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RESEARCH OUTPUT IN THE FIELD OF CHEMISTRY: A SCIENTOMETRIC STUDY OF KUMAUN UNIVERSITY

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Abstract:

Purpose: The purpose of the study is to examine the research output of the chemistry, Kumaun University through scientometric techniques.

Methodology: The SodhSindhu, Google Scholar and ResearchGate databases are chosen for the data extraction and total sixty eight articles are collected from the database for the period of 2010-2014. Search strings 'Kumaun University', 'Chemistry', 'Name of Faculty Members', 'Year', etc are used to extract the papers. Statistical software SPSS 20 and MS Excel were used for refining, presentation and analysis of the collected data as per the objectives of the study. Relative Growth Rate (RGR), doubling Time, Degree of Collaboration, Collaboration Index, Dominance Factor, etc statistical are used.

Findings: There is a decreasing trend in growth pattern of publications in chemistry department and doubling time shows increasing trend. Natural Products Chemistry, Medicinal Chemistry and Environmental Chemistry are most interested areas of research. Multi Authorship Pattern prevails during the period 2010-2014. Collaborative Index (CI) shows that the research team falls from 3-6 persons in their subject. Phytochemistry, Journal of Ethnopharmacology and Indian Perfumer are most cited journals by them and they are interested in publishing their papers in Natural Product Research, Journal of Essential Oil Research and Journal of Essential Oil Bearing Plants. Mostly cited journals are published by USA, United Kingdom and Netherlands. Similarly, United Kingdom, India and USA are the countries, where these faculty members publish their journals. They prefer their own department for the collaboration and internationally, they have mostly collaborated with the Chemistry Department of California State Polytechnic

University, Pomona, Canada. In India they prefer collaboration with in the Uttarakhand region; however, internationally they used to collaborate with Canada.

Conclusions: Researcher concluded that department should not restrict them for the collaboration within the department or within their state, but they should collaborate with other state of India. Similarly, they can sign MOU with different developed and developing countries, so that their research publications can increase and best research output can come.

1. INTRODUCTION

Universities are major sources of creation and use of new information. The University status and image is related with faculty publishing productivity and is strongly associated with an individual faculty member's reputation, visibility and advancement in the academic reward structure, particularly at higher learning institutions. The roles of universities are categorized in the form of imparting education through teaching and learning, research activities, conservation of new knowledge and extension of education.

Gopikuttan & Aswathy (2014) the ranking and performance of any university depends on the knowledge creation through its magnitude of excellence. In the social sphere, a university is conveys past and present knowledge to future generations through education and creation of new knowledge through research activities.

Scientometric is a method for analyzing scholarly communication in the field of sciences through applications of mathematics and statistical tools. However, according to **Nalimov and Mulchenko (1969)** the application of those quantitative methods which are dealing with the analysis of science viewed as information a process which comes under scientometrics method.

In addition, Kumaun University, Nainital is one of the oldest State University of Uttarakhand, which comes in existence in 1973. The University is imparting quality based education and research through its thirteen different faculties, such as Faculty of Science, Faculty of Arts, Faculty of commerce, Faculty of Management, etc. Department of Chemistry, which comes under Faculty of Science, is one of the reputed departments of this University.

2. REVIEW OF LITERATURE

Naveed, Waqas, Majeed, Zeshan, Jahan and Sheikh (2017) study purpose was to explore the research outcomes in the field of child psychiatry through scientometric methods. In **Pathak, Sengar, and Rai (2016)** study revealed the research contribution of Indian Institute of Science

Education and Research (IISER) Bhopal through scientometric applications. Similarly, **Biglu, Eskandari, and Asgharzadeh (2011)** study purpose was to evaluate nanotechnology subject with the help of MEDLINE database. **Dias, Simões and Bonecker (2012)** study purpose was to identify net cages in fish farming research using scientometric method and **Dutta and Sen (2001)** in their study revealed about citation pattern of authors' of Indian Journal of Chemistry.

