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Research productivity of Pepper from 2005-2014: A Bibliometric Analysis

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Abstract

Pepper has been used for its flavour and as a medicine. For the Indian cooking pepper place an important role. Pepper cures constipation, diarrhea, earache, gangrene, heart disease, hernia, hoarseness, indigestion, insect bites, insomnia, joint pain, liver problems, lung disease, oral abscesses, sunburn, tooth decay, and toothaches. Black pepper is the world's most traded spice. Black pepper is originally agriculture in south India. It is farming mainly in the tropical region. PubMed is a primary bibliographic database that covers 18 million references to journal articles in life sciences, which gives great importance to biomedicine. The period of coverage is from 1947 to the present. For this database, citations from about 5,400 worldwide journals in 39 languages and 60 languages for older journals were covered. The period is from the year 2005 to 2014 "Pepper" data were downloaded. Various analysis were done to find out the Individual Authors Contribution, Geographical distribution, year wise research, Ranking of Journals, RGR and Doubling Time of Research. Bibexcel tool is used for data analysis.

Keywords: *Pepper, Bibliometric Analysis, Bibexcel, Pubmed, Medicinal value, Relative Growth Rate, Doubling Time*

1. Introduction

Pepper is widely used in traditional Indian medicine and as a home remedy for relief from sore throat, throat congestion, and cough. Pepper is a native of South and South East Asia. It is referred as "Black Gold" and used as a form of Commodity Money. Pepper was grown particularly in Southern Thailand, Malaysia and Kerala. The study is confined to a period of ten years from 2005 to 2014 covered in the database PubMed only. The key word "Black pepper" or "Piper nigrum" or pepper is used to download the results. The results 2475 were saved in the text file format. The data were analysed with the toolbox named as **Bibexcel**. This is developed by Olle Persson. This software is very useful for analysing bibliographic data. S Aswathy and A.Gopikittan are analysis the "Journal of Space graft and Rockets". It covers various parameters like growth pattern, authorship pattern, distribution with regard to subject, year, institution and geographical area.¹

2. Need for the Study

Pepper is a Dravidian word. Peppercorns are often classified on their place of origin. Two types come from India's Malabar Coast and Tellicherry. "Journal of Chemical Information and Computer Sciences (JCICS) was found out the apex journal in this subsection for the last 30 years. In the subject of chemical information and computer sciences (CICS) bibliometric approach was used to survey the state-of-the-art of research."² C.Baskaran examined the research growth, relative growth rate and doubling time of publications, institution wise and ranking of authors in research productivity of Graph Theory during 2004-2011.³ Plants modulate defense signaling networks in response to different biotic stresses. The study evaluated the effect of a phloem-sucking aphid on plant defense mechanisms in pepper during subsequent pathogen attacks on leaves and rhizosphere bacteria on roots. The findings of this study show that aphid feeding elicits plant resistance responses and attracts beneficial bacterial populations to help the plant cope with subsequent pathogen attacks.⁴ A valuable source of information for improving our understanding of the underlying molecular mechanisms by which pepper leaves become symptomless following infection with geminiviruses. The identification of ortho logs for the majority of genes differentially expressed in recovered tissues in two major solanaceous crop species provides the basis for future comparative analyses of the viral recovery process.⁵ Crop cultivation provides critical ecosystem services in arid lands with the plant root system acting as a "resource island" able to attract and select microbial communities endowed with multiple PGP traits that sustain plant development under water limiting conditions.⁶ Kochujang is a traditional Korean fermented food that is made with red pepper, glutinous rice, salt, and soybean. Kochujang is fermented by naturally occurring microorganisms through which it obtains various health-promoting properties.⁷

