

Growth and Obsolescence Study of Doctoral Theses in Biotechnology

Dr.Koteppa Banateppanavar

Assistant Librarian
Karnataka Folklore University
Gotagodi-581197
Karnataka (State) India
Email.koteshlibrarian@gmail.com

Dr. B S Biradar

Professor
Dept.of PG Studies and Research in Library and Information Science
Jnana Sahyadri, Shankaraghatta-577451
Karnataka(State), India
Email.bsbiradar53@rediffmail.com

Abstract - The present study is to identify the resources cited in doctoral theses submitted for the award of doctoral degree in the field of Biotechnology, Kuvempu University, Karnataka, India during 2003 to 2012 with the aim of improving the existing collection of the library. Also it helps to other academic libraries in the same field. The methodology preferred for this study is based on the analysis of bibliographic references appended at the end of each chapter and footnotes, if any. The research design adopted was a descriptive study. Each thesis was manually examined and citations were extracted from each of the thesis. All the references were noted down on 5"x 3" size standard catalogue card. Later the data were fed into the computer using MS-Excel and separate sheets and columns were created to enter data finally data has been transferred to SPSS software for analysis.

The present study results reveals that journals have the highest number of citations accounting to 84.57% of the total citations. It shows the researchers in the field of Biotechnology are mainly depending upon journals for collecting the information. In addition, more cited materials were contributed by the multi authors and degree of collaboration was found 0.86. Journal of Ethnopharmacology published from Ireland occupies the first rank as the most preferred journal having been cited 558 (3.52%) times. Further bradford's law was applied and studied the obsolescence of journal literature. Finally half-life of journal citations was found 10 years old in the field of Biotechnology.

The result of this study is an original research work with application of bradford's law and obsolescence study of biotechnology literature. Study represents the availability of information and information used by the researchers in the field of Biotechnology for their research work.

Keywords: Doctoral theses, Citation Analysis, Biotechnology, Authorship Pattern, Bradford's law, Obsolescence, Half-life

1. Introduction

The librarian has to perform major role in collection development policy and selection of library materials. Periodicals are an important source of information in academic and special libraries because of its current and high valued information. Periodical is one of the important media for communicating the recent scientific information among scientist, doctors,

engineers, researcher etc. The shrinking budget and escalating costs of journals pose problems to the librarians and information scientists in the selection of the need-based collection. For selection of periodicals in libraries, librarian has to consult different selection tool, among them one of the important tool is citation studies.

Obsolescence has become one of the important characteristics of scientific literature. Growth and obsolescence are usually considered together, because they represent the initial and final stages of the information cycle. An obsolescence study could be treated as an aspect of citation analysis for journals. The study is useful for the practical librarians, who administer growing collections infinite space look to research on obsolescence to help them decide which item to keep and which to store for discard in order to make room for the new acquisitions (Biradar & Sampath, 2003). Obsolescence has been defined by Line and Sandison (1974) as the decline over time in validity or utility of information. This concept is of obvious interest to information theoreticians who concern themselves with the development, career and eventual death or incorporation of particular kinds of information. Obsolescence study also, helpful for pioneers in a scientific discipline to know how far they must go back to obtain a published paper in their field of interest. In this view present study is conducted to investigate the use pattern of literature in the field of Biotechnology during the period of 2003 to 2012.

2. Objectives of the study

The objective of this study is to determine the information materials used in doctoral theses submitted to the Biotechnology department of the Kuvempu University, Karnataka, India during 2003-2012. The following are the main objectives of the study.

- To determine the use of different forms of documents like books, journals, conference proceedings, theses etc.
- To study the collaborative research by analyzing the authorship pattern of the citations
- To study the distribution of documents, according to their subject, chronological, language and country of origin
- To compile a rank list of core journals
- To find out the availability of cited journals in the Kuvempu University Library
- To apply Bradford's Law to the journal citations
- To study the obsolescence and half-life of Biotechnology journal literature

3. Methodology

A list of theses submitted to the Biotechnology department has been collected from the examination branch of the Kuvempu University. Then the theses were identified in the library and the same have been sorted out for primary data collection. The title page of the each thesis and the reference list/bibliography appeared in respective thesis was photocopied. Separate excel sheets have been created for enter the metadata related to the theses, such as name of the author, guide and co-guide, title, year of Ph.D awarded, and number of references covered.

The methodology preferred for this study is based on the analysis of bibliographic references appended at the end of each chapter and footnotes, if any. The research design adopted was a descriptive study. Each thesis was manually examined and citations were extracted from each of the thesis. All the references were noted down on 5"x 3" size standard catalogue card.

Later the data were fed into the computer using MS-Excel software and data has been transferred to SPSS software for analysis.

62 doctoral theses submitted to the Kuvempu University in the field of Biotechnology during 2003-2012 have been taken as the source of data for the present study; these doctoral theses generated 18,758 total citations. Separate sheets and columns were created to enter data such as, number of theses submitted. Further, all the references cited in the collected theses were examined to enter the bibliographic data which include number of authors out of which separated as Indian and Foreign, chronological wise, bibliographical form of cited documents, subject and so on. Duplicate citations were removed from the data set. But the 'Ibid' and 'OpCit' references were considered while entering the data.

The form of documents entered to the MS-Excel includes journals, books, conferences proceedings and reports etc. The date on journal citations were separated and used to create ranking list of journals, country-wise distribution of journals, and language of journals. Further, to know the availability of cited journals in the library.

The study attempted to rank the documents, particularly journals on the basis of their usage and list the most productive journals. If the citation is from a journal, the information regarding the country of publication, language in which it is published is obtained from 'Ulrich's Periodicals Directory'. After entering all above mentioned attributes to MS-Excel necessary tables have been generated to meet the objectives of the study.

4.1 Year -wise distribution of theses

Table-1 shows the total number of theses according to the year of their submission to the department of Biotechnology during 2003 to 2012.

Table-1 Year-wise distribution of theses

| Sl. No. | Year | No. of theses | % |
|---------|--------------|---------------|------------|
| 1. | 2003 | 4 | 6.45 |
| 2. | 2004 | 3 | 4.84 |
| 3. | 2005 | 5 | 8.06 |
| 4. | 2006 | 3 | 4.84 |
| 5. | 2007 | 9 | 14.52 |
| 6. | 2008 | 8 | 12.90 |
| 7. | 2009 | 11 | 17.75 |
| 8. | 2010 | 9 | 14.52 |
| 9. | 2011 | 5 | 8.06 |
| 10. | 2012 | 5 | 8.06 |
| | Total | 62 | 100 |

The study shows that the highest number of doctorates i.e. 11 (17.75%) was awarded in the year 2009 followed by 2007 and 2010 (each 9 theses). Overall results clearly represent that highest number of theses were submitted during 2007 to 2012 (47 theses), which accounts 75.81% of the total submission of theses. The least number of theses was submitted during the period 2003 to 2006 with 15 theses (24.19%).

4.2 Average number of citations per thesis

Table-2 shows the year wise distribution of theses, the corresponding total number of citations and the average number of citations per thesis.

Table-2 Average number of citations per thesis

| Sl.No. | Year | No. of theses | No. of Citations | Average Citation Per thesis |
|--------------|------|---------------|------------------|-----------------------------|
| 1. | 2003 | 4 | 1101 | 275.25 |
| 2. | 2004 | 3 | 692 | 230.66 |
| 3. | 2005 | 5 | 900 | 180.00 |
| 4. | 2006 | 3 | 952 | 317.33 |
| 5. | 2007 | 9 | 2542 | 282.44 |
| 6. | 2008 | 8 | 3189 | 398.62 |
| 7. | 2009 | 11 | 3128 | 284.36 |
| 8. | 2010 | 9 | 2798 | 310.88 |
| 9. | 2011 | 5 | 1071 | 214.20 |
| 10. | 2012 | 5 | 2385 | 477.00 |
| Total | | 62 | 18758 | 302.54 |

The table-2 shows that considerable variations exist among the theses submitted during 2003-2012. It is found that a total of 18758 citations distributed over 62 theses. It is found that the rate of citations of theses has witnessed an increasing trend. The result shows that the average number of citations received per thesis is highest in 2012 (477.00 citations per thesis) followed by 398.62 citations per thesis in 2008. The overall average citation per thesis is 302.54 was found in the study.

4.3 Distribution of citations according to bibliographic forms

Table-3 Distribution of citations according to bibliographic forms

| Bibliographic Forms | No. of Citations | % |
|--------------------------|------------------|-------|
| Journals | 15864 | 84.57 |
| Books and Monographs | 2137 | 11.39 |
| Conference Proceedings | 309 | 1.65 |
| Theses and Dissertations | 159 | 0.85 |
| Reports | 50 | 0.27 |
| Web Resources | 164 | 0.87 |
| Patents | 16 | 0.09 |
| Standards | 2 | 0.01 |
| Others | 57 | 0.30 |
| Total | 18758 | 100 |

Table-3 shows the journals have the highest number of citations accounting to 84.57% of the total citations. It shows the researchers in the field of Biotechnology are mainly depending upon journals for collecting the information. It is the most preferred source of information. Books are the second preferred source of information (11.39%). In other words journals and books together constitute 91.65%. The rest of the citations were scattered in several other document types. Among the rest, conference proceedings and theses & dissertations were cited more as compared to other document sources. It is observed that new source of

information, i.e. the web resource is also found in the place with 0.61% of the total citations. Therefore, it is suggested that library administrators must pay close attention to the present trend.

4.4 Authorship pattern

Table-4 depicts the authorship pattern of journal citations. It indicates that out of 15864 citations, majority of authors preferred to carry out their research work in collaboration.