3. OBJECTIVES OF THE STUDY

- To know the growth pattern of research output of periodical literature by the faculty members of Chemistry Department, DSB Campus, Kumaun University from 2010 to 2014,
- To identify most predominant subject area in the field of Chemistry,
- To identify authorship pattern,
- To identify core journals cited by faculty members,
- To identify the geographical distribution of periodicals,
- To identify most prolific authors, and
- To find out research collaboration of researchers at different levels.

4. SCOPE OF THE STUDY

The scope of the study is restricted with permanent Faculty Members of Chemistry Department, DSB Campus, Kumaun University, Nainital, Uttarakhand and only journals are covered in periodical literature and the study excluded those research publications, which are carried out by the faculties before joining and after leaving the university.

5. METHODOLOGY

The SodhSindhu, Google Scholar and ResearchGate databases are chosen for the data extraction and total sixty eight articles are collected from the database for the period of 2010 -2014. Search strings 'Kumaun University', 'Chemistry', 'Name of Faculty Members', 'Year', etc are used to extract the papers. Statistical software SPSS 20 and MS Excel were used for refining, presentation and analysis of the collected data as per the objectives of the study. Statistical tools such as Relative Growth Rate (RGR), doubling Time, Degree of Collaboration, Collaboration Index and Dominance Factor are used.

6. DATA ANALYSIS

It can be observed from the Table 6.1 that the Relative Growth Rate (RGR) has decreased from 0.25 at year 2010 to 0.06 at year 2014 in a span of five years. However, Doubling Time (DT) in Table 4.3 and Figure 4.6 discloses that research output of Department of Chemistry, DSB Campus, Kumaun University has increased from 2.77 at year 2010 to 11.24 at year 2014. Further, from Table 4.3 maximum articles are publishing in the year 2010 and minimum in year 2014 with a share of 18 and 9 papers.

Table 6.1 RGR and DT of publications of Department of Chemistry

| Year | Frequency of Publications | Cumulative Total | log W1 | log W2 | RGR | DT |
|------|---------------------------|------------------|----------|----------|----------|----------|
| 2010 | 18 | 18 | - | 1.255273 | - | - |
| 2011 | 14 | 32 | 1.255273 | 1.50515 | 0.249877 | 2.773359 |
| 2012 | 10 | 42 | 1.50515 | 1.623249 | 0.118099 | 5.867943 |
| 2013 | 17 | 59 | 1.623249 | 1.770852 | 0.147603 | 4.695035 |
| 2014 | 9 | 68 | 1.770852 | 1.832509 | 0.061657 | 11.23962 |

Tables 6.2 reveal that 6 core research areas in which faculty members of Chemistry Department have contributed mostly articles. The most favoured subject is Natural Products Chemistry with a share of 51 articles (58%) and least favoured subject is Organic Synthesis with a share of 1 article (1.1%).

Table 6.2 Core Research Areas of Chemistry

| Subject Areas | Frequency of Publications | Percentage (%) |
|----------------------------|---------------------------|----------------|
| Natural Products Chemistry | 51 | 58.0 |
| Medicinal Chemistry | 21 | 23.9 |
| Environmental Chemistry | 5 | 5.7 |
| Bio-Organic Chemistry | 7 | 8.0 |
| Nano Chemistry | 3 | 3.4 |
| Organic Synthesis | 1 | 1.1 |

Table 6.3 shows Authorship Pattern of Chemistry Department, DSB Campus, Kumaun University for the period of 2010 to 2014. Highest numbers of articles are published by four authors with a share percent of papers 47.06 and minimum by single author with a share of 0 papers.

