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Authorship and Collaboration Pattern in Biotechnology Research: A study of IBSA Countries

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Abstract

Scientometric is a type of research method used in the library and information science. The study of the use of documents and patterns of publication in which mathematical and statistical methods have been applied in the scientometric study. It is based on quantitative analysis and statistics to describe patterns of publication within a given field. The study presents the trends of authorship pattern and collaborative research activity in Biotechnology in ISBA Countries. A sample of 24888 articles collect from Scopus database during 2007-2016 is analyzed. The applying scientometric tools are; Collaboration Coefficient, Authorship pattern and Activity Index. In the ten years period, the multi-authorship articles are higher and dominant than single authorship pattern. The average Activity Index of IBSA countries for ten years, South Africa computed highest, where the India and Brazil took second and third place. The international collaboration also presented in this article and it is shown that for IBSA countries USA is most collaborated country.

Keywords: Scientometric Analysis, IBSA, Collaboration Coefficient Authorship Pattern, Biotechnology, Activity index.

1-Introduction-

Selecting biotechnology research field for the IBSA countries, we want to revel that how these countries research output correlated with each other which is studied by the scientometric study. The biotechnology is one of the widest research fields in the modern scientific era which included modern Gene technology to century old Beer making process. In this modern time, many issues are emerging related to health, crop, food, energy, environment and livelihood needs which can be controlled by the biotechnology research.

IBSA is standing for India, Brazil and South Africa. It established on 6 June 2003 by the Brasilia Declaration [1] at the time of the G8 summit. There is much reason involved behind the formation of IBSA. These are developing countries, and their economy balance depends on agriculture productions. India has the second largest population in the world; Brazil took the 5th position and South Africa placed at 25th, so their cumulated population will be a world largest population. It is interesting when we aggregate their GDP (Gross Domestic Product) it will be world 4th largest

GDP after United States, China, and Japan.[2] A common trend is existed in IBSA countries to decline agriculture contribution to GDP. During the year 1991-2004 agriculture sector growth rate of IBSA countries has been counted 3.1 to 4.0.

Scientometrics is a tool by which the state of science and technology can be observed, through the overall production of scientific literature, at a given level of specialization. It provides an approach for situating a country concerning the world, an institution with a country and even individual scientists about their peers. This study reveals the pattern of IBSA countries which is compared to know the author contribution pattern. The activity index counted individually of IBSA countries, but it shows the status of biotechnology research against world data. Year wise publication distribution growth rate enumerate the individual country research in the particular year. The collaboration coefficient tool used to evaluate the measurement of single and multi-author collaborative research pattern. The number of authorship pattern is an interesting part of any bibliometric study. By these scientometric tools we able to present the current status as well as the future aspect of biotechnology research within the vicinity of IBSA countries. Every IBSA countries need to increase their agricultural production to serve the food for all but how it possible, either by the individual, or collaborative research activity, so that we conduct the scientometric study and try to revel the objectives.

2-Review of Literature-

Vimala and Pullareddy [3] examine the Venkateswara University doctoral theses in zoology subject. They found the dominance of multiple-authorship on single authorship pattern. The Degree of collaboration 0.75 as a whole but solo research also exists in zoology research.

Pillai [4] studied the pattern of collaborative research and authorship trend in physics subject along with 11,412 journals, and 1,328 citations sample of books that acquired from IISc doctoral dissertations. The result shows that joint research is being dominant and noticed that 0.08 average value of the degree of collaboration in the case of journals.

Prakasan, *et al*. [5] analysed about India's share in international collaborative publications has the rate of growth of 4.6 % in 1991 to 22.8 % in 2010.

Sevukan,[6] *et al.,* scrutinised 349 bibliographic records of plant sciences added by the member of faculties in central universities of India. ~~All~~ data downloaded from ISI Science Citation Index Expanded (SCIE) for ten years' period 1997 to 2006, found that BHU faculties research output was

noticed on 1st position randomly compare to JNU, AMU, and PU. BHU engaged with 47.40 % of total publication that showed its strength in the contribution of faculty research activity. Collaboration analysis finds that three and four authors are contributed the total of 30.41 %, 29.86 %, and 21.37 % of articles respectively.

Majhi & Maharana,[7] assessed 417 papers which published by the Sambalpur University Physical Science researchers. Their study indicates that three-authored collaborations dominate by 123 (29.42 %) and single-authored has counted the total of 7.65 %. It noticed that Physics and Chemistry are contributing the number of publications comparing to other subject areas in Sambalpur University physical science disciplines.