3. Objectives

R Kumaragurupari, Pamela Sieving and Prajna Lalitha were conduct a bibliometric analysis of Indian ophthalmic papers published from 2001 to 2006 in the peer-reviewed journals, to assess productivity, trends in journal choice, publication types, research funding, and collaborative research.⁸ On that basis pepper analysis also done. Dried ground pepper has been used since antiquity for both its flavour and as a medicine. Oil can be extracted from the crushing

of the pepper. This oil is used for Ayurvedic massage and beauty products. The major objectives of this study are:

- Find out the Quantum of research done
- Find out the Distribution of Research Productivity according to Country
- Find out the research by Language
- Find out the Publication Types and Authorship Pattern
- Find out the keyword and Co-word analysis
- Application of Bradford Law of Scattering in Pepper Research Publications
- Application of Zipf Law in the Pepper Research Publications
- Find out individual Authors Pepper Research, RGR and DT

3.1 Quantum of literature published on Pepper during 2005-2014:

The literature has been classified in Table 1 according to year of publication. It is found that there is a gradual growth of literature in the subject of study by year after year. There is a gradual growth for research in Pepper.

Table - 1
Quantum of Literature published in Pepper by year wise

S. No.	Years	No.of Records	%
1.	2005	173	6.99
2.	2006	189	7.64
3.	2007	195	7.88
4.	2008	205	8.28
5.	2009	214	8.65
6.	2010	241	9.74
7.	2011	244	9.86
8.	2012	283	11.43
9.	2013	370	14.95
10.	2014	361	14.59
		2475	100.00

3.2 Distribution of Research Productivity according to Country

Distribution of contributions of Pepper by country and year wise is presented in Table 2. It is seen from the table that United States has produced 842 records ranking in the first position,

England (564) in the second position and Netherland (210) third positions respectively. Indian contributions (45) have been ranked in the 9th position.

Table 2
Country wise Distribution of Pepper Research

S.No	Country	No.of Records
1	United States	842
2	England	564
3	Netherlands	210
4	Germany	208
5	Korea (South)	83
6	Japan	66
7	Switzerland	55
8	China	46
9	India	45
10	Austria	45
11	Brazil	44
12	Ireland	32
13	France	17
14	Belgium	16
15	Poland	15
16	Canada	14
17	Pakistan	12
18	Denmark	12
19	Thailand	11
20	Russia (Federation)	11
21	Others	104

3.3 Distribution of Research Production by Language

The below table shows the dissemination of Pepper literature by language. The scholarly communication is effected through English language in almost all the countries irrespective of the native language of the country. Rojas Sola and AguileraGarcía have studied “various bibliometric indicators for different countries and research centers such as the number of documents (article and review), showing per document, productivity, the average number of citations, authors, research centers, national and international collaboration including their

networks, the weighted and relative impact factor, as well as the h-index. Furthermore, we have analyzed the international dissemination of research of countries through journals and the relationship with the impact factor to detect the published journals of each country. We have also shown that English is the most common language of publication.”¹⁰ This phenomenon is not an exception to the subject of Pepper which published about 96.08% of the research output in English. This is followed by Chinese (1.49%) and Spanish (0.57%) as second and third positions respectively. Therefore from the above analysis, it is inferred that English language is dominating in the scholarly communication of Pepper research

Table 3
Language wise Distribution of Pepper Research

S,No	Languages	No.of Records	Percentage
1.	English	2378	96.08
2.	Chinese	37	1.49
3.	Spanish	14	0.57
4.	Russian	10	0.40
5.	French	7	0.28
6.	Japanese	7	0.28
7.	Portuguese	7	0.28
8.	Polish	5	0.20
9.	German	4	0.16
10.	Czech	2	0.08
11.	Dutch	2	0.08
12.	Italian	2	0.08
		2475	100

3.4 Publication Types Wise Distribution of Pepper Research

Table 4 reveals the distribution of the ‘Pepper’ research output according to publication type. It is conventional that utmost of the scholarly statement of scientific study is available in Journals and occasionally presented in the conferences. Of course, those conference papers are additional updated and issued in journals of the particular field of knowledge. Therefore, scientific statement is being regularly made through subject journals. In the Pepper study, about 84.16% have printed in journals, 6.10% have published in Comparative Study and 3.35% are published in English Abstract.

