

Scientometric Analysis of Bio-Fuel Literature Published from India

Bhimappa, S. H and K.R.Mulla

Visvesvaraya Technological University, Jnana Sangama, Belagavi, Karnataka, India.

Email:bhimappash@gmail.com and krmulla@gmail.com

Abstract:

This article is deals with the scientometric analysis of biofuel research in India. The National Policy for Bio-Fuel has facilitated to optimal development and utilization of indigenous biomass feedstock for production of bio-fuels in India are derived from renewable bio-mass resources and, therefore, provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the energy needs of India's vast rural population. Further it ascertain the bio-fuel research output in India during 1989–2014, Determine the core journals in the field, Identify the prolific authors in the field, Analyze the most productive institutions and funding agencies.

Keywords: Scientometric, renewable energy, bio-fuel, literature publications, India

Introduction:

The renewable energy is a critical input for socio-economic development of the country. The renewable energy resources are indigenous, non-polluting and virtually inexhaustible. The Fossil fuels will continue to play a dominant role in the energy scenario in our country. India is endowed with abundant renewable energy resources among them Bio-fuel is one of the emerging area in the field of renewable energy. However, Bio-fuels are environment friendly and their utilization would address global concerns about containment of carbon emissions. The National Policy for Bio-Fuel has facilitated to optimal development and utilization of indigenous biomass feedstock for production of bio-fuels in India are derived from renewable bio-mass resources and, therefore, provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the energy needs of India's vast rural population. Thus an attempt has been made to understand the

development of bio-fuel research and productivity trend which is reflected on the web of science for the period of 1989 to 2014. However, this study is confined to India only (GOI Ministry of New & Renewable Energy, 2015).

Source of the study:

Thomson Reuters web of Knowledge SM (formerly ISI Web of Knowledge) is today's premier research platform, helping to quickly find, analyze, and share information in the sciences, social sciences, arts, and humanities. It is designed for providing access to multiple databases. Present study is based on data retrieved from web of science for a period of twenty five years from 1989 to 2014 in bio fuel research in India. The Boolean search keys were used to access from database "Biofuel + literature + India" the results were received total 757 publications.

Review of literature:

Among sustainable and renewable energies, bio-fuels appear to be the most promising and attractive, and related research has been expanding along with an exceptional growth of scientific knowledge. Yaoyang and Boeing (2013) studied based on the Science Citation Index Expanded from the Web of Science, a bibliometric evaluation of research output was carried out to map research activities and tendencies of the global biofuel field. Their study indicated that annual output of scientific articles rocketed during the past decade (2003–2012). The United States of America (USA) is leading biofuels research and collaborated mainly with other productive countries (China, United Kingdom, Germany, Canada and South Korea). In general, international collaborative publications resulted in more citations than single country publications. Institutional collaborations became increasingly prevalent over time and the 15 most productive institutions of USA tended to collaborate more with each other. Most research publications on biofuels appeared in the journals Biomass and Bioenergy and Bioresource Technology. Furthermore, biofuels research was based on combinations of multi-subject categories including "Energy and fuels", "Biotechnology and applied microbiology", "Chemical engineering", "Environmental sciences" and "Agricultural engineering". The keyword analysed and confirmed the production of biodiesel from microalgae as the mainstream of recent biofuels research. Biorefinery was the most common technology for conversions of biological feedstock

and life cycle assessment was the most popular tool of decision support to evaluate the sustainability of biofuel development (Yaoyang & Boeing, 2013). Whereas, Mittal (2013) attempted to present the structure of biofuel research through document co-citation patterns of core references and found 26 samples of citations was identified and the co-citation frequencies were analyzed and represented them systematically. It was limited to research articles and co-citation data for the first author only. For the co-citation analysis, the cited references rather than the cited authors were used as the units for analysis. Further, they studied the co-citation analysis method suitable for depicting structure of biofuel research in document clusters by performing multivariate analysis: cluster analysis, factor analysis, multidimensional scaling and network analysis (Mittal, 2013).