Narang [8] explored that highest number of 174 articles were published in 2001 out of 737 articles during 1998-2002. Authorship pattern indicates that two authored articles 352 (47.76 %) top ranked in five years tracked by single authored articles 259 (35.14 %), three authored articles 113 (15.33) and four authored articles 13 (1.77 %). Out of 8396 citations, a maximum number of citations 2047 appeared in 2002, followed by 2016 in 2001.

Govanakoppa & Rajgoli [9] conducted the study on Baltic Astronomy from 2000 to 2008 found that highest number of 113 articles were published in 2004 and lowest of 18 were published in 2001. Authorship pattern revealed that single authored articles were 132, two-authored articles were 135, and three-authored articles were 83. They also have given the finding list about year wise distribution of publication, international collaboration, and citation pattern of Astronomy literature.

3-Objective of Study

1. To know year wise comparative publication distribution of literature.
2. To measure the collaborative coefficient ratio of the IBSA countries.
3. To find out nature of authorship pattern in biotechnology research.
4. To measure an Activity Index of the individual country.

4- Scope and Limitation

The study covers ten years' span between 2007 and 2016, both years inclusive. Records during the term of study have been downloaded exclusively from SCOPUS online database. Generalizations based on the downloaded data within ten year period. Nations that fall under IBSA countries' during the period and coverage of this study have alone been taken into purview as the standard geographical entity for this research investigation. Any later proposal for the inclusion or exclusion

of/from this IBSA group and possible change of nomenclature after 2016 is not taken into the consideration of this study. Total 24888 data are related to our selected study is used. There are 16206 data in India, 715 data of Brazil and 1524 South Africa data covered in this analysis. The field of biotechnology further divided its related subfield to make search string; it is used to download data from Scopus database. Define search string separately downloads the IBSA countries data.

5- Data and Methodology-

SCOPUS has been taken up for the study for the collection of data. **Scopus** database contains abstracts and citations for peer reviewed journal articles. It covers nearly 22,000 titles from over 5,000 publishers, of which 20,000 are peer-reviewed journals in the scientific, technical, medical, and social sciences (including arts and humanities).[10] To extract the record of Biotechnology literature for the study, following search string has been adopted (Biotechnology OR biomedicine OR bioremediation OR biosynthesis OR bioinformatics OR bioengineering OR biogenetics OR biomedicine OR cell biology OR biofuels). The search yielded 24888 records for the period of study 2007-2016. These records provide bibliographical details such as Title, Authors, Source, Year, Abstract, Affiliation, Language, Document Type, etc. The data extracted from the database has been processed and analysed using Microsoft Excel. The extracted data were administrated to the scientometrics tools and techniques to ascertain the fulfilment of stated objectives and its measurement methods discussed below.

5.1 Collaborative Coefficient (CC)

The computation of Collaborative Coefficient first used by Ajiferuke [11] and it is based on fractional productivity defined by Price and Beaver [12]. It is computed using-following formula.

$$CC = 1 - \frac{\sum_{j=1}^{k} \left(\frac{1}{j}\right) f_j}{N}$$

Here, *Fj* denotes the number of *j* authored research papers*;*

N denotes a total number of research papers published,

And *k* is the greatest number of authors per paper.

It is mentioned by Ajiferuke, that CC indicate zero when single-authored papers dominate and to 1-1/*j* as *j*-authored papers dominate. This method shows the result that higher value of CC, related to higher rate of proxy to multi or mega authored papers.

5. 2 Activity Index-

Activity Index accounted for the relative research effort of any country in a given field. It is computed using the following formula;

AI= {(given field's share in the country's publication output) / (given field's share in the world's publication output)} x 100

In this paper activity index for IBSA countries has been computed separately. In the ten-year time span to examine how IBSA countries' research activity changed during different years. Frame first used the AI formula and later adopted by Sehubert and Braun (1986), [13] Price (1981)[14], Karki and Garg (1997)[15].The activity index shows the relative research effort of a particular country in a given field.

