An in-depth Scientometric Analysis of the 100 Most Cited Articles on Biomass Research

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ABSTRACT: *In this study, we conducted a scientometric analysis of the 100 most cited articles on biomass to gain a comprehensive understanding of the biomass research landscape. This study analysis includes an examination of annual total citations per year, top journals with high impact factors and total citations, relevant sources, author indexes, affiliations, keyword frequency, and co-authorship networks. The findings reveal trends in citation impact over time, highlighting the recognition received by articles across different years. Top journals, such as Nature and Science, are identified as influential sources in terms of impact factor and total citations. The analysis of author indexes sheds light on the productivity and impact of top authors, while relevant affiliations are identified based on the number of associated articles. Frequent keywords provide insights into key focus areas within biomass research. Co-authorship networks reveal collaborative relationships among authors, organizations, and countries. These findings contribute to a deeper understanding of citation impact, source relevance, author productivity, affiliations, keyword trends, and collaboration patterns within the field of study. Researchers can utilize these insights to identify influential works, establish research collaborations, and explore emerging trends within the field of study.*

Keywords: Biomass, Biomass Research, Scientometric Analysis, Most Cited Article, Citation Trend, Influential Journal, Authorship Patterns

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1. Introduction and Background

Scientific publications and research are important tools for expanding our knowledge and influencing the growth of many sectors. In order to assess the significance and influence of scientific research in a particular discipline, scientometric analysis is required. By examining the citation patterns and trends of scholarly articles, scientometric studies provide valuable insights into the progress, influence, and knowledge dissemination of scientific disciplines. One such field of study is biomass, which has attracted a lot of interest recently because of its potential as a renewable and sustainable energy source.

The definition of biomass is "organic matter derived from plants or animals." Biomass holds great promise for tackling issues like

materials, including wood, agricultural residues, energy crops, and waste biomass, which can be utilized for various purposes such as heat and electricity generation, biofuels production, and the synthesis of valuable chemicals.

Understanding the research landscape surrounding biomass is crucial for identifying key advancements, emerging trends, and knowledge gaps in the field. Scientometric analysis provides a quantitative framework to assess the scholarly output in terms of article citations, enabling researchers to gauge the influence and impact of published work. By examining the most cited articles on biomass, we can identify seminal contributions, influential authors, popular research topics, and the evolution of ideas within the field.

This scientometric analysis aims to delve into the 100 most cited articles on biomass, exploring their characteristics, trends, and contributions. By analyzing citation data, we seek to uncover the seminal works that have shaped the understanding and development of biomass-related research. Additionally, this analysis will shed light on the disciplinary diversity within biomass research, as well as the collaboration networks and patterns of scientific production.

The findings of this scientometric analysis can provide valuable insights to researchers, policymakers, and stakeholders involved in biomass-related fields. By identifying the most influential articles and authors, this study can help guide future research directions, foster interdisciplinary collaborations, and facilitate the dissemination of knowledge in the biomass domain. Furthermore, understanding the patterns of citation and collaboration can aid in the development of effective strategies for promoting impactful research and maximizing the potential of biomass as a sustainable energy solution.

This scientometric research study, focused on the top 100 publications on biomass, aims to identify significant advancements, patterns, and networks of collaboration. This work seeks to provide a thorough understanding of the scientific environment surrounding biomass research through the analysis of citation patterns, laying the way for next developments in this important field.

2. Review of Literature

In this study, researchers collected and screened the literature related to the research on scientometric analysis of 10 most cited articles. It is found from literature search that few studies at different periods have been conducted by different authors to measure the citations

Garg et al., (2022) conducted a scientometric analysis of the 100 most cited articles on magnetic resonance-guided focused ultrasound. They explored various metrics and found that collaboration and multicentric collaborations were prevalent in these articles. The lead author of the highly cited article in this list was Hynynen K, who has contributed to *FUS* research for over three decades. Zhang et al., (2022) performed a bibliometric analysis of the top 100 most cited articles on atopic dermatitis (*AD*). Their study aimed to provide a historical perspective on the scientific progress of *AD*. They identified the most cited articles and analyzed their characteristics, such as publication years, countries of origin, and focus areas. The Journal of Allergy and Clinical Immunology made the greatest contribution to the top 100 list. Ding et al., (2022) conducted a bibliometric analysis of the top 100 most-cited articles on anterior cervical discectomy and fusion (*ACDF*). They searched the Web of Science database to identify these articles and analyzed their characteristics, including publication dates, citations, and institutions. The study provided insights into worldwide research trends and potential directions for future *ACDF* research. Jain et al., (2022) conducted a scientometric analysis of the top 100 most cited articles on imaging in *COVID-19*. They identified relevant articles using keyword searches and analyzed publication and citation trends. The study highlighted the contribution of countries most affected by the pandemic and identified common characteristics and research trends in the most cited works.Ahmad et al., (2020) performed a bibliometric analysis of the 100 most cited articles in prosthodontic journals. They retrieved articles from the Google Scholar database and analyzed publication dates, citations, and the journals' contributions. The study focused on articles related to dentistry and highlighted the most commonly cited areas of research, such as dental implants. Corbella et al., (2017) analyzed the 100 most-cited articles in the field of periodontology using Scopus and Web of Science databases. They examined the correlation between the number of citations and the age of publication. The study concluded that the actual value of the number of citations should be carefully evaluated when measuring the quality of an article.