Another study was carried by Hoang-Jyh and Chao-Chan (2012) investigated utilizing patent bibliometric analysis in the field of biofuel and biohydrogen energy from the year 2000–2011. Based on the study, the current status indicates that the key technologies for biofuel energy have reached technological maturity in the United States. However, the principal or predominant technologies for biohydrogen energy need a great deal of work to accelerate the development of biohydrogen technology. In addition, three important subjects were found from citation techniques, which are related to biodiesel fuel, biological fuel cell, and the biohydrogen. These patents described that the focus of key techniques of energy production should be established towards low energy demand technologies, and biohydrogen was found to be a potential candidate of the future (Hoang-Jyh & Chao-Chan, 2012). Subsequently Ozcan (2011) explores the characteristics of the literature on the algae and bio-energy published during the last three decades, based on the database of Science Citation Index-Expanded (SCIE) and Social Sciences Citation Index (SSCI) and its implications using the scientometric techniques. The study reveal that the literature on the algae and bio-energy has grown exponentially during this period reaching 717 papers in total. Most of document type is in the form of journal articles, reviews, and proceedings, constituting 98% of the total literature and English is the predominant language (97.6%) and USA biggest contributing countries on the algae and bio-energy literature publishing 26%, the Chinese Academy of Sciences is the largest institutional contributor publishing 2.6% of the papers, the most publishing authors is Wilhelm (13 papers), “Bioresource

Technology” is the most publishing journal with 24 published papers, “Biotechnology & Applied Microbiology” is the subject area with 24.3% of the sample published. The total number of citations is 11,079, giving a ratio for the “Average Citations per Item” as 15.45 and “H-index” as 52. A list of most-cited 25 authors is produced and Chisti (2007) receives 320 citations with 80 total average citations per year and highest impact on the literature on the algae and energy with total average citations per year. This study provides further incentives for all the stakeholders of the research on the algae and energy, but especially for the researchers and their institutions and their countries to do more research in this area. The results of this first ever such study of its kind show that the scientometric analysis has a great potential to gain valuable insights into the evolution of the research the on algae and bio-energy as in the case of new emerging technologies and processes such as nanoscience and nanotechnology complementing literature reviews, content analysis and metaanalysis research techniques (Ozcan K, 2011). However, based on the above studies there were no studies have been carried out on Bio-fuel in Indian research output. The author felt that the present study insight the trends and development of Bio-fuel research in India.

Objectives:

Following objectives have been formulated for the study

1. To ascertain the bio- fuel research output in India during 1989–2014,
2. Determine the core journals in the field,
3. Identify the prolific authors in the field,
4. Analyze the most productive institutions and funding agencies

Scope and methodologies:

The data for this study has been taken from Web of Science multidisciplinary database for a period of twenty five years i.e. 1989 to 2014. The records published under the study in the field of Bio-Fuel was searched and bibliographic details such as author, subject, publication type, state wise, institution wise contributions and source etc. were collected. The retrieved records were transferred into excel sheet for the purpose of analysis. The key word Bio- Fuel literature in India” has been used for extracting the records available in Web of Science for the present study.

Further, the following succeeding sections are analyses of the data in line with the scope and objectives of the study.

Data Analysis and Discussion:

1. Year wise Publications of Biofuel literature in India from 1989 to 2014

Table 1 shows the year wise quantitative growth of publications in the field of Bio-fuel during 1989 to 2014. The highest number of publications was published in the year 2014 with 173 publications which contributes to 22.85%. It is evident that the growth of literature on bio-Fuel shows a continued increasing trend, significantly increased from the year 2011.

Table-1 :Year wise Publications

Publication Years	No. of Publication	% of 757	Cumulative % age
2014	173	22.853	22.853
2013	157	20.740	43.593
2012	120	15.852	59.445
2011	92	12.153	71.598
2010	58	7.662	79.26
2009	51	6.737	85.997
2008	29	3.831	89.828
2007	14	1.849	91.677
2006	9	1.189	92.866
2005	8	1.057	93.923
2002	7	0.925	94.848
2004	6	0.793	95.641
2003	5	0.661	96.302