Table 6.3 Authorship Pattern

| Authors | Year | | | | | |
|-----------------------|-----------|-----------|-----------|-----------|----------|-----------------|
| | 2010 | 2011 | 2012 | 2013 | 2014 | Total (%) |
| Single Author | 0 | 0 | 0 | 0 | 0 | 0 (0.00) |
| Two Authors | 1 | 1 | 0 | 2 | 0 | 4 (5.88) |
| Three Authors | 5 | 3 | 1 | 1 | 1 | 11 (16.18) |
| Four Authors | 8 | 5 | 7 | 10 | 2 | 32 (47.06) |
| Five Authors | 4 | 3 | 2 | 0 | 5 | 14 (20.59) |
| Six Authors | 0 | 2 | 0 | 3 | 1 | 6 (8.82) |
| More than Six Authors | 0 | 0 | 0 | 1 | 0 | 1 (1.47) |
| Grand Total | 18 | 14 | 10 | 17 | 9 | 68 (100) |

Table 6.4 shows that in year 2010 multi authorship is highest with a share of 18 articles and in year 2014 it is lowest with a share of 9 articles. However, multi authored pattern prevail with a percent share of 100. This indicates that in the development of science subject, the collaborative research work is essential.

Table 6.4 Authorship Type

| Authors | Year | | | | | Total Publications | Percentage (%) |
|--------------|------|------|------|------|------|--------------------|----------------|
| | 2010 | 2011 | 2012 | 2013 | 2014 | | |
| Single | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Multiple | 18 | 14 | 10 | 17 | 9 | 68 | 100 |
| Total | | | | | | | |

Table 6.5 we can observe that the average value of degree of collaboration is 1. It indicates that all the papers for the period of 2010-2014 were multiple authored papers.

Table 6.5 Degree of Collaboration

| Year | Authorship Type | | | Degree of collaboration (DC) |
|---------------------------|-----------------|---------------|----------------------------|------------------------------|
| | Single (Ns) | Multiple (Nm) | Total Publications (Nm+Ns) | |
| 2010 | 0 | 18 | 18 | 1 |
| 2011 | 0 | 14 | 14 | 1 |
| 2012 | 0 | 10 | 10 | 1 |
| 2013 | 0 | 17 | 17 | 1 |
| 2014 | 0 | 9 | 9 | 1 |
| Frequency of Publications | 0 | 68 | 68 | 1 |

Table 6.6 provides year wise mean frequency of authors per joint authored paper. We can observe that the collaboration index (CI) varies from the lowest value of 2.83 in 2010 to the

highest value of 5.90 in 2012 and average collaboration index is 4.19. This indicates that research team falls from 3 to 6 in the science subjects.

Table 6.6 Collaboration Index

| Collaboration Index | | | |
|----------------------------|------------------------------|---|-----------|
| Year | Multi Authored Papers | Total Authors of Multi Authored Papers | CI |
| 2010 | 18 | 51 | 2.83 |
| 2011 | 14 | 55 | 3.93 |
| 2012 | 10 | 59 | 5.90 |
| 2013 | 17 | 78 | 4.59 |
| 2014 | 9 | 42 | 4.67 |
| Total | 68 | 285 | 4.19 |

Table 6.7 shows trend about prolific authors in different subjects for the period of 2010 to 2014. Eight (8) authors contributed 68 research articles during five years of span. The ranking is calculated frequency of publications and dominance factor. G. Tewari, Assistant Professor has highest number of publications with a share of 18 papers and rank first. Similarly, investigator has given ranking according to the Dominance Factor (DF). The purpose of this ranking is to give insight about dominant authors, who have published their paper as a first author with multi authors or single author. S. Ali, Assistant professor, rank first with DF value 0.67.

Table 6.7 Prolific Authors

| Author's Name | Status | Department | FP | Rank | Mf | Mt | DF | Rank |
|----------------------|---------------|-------------------|-----------|-------------|-----------|-----------|-----------|-------------|
| A.B. Malkani | P | Chemistry | 7 | 4 | 3 | 7 | 0.43 | 2 |
| C. Pande | P | Chemistry | 14 | 3 | 4 | 14 | 0.29 | 3 |
| C.K. Pant | P | Chemistry | 6 | 5 | 0 | 6 | 0 | - |
| G. Bisht | P | Chemistry | 16 | 2 | 0 | 16 | 0 | - |
| P. Joshi | P | Chemistry | 2 | 7 | 0 | 2 | 0 | - |
| S.P.S. Mehta | P | Chemistry | 1 | 8 | 0 | 1 | 0 | - |
| G. Tewari | AP | Chemistry | 18 | 1 | 4 | 18 | 0.22 | 4 |
| S. Ali | AP | Chemistry | 3 | 6 | 2 | 3 | 0.67 | 1 |