Table 4
Publication Type Distribution of Pepper Research

S.No	Publication Type	No.of Records	Percentage
1.	Journal Article	2083	84.16
2.	Comparative Study	151	6.10
3.	English Abstract	83	3.35
4.	Evaluation Studies	58	2.34
5.	Case Reports	58	2.34
6.	Historical Article	10	0.40
7.	Clinical Trial	8	0.32
8.	Retraction of Publication	6	0.24
9.	Comment	6	0.24
10.	Biography	4	0.16
11.	Letter	4	0.16
12.	Editorial	2	0.08
13.	Book	2	0.08
		2475	100.00

3.5 Authorship Pattern in Pepper Research

The study of authorship pattern or productivity is one of the important aspects in the bibliometric analysis. Generally it is necessary to concentrate on authorship pattern to assess the research contributions in a field and Pepper research is not an exception. Thirty-nine faculty members of School of Biological Sciences at Seoul National University published 640 publications from 2004-2009. Most of them are co-authored with foreign researchers with three or other co-authorship types.¹¹ In order to identify author productivity and authorship pattern the researcher has attempted to analyses this below table - 5. Seventy two authors jointly produce one article. It is evident that 24.32% of product by single author and 14.75% of the contributions were by three authors. About 14.46% represent by four authors.

Table 5
Authorship pattern in Pepper

S.No	Author	No.of Records	Percentage
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1.	Single	602	24.32
2.	Joint	320	12.93
3.	Three	365	14.75
4.	Four	358	14.46
5.	Five	295	11.92
6.	Six	188	7.60
7.	Seven	139	5.62
8.	Eight	82	3.31
9.	More than Eight	126	5.09
	Total	2475	100.00

3.6 Distribution of Journals in Pepper based on Bradford Law of Scattering

Bradford (1934) first expressed his law, but it did not accepted by more until the first publication of his book ‘Documentation’ in 1948. Bradford studied all of the journal titles and bibliography in applied Geophysics. He divided the list into three ‘zones’ each containing roughly equal number of references. On the basis of this observation Bradford work out his law.

“If scientific periodicals are arranged in the order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus where the number of periodicals in the nucleus and the succeeding zones will be as 1: n:n²”

Accordingly, the journals are grouped into three zones producing a similar number of articles. The distribution of journal by zone wise is given in the Table 6. 32 core journals are grouped in zone-1 published 827 (33.41%) articles accounts for one third of the total output. Similarly the second zone comprises of 133 journals 825 (33.33%) research and in the third zone 627 journals 823 (33.25%) scientific work grouped in third zone. The Bradford’s Law states that the number of periodicals in zones, the first zone and second zones will be 1: n: n². We can implement the Bradford’s Law in Pepper Research.

Table 6
Zone and Number of Journals in Pepper Research

Zone	No. of Journals		No. of articles	
	No.	(%)	No.	(%)
Zone 1	32	4.04	827	33.41
Zone 2	133	16.79	825	33.33
Zone 3	627	79.17	823	33.25
Total	792	100.00	2475	100.00

3.7 Major Contribution of Journals in Pepper Research

Ranking of the journals along with the research output on ‘Pepper’ during the study period of 2005 to 2014 has been presented in the Table 7.