Table-4 Authorship pattern

| Authors | Total Citations | Foreign Authors | Indian Authors |
|-------------------|-------------------|------------------|-----------------|
| One | 2193 (13.82) | 1782 (11.23) | 411 (2.59) |
| Two | 3875 (24.42) | 2456 (15.48) | 1419 (8.94) |
| Three | 3502 (22.08) | 2253 (14.20) | 1249 (7.88) |
| Four | 2418 (15.24) | 1577 (9.94) | 841 (5.30) |
| Five | 1531 (9.66) | 1021 (6.44) | 510 (3.22) |
| Six | 977 (6.16) | 701 (4.42) | 276 (1.74) |
| Seven | 473 (2.98) | 384 (2.42) | 89 (0.56) |
| Eight | 579 (3.65) | 516 (3.25) | 63 (0.40) |
| Nine | 85 (0.54) | 71 (0.45) | 14 (0.09) |
| Ten | 89 (0.56) | 71 (0.45) | 18 (0.11) |
| Eleven | 34 (0.21) | 26 (0.16) | 8 (0.05) |
| Twelve | 45 (0.28) | 24 (0.15) | 21 (0.13) |
| Thirteen | 22 (0.14) | 12 (0.08) | 10 (0.06) |
| Fourteen | 12 (0.08) | 8 (0.05) | 4 (0.03) |
| Fifteen and above | 29 (0.18) | 22 (0.14) | 7 (0.04) |
| Total | 15864 (100.00) | 10924 (68.86) | 4940 (31.14) |

Particularly large number of publications are in two authorship mode, i.e., 38.75% (24.45%). Out of 38.75% of two authored citations foreign author's contribution constitutes 15.48% and Indian author's contribution constitutes 8.94%. Out of 15864 citations, the contribution of foreign authors was 68.86%, whereas the Indian author's contribution counts 31.14%. Second place is occupied by work involving three authors (22.08%), followed by single authors (13.82%). Remaining 39.68% citations are contributed by four to fifteen-and-above authors. Table-4 shows that the majority of the cited documents were by two and more than two authors which means the collaborative research is prevailing on Biotechnology subject. Further, the table shows that 13.82% of all the citations are in favor of single authors, and remaining 86.18% of citations are in favor of team research. The high incidence of multiple authorship is a characteristic of the science.

Degree of author collaboration

The extent of collaboration in research can be measured with the help of multi-authored works. To determine the degree of collaboration in quantitative terms, the formula given by K. Subramanyam (1983) has been used. The formula is as follows:

$$C = \frac{NM}{NM+NS}$$

NM+NS where, C = Degree of collaboration in a discipline

$$\begin{array}{l}
 \text{Nm= No. of multi-author papers} \\
 \text{Ns= No. of single author papers} \\
 13671 \\
 \text{-----} = \frac{13671}{13671+2193} = \frac{13671}{15864} = 0.86
 \end{array}$$

In the present study, the degree of collaboration is C= 0.86 as a whole. This clearly indicates the trend towards collaborative research. This reflects the degree of prevalence of multiple authored publications in Biotechnology, which reflects higher level of collaboration.

4.5 Subject wise distribution of citations

Subject-wise analysis of total citations appended to the theses in Biotechnology shows the distribution of citations among various subject specialization and associated disciplines. This shows the outgrowth of specializations from a basic discipline on one hand and interdisciplinary nature of the literature on the other hand (Govindaraju, 2013). The subject-wise distribution of citations in Biotechnology is shown in table-5.

Table-5 Subject wise distribution of citations

| Sl.No | Subject | No. of Citations | % |
|-------|---------------------------|------------------|-------|
| 1. | Pharmacology | 2329 | 14.68 |
| 2. | Medicinal Plant Research | 1795 | 11.32 |
| 3. | Photochemistry | 1781 | 11.23 |
| 4. | Plant Biotechnology | 734 | 4.63 |
| 5. | Genetic Engineering | 618 | 3.90 |
| 6. | Plant Tissue Culture | 596 | 3.76 |
| 7. | Cancer Research | 542 | 3.42 |
| 8. | Plant Pathology | 483 | 3.04 |
| 9. | Molecular Biology | 453 | 2.86 |
| 10. | Horticulture | 439 | 2.77 |
| 11. | Bioinformatics | 373 | 2.35 |
| 12. | Entomology | 358 | 2.26 |
| 13. | Agriculture Biotechnology | 333 | 2.10 |
| 14. | Molecular Genetics | 322 | 2.03 |
| 15. | Natural Remedy | 314 | 1.98 |
| 16. | Proteomics | 308 | 1.94 |
| 17. | Geonomics | 291 | 1.83 |
| 18. | Plant Disease Management | 228 | 1.44 |
| 19. | Hepatology | 221 | 1.39 |
| 20. | Biochemistry | 183 | 1.16 |
| 21. | Mycology | 176 | 1.12 |
| 22. | Apiculture | 144 | 0.90 |
| 23. | Virology | 136 | 0.86 |
| 24. | Floristics Studies | 135 | 0.85 |
| 25. | Plant Biodiversity | 130 | 0.82 |
| 26. | Cytogenetics | 121 | 0.76 |
| 27. | Fermentation Technology | 118 | 0.74 |
| 28. | Transgenic Plants | 113 | 0.71 |
| 29. | Micro Propagation | 112 | 0.70 |

| | | | |
|-----|-----------------------------|--------------|------------|
| 30. | Bacteriology | 107 | 0.67 |
| 31. | Microbiology | 102 | 0.64 |
| 32. | Biocontrol | 98 | 0.62 |
| 33. | Immunology | 92 | 0.58 |
| 34. | Environmental Biotechnology | 90 | 0.57 |
| 35. | Histopathology | 90 | 0.57 |
| 36. | Biodiversity | 88 | 0.55 |
| 37. | Food Chemistry | 88 | 0.55 |
| 38. | Plant Physiology | 87 | 0.55 |
| 39. | Psciculture | 85 | 0.54 |
| 40. | Other subjects | 1041 | 6.56 |
| 41. | Un identified | 10 | 0.06 |
| | Total | 15864 | 100 |

Subject wise data shows that highly cited documents were in the Pharmacology which has 2329 (14.68%) citations. This is closely followed by Medicinal Plant Research with 1795 (11.32%) citations, Photochemistry with 1781 (11.23%) citations, Plant Biotechnology 734 (4.63%), Genetic Engineering 618 (3.90%), Plant Tissue Culture 596 (3.76%), Cancer Research 542 (3.42%), Plant Pathology 483 (3.04%), Molecular Biology 453 (2.86%) and Horticulture 439 (2.77%) citations. These ten subjects contribute to 61.61% of the total citations. The remaining 38.39% of the total citations are from the subject area of Bioinformatics (2.35%), Entomology (2.26%), Agriculture Biotechnology (2.10%), Molecular Genetics (2.03%), Natural Remedy (1.98%) etc. This clearly shows that above mentioned subjects are more important for the Biotechnologists.

4.6 Chronological distribution of citations

Chronological table reveals the number of citations scattered during a particular year. It is easy to identify subject interest or development in a year.

Table-6 Chronological distribution of citations

| Period | No. of Citations | % |
|-----------|------------------|--------|
| 1700-1800 | 1 | 0.01 |
| 1800-1849 | 3 | 0.02 |
| 1850-1899 | 19 | 0.12 |
| 1900-1909 | 16 | 0.10 |
| 1910-1919 | 27 | 0.17 |
| 1920-1929 | 52 | 0.33 |
| 1930-1939 | 111 | 0.70 |
| 1940-1949 | 105 | 0.66 |
| 1950-1959 | 293 | 1.85 |
| 1960-1969 | 610 | 3.85 |
| 1970-1979 | 954 | 6.01 |
| 1980-1989 | 2063 | 13.00 |
| 1990-1999 | 4817 | 30.36 |
| 2000-2009 | 6537 | 41.21 |
| 2010-2012 | 256 | 1.61 |
| Total | 15864 | 100.00 |

In table-6 shows, the citations are divided into 15 groups. A total of 15864 citations were analyzed for determining the age of utility of the publications. The study covers the periods as indicated under period column. Each comprising time span of 100 years up to 1800 and 50 years up to 1900. Followed by the time span of 10 years up to 2009 and 2 year from 2010-2012.

It is observed that the highest number of citations were found in 2000-2009 i.e. 6537 (41.21%) citations are the most productive decade. A decade 1990-1999 followed by the second position which account 4817 (30.36%) of citations. The rate of citations is slightly less in later decades. Lowest number of citations were cited during 1700 to 1929 that is 118 (0.75%). The study clearly shows that Biotechnology researchers are in need of recent information for their research and developmental activities. It is also identified that a very small percent of references are cited which are published about a century ago.

4.7 Language wise distribution of citations

Table-7 presents the language wise distribution of citations in Biotechnology. The distribution of Biotechnology literature in many languages shows its international nature. The languages of the cited documents are traced out from 'Ulrich's Periodicals Directory' and all the cited documents are grouped according to their language.

Table-7 Language wise distribution of citations

| Sl. No. | Language | No. of Citations | % |
|--------------|--------------|------------------|-------------|
| 1. | English | 13678 | 86.22 |
| 2. | German | 806 | 5.08 |
| 3. | Japanese | 395 | 2.49 |
| 4. | Italian | 374 | 2.36 |
| 5. | Chinese | 101 | 0.64 |
| 6. | Korean | 87 | 0.55 |
| 7. | Danish | 74 | 0.47 |
| 8. | French | 59 | 0.37 |
| 9. | Dutch | 39 | 0.25 |
| 10. | Russian | 31 | 0.20 |
| 11. | Turkish | 28 | 0.18 |
| 12. | Greek | 27 | 0.17 |
| 13. | Spanish | 17 | 0.11 |
| 14. | Polish | 16 | 0.10 |
| 15. | Hungarian | 14 | 0.09 |
| 16. | Swedish | 12 | 0.08 |
| 17. | Czech | 11 | 0.07 |
| 18. | Unidentified | 95 | 0.60 |
| Total | | 15864 | 100. |

Total number of citations distributed in different languages are as shown in table- 7. It shows that the maximum number of citations are from English language accounting for 13678 (86.22%). It is followed by German with 806 (5.08%) citations, 395 (2.49%) citations were in Japanese language, 374 (2.36%) citations were in Italian language and 101 (0.64%) citations were in Chinese language. These five languages together contribute 96.79% of the total percentage. Other languages such as Korean, Danish, French, etc., cover only 3.21%.