2000	5	0.661	96.963
1998	5	0.661	97.624
1995	5	0.661	98.285
2001	3	0.396	98.681
1996	2	0.264	98.945
1994	2	0.264	99.209
1999	1	0.132	99.341
1997	1	0.132	99.473
1993	1	0.132	99.605
1992	1	0.132	99.737
1991	1	0.132	99.868
1989	1	0.132	100

2 Types of Documents

The table 2 categorizes the types of documents published in the publications for Bio-fuel. There are 25 years of documents namely articles, Review, Proceedings, Editorial materials, Letter, Meeting abstract, News item Reprint observed in the table. The maximum number of paper is published in 'Articles' with 572 (75.56%) followed by Reviews 117 (15.45). Four types of documents namely letter meeting abstract, News item & Reprint are less than 1% of total publications.

Table-2: Types of Documents

Document Types	No. of Publication	% of 757
Article	572	75.561
Review	117	15.456
Proceedings Paper	64	8.454
Editorial Material	9	1.189
Letter	7	0.925
Meeting Abstract	6	0.793

News Item	4	0.528
Reprint	1	0.132

3 Most Productive Authors

The table 3 highlights the most prolific contribution of the researcher output (top ten) on Bio-fuel. It is clear that Venkataraman has contributed maximum number of articles (20 papers) and he has secured first rank and Kumar with 16 publications who have secured second rank followed by other others stands subsequent ranks.

Table-3: Most Productive Authors

Author	No. of Publication	Rank
Venkataraman C	20	1
Kumar R	16	2
Kumar S	14	3
Pandey A	13	4
Reddy M	11	5
Kumar A	11	5
Singh S	10	6
Singh B	10	6
Mohan S	10	6
Singh R	9	7
Kumar N	9	7
Chinnasamy S	9	7
Agarwal Ak	9	7
Wani Sp	8	8
Sukumaran Rk	8	8
Sarma Pn	8	8

Panda Pk	8	8
Dutta S	8	8
Das Kc	8	8
Bhatnagar A	8	8
Sinha Ak	7	9
Singh N	7	9
Singh K	7	9
Sharma S	7	9
Saha B	7	9
Moholkar Vs	7	9
Misra N	7	9
Joshi V	7	9
Gupta S	7	9
Ghosh A	7	9
Tiwari S	6	10
Singh Sk	6	10
Rao Ps	6	10
Ramachandra Tv	6	10
Prasad R	6	10
Prasad M	6	10
Kumar V	6	10
Kandpal Tc	6	10
Habib G	6	10

a. Top 10 Publications on Bio-Fuel energy

Table 4 reveals the list of core journals in Bio-Fuel as recorded in the secondary database. The authors mostly preferred to publish their articles in Bio Resource Technology (47 papers) followed by Renewable Sustainable Energy reviews (33 papers) and followed by other journals.

Table-4: Publications on Bio-Fuel energy

Source Titles	No. of Publications	% of 757
Bio-Resource Technology	47	6.21
Renewable Sustainable Energy Reviews	33	4.36
Biomass Bio-energy	32	4.23
Current Science	19	2.51
Fuel	17	2.25
Applied Energy	16	2.11
Journal of Scientific Industrial Research	14	1.85
Atmospheric Environment	12	1.59
Journal of Renewable And Sustainable Energy	10	1.32
Journal of Geophysical Research Atmospheres	10	1.32

b. Top 10 Funding agencies wise Publications

Table 5 shows, top 10 most productivity of funding agencies on Bio Fuel research. It is confined that most of the funding agencies are from the Central and State Government. However, the Council of Scientific Industrial Research (CSIR) secured first rank with 171 publications subsequently the Dept. of Science and Technology is secured second rank with 60 publications and followed by other funding agencies.

Table-5 : Funding agencies wise Publications

Funding Agencies	Publications	Rank
Council of Scientific Industrial Research (CSIR) India	171	1
Department of Science And Technology (DST) Government of India	60	2
Department of Biotechnology Ministry Of Science Government of India	52	3
University Grant Commission, India	16	4
Energy Biosciences Institute	3	5

Flemish Interuniversity Council University Development Co Operation VLIR UDC	3	6
ICS UNIDO	3	7
Indian Council of Medical Research ICMR New Delhi	3	8
Ministry of Human Resources Development MHRD Government of India	3	9
Ministry of The Environment Japan	3	10

c. Organization wise Publications Bio-fuel publications in India 1989-2014

Table 6: shows that the top 10 most productive institutions involved in Bio-fuel research activities which have been published 171 papers (22.59%) from CSIR, and IIT, Kharagpur published 136 papers (17.97%) during 1989 to 2014 followed by rest of the institutions has published less than 50 papers.