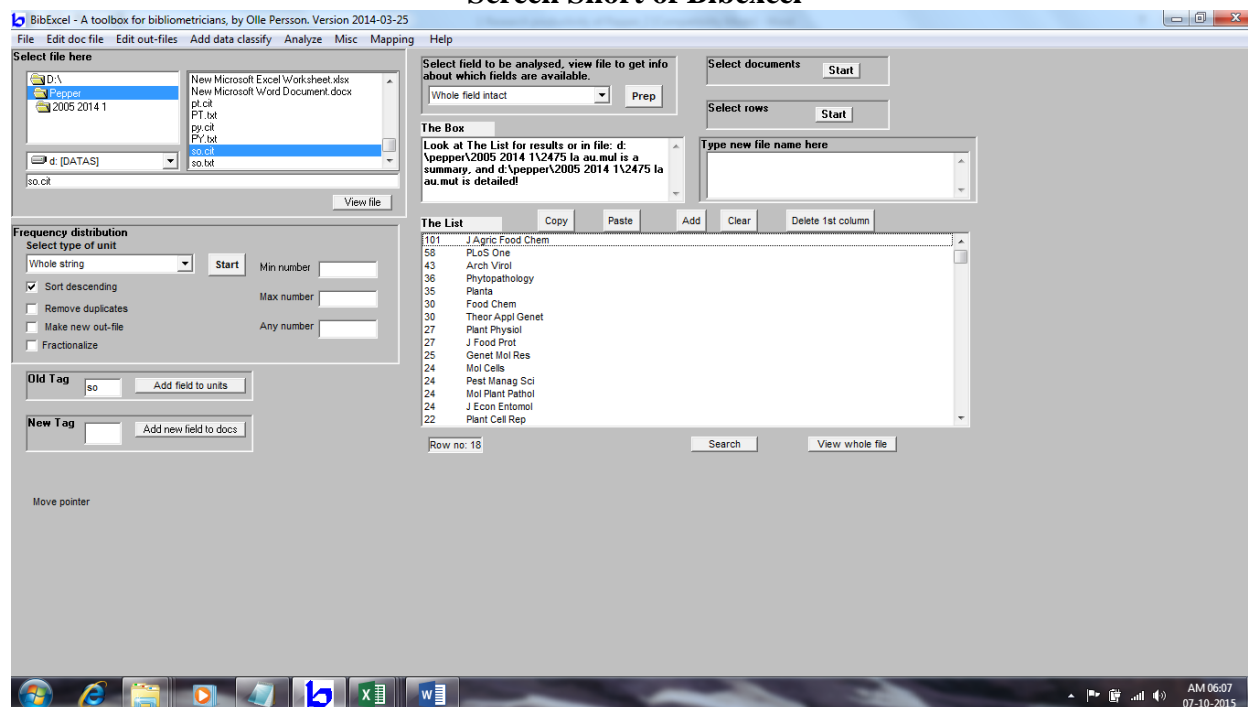
The highly productive journals up to three ranks are as follows

1. “J Agric Food Chem” with 101 contributions amounting First Rank.
2. “PLoS One” with 58 publications as Second Rank.
3. “Arch Virol” with 43 research in third place.

Table 7
Ranking of Journals in Pepper Research

1	J Agric Food Chem	101
2	PLoS One	58
3	Arch Virol	43
4	Phytopathology	36
5	Planta	35
6	Food Chem	30
7	Theor Appl Genet	30
8	Plant Physiol	27
9	J Food Prot	27
10	Genet Mol Res	25
11	Mol Cells	24
12	Pest Manag Sci	24
13	Mol Plant Pathol	24
14	J Econ Entomol	24
15	Plant Cell Rep	22
16	Mol Plant Microbe Interact	22
17	J Food Sci	21
18	Biochem Biophys Res Commun	21
19	J Sci Food Agric	20
20	Food Chem Toxicol	20

Image – 1 Screen Short of Bibexcel



3.8 Authors Productivity in Peper Research:

Santhakumar and Kaliyaperumal clearly analysed in the Mobile Technology publication with language, most prolific authors, their affiliation, and subject area. Most of the scientist are ready to do research in this newly emerging field.¹² This table – 8 shows some to the top the individual scientist productivity Hwang BK contributes 55, Choi D publish 24 Kim BD brings out 19. During the year 2005 to 2014 for the Pepper Research 11,041 authors are contributing their work. This analysis is carried out by the help of Bibexcel Software. According to Lotka's Law, large number of papers published by the limited number of authors is revealed true by Pepper research.