3. Objectives of the study

• Examine the citation trends over time for the top 100 most cited articles on biomass.

• Identify the top 20 journals with highest impact factor and total citations.
• Determine the most relevant Sources.
• Analyze and compare various indexes of the Top 10 Authors.
• Identify top 20 most relevant Affiliations.
• Determine the most frequently occurring keywords.
• Identify Co-authorship network.

4. Methodology

The scientometric study began by selecting the Scopus database for retrieving scientific articles related to biomass research. Scopus database was chosen due to its extensive coverage of scholarly literature across various disciplines. The search term "biomass" was used to retrieve relevant articles encompassing topic on "biomass" between year 2003 to 2022. To retrieve the most influential and impactful articles, a search query was formulated and executed within the Scopus database, sorting the results in descending order based on the number of citations received by each article. This approach ensured that the top 100 most cited articles were identified for further analysis.

The next step involved downloading the bibliographic data of the top 100 articles from the Scopus database. Systematic data extraction was performed to capture pertinent details from each downloaded article. This process involved extracting information such as the article's title, authors, publication year, sources journal, keywords, citations of articles, and other relevant information. The aim was to gather essential information necessary for the subsequent scientometric analysis. The downloaded articles were subjected to scientometric analysis, which entailed quantitatively examining various scientometric and bibliometric parameters. These parameters may include citation counts, authorship patterns, journal impact factors, publication trends over time, and co-authorship networks. Statistical and visualization tools were utilized to analyze and present the findings derived from the scientometric analysis.

5. Data Analysis

5.1 Annual Total Citation Per Year

The table 1 provides information on the annual total citation statistics for different years. Each row represents a specific year, and the corresponding columns provide various measures of citation impact.

Year	Mean Total Citations Per Article	Mean Total Citations Per Year	Citable Years
2003	1465.78	69.80	21
2004	1852.45	92.62	20
2005	1440.36	75.81	19
2011	1728.27	132.94	13
2012	1398.17	116.51	12
2013	1385.89	125.99	11
2014	1336.62	133.66	10
2015	1904.75	211.64	9
2016	966	120.75	8
2017	1345.5	192.21	7
2018	1274	212.33	6

Table 1. Annual Total Citation per Year

The papers from the years 2006 to 2010 and 2019 to 2022 that did not receive a lot of citations from the other years are shown in table 1. The "**Mean Total Citations per Article**" column denotes the average number of citations received by an article published in that particular year. For example, in 2003, the average number of citations per article was 1465.78. This indicates the overall impact or recognition that articles from that year received from other scholarly works. The "**Mean Total Citations per Year**" column represents the average number of citations received by an article in a given year. It is calculated by dividing the total number of citations for that year by the number of articles published. For instance, in 2003, each article received an average of 69.80 citations per year. The "**Citable Years**" column indicates the duration for which the articles published in a specific year are considered citable. This provides insights into the length of time over which citations accumulate. For example, articles published in 2003 are considered citable for a period of 21 years.

5.2. Top 20 Journals With Highest Impact Factor and Total Citations

This table 2 provides information about the source impact of various scientific publications or journals. Each row represents

Element	*h* index	*g* index	*m* index	Total Citations	Number of Publications	Production Year start
Nature	11	11	0.52	22849	11	2003
Science	11	11	0.57	19086	11	2005
Bioresource Technology	6	6	0.31	11156	6	2005
Chemical Society Reviews	6	6	0.46	7112	6	2011
Proceedings of the national academy of sciences of the United States of America	5	5	0.25	7854	5	2004
Biomass and Bioenergy	4	4	0.19	7134	4	2003
Soil biology and Biochemistry	3	3	0.14	3412	3	2003
Ecology	2	2	0.09	2417	2	2003
Energy and Environmental Science	2	2	0.18	1846	2	2013
Energy Conversion and Management	2	2	0.1	2026	2	2004
Global Change Biology	2	2	0.09	3235	2	2003
Journal of Geophysical Research: atmospheres	2	2	0.09	3597	2	2003
Nature Geoscience	2	2	0.15	2744	2	2011
Plant and Soil	2	2	0.09	2415	2	2003
Acs nano	1	1	0.11	1275	1	2015
Acs sustainable chemistry and engineering	1	1	0.1	1007	1	2014
Annual review of cell and developmental Biology	1	1	0.07	1888	1	2011
Atmospheric Chemistry and Physics	1	1	0.07	1194	1	2011
Biofuels	1	1	0.07	1188	1	2011
Biotechnology Advances	1	1	0.04	1698	1	2003

Table 2. Top 20 journals with highest impact factor and total citations

a specific publication, and the columns present different metrics to measure their impact.