AP-Assistant Professor, ASP-Associate Professor, P-Professor, FP-Frequency of Publications, Mf-Multi Authored Paper First Author, Mt-Total Multi Authored Papers, DF-Dominance Factor Table 6.8 cited journals' list of chemistry depicts, faculty members of chemistry prefer Phytochemistry journal and Journal of Ethnopharmacology for their references as the share of their citation is 64 and 32 times respectively. Similarly, Indian Perfumer and Journal of Agricultural and Food Chemistry are also preferred by them for their references with a share of

22 and 19 times respectively. Journal of Agricultural and Food Chemistry (19 times), Phytotherapy Research (18 times), Current Science (17 times), Journal of Essential Oil Research (15 times), Soil Science (12 times) and Fitoterapia (11 times) are journals, which are mostly cited by them for their references.

Table 6.8 Cited Journal List of Chemistry

| Journal Name | Frequency |
|---|------------------|
| Phytochemistry | 64 |
| Journal of Ethnopharmacology | 32 |
| Indian Perfumer | 22 |
| Journal of Agricultural and Food Chemistry | 19 |
| Phytotherapy Research | 18 |
| Current Science | 17 |
| Journal of Essential Oil Research | 15 |
| Soil Science | 12 |
| Fitoterapia | 11 |
| Flavour and Fragrance Journal | 11 |
| Natural Product Research | 11 |
| Food Chemistry | 10 |
| Plnta Medica | 10 |
| Journal of Electro Analytical Chemistry | 9 |
| Journal of Molecular Evolution | 8 |
| International Journal of Astrobiology | 7 |
| Natural Product Communications | 6 |
| Phytomedicine | 6 |
| Science of the Total Environment | 6 |
| Biochemical Systematics and Ecology | 7 |
| Journal of the Indian Society of Soil Science | 6 |
| Science | 5 |
| Journal of Applied Microbiology | 5 |
| Soil Science Society of America Journal | 5 |
| Analytical Biochemistry | 5 |
| Journal of Chemical and Pharmaceutical Research | 5 |
| Zeitschrift für Naturforschung A | 4 |
| Agriculture, Ecosystems & Environment | 4 |
| Journal of Environmental Quality | 4 |
| Geochimica et Cosmochimica Acta | 4 |

Table 6.9 exhibits published journals' list of chemistry subject. Faculties of this department prefer Natural Product Research and Journal of Essential Oil Research for the publication of their articles with a share of 11 and 6 times respectively. Journal of Essential Oil Bearing Plants (5 times), Research journal of Phytochemistry (4 times) and International Journal of Scientific & Technology Research (4 times) are also preferred by them for their publications.

Table 6.9 Published Journals' List of Chemistry

| Name of the Journal | Frequency |
|---|------------------|
| Natural Product Research | 11 |
| Journal of Essential Oil Research | 6 |
| Journal of Essential Oil Bearing Plants | 5 |
| International Journal of Scientific & Technology Research | 4 |
| Research journal of Phytochemistry | 4 |
| Asian Journal of Research in chemistry | 3 |
| Pharmaceutical Biology | 3 |
| Indian journal of Natural Products and Resources | 2 |
| International Journal of Green Pharmacy | 2 |
| Records of Natural Products | 2 |

Table 6.10 reveal the geographical distribution pattern of cited journal in the field of chemistry. The highest contributions come from USA and United Kingdom with a share of 180 and 149 journals respectively. Netherland and India are third and fourth place in terms of journal publications with a share of 123 and 109 journals respectively. Similarly, Denmark (57 journals), Germany (17 journals), Japan (14 journals), Pakistan (10 journals), Canada (7 journals) and Turkey (7 journals) are also contributing to publication world.

