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Scientific Output on Bovine Viral Diarrhoea: A Scientometric Study

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Abstract

The study analyses the dynamics of scientific output on 'Bovine Viral Diarrhoea' (BVD) published in journals, applying scientometric tools. The data was gathered from 'Scopus' database, conducting an advanced search for phrase '*Bovine Viral Diarrhoea*' and substitute terms including '*Bovine Virus Diarrhoea*', '*Bovine Viral Diarrhea*' and '*Bovine Virus Diarrhea*' as main operators for analytical purposes. The retrieved data was filtered for English language journal articles, for the period up to 31st December 2015, yielding 3561 relevant results. The different scientometric indicators of literature on BVD including it is growth, authorship, collaboration, publication pattern, geographical distribution, etc. were computed. International collaboration and keyword landscapes were visualized.

Keywords: Bovine Virus Diarrhoea (BVD), Scientometric Analysis, Quantitative Analysis

1. Introduction

Bovine Viral Diarrhoea (BVD) is a significant viral disease of ruminants. It affects both health and productivity of the herd resulting in reproductive disorders, decreased milk production, abortions, increased occurrence of other diseases, and even death of animals[1]. Bovine Viral Diarrhoea is caused by Bovine Viral Diarrhea Virus (BVDV) of family *Flaviviridae*, genus *Pestivirus*. It is a single-stranded positive sense RNA virus, having 2 genotypes, BVDV-1 and BVDV-2, and also classified into cytopathogenic (cp) or non-cytopathogenic (ncp) based on in vitro cell culture characteristics[2,6]. Based on time of infection with ncp BVDV, degree of disease either be transient or persistent. If infection occurs after 150 days of gestation, innate and adaptive immune response clears the virus results in transient infection. If it occurs between 90-150 days, the fetal immune response does not recognize the virus as foreign antigen, hence immune tolerance to BVDV occurs, which results in Persistent Infection (PI)[6,11,12]. Calves with PI can develop secondary infection by other microorganism, such as BRD by altering pulmonary and systemic immune[6].

Bovine Viral Diarrhoea is of immense economic significance in livestock industry in terms of desperate disease and fatal loss[9] and is widespread in most cattle raising countries[7]. Goens (2002)[5] says "Continued research into the identification of virulence factors of BVDV will be useful in determining the pathogenesis of severe acute BVD and associated reproductive anomalies, as well as providing useful tools and targets for better diagnostic tests and for more effective control of BVDV". The literature on BVD is central to the further research and scientific developments to confront the challenges of disease. A quantitative assessment of literary output on BVD is useful in providing an understanding of the research trends[8]. Bibliometric analysis is the "statistical support device that allows mapping and generating different information and knowledge handling and management indicators, particularly in scientific, technological and productivity-related information and communication systems"[10]. The term scientometrics is used more preferably for analysis of literature in science and technology. Bibliometric / scientometric studies provide an outline of the literary outcome in a given subject over a period and are also useful to academic institutions for collecting and organizing the information resources of interest.

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2. Objectives of the Study

The study examines:

1. Growth of scientific output on Bovine Viral Diarrhoea,
2. Authorship pattern and distribution of articles in journals,
3. The core journals publishing articles on Bovine Viral Diarrhoea, and
4. International collaboration based on authors' affiliation.

3. Methodology

To accomplish the objectives of the study data was accessed from 'Scopus' database during August 2016:

1. The phrase '*Bovine Viral Diarrhoea*', and substitute terms, i. e. '*Bovine Virus Diarrhoea*', '*Bovine Viral Diarrhea*' and '*Bovine Virus Diarrhea* were searched using advanced search,
2. The Boolean Operator 'OR' was applied to get exhaustive results represented by either of the phrases mentioned in step 1,
3. The search was filtered for occurrence of phrases given in step 1 in the title / abstract or keywords of articles. The filters for language (i. e. English), journal articles and period up to 31st December 2015 were further applied,
4. The search retrieved 3654. The data originally downloaded in .csv format was also saved as .xlsx format for analysis,
5. After deleting the duplicate records, letters and anonymous papers, 3561 articles were found relevant and data analysis was performed on these using frequencies and mean values, and
6. Visualization maps were developed using 'VOSviewer'.