The "**h index**" represents the highest number of papers that have received at least h citations. For example, both NATURE and SCIENCE have an h index of 11, indicating that they have published at least 11 papers that have received 11 or more citations each. The "**g index**" measures the distribution of citations among the publications of a source, providing a more nuanced view of its impact. In this table, the g index values are also 11 for NATURE and SCIENCE, indicating a similar distribution pattern. The "**m index**" reflects the ratio of the h index to the number of publications, providing an average measure of the citation impact per paper. It allows for comparison across sources with different numbers of publications. For example, NATURE has an m index of 0.524, while SCIENCE has an m index of 0.579. The "**Total Citations**" column represents the overall number of citations received by papers published in a particular source. For instance, NATURE has received 22,849 citations in total. The "**Number of Publications**" column indicates the total count of publications associated with each source. The "**Production Year start**" column signifies the year in which the source started producing publications.

5.3. Most Relevant Sources

This table 3 provides a list of the most relevant sources in a specific context, along with the number of articles associated with each source. The relevance of these sources is determined by their significance and impact within the given field of

Sources	Articles
Nature	11
Science	11
Bioresource Technology	6
Chemical Society Reviews	6
Proceedings of the national academy of sciences of the United States of America	5
Biomass and Bioenergy	4
Soil biology and Biochemistry	3
Ecology	2
Energy and Environmental Science	2
Energy conversion and Management	2
Global change Biology	2
Journal of geophysical research: atmospheres	2
Nature Geoscience	2
Plant and Soil	2
Acs nano	1
Acs sustainable Chemistry and Engineering	1
Annual review of cell and developmental Biology	1
Atmospheric Chemistry and Physics	1
Biofuels	1
Biotechnology Advances	1

Table 3. Most Relevant Sources

study or research area.

The table 3 reveals that both Nature and Science, two highly prestigious scientific journals, have the highest number of articles, with 11 articles each. These journals are widely recognized for publishing groundbreaking research across various disciplines, making them highly influential sources in the scientific community. Following Nature and Science, there are several other sources with a considerable number of articles. Bioresource Technology and Chemical Society Reviews each have six articles, indicating their importance and contribution to their respective fields.

The Proceedings of the National Academy of Sciences of the United States of America (*PNAS*) follows closely with five articles. PNAS is a prestigious multidisciplinary journal that publishes high-impact research spanning the natural, social, and applied sciences. Its inclusion in this list further emphasizes its relevance and impact. Other sources, such as Biomass and Bioenergy, Soil Biology and Biochemistry, and Ecology, have contributed four, three, and two articles, respectively. Moreover, there are several sources with two articles, including Energy and Environmental Science, Energy Conversion and Management, Global Change Biology, Journal of Geophysical Research: Atmospheres, Nature Geoscience, and Plant and Soil. The remaining sources listed in the table have one article each, indicating their relatively lower contribution or narrower focus within their respective fields. However, even with a single article, each source may have made a significant impact on a specific research topic or area of study.

5.4. Various indexes of the top 10 authors

The h-index, g-index, and m-index are measures of an author's productivity and impact. The h-index reflects the number of papers an author has published that have received at least h citations. The g-index is a similar metric that takes into account the distribution of citations across an author's publications. The m-index measures the ratio of an author's h-index to the number of years they have been active in publishing.

This table 4 and figure 1provides information about the top 10 authors based on various indexes and citation metrics. The authors' names are listed in the "Element (Authors)" column, and their corresponding metrics are shown in the subsequent columns.

Element (Authors)	*h* index	*g* index	*m* index	Total Citations	Numbers of Publications	Publication Yearstart
GARNIER E	2	2	0.1	7470	2	2004
NAVAS M-L	2	2	0.1	7470	2	2004
ROUMET C	2	2	0.1	7470	2	2004
BOND TC	3	3	0.143	7468	3	2003
KLIMONT Z	3	3	0.143	7468	3	2003
BRIDGWATER AV	3	3	0.143	7246	3	2003
HOLTZAPPLE M	2	2	0.105	6134	2	2005
LEE YY	2	2	0.105	6134	2	2005
LEWIS SL	2	2	0.154	6006	2	2011
ACKERLY DD	1	1	0.05	5963	1	2004

Table 4. Various indexes of the top 10 authors

Table 4 indicted that three authors, Garnier E, Navas M-L, and Roumet C, have the same values for h-index, g-index, m-index, and total citations. Each of them has an h-index and g-index of 2, indicating that they have published at least 2 papers that have received 2 or more citations. Their m-index is 0.1, suggesting a relatively low productivity rate. Collectively, they have

accumulated a total of 7,470 citations across their publications. The next three authors, Bond TC, Klimont Z, and Bridgwater AV, also share similar values for their indexes. They each have an h-index and g-index of 3, indicating the presence of 3 papers with 3 or more citations. Their m-index is 0.143, slightly higher than the previous group, suggesting a slightly higher productivity rate. In total, they have amassed 7,468 citations.