Table 6.11 exhibits geographical distribution of published journal in the field of Chemistry. The highest contributions come from United Kingdom, India and USA with a share of 25, 13 and 13 journals respectively. Netherland and France are third and fourth place in terms of journal publications with a share of 5 and 4 journals respectively. Similarly, Germany (3 journals) and Turkey (2 journals) are also contributing to publication world.

Table 6.10 Geographical Distribution of Cited Journal Chemistry

| Country Name | Frequency |
|---------------------|------------------|
| USA | 180 |
| United Kingdom | 149 |
| Netherlands | 123 |
| India | 109 |
| Denmark | 57 |
| Germany | 17 |
| Japan | 14 |
| Pakistan | 10 |
| Canada | 7 |
| Turkey | 7 |
| Australia | 5 |
| Poland | 4 |
| UAE | 4 |
| Yugoslavia | 3 |
| Iran | 2 |
| Russian | 2 |
| China | 2 |
| Ethiopia | 2 |
| France | 2 |
| Brazil | 2 |
| Italy | 2 |
| Sweden | 1 |
| Czech Republic | 1 |
| Saudi Arabia | 1 |
| Finland | 1 |
| Belgium | 1 |
| Nigeria | 1 |
| Kenya | 1 |
| Norway | 1 |
| Switzerland | 1 |

Table 6.12 shows the national research trend collaboration of Chemistry Department, DSB Campus, Kumaun University. The result reveal that Department of Chemistry, DSB Campus, Kumaun University, Uttarakhand, Department of Chemistry, M.B.G.P.G. College, Haldwani, Uttarakhand and Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh are most highest collaborative institutions with a share of 67, 11 and 10 respectively. Department of Applied Chemistry, Birla Institute of Applied Sciences Bhimtal, Uttarakhand, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand and Uttarakhand

Science Education and Research Centre (USERC), Dehradun, Uttarakhand are top fourth and fifth collaborative institutions with a share of 9, 8, and 8 respectively. Similarly, Department of Pharmaceutical Sciences, Bhimtal Campus, Kumaun University, Uttarakhand (7 times), Department of Botany, D.S.B. Campus, Kumaun University, Nainital, Uttarakhand (4 times), Department of Science and Technology (DST), New Delhi and Department of Biotechnology, Bhimtal Campus, Kumaun University, Bhimtal, Uttarakhand (3 times) are also productive collaborative institutions.

Table 6.11 Geographical Distribution of Published Chemistry Journal

| Country | Frequency |
|----------------|------------------|
| United Kingdom | 25 |
| India | 13 |
| USA | 13 |
| Netherland | 5 |
| France | 4 |
| Germany | 3 |
| Turkey | 2 |
| Italy | 1 |
| Spain | 1 |
| Japan | 1 |

Table 6.13 shows the international research trend collaboration of Botany Department, DSB Campus, Kumaun University. The result reveal that only two institutions, namely, Chemistry Department California state polytechnic University Pomona Canada and Epilepsy Branch, National Institute of Neurological Disorders and Stroke, Bethesda, USA have collaborated with a share of 5 and 1.

Table 6.14 and Figure 4.38 exhibits State Wise collaboration in Chemistry subject and Uttarakhand is highest productive state with a percent share of 84.56 (126 times). Uttar Pradesh, New Delhi and Madhya Pradesh are comes second, third and fourth in collaborative state with a percent share of 10.07 (15 times), 4.69 (7 times) and 0.68 (1 times) respectively.