4.8 Geographical distribution of citations with bibliographic forms in Biotechnology

Literature in science is being published from different parts of the world in several subject areas. The relevance and importance of the maximum used material can be related to the country producing the largest usable literature. The citation study of the research can lead to understand the country wise use pattern of resources by researchers in Biotechnology.

Table-8 Geographical distribution of citations with bibliographic forms

| Sl. No | Country | J | B&M | CP | T&D | R | P | WR | S | O | Total | % |
|--------|-----------------|--------------|-------------|------------|------------|-----------|-----------|------------|----------|-----------|--------------|---------------|
| 1. | USA | 4992 | 750 | 89 | 6 | 7 | 5 | 107 | 2 | 24 | 5982 | 31.89 |
| 2. | India | 2452 | 693 | 135 | 137 | 32 | | 51 | | 20 | 3520 | 18.77 |
| 3. | UK | 2586 | 459 | 13 | 3 | 2 | 5 | 2 | | 5 | 3075 | 16.39 |
| 4. | Netherlands | 1241 | 32 | 5 | | | | | | 1 | 1279 | 6.82 |
| 5. | Germany | 1152 | 67 | 1 | | | | | | | 1220 | 6.50 |
| 6. | Ireland | 604 | 4 | | | | | | | | 608 | 3.24 |
| 7. | Italy | 521 | 7 | 2 | | | | 1 | | 1 | 532 | 2.84 |
| 8. | Japan | 483 | 17 | 10 | 1 | 2 | 1 | | | | 514 | 2.74 |
| 9. | Switzerland | 153 | 21 | 1 | | 3 | | 3 | | 2 | 183 | 0.98 |
| 10. | China | 155 | 8 | 2 | | | | | | | 165 | 0.88 |
| 11. | Canada | 144 | 1 | 10 | | | | | | | 155 | 0.83 |
| 12. | South Africa | 114 | 2 | 1 | | 2 | | | | 2 | 121 | 0.65 |
| 13. | Korea | 108 | 1 | 1 | | | | | | | 110 | 0.59 |
| 14. | Denmark | 93 | 2 | 1 | | | | | | | 96 | 0.51 |
| 15. | Brazil | 70 | 2 | 5 | 2 | | | | | | 79 | 0.42 |
| 16. | France | 63 | 9 | 4 | | 2 | | | | | 78 | 0.42 |
| 17. | Pakistan | 63 | 6 | 2 | 2 | | | | | | 73 | 0.39 |
| 18. | Australia | 46 | 9 | 5 | | | | | | | 60 | 0.32 |
| 19. | Belgium | 47 | 2 | 2 | 1 | | | | | | 52 | 0.28 |
| 20. | Russia | 32 | 1 | 1 | | | 4 | | | | 38 | 0.21 |
| 21. | Austria | 37 | | | | | | | | | 37 | 0.20 |
| 22. | Turkey | 32 | | | | | | | | | 32 | 0.17 |
| 23. | Greece | 31 | | | | | | | | | 31 | 0.17 |
| 24. | Malaysia | 13 | 13 | 4 | | | | | | | 30 | 0.16 |
| 25. | Taiwan | 27 | 1 | 1 | | | | | | | 29 | 0.15 |
| 26. | Israel | 23 | | 1 | | | | | | | 24 | 0.13 |
| 27. | Thailand | 20 | 1 | 1 | | | | | | | 22 | 0.12 |
| 28. | Spain | 19 | | 2 | | | | | | | 21 | 0.11 |
| 29. | Poland | 19 | 1 | | | | | | | | 20 | 0.11 |
| 30. | Hong Kong | 16 | 2 | | 2 | | | | | | 20 | 0.11 |
| 31. | Hungary | 18 | | | | | | | | | 18 | 0.10 |
| 32. | Czech Republic | 16 | | | | | | | | | 16 | 0.09 |
| 33. | Sweden | 9 | 5 | 1 | | | | | | | 15 | 0.08 |
| 34. | Norway | 14 | | | | | | | | | 14 | 0.07 |
| 35. | Philippines | 14 | | | | | | | | | 14 | 0.07 |
| 36. | Chile | 11 | | | 1 | | | | | | 12 | 0.06 |
| 37. | Bangladesh | 11 | | | | | | | | | 11 | 0.06 |
| 38. | Other countries | 104 | 5 | 6 | 1 | | | | | 2 | 118 | 0.63 |
| 39. | Unidentified | 311 | 16 | 3 | 3 | | 1 | | | | 334 | 1.78 |
| | | 15864 | 2137 | 309 | 159 | 50 | 16 | 164 | 2 | 57 | 18758 | 100.00 |

J=Journals, BM=Books & Monographs, CP=Conference Proceedings, TD=Theses & Dissertations, R=Reports, P=Patents, W=Web Resources, S=Standards, O=Others

Table-8 represents the geographical distribution with bibliographic forms. It has been observed from the analysis that USA is the leading country and occupies the top position with 5982 (31.89%) citations. India is placed second with 3520 (18.77%) citations, followed by UK in the third place with 3075 (16.39%) citations. The fourth place is occupied by Netherlands with 1279 (6.82%) citations, and fifth position is occupied by Germany with 1220 (6.50%) citations. Ireland, Italy, Japan, China, and Switzerland placed in sixth, seventh, eighth, ninth and tenth positions, respectively. These top ten countries contribute 91.05% of the total citations. It indicates that scholars depend mostly on the literature published from these top countries.

4.9 Rank list of journals

Table-9 provides an overall rank list of journals. This is done by counting the total number of citations from the source document and on the basis of grand total a rank list has been made according to descending order of arrangement. The table shows that the journal with the highest number of citations occupies the highest rank, therefore, it is the most important journal referred by authors in Biotechnology. The less important titles are placed at the bottom in the table and the rest of the journals having less than 10 citations are given as the last rank.

Table-9 Rank list of journals

| Sl. No | Rank | Name of the Journal | Country | Number of Citations | Cumulative Citations | % | Cumulative % |
|--------|------|--|-------------|---------------------|----------------------|------|--------------|
| 1. | 1 | Journal of Ethnopharmacology | Ireland | 558 | 558 | 3.52 | 3.52 |
| 2. | 2 | Fitoterapia | Italy | 435 | 993 | 2.74 | 6.26 |
| 3. | 3 | Plant Cell Reports | Germany | 357 | 1350 | 2.25 | 8.51 |
| 4. | 4 | Plant Cell Tissue & Organ Culture | Netherlands | 320 | 1670 | 2.02 | 10.53 |
| 5. | 5 | Indian Journal of Pharmaceutical Science | India | 283 | 1953 | 1.78 | 12.31 |
| 6. | 6 | Indian Journal of Experimental Biology | India | 260 | 2213 | 1.64 | 13.95 |
| 7. | 7 | Phytochemistry | UK | 234 | 2447 | 1.48 | 15.43 |
| 8. | 8 | Phytopathology | USA | 215 | 2662 | 1.36 | 16.78 |
| 9. | 9 | Indian Drugs | India | 204 | 2866 | 1.29 | 18.07 |
| 10. | 10 | Planta Medica | Germany | 187 | 3053 | 1.18 | 19.25 |
| 11. | 11 | Current Science | India | 157 | 3210 | 0.99 | 20.24 |
| 12. | 12 | Plant Physiology | USA | 156 | 3366 | 0.98 | 21.22 |
| 13. | 13 | Journal of Biological Chemistry | USA | 149 | 3515 | 0.94 | 22.16 |
| 14. | 14 | Nature | UK | 143 | 3658 | 0.90 | 23.06 |
| 15. | 15 | Journal of Natural Products | USA | 136 | 3794 | 0.86 | 23.92 |
| 16. | 16 | Journal of Agricultural and Food Chemistry | USA | 133 | 3927 | 0.84 | 24.76 |
| 17. | 17 | Theoretical and Applied Genetics | Germany | 124 | 4051 | 0.78 | 25.54 |
| 18. | 17 | Science | USA | 124 | 4175 | 0.78 | 26.32 |
| 19. | 18 | Plant Science | USA | 122 | 4297 | 0.77 | 27.09 |
| 20. | 19 | Phytotherapy Research | UK | 110 | 4407 | 0.69 | 27.78 |
| 21. | 20 | Indian Journal of Pharmacology | India | 104 | 4511 | 0.66 | 28.44 |
| 22. | 20 | Proc Natl Acad Sci USA | USA | 104 | 4615 | 0.66 | 29.09 |
| 23. | 20 | Plant Cell and Environment | UK | 104 | 4719 | 0.66 | 29.75 |
| 24. | 20 | Nucleic Acids Research | UK | 104 | 4823 | 0.66 | 30.41 |
| 25. | 21 | Phytotherapy Research | UK | 92 | 4915 | 0.58 | 30.99 |
| 26. | 22 | Mutation Research | Netherlands | 91 | 5006 | 0.57 | 31.56 |
| 27. | 23 | Pharmaceutical Biology | Netherlands | 86 | 5092 | 0.54 | 32.10 |
| 28. | 24 | Food Chemistry | UK | 83 | 5175 | 0.52 | 32.62 |
| 29. | 25 | Phytomedicine- (Jena) | Germany | 77 | 5252 | 0.49 | 33.11 |
| 30. | 26 | Applied and Environmental Microbiology | USA | 70 | 5322 | 0.44 | 33.55 |
| 31. | 27 | Indian Phytopathology | India | 66 | 5388 | 0.42 | 33.97 |
| 32. | 27 | Physiological and Molecular | UK | 66 | 5454 | 0.42 | 34.38 |