Holtzapple M and Lee YY have an h-index and g-index of 2, indicating that they have published 2 papers with 2 or more citations. Their m-index is 0.105, and they have accrued 6,134 citations.Lewis SL, with an h-index and g-index of 2, has a relatively higher m-index of 0.154. This suggests that they have achieved a higher level of productivity compared to the previous authors. They have accumulated a total of 6,006 citations. Finally, Ackerly DD has an h-index and g-index of 1, indicating that their single publication has received at least 1 citation. Their m-index is 0.05, and they have accumulated 5,963 citations.

5.5. Top 20 Most Relevant Affiliations

This table 5 presents the top 20 most relevant affiliations based on the number of articles associated with each affiliation. The affiliations listed represent institutions and research centers where the authors of the articles are affiliated.

Affiliation	Articles
Swedish University of Agricultural Sciences	20
University of California	20
University of Washington	17
Chinese academy of sciences	16
Paul Scherrer Institute (psi)	15
Ctr. D'ecologie fonct. Et evolutive	14
Joint Genome Institute	11
Radboud University	11
University of Tasmania	11
Woods Hole Research Center	10
Argonne National Laboratory	9
University of South Florida	9
University of Colorado	8
University of Massachusetts	8
Utrecht University	8
Chongqing University of Arts and Sciences	7
Institute of Chemical Sciences and Engineering	7
Entomological Collections Krefeld	6
University of Florida	6
University of Leeds	6

