemistry, Genetics and Molecular Biology: Molecular Medicine	6.2
Phytomedicine	27	6.656	Elsevier	Medicine: Complementary and Alternative Medicine; Pharmacology, Toxicology and Pharmaceutics: Pharmaceutical Science; Pharmacology, Toxicology and Pharmaceutics: Pharmacology; Pharmacology, Toxicology and Pharmaceutics: Drug Discovery; Biochemistry, Genetics and Molecular Biology: Molecular Medicine	9.6
Journal of Agricultural and Food Chemistry	26	5.895	American Chemical Society	Agricultural and Biological Sciences: General Agricultural and Biological Sciences; Chemistry:	8.6

				General Chemistry	
Phytotherapy Research	23	6.388	Wiley-Blackwell	Pharmacology, Toxicology and Pharmaceutics: Pharmacology	9.3
Zeitschrift Für Phytotherapie	20	N/A	Hippokrates Verlag	Pharmacology, Toxicology and Pharmaceutics: Pharmacology; Medicine: Complementary and Alternative Medicine	0.2
Journal of Herbs Spices and Medicinal Plants	17	N/A	Taylor & Francis	Medicine: Complementary and Alternative Medicine; Pharmacology, Toxicology and Pharmaceutics: Pharmacology;	1.9
Pharmaceutical Biology	17	3.889	Taylor & Francis	Medicine: Complementary and Alternative Medicine; Pharmacology, Toxicology and Pharmaceutics: Pharmaceutical Science; Pharmacology, Toxicology and Pharmaceutics: Pharmacology; Pharmacology, Toxicology and Pharmaceutics: Drug Discovery; Biochemistry, Genetics and Molecular Biology: Molecular Medicine	4.8
Industrial Crops and Products	16	6.449	Elsevier	Agricultural and Biological Sciences: Agronomy and Crop Science	9.6
Phytochemistry	16	4.004	Elsevier	Agricultural and Biological Sciences: Horticulture; Agricultural and Biological Sciences: Plant Science; Biochemistry, Genetics and Molecular Biology: Biochemistry; Biochemistry, Genetics and Molecular Biology: Molecular	6.2

				Biology	
Plant Cell Tissue and Organ Culture	14	2.726	Springer Nature	Agricultural and Biological Sciences: Horticulture	4.6
Scientia Horticulturae	14	4.342	Elsevier	Agricultural and Biological Sciences: Horticulture	7.0
Hortscience	12	1.874	American Society for Horticultural Science	Agricultural and Biological Sciences: Horticulture	2.6
Central European Journal of Immunology	11	1.634	Termedia Publishing House Ltd.	Medicine: Immunology and Allergy; Immunology and Microbiology: Immunology	2.9
In Vitro Cellular and Developmental Biology - Plant	10	2.347	Springer Nature	Agricultural and Biological Sciences: Plant Science; Biochemistry, Genetics and Molecular Biology: Biotechnology	3.9
International Immunopharmacology	10	5.714	Elsevier	Pharmacology, Toxicology and Pharmaceutics: Pharmacology; Medicine: Immunology and Allergy; Immunology and Microbiology: Immunology	7.0
Pharmaceutical Chemistry Journal	10	1.063	Springer Nature	Pharmacology, Toxicology and Pharmaceutics: Pharmacology; Pharmacology, Toxicology and Pharmaceutics: Drug Discovery	1.1

Table 2: General Characteristics of Echinacea Publications

Publication Volume	
Number of Total Publications (n=1267)	
Number of Open Access Publications (n=302)	
Document Type (# of publications)	Article (n=1192)
	Review (n=75)
Source Titles (Journals) Across All Publications (n=638)	
Unique Authors Across All Publications (n=3727)	
Total Citations (n=28598)	
Mean # of Citations per Publication (n=22.57)	
International Collaborative Publications (n=213)	
Subject Area of Publication (10 Highest)	
# of publications	Medicine (n=482)
	Agricultural and Biological Sciences (n=414)
	Pharmacology, Toxicology and Pharmaceutics (n=410)
	Biochemistry, Genetics and Molecular Biology (n=372)
	Chemistry (n=193)
	Immunology and Microbiology (n=97)
	Environmental Science (n=67)
	Chemical Engineering (n=51)
	Veterinary (n=48)
	Nursing (n= 35)
Language of Publication (7 Highest)	
# of publications	English (n=1130)
	German (n=63)
	Chinese (n=28)
	Czech (n=7)
	French (n=7)
	Persian (n=7)
	Spanish (n=6)
Country of Publication (10 Highest)	