| | | | | | | | |
|-----|----|--|--------------|----|------|------|-------|
| | | Plant Pathology | | | | | |
| 33. | 28 | In Vitro Cellular & Developmental Biology Plant | USA | 64 | 5518 | 0.40 | 34.79 |
| 34. | 29 | Genome Research | USA | 63 | 5581 | 0.40 | 35.18 |
| 35. | 30 | Plant Disease | USA | 61 | 5642 | 0.38 | 35.57 |
| 36. | 31 | Journal of Virology | USA | 60 | 5702 | 0.38 | 35.95 |
| 37. | 32 | Indian Bee Journal | India | 57 | 5759 | 0.36 | 36.31 |
| 38. | 32 | African Journal of Biotechnology | South Africa | 57 | 5816 | 0.36 | 36.66 |
| 39. | 33 | Indian Journal of Natural Products | India | 54 | 5870 | 0.34 | 37.01 |
| 40. | 34 | Crop Science | USA | 50 | 5920 | 0.32 | 37.32 |
| 41. | 34 | Euphytica | Netherlands | 50 | 5970 | 0.32 | 37.64 |
| 42. | 34 | Plant Pathology Journal | Korea | 50 | 6020 | 0.32 | 37.95 |
| 43. | 35 | Journal of Tropical Medicinal | Japan | 49 | 6069 | 0.31 | 38.26 |
| 44. | 36 | Journal of Natural Remedies | USA | 48 | 6117 | 0.30 | 38.56 |
| 45. | 37 | Plant Molecular Biology Reporter | Netherlands | 47 | 6164 | 0.30 | 38.86 |
| 46. | 38 | Biochemistry Series | USA | 46 | 6210 | 0.29 | 39.15 |
| 47. | 38 | Pharmacogenetics | USA | 46 | 6256 | 0.29 | 39.44 |
| 48. | 38 | Biological & Pharmaceutical Bulletin | Japan | 46 | 6302 | 0.29 | 39.73 |
| 49. | 39 | Chemical and Pharmaceutical Bulletin | Japan | 45 | 6347 | 0.28 | 40.01 |
| 50. | 39 | Cancer Research | USA | 45 | 6392 | 0.28 | 40.30 |
| 51. | 40 | Acta Horticulturae | Belgium | 44 | 6436 | 0.28 | 40.57 |
| 52. | 41 | Biotechnology Abstracts | UK | 43 | 6479 | 0.27 | 40.84 |
| 53. | 42 | Journal of General Virology | UK | 42 | 6521 | 0.26 | 41.11 |
| 54. | 43 | Genetics Research | UK | 40 | 6561 | 0.25 | 41.36 |
| 55. | 44 | Annual Review of Phytopathology | USA | 39 | 6600 | 0.25 | 41.61 |
| 56. | 44 | Journal of Plant Physiology | Germany | 39 | 6639 | 0.25 | 41.85 |
| 57. | 44 | Molecular Breeding | Netherlands | 39 | 6678 | 0.25 | 42.10 |
| 58. | 45 | Indian Journal of Sericulture | India | 38 | 6716 | 0.24 | 42.34 |
| 59. | 45 | Journal of Molecular Biology | UK | 38 | 6754 | 0.24 | 42.58 |
| 60. | 45 | Hepatology | USA | 38 | 6792 | 0.24 | 42.82 |
| 61. | 46 | American Journal of Botany | USA | 37 | 6829 | 0.23 | 43.05 |
| 62. | 46 | Indian Journal of Biotechnology | India | 37 | 6866 | 0.23 | 43.28 |
| 63. | 46 | Methods in Enzymology | USA | 37 | 6903 | 0.23 | 43.52 |
| 64. | 47 | FEBS Letters | Netherlands | 36 | 6939 | 0.23 | 43.74 |
| 65. | 47 | Life Science | USA | 36 | 6975 | 0.23 | 43.97 |
| 66. | 48 | Biochemistry & Biophysics | USA | 35 | 7010 | 0.22 | 44.19 |
| 67. | 48 | Plant Journal | UK | 35 | 7045 | 0.22 | 44.41 |
| 68. | 48 | Journal of Inverte Pathology | USA | 35 | 7080 | 0.22 | 44.63 |
| 69. | 49 | The Lancet | UK | 34 | 7114 | 0.21 | 44.85 |
| 70. | 50 | Bulletin of Botanical Survey India | India | 33 | 7147 | 0.21 | 45.05 |
| 71. | 50 | Indian Journal of Medical Research | India | 33 | 7180 | 0.21 | 45.26 |
| 72. | 50 | EMBO Journal | UK | 33 | 7213 | 0.21 | 45.47 |
| 73. | 50 | Journal of Economic Entomology | USA | 33 | 7246 | 0.21 | 45.68 |
| 74. | 50 | Tetrahedron Letters | UK | 33 | 7279 | 0.21 | 45.89 |
| 75. | 51 | Annals Review of Plant Physiology & Plant Mol. Biol. | USA | 32 | 7311 | 0.20 | 46.09 |
| 76. | 52 | Journal of Alternative and Complementary Medicine | USA | 31 | 7342 | 0.20 | 46.28 |
| 77. | 52 | Canadian Journal of Botany | Canada | 31 | 7373 | 0.20 | 46.48 |
| 78. | 53 | Plant Molecular Biology | Netherlands | 30 | 7403 | 0.19 | 46.67 |
| 79. | 53 | Journal of Bacteriology | USA | 30 | 7433 | 0.19 | 46.86 |
| 80. | 54 | Phytomorphology | India | 29 | 7462 | 0.18 | 47.04 |
| 81. | 54 | Annals of Botany | UK | 29 | 7491 | 0.18 | 47.22 |
| 82. | 55 | Indian Journal of Chemistry | India | 28 | 7519 | 0.18 | 47.40 |
| 83. | 55 | Nature Biotechnology | USA | 28 | 7547 | 0.18 | 47.58 |
| 84. | 55 | Canadian Journal of Plant | Canada | 28 | 7575 | 0.18 | 47.75 |

| | | Science | | | | | |
|------|----|---|-------------|----|------|------|-------|
| 85. | 55 | European Journal of Plant Pathology | Netherlands | 28 | 7603 | 0.18 | 47.93 |
| 86. | 55 | Journal of Virological Methods | Netherlands | 28 | 7631 | 0.18 | 48.11 |
| 87. | 55 | Scientia Horticulturae | Netherlands | 28 | 7659 | 0.18 | 48.28 |
| 88. | 56 | Toxicology | Ireland | 27 | 7686 | 0.17 | 48.45 |
| 89. | 56 | Journal of Immunology | USA | 27 | 7713 | 0.17 | 48.62 |
| 90. | 56 | International Journal of Cancer | USA | 27 | 7740 | 0.17 | 48.79 |
| 91. | 57 | Indian Forester | India | 26 | 7766 | 0.16 | 48.96 |
| 92. | 57 | Indian Journal of Nematology | India | 26 | 7792 | 0.16 | 49.12 |
| 93. | 57 | Journal of Phytopathology | Germany | 26 | 7818 | 0.16 | 49.28 |
| 94. | 58 | Free Radical Biology and Medicine | USA | 25 | 7843 | 0.16 | 49.44 |
| 95. | 58 | Biochimica et Biophysica Acta | Netherlands | 25 | 7868 | 0.16 | 49.60 |
| 96. | 58 | Soil Biology and Biochemistry | UK | 25 | 7893 | 0.16 | 49.76 |
| 97. | 58 | Bioscience Biotechnology & Biochemistry | Japan | 25 | 7918 | 0.16 | 49.91 |
| 98. | 58 | Annual Review of Entomology | USA | 25 | 7943 | 0.16 | 50.07 |
| 99. | 58 | Clinical Chemistry | USA | 25 | 7968 | 0.16 | 50.23 |
| 100. | 59 | Indian Journal of Genetics & Plant Breeding | India | 24 | 7992 | 0.15 | 50.38 |
| 101. | 59 | Molecular Plant Microbe Interactions | USA | 24 | 8016 | 0.15 | 50.53 |
| 102. | 59 | Journal of Medicinal and Aromatic Plant Sciences | India | 24 | 8040 | 0.15 | 50.68 |
| 103. | 59 | Plant and Soil | Netherlands | 24 | 8064 | 0.15 | 50.84 |
| 104. | 59 | Journal of Hepatology | Denmark | 24 | 8088 | 0.15 | 50.99 |
| 105. | 59 | Biochemical Pharmacology | USA | 24 | 8112 | 0.15 | 51.14 |
| 106. | 60 | Bulletin of Seric. Expt. Sta. Japan | Japan | 23 | 8135 | 0.14 | 51.28 |
| 107. | 60 | Madras Agricultural Journal | India | 23 | 8158 | 0.14 | 51.43 |
| 108. | 60 | Molecular & General Genetics | Germany | 23 | 8181 | 0.14 | 51.57 |
| 109. | 60 | Pflanzenphysiol | Germany | 23 | 8204 | 0.14 | 51.72 |
| 110. | 60 | Journal of Proteome Chemistry | USA | 23 | 8227 | 0.14 | 51.86 |
| 111. | 60 | Journal of Experimental Botany | UK | 23 | 8250 | 0.14 | 52.01 |
| 112. | 60 | Plant Cell | USA | 23 | 8273 | 0.14 | 52.15 |
| 113. | 61 | Journal of American Society for Horticultural Science | USA | 22 | 8295 | 0.14 | 52.29 |
| 114. | 61 | Annals of Biochemistry | USA | 22 | 8317 | 0.14 | 52.43 |
| 115. | 61 | Turkish Journal of Biology | Turkey | 22 | 8339 | 0.14 | 52.57 |
| 116. | 61 | Analytical Biochemistry | USA | 22 | 8361 | 0.14 | 52.71 |
| 117. | 61 | Biotechnology Letters | Netherlands | 22 | 8383 | 0.14 | 52.85 |
| 118. | 61 | Bioinformatics | UK | 22 | 8405 | 0.14 | 52.98 |
| 119. | 61 | Gastroenterology | USA | 22 | 8427 | 0.14 | 53.12 |
| 120. | 61 | Journal of Pharmaceutical Sciences | USA | 22 | 8449 | 0.14 | 53.26 |
| 121. | 62 | Bulletin of Japan Soc. Sci. Fish | Japan | 21 | 8470 | 0.13 | 53.39 |
| 122. | 62 | Annals of Applied Biology | UK | 21 | 8491 | 0.13 | 53.53 |
| 123. | 62 | Annual Review of Biochemistry | USA | 21 | 8512 | 0.13 | 53.66 |
| 124. | 62 | Archives of Biochemistry & Biophysics | USA | 21 | 8533 | 0.13 | 53.79 |
| 125. | 62 | Transgenic Research | Netherlands | 21 | 8554 | 0.13 | 53.92 |
| 126. | 62 | Antimicrobial Agents and Chemotherapy | USA | 21 | 8575 | 0.13 | 54.06 |
| 127. | 63 | Indian Journal of Agricultural Sciences | India | 20 | 8595 | 0.13 | 54.18 |
| 128. | 63 | Molecular & Cellular Proteomics | USA | 20 | 8615 | 0.13 | 54.31 |
| 129. | 63 | Plant Breeding | Germany | 20 | 8635 | 0.13 | 54.43 |
| 130. | 63 | Seed Science and Technology | Switzerland | 20 | 8655 | 0.13 | 54.56 |
| 131. | 63 | Virology | USA | 20 | 8675 | 0.13 | 54.69 |
| 132. | 63 | Analytical Chemistry | USA | 20 | 8695 | 0.13 | 54.81 |
| 133. | 63 | Bioorganic & Medicinal Chem Letters | UK | 20 | 8715 | 0.13 | 54.94 |
| 134. | 63 | Ecology | USA | 20 | 8735 | 0.13 | 55.06 |