4. Results and Discussion

The various facets of scientific output on BVD including growth, authorship, collaboration, geographical distribution, etc. have been analyzed and discussed in the following sections:

5. Growth of Literature

5.1 Chronological Growth

Table 1 shows the growth of scientific output on Bovine Viral Diarrhoea from 1962 to 2015. The recent years, i. e. 2011-2015 produced maximum number of articles (825) on BVD. The years 2006-2010 witnessed 673 articles, while the last five years of 20th century, i.e. 1996-2000 witnessed 440 articles. The first journal article on the disease appeared in 1962. Chronologically, continuous increase in the number of articles on the subject has been observed, making it obvious that since 1962 the disease has received attention of the scientific community.

Table 1. Distribution of articles over time

Sl. No.	Years	Number of articles	Percentage	Cumulative Frequencies
1	1961-1970	62	1.74	62
2	1971-1980	239	6.71	301
3	1981-1990	391	10.98	692
4	1991-1995	371	10.42	1063
5	1996-2000	440	12.36	1503
6	2001-2005	560	15.73	2063
7	2006-2010	673	18.90	2736
8	2011-2015	825	23.17	3561
Total		3561	100.00%	

6. Authorship Pattern and Degree of Collaboration

In total, 16816 authors contributed 3561 articles. This makes it clear that on an average, each article had 4-5 authors. All except 08.34% (297) articles are of joint authorship (Table 2). Around 12.33% of the papers on BVD were contributed by two authors and 17.02% by three authors. 17.38% articles have been written by 4 authors. Nearly 03.29% articles have more than 10 authors. Findings show that the need to counter the disease has resulted in collaborative research efforts on BVD.

Table 2. Authorship trends

Sl. No.	No. of authors	No. of articles	Percentage
1	1	297	8.34
2	2	439	12.33
3	3	606	17.02
4	4	619	17.38

5	5	458	12.86
6	6	376	10.56
7	7	279	7.83
8	8	187	5.25
9	9	104	2.92
10	10	79	2.22
11	More than 10	117	3.29

The degree of authorship collaboration was arrived at using formula of Subramanian (1983)[13]:

$$C = \frac{Nm}{Nm + Ns}, \quad C = \frac{3264}{3264 + 297} = 0.9165$$

7. Prolific Authors

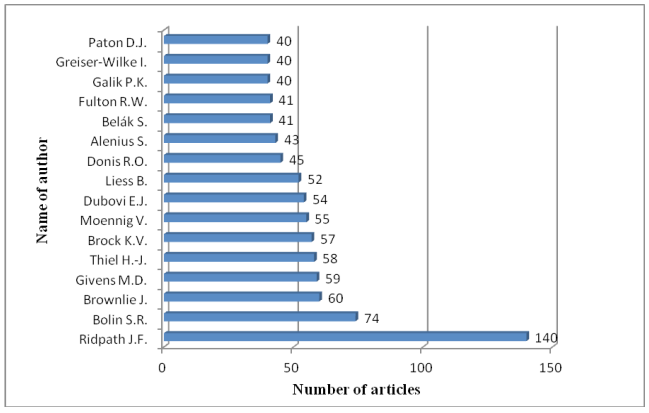

Figure 1. Authors with maximum contributions on BVD.

Total 8043 authors contributed the 3561 articles and 95 of these made contributions to 2589 papers forming 72.70% of the total articles. The sixteen authors having contributed to 40 or more articles are given in Figure 1.

8. Bradford's Law of Scattering

Bradford's law of scattering portrays the distribution of articles in journals on a subject (Bradford, 1950). To find whether the Bradford's law of distribution holds good for scientific literature on Bovine Viral Diarrhoea, the mathematical formulations of Egghe (1990)[4] and Egghe and Rousseau (1990)[3] were used to derive the constant *k*.