Table 5. Top 20 Most relevant Affiliations

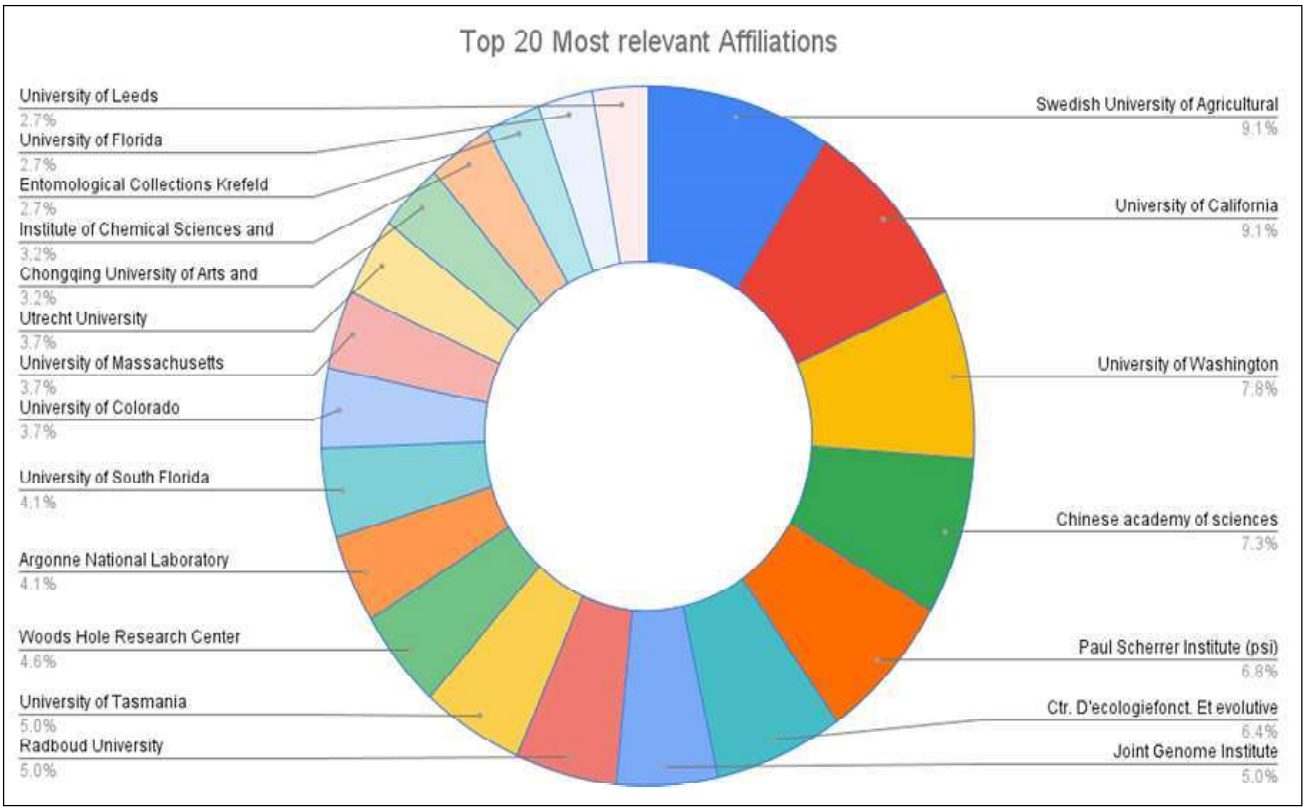

Figure 1. Top 20 Most relevant Affiliations

The Swedish University of Agricultural Sciences and the University of California are tied for the highest number of articles, with 20 publications each. These institutions have been actively involved in a wide range of research areas and have made significant contributions to the scientific community. The University of Washington follows closely with 17 articles. This university has a strong reputation for its research output and is known for its diverse academic programs across various disciplines. The Chinese Academy of Sciences, a renowned research institution in China, ranks fourth with 16 articles. It is recognized for its significant contributions to scientific advancements, particularly in the fields of natural sciences and technology. The Paul Scherrer Institute (PSI), a leading research center in Switzerland, has 15 articles associated with it. PSI focuses on multidisciplinary research, including energy, environment, and materials science.Ctr. D'ecologie fonct. Et evolutive, Radboud University, and the University of Tasmania all have 14 articles each. These institutions have shown their commitment to ecological and evolutionary research, making substantial contributions in these fields.The Woods Hole Research Center, a renowned scientific institution in the United States, is associated with 10 articles. It specializes in studying global environmental issues, particularly related to climate change and ecosystems. Several other prominent institutions such as the Argonne National Laboratory, the University of South Florida, and the University of Colorado are also represented in the table, with varying numbers of associated articles.

5.6. Most Frequent Keywords

The table 6 and figure 2 displays the most frequent keywords extracted from the titles, abstracts, or keyword lists of the top 100 most cited articles on biomass. These keywords provide valuable insights into the key focus areas and recurring themes within the field of biomass research.

The most common keyword, "biomass," appears 20 times, indicating its central importance in the field. Biomass refers to organic matter derived from plants, agricultural residues, or wood, which can be utilized as a renewable energy source or as a raw material for various applications. The second most frequent keyword is "carbon," which appears 18 times. This suggests a significant emphasis on carbon-related aspects within biomass research. Carbon is a fundamental element involved in biomass formation, carbon sequestration, and the carbon emissions associated with biomass utilization. The keyword "global"

appears 10 times, highlighting a global perspective in the context of biomass research. This indicates that the articles may address topics related to global biomass resources, global biomass production, or the overall global impact of biomass utilization. Both "production" and "review" appear 10 and 7 times, respectively. "Production" signifies a focus on biomass production methods, processes, or technologies, covering aspects such as cultivation, harvesting, and conversion into bioenergy or bioproducts. On the other hand, the presence of "review" suggests that some articles in the dataset are literature reviews, providing a comprehensive summary and analysis of existing knowledge in the field. The keywords "ecosystem" and "microbial" each appear 6 times, indicating specific areas of interest within biomass research. "Ecosystem" suggests that some articles explore the ecological aspects of biomass, including the impact of biomass production or utilization on ecosystems, biodiversity, or ecosystem services. "Microbial" highlights the role of microorganisms in biomass-related processes, such as microbial conversion, communities associated with biomass systems, or microbial ecology in biomass-rich environments.