Table 6.12 Collaboration with National Institutions by Chemistry Department

| Name of Institutions | Frequency |
|--|------------------|
| Department of Chemistry, DSB Campus, Kumaun University, Uttarakhand | 67 |
| Department of Chemistry, M.B.P.G. College, Haldwani, Uttarakhand | 11 |
| Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh | 10 |
| Department of Applied Chemistry, Birla Institute of Applied Sciences Bhimtal, Uttarakhand | 9 |
| G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand | 8 |
| Uttarakhand Science Education and Research Centre (USERC), Dehradun, Uttarakhand | 8 |
| Department of Pharmaceutical Sciences, Kumaun University, Uttarakhand | 7 |
| Department of Botany, University, Nainital, Uttarakhand | 4 |
| Department of Science and Technology (DST), New Delhi | 3 |
| Department of Biotechnology, Kumaun University, Bhimtal, Uttarakhand | 3 |
| Council of Scientific and Industrial Research (CSIR), New Delhi | 3 |
| Department of Chemistry, B. H. U., Banaras, Uttar Pradesh | 2 |
| Botanical Survey of India (BSI), Dehradun, Uttarakhand | 2 |
| Department of Chemistry, Gurukula Kangri University, Haridwar, Uttarakhand | 2 |
| Faculty of Chemistry, Department of Applied Science, Mangalayatan University, Aligarh, Uttar Pradesh | 2 |
| Central Institute of Medicinal and Aromatic Plants, Pantnagar, Uttarakhand | 1 |
| Central Council for Research in Ayurvedic Sciences (C.C.R.A.S.), Ranikhet, Uttarakhand | 1 |
| Uttarakhand Technical University, Dehradun, Uttarakhand | 1 |
| Saroj Institute of Pharmacy, Lucknow, Uttar Pradesh | 1 |
| School of Chemical Sciences, Devi Ahilya University, Takshashila Campus, Indore, Madhya Pradesh | 1 |
| Advanced Instrumentation Research Facility, Jawaharlal, Nehru University, New Delhi | 1 |
| Department of Chemistry, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand | 1 |
| Department of Chemistry, University of Petroleum & Energy Studies, Dehradun, Uttarakhand | 1 |

Table 6.13 Collaboration with International Institutions by Chemistry Department

| Name of Institutions | Frequency |
|---|------------------|
| Chemistry Department California State Polytechnic University, Pomona, Canada | 5 |
| Epilepsy Branch, National Institute of Neurological Disorders and Stroke, Bethesda, USA | 1 |

Table 6.14 State Wise Collaboration Trend of Chemistry

| Name of State | Frequency | Percentage (%) |
|----------------|------------|----------------|
| Uttarakhand | 126 | 84.56 |
| Uttar Pradesh | 15 | 10.07 |
| New Delhi | 7 | 4.69 |
| Madhya Pradesh | 1 | 0.68 |
| Total | 149 | 100 |

Table 4.46 and Figure 4.42 exhibits Country Wise collaboration in Chemistry subject. Only two countries, namely, Canada (5 times, 83.33%) and USA (16.67%) have contributed with this department.

Table 6.15 Country Wise Collaboration of Chemistry Department

| Name of Country | Frequency | Percentage (%) |
|-----------------|-----------|----------------|
| Canada | 5 | 83.33 |
| USA | 1 | 16.67 |
| Total | 6 | 100 |

FINDINGS

There is a decreasing trend in growth pattern of publications in chemistry department and doubling time shows increasing trend. Natural Products Chemistry, Medicinal Chemistry and Environmental Chemistry are most interested areas of research. Multi Authorship Pattern prevails during the period 2010-2014. Collaborative Index (CI) shows that the research team falls from 3-6 persons in their subject. Phytochemistry, Journal of Ethnopharmacology and Indian Perfumer are most cited journals by them and they are interested in publishing their papers in Natural Product Research, Journal of Essential Oil Research and Journal of Essential Oil Bearing Plants. Mostly cited journals are published by USA, United Kingdom and Netherlands. Similarly, United Kingdom, India and USA are the countries, where these faculty members publish their journals. They prefer their own department for the collaboration and internationally, they have mostly collaborated with the Chemistry Department of California State Polytechnic University, Pomona, Canada. In India they prefer collaboration with in the Uttarakhand region; however, internationally they used to collaborate with Canada.

CONCLUSION

Lastly, it can be concluded that department should not restrict them for the collaboration within the department or within their state, but they should collaborate with other state of India.

Similarly, they can sign MOU with different developed and developing countries, so that their research publications can increase and best research output can come.

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