| | | | | | | | |
|------|----|---|-----|------|-------|------|--------|
| 135. | 63 | Hort science | USA | 20 | 8755 | 0.13 | 55.19 |
| 136. | 63 | International Journal of Pharma Medicine | USA | 20 | 8775 | 0.13 | 55.32 |
| 137. | 63 | Pharmacological Research | UK | 20 | 8795 | 0.13 | 55.44 |
| 138. | 64 | 10 Journals with 19 Citations each | | 190 | 8985 | 1.20 | 56.64 |
| 139. | 65 | 10 Journals with 18 Citations each | | 180 | 9165 | 1.13 | 57.77 |
| 140. | 66 | 9 Journals with 17 Citations each | | 153 | 9318 | 0.96 | 58.73 |
| 141. | 67 | 7 Journals with 16 Citations each | | 112 | 9430 | 0.71 | 59.44 |
| 142. | 68 | 17 Journals with 15 Citations each | | 255 | 9685 | 1.61 | 61.05 |
| 143. | 69 | 16 Journals with 14 Citations each | | 224 | 9909 | 1.41 | 62.46 |
| 144. | 70 | 16 Journals with 13 Citations each | | 208 | 10117 | 1.31 | 63.77 |
| 145. | 71 | 22 Journals with 12 Citations each | | 264 | 10381 | 1.66 | 65.43 |
| 146. | 72 | 28 Journals with 11 Citations each | | 308 | 10689 | 1.95 | 67.38 |
| 147. | 73 | 28 Journals with 10 Citations each | | 280 | 10969 | 1.77 | 69.14 |
| 148. | 74 | 33 Journals with 9 Citations each | | 297 | 11266 | 1.88 | 71.02 |
| 149. | 75 | 46 Journals with 8 Citations each | | 368 | 11634 | 2.32 | 73.34 |
| 150. | 76 | 63 Journals with 7 Citations each | | 441 | 12075 | 2.78 | 76.12 |
| 151. | 77 | 73 Journals with 6 Citations each | | 438 | 12513 | 2.76 | 78.88 |
| 152. | 78 | 96 Journals with 5 Citations each | | 480 | 12993 | 3.02 | 81.90 |
| 153. | 79 | 115 Journals with 4 Citations each | | 460 | 13453 | 2.90 | 84.80 |
| 154. | 80 | 200 Journals with 3 Citations each | | 600 | 14053 | 3.78 | 88.58 |
| 155. | 81 | 368 Journals with 2 Citations each | | 736 | 14789 | 4.64 | 93.22 |
| 156. | 82 | 1075 Journals with 1 Citations each | | 1075 | 15864 | 6.78 | 100.00 |

Table-9 provides rank list of journals in Biotechnology. After analyzing the data, it is found that around 2369 journals have been cited in 62 theses and the complete list is provided in the form of table.

It is found that Journal of Ethnopharmacology published from Ireland occupies the first rank as the most preferred journal having been cited 558 times followed by Fitoterapia published from Italy with second highest citations i.e. 435 citations. The third rank goes to Plant Cell Reports from Germany with 357 citations, and fourth rank to Plant Cell Tissue & Organ Culture from Netherlands with 320 citations. The first ten journals in the rank list together account nearly 20% of the total citations. The first 98 journals in the rank list contribute 50% of the total citations. Out of 98 journals 16 journals are from India, which accounts 1435 (9.05%) of citations. It is also evident from the table that 75% of total citations are contributed by the first 417 journals in the rank list. The remaining 25% of citations are scattered among 2369 journals.

4.10 Availability of cited journals in Kuvempu University Library

Out of total 2369 cited journals, the researcher made an attempt to know number of journals are available in Kuvempu University Library. The same has been given in table-10.

Table-10 Availability of cited journals in Kuvempu University

| Sl. No | Name of the Journal | Total citations |
|--------|---|-----------------|
| 1. | Indian Journal of Experimental Biology | 260 |
| 2. | Indian Journal of Biotechnology | 37 |
| 3. | Canadian Journal of Plant Science | 28 |
| 4. | Journal of Genetics | 24 |
| 5. | Indian Journal of Genetics and Plant Breeding | 24 |
| 6. | Journal of Plant Biochemistry and Biotechnology | 19 |
| 7. | Asian Journal of Microbiology Biotechnology and Environmental Science | 14 |
| 8. | Trends in Biotechnology | 13 |
| 9. | International Journal of Biotechnology | 12 |
| 10. | Indian Journal of Physiology and Pharmacology | 11 |
| 11. | Journal of Biosciences | 10 |
| 12. | Journal of Mycology and Plant Pathology | 10 |
| 13. | Biotechnology & Applied Biochemistry | 4 |
| 14. | Advances in Biotechnology | 4 |
| 15. | Indian Journal of Medicinal Research | 4 |
| 16. | Bioinformatics Trends | 4 |
| 17. | Journal of Food Science and Technology | 3 |
| | | 481 |
| | Electronic Journals (UGC-Infonet) | |
| 1. | Biotechnology Letters | 22 |
| 2. | World Journal of Microbiology and Biotechnology | 12 |
| 3. | Applied Microbiology & Biotechnology | 11 |
| 4. | Bioprocess engineering | 5 |
| 5. | Bioscience Reports | 1 |
| 6. | Journal of Indus. Micro. & Biotechnology | 1 |
| 7. | Marine Biotechnology | 1 |
| | | 53 |

Table-10 data deals with the journals available in Kuvempu University library which are cited by the Biotechnology researchers. Out of 2369 cited journals by the Biotechnology researchers only 24 journals have been subscribed by the Kuvempu University library. Out of 24 journals 17 journals are available in print version remaining 7 journals are available in electronic version accessible through UGC-Infonet consortia. These subscribed journals covering 534 citations to the total of 15864 journal citations. It is clearly indicating that only 3.37% of cited journals are available in the library. But, it is an interesting fact to know that Indian Journal of Experimental Biology has ranked in 6th position of journal ranking list with 260 citations. This journal is one among the journals available in the Kuvempu University library. Above results clearly indicates that university library is not meeting the information requirements of researchers in Biotechnology.

4.11 Ranked Countries of Journals

In table-11 all the cited journals categorized according to their country of origin to find out the most productive countries in the field of Biotechnology. The countries of origin of the cited journals are traced out from ‘Ulrich’s Periodicals Directory’.