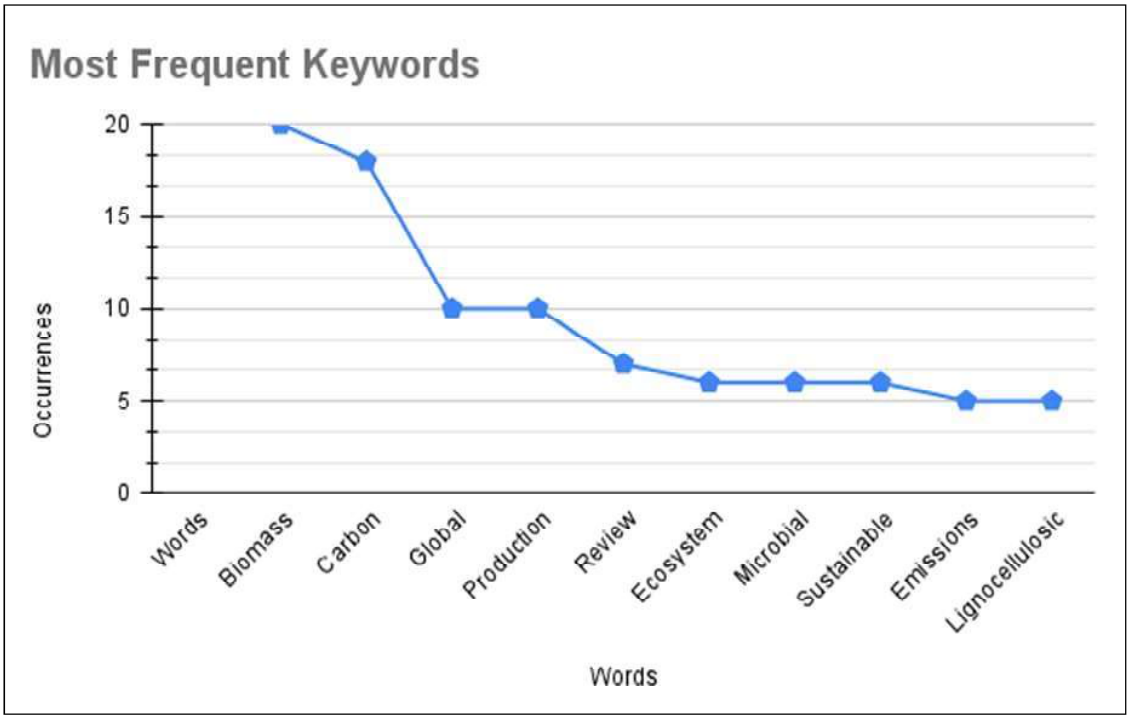

Figure 2. Most Frequent Keywords Occurrences

5.7. Co-authorship Network of Authors

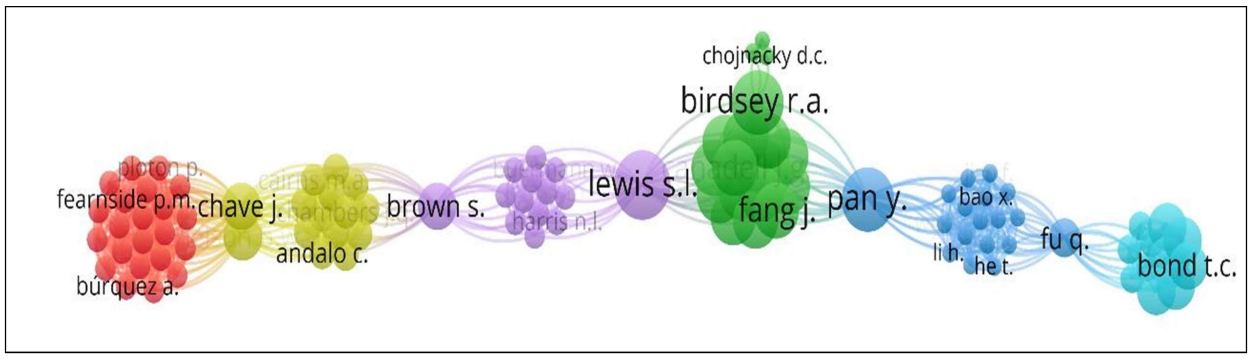

Figure 3.Co-authorship Network of Authors

Words	Occurrences
Biomass	20
Carbon	18
Global	10
Production	10
Review	7
Ecosystem	6
Microbial	6
Sustainable	6
Emissions	5
Lignocellulosic	5

Table 6. Most Frequent Keywords

Figure 3 display the visualization of the Co-authorship network of authors. Network was created on the basis of bibliographical data downloaded from Scopus. The download data were input in VOSviewer software for create Co-authorship network of an authors. We analyze manually defined criteria which is minimum 1 document and 1 citation of an author. A total 588 authors, 568 meet the threshold. For each of the 568 authors, the total strength of the co-authorship links with other authors willcalculate. Then authors with the greatest total link strength were selected is 568. In the 568 items of network are not connected to each other. The largest set of connected items consists of 99 items.The software separates these 99 authors into 6 clusters which from 864 links with a total link strength of 880. Author **Bridgwater A.V.** have3 documents with 7426 citations and 1 link strength, authors **Holtzapple M.** have 2 documents with 6134 citations and 11 link strength, author **Lee Y.Y.** have 2 documents with 6134 citations and 11 link strength, author **Lewis S.L.**have 2 documents with 6006 citations and 30 link strength, and author **Birdsey R.A.** have 2 documents with 5558 citations and 20 link strength.

5.8. Co-authorship Network of Organizations

Figure 4 display the visualization of the Co-authorship network of Organizations. Network was created on the basis of bibliographical data downloaded from Scopus. The download data were input in VOSviewer software for create Co-authorship network of Organizations. We analyze manually defined criteria which is minimum 1Organization and 1 citation of an author. A total 399 authors, 399 meet the threshold. For each of the 399 organization, the total strength of the co-authorship links with other organizations will calculate. Then organization with the greatest total link strength were selected is 399. In the 399 items of network are not connected to each other. The largest set of connected items consists of 22 items. The software separates these 22 organizations into 1 cluster which from 231 links. OrganizationDepartment of Applied Chemistry, Institute of Molecular Science, National Chiao Tung University, Hsinchu, 300, Taiwan,OrganizationDepartment of Chemistry, Center of Nanoscience and Nanotechnology, National Chung Hsing University, Taichung, 402, Taiwanand Laboratory for Photonics and Interfaces, Institute of Chemical Sciences and Engineering, école polytechnique fédérale de lausanne, Lausanne-1015, Switzerlandeach organizations have1 documents with 5537 citations and 2 link strength, whereas OrganizationAuburn University, 230 Ross Hall, Auburn, al 36849, USA, United States andOrganization Department of Chemical Engineering, 3122 Tamu, Texas Aandm univ., coll. stn., t., United Statesboth organizations have 1 documents with 5000 citations and 5 link strength.