$k = (e\gamma x Y m)^{1/p}$

Where γ is Euler's number having value .57772. *Ym* is the number of articles published in the top-ranked journal and *p* is Bradford's groups or number of zones i.e. *p*=3

Therefore

$k = (1.781 \times 227)^{1/3} = 7.39429192149$

The different Bradford's groups had been calculated using *k*. The nucleus zone r^0 can be defined as:

$$r^0 = \frac{T(k-1)}{(k^p - 1)}$$

'T' represents a total number of journals under the study.

$$r^0 = \frac{460(7.40 - 1)}{(7.43^3 - 1)}$$

$$= \frac{2944}{404.224} = 7.28$$

Different Bradford's zones had been obtained using the value of *k* and r^0:

Nucleus zone $r^0 = r^0 \times 1 = 7.28$

First zone $r^1 = r^0 \times k = 7.28 \times 7.40 = 53.87$

Second zone $r^2 = r^0 \times k^2 = 7.28 \times 7.40^2 = 398.65$

Hence, Bradford's' distribution = 7.28+53.87+398.65 = 459.8

Percentage of error $= \frac{459.8 - 460}{460} \times 100 = 0.043\%$

Table 3. Zones of journals

Zones	Number of journals	Percentage of journals	Number of articles	*K*
Core Zone	7	1.52	989	--
Zone 1	54	11.74	1737	7.39
Zone 2	399	86.74	835	7.39
Total	**460**	**100.00**	**3561**	

Using Bradford's multiplier, the three zones of journals were identified. The value of *k*=7.39 calculated using the formula k =(eγxYm)1/p for the core zone was found similar for zones 1 and 2 (Table 3). The percentage of error (i. e. 0.043%) was also insignificant. This makes it clear that the distribution of articles on BVD in journals is exact fit to the three zones of Bradfords' Law of Scattering i.e. 1:*k*:*k2* or *1:n:n2*.

9. Core Journals

The 3561 articles on Bovine Viral Diarrhoea were published in 460 journals. The top 7 journals publishing maximum number of articles on the subject are listed in Table 4 as core journals. These journals covered 27.58% of the total articles published on BVD as reflected in 'Scopus'. The *Veterinary Microbiology* tops the list with highest number of articles (227), followed by *Veterinary Record* (176), *American Journal of Veterinary Research* (145), *Journal of Veterinary Diagnostic Investigation* (124), *Journal of Virology* (111), *Preventive Veterinary Medicine* (110) and *Journal of the American Veterinary Medical Association* (96). The distribution of 3561 articles in 460 journals supports the concept of core journals.

10. Geographical Contribution

The geographical location of authors represents the contribution of countries towards literature on the subject. Out of total 3561 articles, geographical information was available for 3219 papers. Authors from 85 countries contributed these articles on Bovine Viral Diarrhoea. While authors from 80 countries worked in international collaboration on one or more articles, the authors from remaining 5 nations worked at institutional or national level collaboration only. The international collaboration visualization map on BVD prepared using VoSviewer Software (http://www.vosviewer.com/) comprises of nodes and links (Figure 2). The links between two countries reveal that the researchers from these nations have co-authored at least one paper on BVD.

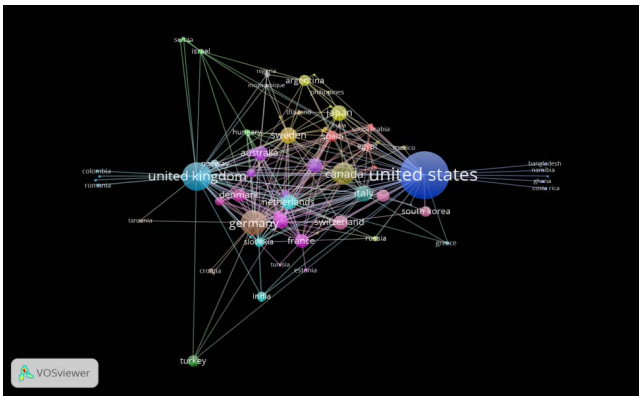

Figure 2. Map of international collaboration.