Table-11 Ranked Countries of Journals

| Sl.No. | Rank | Country | No of Journal cited |
|--------------|------|-----------------|---------------------|
| 1. | 1 | USA | 721 (30.43) |
| 2. | 2 | UK | 319 (13.47) |
| 3. | 3 | India | 269 (11.36) |
| 4. | 4 | Netherlands | 128 (5.40) |
| 5. | 5 | Japan | 101 (4.26) |
| 6. | 6 | Germany | 95 (4.01) |
| 7. | 7 | China | 60 (2.53) |
| 8. | 8 | Switzerland | 40 (1.69) |
| 9. | 9 | Italy | 36 (1.52) |
| 10. | 10 | Brazil | 27 (1.14) |
| 11. | 11 | Canada | 25 (1.06) |
| 12. | 12 | France | 23 (0.97) |
| 13. | 13 | Australia | 21 (0.89) |
| 14. | 13 | South Africa | 21 (0.89) |
| 15. | 14 | Pakistan | 20 (0.84) |
| 16. | 15 | Denmark | 19 (0.80) |
| 17. | 16 | Korea | 16 (0.68) |
| 18. | 17 | Poland | 14 (0.59) |
| 19. | 18 | Spain | 13 (0.54) |
| 20. | 19 | Russia | 10 (0.42) |
| 21. | | Other Countries | 164 (6.94) |
| 22. | | Un Identified | 227 (9.58) |
| Total | | | 2369(100) |

The journals are analyzed according to their country of origin and the result of the most productive countries is shown in the table-11. All the countries which have cited more than 10 journals are figured in the table, countries responsible for the publication of less than 10 journals are grouped under others countries. It is noticed from the cited documents that the research scholars in Biotechnology have referred to the literature from different countries. Of all the countries USA is the leading country accounting for 721 (30.43%) of the total cited journals. UK follows second position with a list of 319 (13.47%) journals. India occupies the third place with a total of 269 (11.36%) journals. In case of other countries viz; Netherlands 128 (5.40%), and Japan 101 (4.26%), occupy the fourth, and fifth places combining with 229 (9.66%) of citations.

These above mentioned five countries together constitute 64.92%. The researchers have referred to only 35.08% of the citations from the remaining countries.

4.12 Productivity of journals

Table-12 Productivity of journals in Biotechnology

| Sl.No | % of Citations | No. of Citations | No. of Journals Covered | Average productivity of Journals |
|--------------|----------------|------------------|-------------------------|----------------------------------|
| 1 | 0-25 | 4051 | 17 (0.72) | 238.29 |
| 2 | 26-50 | 3892 | 81 (3.42) | 48.04 |
| 3 | 51-75 | 3957 | 319 (13.46) | 12.40 |
| 4 | 76-100 | 3964 | 1952 (82.40) | 2.03 |
| Total | | 15864 | 2369 (100) | 6.69 |

Table-12 depicts that the first group of citations are to the first 17 journals of the rank list, thus signifying their high rate of productivity. The average productivity of each journal in the first group was 238.29 journals, where it has considerably gone down to 2.03 journals in the fourth category. This marked difference easily confirms the decreasing productivity of individual journals in the rank list.

4.13 Bradford’s distribution

In the present study, an attempt is made to find the distribution of citations among periodicals in Biotechnology is in accordance with Bradford’s law of scattering. For this purpose, a bibliography of cumulated some of citations verses rank was developed on semi-log graph paper.

Table-13 presents the data of journals ranked by citations and it is used for application of Bradford’s law to identify the three zones of journals.

Table-13 Bradford’s zones for Biotechnology

| Sl.No | Number Of | | Cumulative No. of | |
|-------|-------------|---------------------|-------------------|-------------|
| | Citations | Journals | Citations | Journals |
| 1 | 5252 | 29(1.22) | 5252 | 29 |
| 2 | 5316 | 232 (9.80) | 10568 | 261 |
| 3 | 5296 | 2108 (88.98) | 15864 | 2369 |

Study shows that there are 29 journals in the nucleus and they are the most productive journals devoted to Biotechnology sharing 1.22% of total cited journals. The next zone is represented by 232 journals which share 9.80% of total journal, and the last zone is represented by 2108 journals which share 88.98% of total cited journals. Each zone has approximately one-third of the total citations. Table-14 and fig.1 also reveals the same results. The journals distribution as per the Bradford’s law reveals the ratio of 29:232:2108. 29 represent the number of periodicals in the nucleus and n=8.54 is a multiplier. The mean value of multiplier is 8.54.

Therefore: 29:232:2108= 2369

232

----- = 8

29

2108

----- = 9.08

232

8

+

9.08

17.08

17.08

-----= 8.54 Mean value of multiplier

2

n= 8.54

29:29X8.54:29X (8.54)² ::1:n:n²

29:248:2115>>29+248+2115=2392

$$\text{Percentage error} = \frac{2392-2369}{2369} \times 100$$

Error= 0.97

Since the percentage error is here data will not fit well the Bradford's Law.

4.14 Distribution of cited journals by decreasing frequencies of citations in Biotechnology

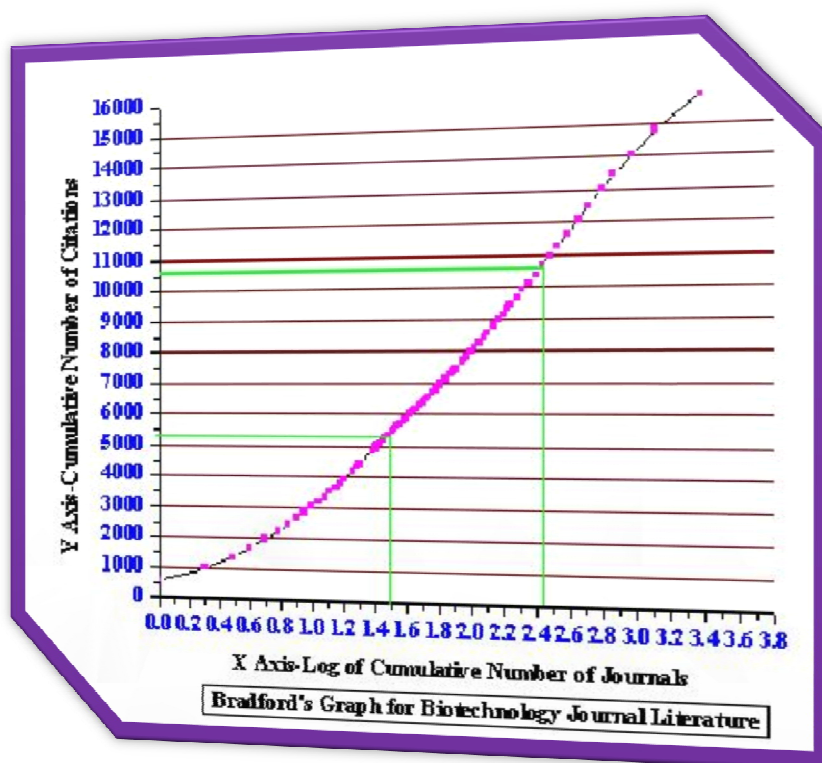
Table-14 Distribution of cited journals by decreasing frequencies of citations in Biotechnology

| No. of Journals | Cumulative No. of Journals | Log of Cumulative Journals | No. of Citations | Total Citations | Cumulative Citations | % of Cumulative Citations | % of Cumulative Journals |
|-----------------|----------------------------|----------------------------|------------------|-----------------|----------------------|---------------------------|--------------------------|
| 1 | 1 | 0.00 | 558 | 558 | 558 | 3.52 | 0.04 |
| 1 | 2 | 0.30 | 435 | 435 | 993 | 6.26 | 0.08 |
| 1 | 3 | 0.48 | 357 | 357 | 1350 | 8.51 | 0.13 |
| 1 | 4 | 0.60 | 320 | 320 | 1670 | 10.53 | 0.17 |
| 1 | 5 | 0.70 | 283 | 283 | 1953 | 12.31 | 0.21 |
| 1 | 6 | 0.78 | 260 | 260 | 2213 | 13.95 | 0.25 |
| 1 | 7 | 0.85 | 234 | 234 | 2447 | 15.42 | 0.30 |
| 1 | 8 | 0.90 | 215 | 215 | 2662 | 16.78 | 0.34 |
| 1 | 9 | 0.95 | 204 | 204 | 2866 | 18.07 | 0.38 |
| 1 | 10 | 1.00 | 187 | 187 | 3053 | 19.24 | 0.42 |
| 1 | 11 | 1.04 | 157 | 157 | 3210 | 20.23 | 0.46 |
| 1 | 12 | 1.08 | 156 | 156 | 3366 | 21.22 | 0.51 |
| 1 | 13 | 1.11 | 149 | 149 | 3515 | 22.16 | 0.55 |
| 1 | 14 | 1.15 | 143 | 143 | 3658 | 23.06 | 0.59 |
| 1 | 15 | 1.18 | 136 | 136 | 3794 | 23.92 | 0.63 |
| 1 | 16 | 1.20 | 133 | 133 | 3927 | 24.75 | 0.68 |
| 2 | 18 | 1.26 | 124 | 248 | 4175 | 26.32 | 0.76 |
| 1 | 19 | 1.28 | 122 | 122 | 4297 | 27.09 | 0.80 |
| 1 | 20 | 1.30 | 110 | 110 | 4407 | 27.78 | 0.84 |
| 4 | 24 | 1.38 | 104 | 416 | 4823 | 30.40 | 1.01 |
| 1 | 25 | 1.40 | 92 | 92 | 4915 | 30.98 | 1.06 |
| 1 | 26 | 1.41 | 91 | 91 | 5006 | 31.56 | 1.10 |
| 1 | 27 | 1.43 | 86 | 86 | 5092 | 32.10 | 1.14 |
| 1 | 28 | 1.45 | 83 | 83 | 5175 | 32.62 | 1.18 |
| 1 | 29 | 1.46 | 77 | 77 | 5252 | 33.11 | 1.22 |
| 1 | 30 | 1.48 | 70 | 70 | 5322 | 33.55 | 1.27 |
| 2 | 32 | 1.51 | 66 | 132 | 5454 | 34.38 | 1.35 |
| 1 | 33 | 1.52 | 64 | 64 | 5518 | 34.78 | 1.39 |
| 1 | 34 | 1.53 | 63 | 63 | 5581 | 35.18 | 1.44 |
| 1 | 35 | 1.54 | 61 | 61 | 5642 | 35.56 | 1.48 |
| 1 | 36 | 1.56 | 60 | 60 | 5702 | 35.94 | 1.52 |
| 2 | 38 | 1.58 | 57 | 114 | 5816 | 36.66 | 1.60 |
| 1 | 39 | 1.59 | 54 | 54 | 5870 | 37.00 | 1.65 |
| 3 | 42 | 1.62 | 50 | 150 | 6020 | 37.95 | 1.77 |
| 1 | 43 | 1.63 | 49 | 49 | 6069 | 38.26 | 1.82 |
| 1 | 44 | 1.64 | 48 | 48 | 6117 | 38.56 | 1.86 |
| 1 | 45 | 1.65 | 47 | 47 | 6164 | 38.86 | 1.90 |
| 3 | 48 | 1.68 | 46 | 138 | 6302 | 39.73 | 2.03 |
| 2 | 50 | 1.70 | 45 | 90 | 6392 | 40.29 | 2.11 |
| 1 | 51 | 1.71 | 44 | 44 | 6436 | 40.57 | 2.15 |