Figure 5 display the visualization of the Co-authorship network of countries. Network was created on the basis of bibliographical data downloaded from Scopus. The download data were input in VOSviewer software for create Co-authorship network of a countries. We analyze manually defined criteria which is minimum 1 documents of a country and 1 citation of a country. A total 48 countries, 48 meet the threshold. For each of the 48 countries, the total strength of the co-authorship links with

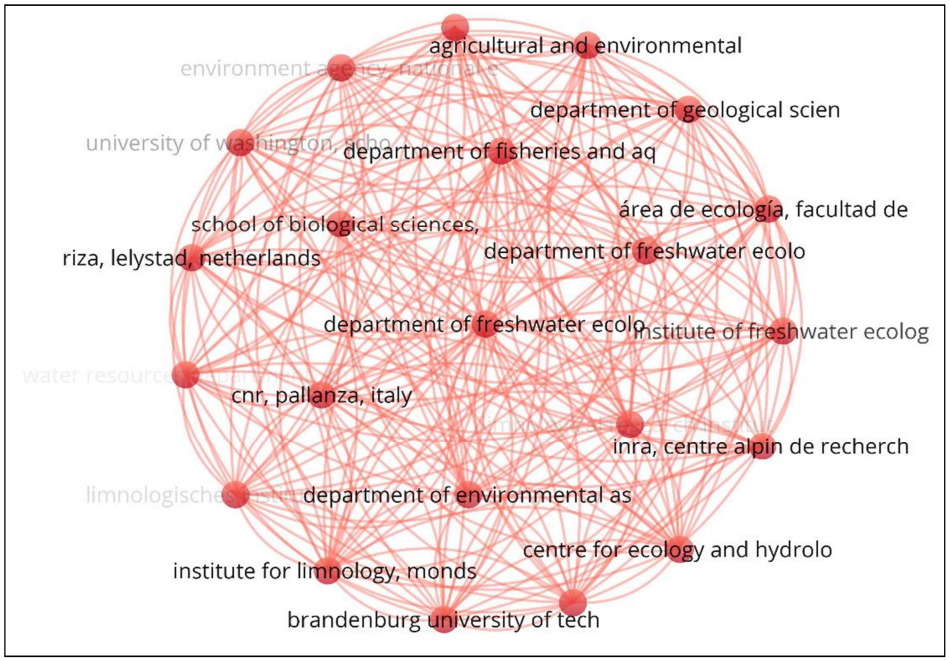

Figure 4. Co-authorship Network of Organizations

other countries will calculate. Then authors with the greatest total link strength were selected is 48. In the 48 items in network are not connected to each other. The largest set of connected items consists of 47 items. The software separates these 47 authors into 7 clusters which from 353 links with a total link strength of 525. Country **United States** has66 documents with 103493 citations and 118 link strength, country **United Kingdom** has 20 documents with 35277 citations and 77 link strength, country China has 13 documents with 23358 citations and 29 link strength, Country France have 10 documents with 22689 citations and 58 link strength, and country Switzerland has 7 documents with 21798 citations and 33 link strength with other authors are the leading authors who produced maximum paper in collaboration.

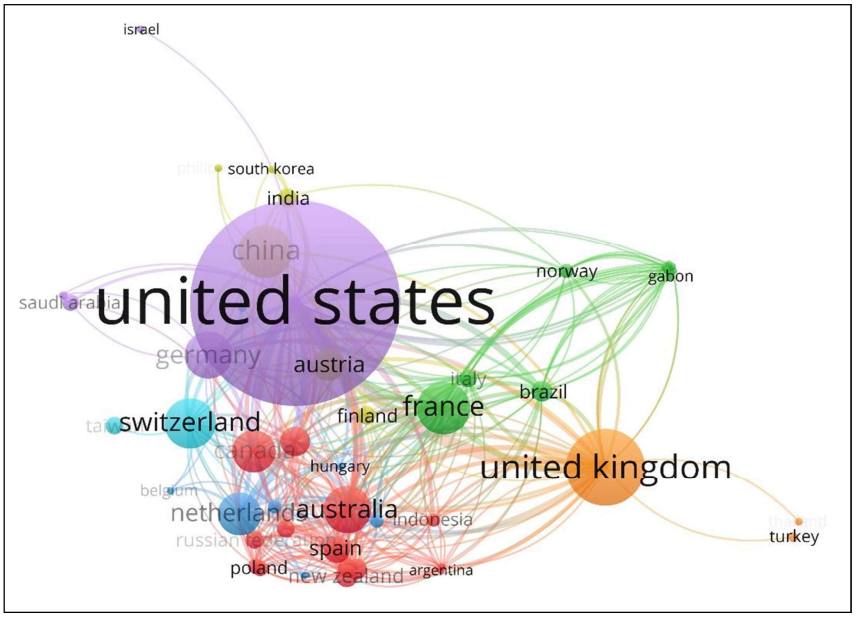

Figure 5. Co-authorship Network of Countries

6. Findings

• The analysis revealed variations in the annual total citation per year for different years. The mean total citations per article ranged from 966 to 1,904.75, indicating the varying impact and recognition of articles across different publication years.