Mathematically: s

AI = { (Ii / Io) / (Wi / Wo) } x 100 (4.8) whereas Ii = Indian output in the year i

Io = Total Indian output

Wi = World output in the year i

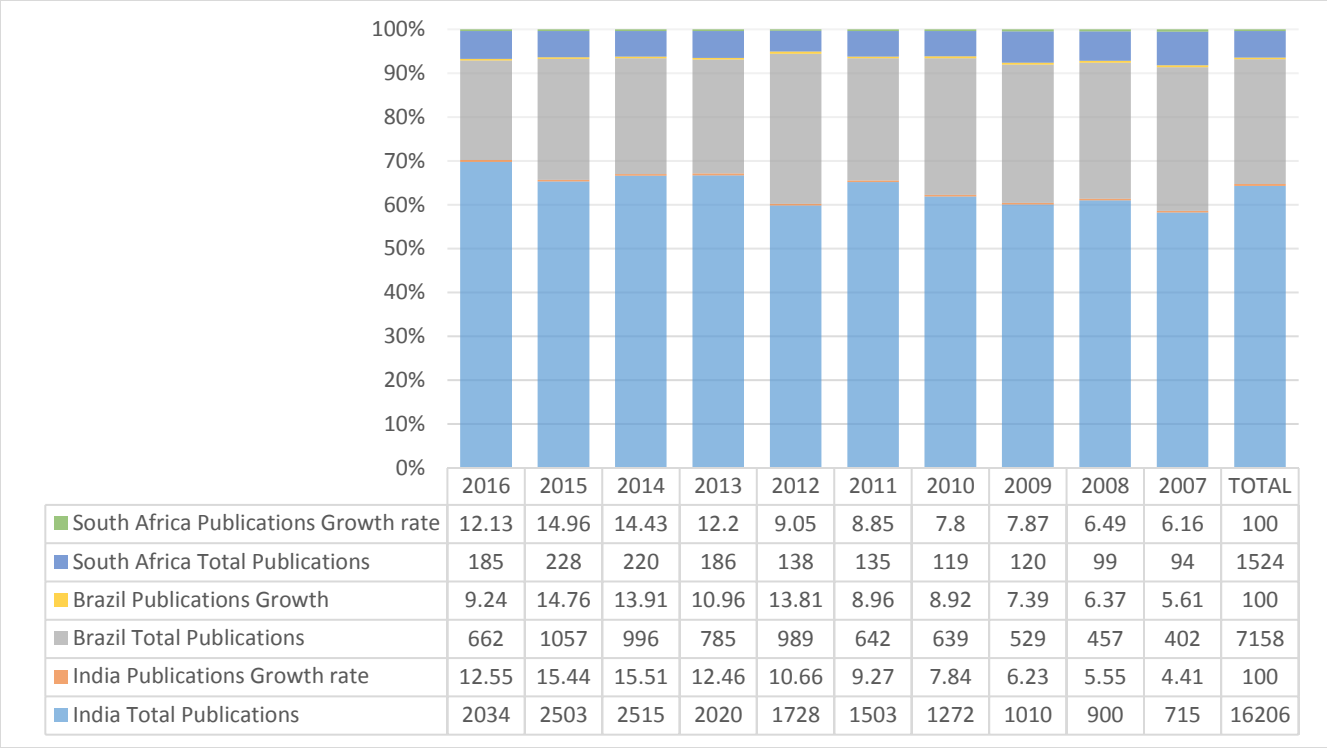
Wo = Total output.

.**6. Results and discussion-**

6.1 Year wise growth rate- The Table 1 presents the data on Year wise publications of IBSA countries in Biotechnology. There is total 24891 article published in year span 2007-2016. India shared 65.12% of total 16206 publications. Brazil contributed 28.76% with 7158. The South Africa has only 6.12% of publications with 1524 article. The average number of the article per year is 24.8, from 2007-2011 it shows less than the average. The highest year of publication is 15.2 in 2015 and lowest 4.8 in 2007.

Table No.1 Year wise publications

India			Brazil		South Africa	
YEAR	Total Publications	Publications Growth rate	Total Publications	Publications Growth	Total Publications	Publications Growth rate
2016	2034	12.55	662	9.24	185	12.13
2015	2503	15.44	1057	14.76	228	14.96
2014	2515	15.51	996	13.91	220	14.43
2013	2020	12.46	785	10.96	186	12.20
2012	1728	10.66	989	13.81	138	9.05
2011	1503	9.27	642	8.96	135	8.85
2010	1272	7.84	639	8.92	119	7.80
2009	1010	6.23	529	7.39	120	7.87
2008	900	5.55	457	6.37	99	6.49
2007	715	4.41	402	5.61	94	6.16
TOTAL	16206	100	7158	100	1524	100