| | | | | | | | |
|------|------|------|----|------|-------|--------|-------|
| 1 | 52 | 1.72 | 43 | 43 | 6479 | 40.84 | 2.20 |
| 1 | 53 | 1.72 | 42 | 42 | 6521 | 41.11 | 2.24 |
| 1 | 54 | 1.73 | 40 | 40 | 6561 | 41.36 | 2.28 |
| 3 | 57 | 1.76 | 39 | 117 | 6678 | 42.10 | 2.41 |
| 3 | 60 | 1.78 | 38 | 114 | 6792 | 42.81 | 2.53 |
| 3 | 63 | 1.80 | 37 | 111 | 6903 | 43.51 | 2.66 |
| 2 | 65 | 1.81 | 36 | 72 | 6975 | 43.97 | 2.74 |
| 3 | 68 | 1.83 | 35 | 105 | 7080 | 44.63 | 2.87 |
| 1 | 69 | 1.84 | 34 | 34 | 7114 | 44.84 | 2.91 |
| 5 | 74 | 1.87 | 33 | 165 | 7279 | 45.88 | 3.12 |
| 1 | 75 | 1.88 | 32 | 32 | 7311 | 46.09 | 3.17 |
| 2 | 77 | 1.89 | 31 | 62 | 7373 | 46.48 | 3.25 |
| 2 | 79 | 1.90 | 30 | 60 | 7433 | 46.85 | 3.33 |
| 2 | 81 | 1.91 | 29 | 58 | 7491 | 47.22 | 3.42 |
| 6 | 87 | 1.94 | 28 | 168 | 7659 | 48.28 | 3.67 |
| 3 | 90 | 1.95 | 27 | 81 | 7740 | 48.79 | 3.80 |
| 3 | 93 | 1.97 | 26 | 78 | 7818 | 49.28 | 3.93 |
| 6 | 99 | 2.00 | 25 | 150 | 7968 | 50.23 | 4.18 |
| 6 | 105 | 2.02 | 24 | 144 | 8112 | 51.13 | 4.43 |
| 7 | 112 | 2.05 | 23 | 161 | 8273 | 52.15 | 4.73 |
| 8 | 120 | 2.08 | 22 | 176 | 8449 | 53.26 | 5.07 |
| 6 | 126 | 2.10 | 21 | 126 | 8575 | 54.05 | 5.32 |
| 11 | 137 | 2.14 | 20 | 220 | 8795 | 55.44 | 5.78 |
| 10 | 147 | 2.17 | 19 | 190 | 8985 | 56.64 | 6.21 |
| 10 | 157 | 2.20 | 18 | 180 | 9165 | 57.77 | 6.63 |
| 9 | 166 | 2.22 | 17 | 153 | 9318 | 58.74 | 7.01 |
| 7 | 173 | 2.24 | 16 | 112 | 9430 | 59.44 | 7.30 |
| 17 | 190 | 2.28 | 15 | 255 | 9685 | 61.05 | 8.02 |
| 16 | 206 | 2.31 | 14 | 224 | 9909 | 62.46 | 8.70 |
| 16 | 222 | 2.35 | 13 | 208 | 10117 | 63.77 | 9.37 |
| 22 | 244 | 2.39 | 12 | 264 | 10381 | 65.44 | 10.30 |
| 28 | 272 | 2.43 | 11 | 308 | 10689 | 67.38 | 11.48 |
| 28 | 300 | 2.48 | 10 | 280 | 10969 | 69.14 | 12.66 |
| 33 | 333 | 2.52 | 9 | 297 | 11266 | 71.02 | 14.06 |
| 46 | 379 | 2.58 | 8 | 368 | 11634 | 73.34 | 16.00 |
| 63 | 442 | 2.65 | 7 | 441 | 12075 | 76.12 | 18.66 |
| 73 | 515 | 2.71 | 6 | 438 | 12513 | 78.88 | 21.74 |
| 96 | 611 | 2.79 | 5 | 480 | 12993 | 81.90 | 25.79 |
| 115 | 726 | 2.86 | 4 | 460 | 13453 | 84.80 | 30.65 |
| 200 | 926 | 2.97 | 3 | 600 | 14053 | 88.58 | 39.09 |
| 368 | 1294 | 3.11 | 2 | 736 | 14789 | 93.22 | 54.62 |
| 1075 | 2369 | 3.37 | 1 | 1075 | 15864 | 100.00 | 100 |

The graphical and verbal interpretation of the Bradford's law of scattering has been applied to the literature of Biotechnology. Here, it is observed that an experimental curve (continuous line) is closely in association with the theoretical line (dotted line) up to about 16000 citations and then starts dropping as shown in fig.1.

Fig.1. Bradford's Graph for Biotechnology Journal Literature



4.15 Obsolescence and Half-life of journal literature in Biotechnology

Table-15 Obsolescence and Half-life of journal literature in Biotechnology

| Age in years | No. of Citations | % | Cumulative % | Citations in Total (t) |
|--------------|------------------|-------|--------------|------------------------|
| 0 | 231 | 1.456 | 1.456 | 15864 |
| 1 | 596 | 3.757 | 5.213 | 15633 |
| 2 | 719 | 4.532 | 9.745 | 15037 |
| 3 | 838 | 5.282 | 15.028 | 14318 |
| 4 | 913 | 5.755 | 20.783 | 13480 |
| 5 | 789 | 4.974 | 25.756 | 12567 |
| 6 | 880 | 5.547 | 31.303 | 11778 |
| 7 | 783 | 4.936 | 36.239 | 10898 |
| 8 | 817 | 5.150 | 41.389 | 10115 |
| 9 | 687 | 4.331 | 45.720 | 9298 |
| 10 | 666 | 4.198 | 49.918 | 8611 |
| 11 | 585 | 3.688 | 53.606 | 7945 |
| 12 | 533 | 3.360 | 56.965 | 7360 |
| 13 | 498 | 3.139 | 60.105 | 6827 |
| 14 | 498 | 3.139 | 63.244 | 6329 |
| 15 | 423 | 2.666 | 65.910 | 5831 |
| 16 | 415 | 2.616 | 68.526 | 5408 |
| 17 | 364 | 2.295 | 70.821 | 4993 |
| 18 | 293 | 1.847 | 72.668 | 4629 |
| 19 | 283 | 1.784 | 74.451 | 4336 |

| | | | | |
|----|-----|-------|--------|------|
| 20 | 279 | 1.759 | 76.210 | 4053 |
| 21 | 235 | 1.481 | 77.692 | 3774 |
| 22 | 242 | 1.525 | 79.217 | 3539 |
| 23 | 190 | 1.198 | 80.415 | 3297 |
| 24 | 219 | 1.380 | 81.795 | 3107 |
| 25 | 219 | 1.380 | 83.176 | 2888 |
| 26 | 183 | 1.154 | 84.329 | 2669 |
| 27 | 174 | 1.097 | 85.426 | 2486 |
| 28 | 134 | 0.845 | 86.271 | 2312 |
| 29 | 139 | 0.876 | 87.147 | 2178 |
| 30 | 135 | 0.851 | 87.998 | 2039 |
| 31 | 129 | 0.813 | 88.811 | 1904 |
| 32 | 95 | 0.599 | 89.410 | 1775 |
| 33 | 93 | 0.586 | 89.996 | 1680 |
| 34 | 100 | 0.630 | 90.626 | 1587 |
| 35 | 62 | 0.391 | 91.017 | 1487 |
| 36 | 70 | 0.441 | 91.459 | 1425 |
| 37 | 68 | 0.429 | 91.887 | 1355 |
| 38 | 82 | 0.517 | 92.404 | 1287 |
| 39 | 71 | 0.448 | 92.852 | 1205 |
| 40 | 79 | 0.498 | 93.350 | 1134 |
| 41 | 72 | 0.454 | 93.803 | 1055 |
| 42 | 77 | 0.485 | 94.289 | 983 |
| 43 | 60 | 0.378 | 94.667 | 906 |
| 44 | 41 | 0.258 | 94.925 | 846 |
| 45 | 50 | 0.315 | 95.241 | 805 |
| 46 | 46 | 0.290 | 95.531 | 755 |
| 47 | 40 | 0.252 | 95.783 | 709 |
| 48 | 45 | 0.284 | 96.066 | 669 |
| 49 | 32 | 0.202 | 96.268 | 624 |
| 50 | 31 | 0.195 | 96.464 | 592 |
| 51 | 37 | 0.233 | 96.697 | 561 |
| 52 | 28 | 0.177 | 96.873 | 524 |
| 53 | 37 | 0.233 | 97.107 | 496 |
| 54 | 29 | 0.183 | 97.289 | 459 |
| 55 | 23 | 0.145 | 97.434 | 430 |
| 56 | 36 | 0.227 | 97.661 | 407 |
| 57 | 22 | 0.139 | 97.800 | 371 |
| 58 | 12 | 0.076 | 97.876 | 349 |
| 59 | 14 | 0.088 | 97.964 | 337 |
| 60 | 15 | 0.095 | 98.058 | 323 |
| 61 | 11 | 0.069 | 98.128 | 308 |
| 62 | 9 | 0.057 | 98.184 | 297 |
| 63 | 8 | 0.050 | 98.235 | 288 |
| 64 | 16 | 0.101 | 98.336 | 280 |
| 65 | 13 | 0.082 | 98.418 | 264 |
| 66 | 7 | 0.044 | 98.462 | 251 |
| 67 | 12 | 0.076 | 98.537 | 244 |
| 68 | 11 | 0.069 | 98.607 | 232 |
| 69 | 13 | 0.082 | 98.689 | 221 |
| 70 | 18 | 0.113 | 98.802 | 208 |
| 71 | 18 | 0.113 | 98.916 | 190 |
| 72 | 14 | 0.088 | 99.004 | 172 |