# of publications	United States (n=290)
	Germany (n=142)
	Canada (n=125)
	Italy (n=107)
	China (n=105)
	Iran (n=105)
	Australia (n=46)
	Switzerland (n=46)
	Egypt (n=40)
	Poland (n=33)
Institutional Affiliation (9 Highest)	
# of publications	Iowa State University (n=38)
	The University of British Columbia (n=31)
	University of Ottawa (n=29)
	Ludwig-Maximilians-Universität München (n=25)
	Università di Pisa (n=21)
	South China Agricultural University (n=20)
	Universitat Graz (n=18)
	Christian-Albrechts-Universität zu Kiel (n=17)
	Chungbuk National University (n=16)
Funding Sponsor (9 Highest)	
# of publications	National Institutes of Health (n=44)
	National Center for Complementary and Integrative Health (n=41)
	National Natural Science Foundation of China (n=29)
	National Institute of Environmental Health Sciences (n=22)
	Natural Sciences and Engineering Research Council of Canada (n=19)
	National Center for Complementary and Alternative Medicine (n=17)
	U.S. Department of Health and Human Services (n=16)
	Office of Dietary Supplements (n=15)
	Government of Canada (n=13)

Table 3: 10 Most Productive Authors Across Echinacea Publications

Author Name	Number of Publications	Number of Articles Published	Number of Citations Received	Institution	Country
Bauer, Rudolf	40	265	10389	Universitat Graz	Austria
Arnason, John Thor A.	27	408	14888	University of Ottawa	Canada
Wagner, Hildebert	19	307	9654	Ludwig-Maximilians-Universität München	Germany
Schoop, Roland	18	27	1059	A. Vogel / Bioforce Group	Switzerland
Wu, Hong	18	135	2630	South China Agricultural University	China
Hudson, James B.	16	148	5050	The University of British Columbia	Canada
Classen, Birgit	15	50	770	Christian-Albrechts-Universität zu Kiel	Germany
Fani, Renato	15	229	6205	Università degli Studi di Firenze	Italy
Saxena, Praveen Kumar	15	231	8000	Gosling Research Institute for Plant Preservation	Canada
Wu, Chunhua	15	24	837	Dalian Institute of Science and Technology	China

Table 4: 10 Highest Cited Echinacea Publications

Title	Author(s)	Year	Source Title	Number of Citations Received
The risk-benefit profile of commonly used herbal therapies: Ginkgo, St. John's wort, ginseng, echinacea, saw palmetto, and kava	Ernst E.	2002	Annals of Internal Medicine	449
Medicinal properties of Echinacea: A critical review	Barrett B.	2003	Phytomedicine	348
Echinacea species (Echinacea angustifolia (DC.) Hell., Echinacea pallida (Nutt.) Nutt., Echinacea purpurea (L.) Moench): A review of their chemistry, pharmacology and clinical properties	Barnes J., Anderson L.A., Gibbons S., Phillipson J.D.	2005	Journal of Pharmacy and Pharmacology	299
The effect of echinacea (Echinacea purpurea root) on cytochrome P450 activity in vivo	Gorski J.C., Huang S.-M., Pinto A., Hamman M.A., Hilligoss J.K., Zaheer N.A., Desai M., Miller M., Hall S.D.	2004	Clinical Pharmacology and Therapeutics	240
Studies on the antioxidant activity of Echinacea root extract	Hu C., Kitts D.D.	2000	Journal of Agricultural and Food Chemistry	227
In vitro effects of echinacea and ginseng on natural killer and antibody-dependent cell cytotoxicity in healthy subjects and chronic fatigue syndrome or acquired immunodeficiency syndrome patients	See D.M., Broumand N., Sahl L., Tilles J.G.	1997	Immuno-pharmacology	224
Immune system effects of echinacea, ginseng, and astragalus: A review	Block K.I., Mead M.N.	2003	Integrative Cancer Therapies	222
Echinacea for preventing and treating the common cold	Linde K., Barrett B., Wölkart K., Bauer R., Melchart D.	2006	Cochrane Database of Systematic Reviews	216
Alkylamides from Echinacea are a new class of cannabinomimetics: Cannabinoid type 2 receptor-dependent and -independent	Raduner S., Majewska A., Chen J.-Z., Xie X.-Q., Hamon J., Faller B., Altmann K.-H., Gertsch J.	2006	Journal of Biological Chemistry	210

immunomodulatory effects				
Macrophage activation by the polysaccharide arabinogalactan isolated from plant cell cultures of Echinacea purpurea	Luettig B., Steinmüller C., Gifford G.E., Wagner H., Lohmann-matthes M.-L.	1989	Journal of the National Cancer Institute	210