Table-6: Organization wise Publications

Organization	Publications	% of 757
Council of Scientific Industrial Research India (Delhi)	171	22.59
Indian Institute of Technology, Kharagpur	136	17.97
Indian Institute of Technology, Delhi	36	4.76
Indian Institute of Technology, Bombay	28	3.70
Central Salt Marine Chemical Research Institute India	24	3.17
Indian Institute of Science, Bangalore	23	3.04
Indian Institute of Chemical Technology, Hydrabad	20	2.64
Anna University, Chennai	19	2.51
Indian Institute of Technology, Guwahati	18	2.38
National Chemistry Laboratory, Pune	17	2.25

Conclusion:

The National Policy for Bio-Fuel has facilitated to optimal development and utilization of indigenous biomass feedstock for production of bio-fuels in India are derived from renewable bio-mass resources and therefore, provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the energy needs of India's vast rural population. This study extensive review of the rapidly growing biofuel literature is carryout from 1989 to 2014. Further it has been analyzed based on the contributed by the respective research founding agency and most productive institutions. However, the study found that significant development of publications trend was traced from 2012 onwards by way of publications and it is also evident that government funded institutions were more active in research on biofuel and its related discipline. Thus, the study is useful for LIS professionals to carry out further research in the field.

References:

- Aleixandre-Benavent, R., Montalt-Resureccio, V., & Valderrama-Zurian, J. C. (2014). A descriptive study of inaccuracy in article titles on bibliometrics published in biomedical journals. *Scientometrics*, 101(1), 781–791.
- Arunachalam, S., & Gunasekaran, S. (2002). Diabetes research in India and China today: From literaturebased mapping to health-care policy. *Current Science*, 82(9), 1086–1097.
- Aswathy, S., & Gopikuttan, A. (2014). Research in renewable energy among BRICS countries during 1999-2012: An analysis with special reference to Web of Science. *International Journal of Information Dissemination and Technology*, 4 (4), 289-297.
- Bradford, S. C. (1934). Sources of information on specific subjects. *Engineering*, 137, 85–86.
- Chen, Z., & Guan, J. (2011). Mapping of biotechnology patents of China from 1995–2008. *Scientometrics*, 88(1), 73–89.
- Fakhree, M. A. A., & Jouyban, A. (2011). Scientometric analysis of the major Iranian medical universities. *Scientometrics*, 87(1), 205–220.
- Government of India Ministry of New & Renewable Energy. (2015). National Policy on Biofuels. Retrieved from http://mnre.gov.in/file-manager/UserFiles/biofuel_policy.pdf on 30th August 2015.

- Hoang-Jyh, L., & Chao-Chan, W. (2012). Technology exploration and forecasting of biofuels and biohydrogen energy from patent analysis. *International Journal of Hydrogen Energy*, 37(20), 15719-15725.
- Kakkar, M., Venkataraman, V., Krishnan, S., Chauhan, R. S., & Abbas, S. S. (2012). Moving from rabies research to rabies control: Lessons from India. *PLoS Neglected Tropical Diseases*, 6(8), 1748.
- Mittal, R. (2013). Biofuel research and data mining. *Performance Measurement and Metrics*, 14(1), 71-92.
- Ozcan, K. (2011). The scientometric evaluation of the research on the algae and bio-energy. *Applied Energy- Special Issue of Energy from algae: Current status and future trends*, 88(10), 3532-3540
- Patra, S. K., & Chan, P. (2007). HIV/AIDS research in India: A bibliometric study. *Library and Information Science Research*, 29(1), 124–134.
- Yaoyang, X., & Boeing, W. J. (2013). Mapping biofuel field: A bibliometric evaluation of research output. *Renewable and Sustainable Energy Reviews*, 28, 82–91