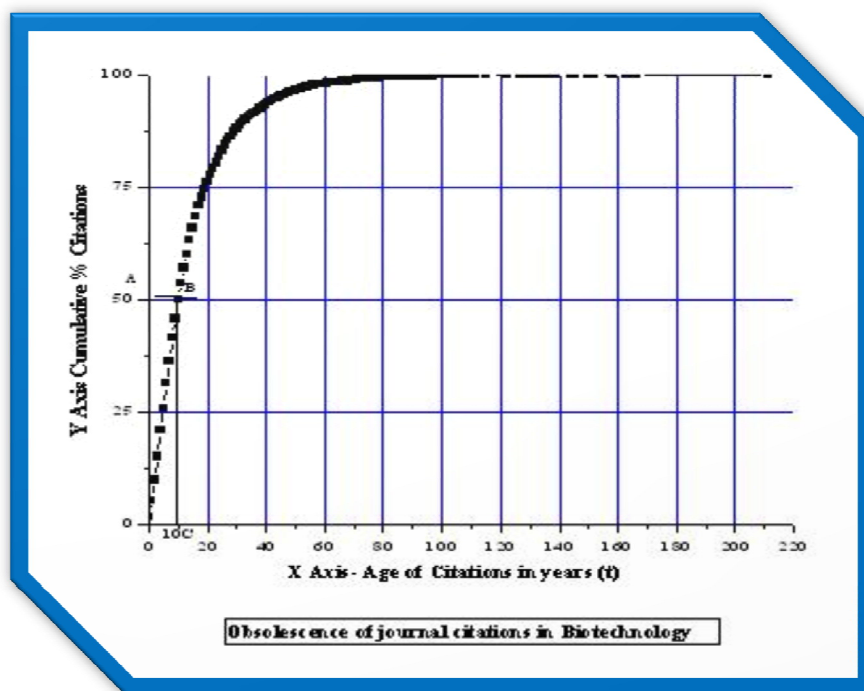
| | | | | |
|-----|--------------|------------|---------|-----|
| 73 | 12 | 0.076 | 99.080 | 158 |
| 74 | 6 | 0.038 | 99.117 | 146 |
| 75 | 8 | 0.050 | 99.168 | 140 |
| 76 | 11 | 0.069 | 99.237 | 132 |
| 77 | 4 | 0.025 | 99.262 | 121 |
| 78 | 9 | 0.057 | 99.319 | 117 |
| 79 | 6 | 0.038 | 99.357 | 108 |
| 80 | 4 | 0.025 | 99.382 | 102 |
| 81 | 7 | 0.044 | 99.426 | 98 |
| 82 | 8 | 0.050 | 99.477 | 91 |
| 83 | 6 | 0.038 | 99.514 | 83 |
| 84 | 3 | 0.019 | 99.533 | 77 |
| 85 | 6 | 0.038 | 99.571 | 74 |
| 86 | 5 | 0.032 | 99.603 | 68 |
| 87 | 2 | 0.013 | 99.615 | 63 |
| 88 | 3 | 0.019 | 99.634 | 61 |
| 89 | 5 | 0.032 | 99.666 | 58 |
| 90 | 1 | 0.006 | 99.672 | 53 |
| 91 | 4 | 0.025 | 99.697 | 52 |
| 92 | 2 | 0.013 | 99.710 | 48 |
| 93 | 3 | 0.019 | 99.729 | 46 |
| 94 | 1 | 0.006 | 99.735 | 43 |
| 95 | 4 | 0.025 | 99.760 | 42 |
| 96 | 2 | 0.013 | 99.773 | 38 |
| 97 | 2 | 0.013 | 99.786 | 36 |
| 98 | 4 | 0.025 | 99.811 | 34 |
| 99 | 1 | 0.006 | 99.817 | 30 |
| 100 | 2 | 0.013 | 99.830 | 29 |
| 101 | 3 | 0.019 | 99.849 | 27 |
| 102 | 1 | 0.006 | 99.855 | 24 |
| 103 | 1 | 0.006 | 99.861 | 23 |
| 104 | 1 | 0.006 | 99.867 | 22 |
| 105 | 1 | 0.006 | 99.874 | 21 |
| 106 | 1 | 0.006 | 99.880 | 20 |
| 107 | 1 | 0.006 | 99.886 | 19 |
| 108 | 1 | 0.006 | 99.893 | 18 |
| 109 | 1 | 0.006 | 99.899 | 17 |
| 110 | 2 | 0.013 | 99.912 | 16 |
| 111 | 1 | 0.006 | 99.918 | 14 |
| 112 | 1 | 0.006 | 99.924 | 13 |
| 113 | 1 | 0.006 | 99.931 | 12 |
| 114 | 1 | 0.006 | 99.937 | 11 |
| 115 | 1 | 0.006 | 99.943 | 10 |
| 116 | 1 | 0.006 | 99.949 | 9 |
| 117 | 1 | 0.006 | 99.956 | 8 |
| 118 | 2 | 0.013 | 99.968 | 7 |
| 119 | 1 | 0.006 | 99.975 | 5 |
| 120 | 1 | 0.006 | 99.981 | 4 |
| 121 | 1 | 0.006 | 99.987 | 3 |
| 122 | 1 | 0.006 | 99.994 | 2 |
| 123 | 1 | 0.006 | 100.000 | 1 |
| | 15864 | 100 | | |

Table-15 reveals the obsolescence of journal literature in the field of Biotechnology. It clearly shows that more number of citations (60.10%) are distributed in the age of 0-13 years. Nearly one-quarter of journal citations are 5 years old. It is also observed that nearly 75% of citations are 19 years old. This indicates that librarians have to maintain 19 years old periodicals in easily accessible place, rest of the 25% may be deposited in the dormitory section of the library. The documents as old as 123 years have also been cited fig.2.

Half- life of journal citations

A graph is plotted taking the age of citations in years on X-axis and cumulative percentage of citations on Y-axis to find out half-life of citations. A line parallel to the X-axis is drawn from a point say “A” drawn from point “B” to meet the X-axis at C. “C” represents the half-life period of citations. Half-life of journal citations is found in the field of Biotechnology 10 years old.

Fig.2 Obsolescence of journal citations in Biotechnology



4.16 Conclusion

The primary purpose of citation is to enable a reader to go the referred document for information on a point of check the authenticity of a particular view finding or method. Each citation is a message from the author of a document to his readers. Citation analysis provides relevant measurement of utility and relationship of journal whose primary function is to communicate research results. This analytical method is very useful in libraries.

Paper presented the detailed analysis and overview of Biotechnology research activity conducted in Kuvempu University, Karnataka, India. The analysis of data helped in finding many significant facts. The observations noticed in this study are useful for building findings and suggestions. The data analyses presented in this study fulfill the objectives. Such as to study the use of different information sources consulted and cited by Biotechnology research scholars, while conducting research study and identification of cited sources and its ranking.

This study also found the some results positively. Research scholars most preferred source is journal literature while conducting research study than other sources and now use of web and internet sources are also used by the researchers in the field Biotechnology. English is the dominant language and also an important communication language in the field of Biotechnology. However, very small percent of researchers used literature published in other languages. Country wise distribution of journals reveals that USA ranked first in number of times cited journals.

Finally the study found that obsolescence of journal literature in the field of Biotechnology. It is clearly shows that halflife of journal citations is 10 years old. This indicates that librarians have to maintain recent information in easily accessible place.

References

1. Bibliometric laws: Available at:
2. http://shodhganga.inflibnet.ac.in:8080/jspui/bitstream/10603/18612/8/08_chapter%203.pdf
3. Biradar, B. S., & Sampath Kumar, B. T. (2003). Chemical technology literature: An obsolescence study. *Annals of Library and Information Studies*, Vol.50(4), pp.156-162.
4. Govinda Raju, N. (2013). Citation analysis in doctoral dissertations in Physics: A quantitative study. *International Journal of Innovative Research & Practice (IJIRP)*, pp.1-10. Available at: http://www.forum4researchers.com/fr_admin/docs/IJIRP-FEB-13-01.pdf
5. Koteppa Banateppanavar., P Dharanikumar & Vindya A B (2015) Bradford's Zone to LIS Publications Published in Collection Building Journal from 2009-2012: A Citation Study. *Collection Building (Emerald Publications)*, vol.34(2).
6. Line, M. B., & Sandison, Alexander. (1974). Obsolescence and changes in the use of literature. *Journal of Documentation*, 30, pp.283-350.
7. Subramanyam, K. (1983). Bibliometrics studies of research collaboration: a review. *Journal of Information Science*, 6(1), 33-8.