	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	TOTAL
South Africa Publications Growth rate	12.13	14.96	14.43	12.2	9.05	8.85	7.8	7.87	6.49	6.16	100
South Africa Total Publications	185	228	220	186	138	135	119	120	99	94	1524
Brazil Publications Growth	9.24	14.76	13.91	10.96	13.81	8.96	8.92	7.39	6.37	5.61	100
Brazil Total Publications	662	1057	996	785	989	642	639	529	457	402	7158
India Publications Growth rate	12.55	15.44	15.51	12.46	10.66	9.27	7.84	6.23	5.55	4.41	100
India Total Publications	2034	2503	2515	2020	1728	1503	1272	1010	900	715	16206

6.2 Collaboration Coefficient-

The CC trends to zero as single author paper dominates. IBSA countries CC shows different value; Brazil has 0.71 (table.2.) highest average of CC followed by India 0.63 (table.3) and South Africa 0.64 (table 4.). In the year 2011 South Africa has been taken highest CC 0.84 of any IBSA countries where Brazil 0.75 and India's 0.65 highest CC in 2014.

Table No.2 Collaboration Coefficient of Brazil

YEAR	Total Publication	Total Author	Collaborative Index	Collaboration Coefficient
2016	662	4768	7.20	0.72
2015	1057	6977	6.60	0.72
2014	996	6490	6.51	0.75
2013	785	4815	6.13	0.71
2012	989	5175	5.23	0.69

2011	642	3654	5.69	0.70
2010	639	3720	5.82	0.70
2009	529	2976	5.62	0.70
2008	457	2940	6.43	0.71
2007	402	2128	5.29	0.69
	7158	43643	6.09	0.71(Average)

Table No.3 Collaboration Coefficient of India

YEAR	Total Pub	Total Author	Collaborative Index	Collaboration Coefficient
2016	2034	9675	4.75	0.34
2015	2503	9129	4.83	0.64
2014	2515	9022	4.60	0.65
2013	2020	8085	4.00	0.64
2012	1728	6906	3.99	0.63
2011	1503	5856	3.89	0.62
2010	1272	4924	3.87	0.61
2009	1010	3777	3.73	0.60
2008	900	3425	3.80	0.61
2007	715	2613	3.65	0.58
	16206			0.63 (Average)

Table No.4 Collaboration Coefficient of South Africa

YEAR	Total Pub	Total Author	Collaborative Index	Collaboration Coefficient
2016	662	4768	7.20	0.72
2015	1057	6977	6.60	0.72
2014	996	6490	6.51	0.75
2013	785	4815	6.13	0.71
2012	989	5175	5.23	0.69
2011	642	3654	5.69	0.70
2010	639	3720	5.82	0.70
2009	529	2976	5.62	0.70
2008	457	2940	6.43	0.71
2007	402	2128	5.29	0.69
Total	7158	43643	6.09	0.71(Average)

8.3 Authorship Pattern-

The authorship pattern calculated separately for each IBSA countries. Single authorship pattern is lowest by Brazilian with 316 articles which are 4.41% of total articles and 0.63% of the author (Table 5). India's 1119 articles total of 6.90% and 1.64% of the total author (Table 6.) and South Africa 143 that is 9.38% of the total article and 1.58% of authors. The dominance pattern of the author in India is two authors who shared 21.79% of the article and 10.35% of the author. Brazil four author pattern share 15.0% and 9.49% of the author where South Africa has 17.97% of three author pattern with 9.12% of the author. The ten+ authorship India contributes lower in article 3.38 but 14.71 of the total author. Brazil 13.73% ten+ articles with 34.42% of the author and South

Africa 12.72% of the article and 43.25 % of author highest in IBSA countries. The average number of author per paper highest 6.32 for Brazil followed by South Africa 5.91 and 4.20 for India. The cumulated counting denotes 4.92 average authors per paper for IBSA countries.