The top 5 countries with contribution of highest number of articles and international collaboration are given in Table 5

The United States has played a leading role in terms of contribution of scientific literature on BVD. It has the highest number of articles and is the foremost international collaborator too. The United States have link strength 46 with Canada, 25 with United Kingdom and 24 with Germany. The authors from United

Table 4. Journals publishing highest number of articles

Sl. No.	Title of the journal	Number of articles	Percentage	Country
1.	Veterinary Microbiology	227	6.37	Netherlands
2.	Veterinary Record	176	4.94	United Kingdom
3.	American journal of veterinary research	145	4.07	United States
4.	Journal of veterinary diagnostic investigation	124	3.48	United States
5.	Journal of Virology	111	3.12	United States
6.	Preventive veterinary medicine	110	3.09	Netherlands
7.	Journal of the American Veterinary Medical Association	96	2.70	United States

Table 5. Geographical contribution on BVD

Sl. No.	Country	Total number of articles	Country	Articles in international collaboration
1.	United States	1065	United States	255
2.	United Kingdom	389	United Kingdom	219
3.	Germany	307	Germany	165
4.	Canada	239	Sweden	92
5.	Italy	127	Italy	90

Kingdom contributed to 389 articles, 219 of which were in international collaboration. Researchers from Canada added to 239 articles but it is not among top 5 international collaborator countries. On the other hand, Sweden did not stand among top five contributors, but emerged as 4th largest international collaborator on BVD. It is evident from Figure 2 that collaborative efforts are being made from all parts of the world to meet the challenges of BVD.

11. Keywords Map

There were total 9329 index keywords available for 3386 articles. The keyword map of 691 keywords having 20 or more occurrences is given in Figure 3. The keywords in close neighbourhood and having higher weights are represented by red. The keywords with smaller neighbourhood and with lower weights are in blue.

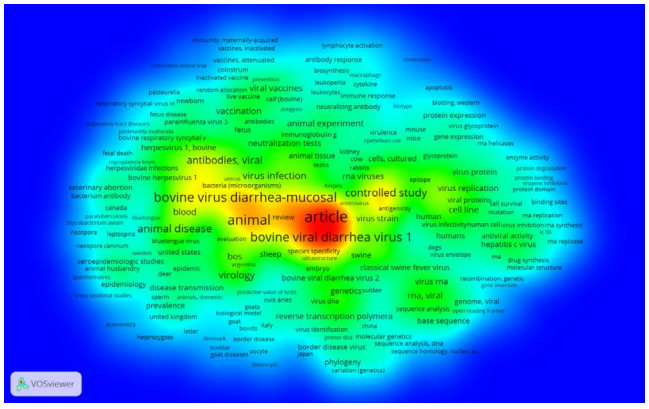

Figure 3. Keywords map.

The occurrence of keywords reveals that majority of the articles deal with symptoms of BVD, occurrence pathology and diagnostic aspects. The keywords 'lymphoid tissue', 'inoculation', 'spleen', etc. deal with the occurrence of disease with respect to organ involved. The keywords 'neutralizing antibody, FAT, immunofluorescence deal with diagnostic methods.

12. Conclusion

The study provides landscape of the research activities on BVD, providing useful indicators about status of the subject in quantitative terms. Findings of the study reveal that the scientific literature on Bovine Viral Diarrhoea has almost continuously increased since 1960's. Over the period the relative growth rate of literature has decreased and correspondingly the doubling time has increased. A high degree of research collaboration has been observed on BVD. Seven core journals publishing maximum number of articles on BVD were identified. This could be helpful to the universities and institutions under Indian Council of Agricultural Research working on BVD to provide access to core content on BVD to the stakeholders. This finding can also be advantageous in making judicious use of funds by helping the institutions in selection of only relevant journals on BVD. The researchers from all corners of the world primarily lead by United States are making efforts in international collaboration to challenge the disease.

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