• The mean total citations per year ranged from 69.80 to 212.33, providing insights into the average number of citations received by an article in a specific year.

• The top journals with the highest impact factors and total citations were identified. Nature and Science emerged as the leading journals, with significant impact and recognition within the scientific community. Other prominent journals included Bioresource Technology, Chemical Society Reviews, and Proceedings of the National Academy of Sciences of the United States of America.

• Nature and Science stood out as the most relevant sources, each having 11 articles associated with them. These journals are widely recognized for publishing groundbreaking research across various disciplines. Other significant sources with a considerable number of articles included Bioresource Technology, Chemical Society Reviews, and Proceedings of the National Academy of Sciences of the United States of America.

• The top 10 authors were assessed based on their h-index, g-index, m-index, total citations, number of publications, and publication year start. The results showed variations in these indexes, indicating differences in authors' productivity and impact within the field.

• The analysis identified the top 20 most relevant affiliations based on the number of associated articles. Swedish University of Agricultural Sciences and the University of California emerged as the leading affiliations, with 20 articles each. Other notable affiliations included the University of Washington, Chinese Academy of Sciences, and Paul Scherrer Institute.

• The most frequent keywords extracted from the titles, abstracts, or keyword lists of the top 100 most cited articles on biomass research were analyzed. The results highlighted key recurring themes within the field, including biomass, carbon, global, production, review, ecosystem, microbial, sustainable, emissions, and lignocellulosic.

• The co-authorship networks provide insights into the collaboration patterns among authors, organizations, and countries in the respective fields.The network analysis helps identify prominent authors, organizations, and countries with significant contributions and collaborations.

7. Discussion

The results of the data analysis provide valuable insights into the citation impact, relevance of sources, author productivity, affiliations, keyword trends, and collaboration patterns within the field of study.

The findings indicate that the annual total citation per year varies across different years, suggesting fluctuations in the recognition and impact of articles over time. This could be attributed to various factors such as emerging research trends, changing citation practices, or evolving scientific priorities.

The identification of top journals with high impact factors and total citations, such as Nature and Science, highlights the influential role of these publications in disseminating significant research findings. Other relevant sources also contribute significantly to their respective fields, indicating a diverse landscape of impactful publications.

The analysis of author indexes provides insights into the productivity and impact of top authors within the field. Variations in the indexes indicate differences in authors' citation counts, publication records, and overall influence. These findings can help identify influential researchers and potential collaborators within the field.

The examination of the most relevant affiliations sheds light on the institutions and research centers that have made significant contributions to biomass research. The presence of highly relevant affiliations suggests the presence of well-established research programs and expertise in the field.

The analysis of frequent keywords provides an understanding of the key focus areas and recurring themes within biomass research. The identification of commonly used keywords reflects the central topics and trends within the field and can inform researchers about important areas of study.

The co-authorship networks reveal collaborative relationships among authors, organizations, and countries. These networks demonstrate the importance of collaboration in producing impactful research and highlight the interconnectedness of researchers within the field.

Overall, the results and discussion provide valuable insights into the citation impact, source relevance, author productivity, affiliations, keyword trends, and collaboration patterns within the field of study. These findings contribute to a better understanding of the research landscape in biomass research and can inform future research directions, collaborations, and decision-making within the field.

8. Conclusion

Scientometric analysis of the top 100 cited articles on biomass has provided valuable insights into the research landscape of this field. The data analysis conducted in this study provides valuable insights into various aspects of scholarly research. The analysis includes information on annual total citations per year, top journals with high impact factors and total citations, most relevant sources, indexes of top authors, relevant affiliations, frequent keywords, and co-authorship networks.

The findings reveal the varying citation impact of articles across different years, highlighting the recognition and influence they receive in the academic community. The top journals, such as Nature and Science, hold significant importance in terms of impact factor and total citations, while other sources also contribute significantly to their respective fields. The analysis of indexes of top authors sheds light on their productivity and impact, showcasing variations in their citation counts and publication records. The study also identifies the most relevant affiliations, indicating the institutions and research centers that have made substantial contributions to the field. The examination of frequent keywords provides an understanding of the key focus areas and recurring themes within biomass research. This information helps researchers identify prominent topics and areas of interest within the field.

Lastly, the co-authorship networks of authors, organizations, and countries reveal the collaborative relationships among researchers. These networks demonstrate the interconnectedness and collaborative nature of scholarly research, allowing researchers to identify influential authors, organizations, and countries in the respective fields.Overall, the data analysis conducted in this study contributes to a deeper understanding of the citation impact, relevance of sources, author productivity, affiliations, keyword trends, and collaboration patterns in the field of study. These insights can assist researchers in identifying influential works, establishing research collaborations, and exploring emerging trends in their respective fields.

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