Table No.5 Authorship pattern Brazil

Sl No.	Number of authors	No. of Articles	Total No. of Authors	Percentage(%) of articles	Percentage (%) of Authors
1	Single	316	316	4.41	0.63
2	Two	636	1272	8.88	2.81
3	Three	878	2634	12.26	5.82
4	Four	1074	4296	15.00	9.49
5	Five	939	4695	13.11	10.37
6	Six	877	5262	12.25	11.62
7	Seven	607	4249	8.48	9.38
8	Eight	501	4008	6.99	8.85
9	Nine	347	3123	4.84	6.90
10	Ten	983	15576	13.73	34.42
	Total	7158	45251	100	100

Table No.6 Authorship pattern India

Sl. No.	Number of authors	No. of Articles	Total No. of Authors	Percentage(%) of articles	Percentage (%) of Authors
1	Single	1119	1119	6.90	1.64
2	Two	3531	7062	21.79	10.35
3	Three	3527	10581	21.76	15.51
4	Four	2906	11624	17.93	17.04
5	Five	1958	9790	12.08	14.35
6	Six	1245	7503	7.68	10.99
7	Seven	704	4928	4.34	7.22

8	Eight	430	3440	2.65	5.04
9	Nine	237	2133	1.46	3.12
10	Ten+	549	10037	3.38	14.71
	Total	16206	68216	100	100

Table No.7 Authorship pattern South Africa

No.	Number of authors	No. of Articles	Total No. of Authors	Percentage of articles	Percentage of Authors
1	One	143	143	9.38	1.58
2	Two	255	510	16.73	5.65
3	Three	274	822	17.97	9.12
4	Four	227	908	14.89	10.07
5	Five	154	770	10.10	8.54
6	Six	105	630	6.88	6.98
7	Seven	84	588	5.51	6.52
8	Eight	49	392	3.21	4.34
9	Nine	39	351	2.55	3.89
10	Ten+	194	3899	12.72	43.25
	Total	1524	9013	100	100

8.4 - Activity index of India, Brazil and South Africa-

To measure the relative research effort of IBSA countries in biotechnology a detailed account of activity index has been presented in Table 8. Activity Index of IBSA countries indicated upward pattern from 2007-2016. India 57.1 and Brazil 72.7 lowest activity index counted in 2007, where

South Africa 75.2 in 2008. India highest 151.25 and Brazil 138.2 in 2016, but South Africa 146.2 scored in 2012. The average Activity Index of South Africa 106.29 is highest accounted for Brazil 99.82 and 98.05 for India.

Table No.8 Activity index of India, Brazil and South Africa

YEAR	INDIA	BRAZIL	SOUTH AFRICA
2016	2034 (149.7)	662 (109.7)	185 (145.8)
2015	2503 (115.4)	1057 (110.2)	228 (114.2)
2014	2515 (114.9)	996 (104.2)	220 (105.7)
2013	2020 (122.4)	785 (111)	186 (120.9)
2012	1728 (107.4)	989 (136)	138 (88.7)
2011	1503 (99.5)	642 (95.6)	135 (165.1)
2010	1272 (81.2)	639 (91.7)	119 (78.9)
2009	1010 (67.2)	529 (78.8)	120 (86)
2008	900 (65)	457 (89)	99 (76.7)
2007	715 (57.8)	402 (72)	94 (81.3)

8.5- International Collaboration of IBSA countries-

Table 9 shows the IBSA collaboration with other nations. The United States with 1127 collaboration is higher for Brazil where India at 14th place with 90 article. For South Africa, United States again the top collaborative country with 320 publications and India find the 10th place with 63 publications. In the Indian context, the United States with 1424 as a high collaborative country but no place has shown within top 15 for South Africa and Brazil. The result indicates the United States is the top Collaborative country for IBSA countries in biotechnology research field.

Table 9. International Collaboration of IBSA countries

Brazil			India		South Africa	
S.No.	Country	Collaboration	Country	Collaboration	Country	Collaboration
1.	United States	1171	United States	1424	United States	320

2.	United Kingdom	359	South Korea	380	United Kingdom	224
3.	France	350	Germany	349	Germany	135
4.	Germany	319	United Kingdom	321	Canada	84
5.	Spain	248	Japan	276	France	79
6.	Canada	223	Australia	238	Australia	74
7.	Italy	202	France	214	Netherlands	65
8.	Portugal	175	Saudi Arabia	291	Italy	64
9.	Australia	139	Canada	190	Switzerland	64
10.	Argentina	129	China	169	India	63

Findings-

The study showed the status of IBSA countries research pattern, collaborative exchange of research activity within authorship and country activity profile. India has shared 65.12 publications where Brazil and South Africa 28.76 and 6.12of total publication. These countries collaboration coefficients are different from one another. In India, two author publications dominated where Brazil four authors and South Africa multi-author publication contributed generally. The result of activity index shows upward growth pattern from 2007-2016 for IBSA countries. The International collaboration pattern indicates that United States is a common country for IBSA group and it needs to increase collaboration within IBSA countries.

Author Biography-

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