Table – 8
Individual Authors Contribution in Pepper Research

1	Hwang BK	55
2	Choi D	24
3	Kim BD	19
4	Moury B	15

5	Paran I	14
6	Shim JH	12
7	Gong ZH	12
8	Lee SC	12
9	Antonious GF	11
10	Kang BC	11
11	Paek KH	11
12	Kim WT	10
13	Kim HJ	10
14	Jahn MM	10
15	Lee S	9
16	Kim DS	9
17	Wang Y	8
18	Lahaye T	8
19	Kim NH	8
20	Fernandez-Alba AR	8

3.9 Application of Zipf Law in the Pepper Research Publications:

We can find out how many keyword are used. This is analyzed with the help of Bibexcel tool. By that we can able to find out how many keywords are used for each and every article and what are they. We can catch the number of key words used. “Humans” is used 575 times, “Animals” in 497 times and “Male” in 323 times. Total 11,546 key words were used for 2475 publications in Pepper.

Table – 9
Application of Zipf’ Law in for Pepper Research

S.No	Keywords	No. of times occurred
1.	Humans	575
2.	Animals	497
3.	Male	323
4.	Molecular Sequence Data	291
5.	Female	284
6.	Amino Acid Sequence	150
7.	Adult	149
8.	Phylogeny	146
9.	Gene Expression Regulation	141

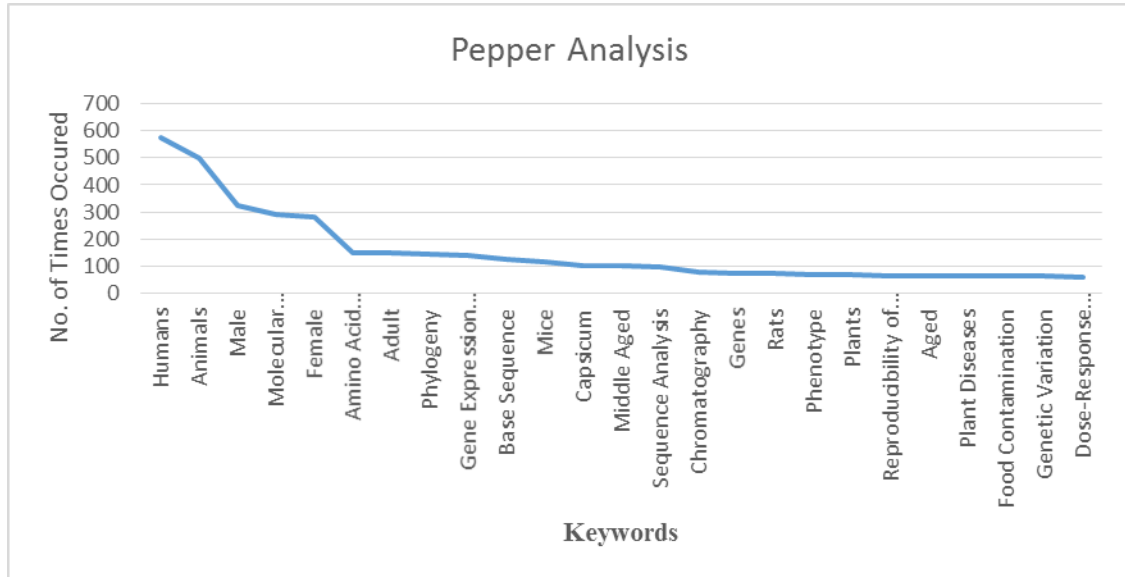
10.	Base Sequence	126
11.	Mice	118
12.	Capsicum	104
13.	Middle Aged	102
14.	Sequence Analysis	100
15.	Chromatography	81
16.	Genes	75
17.	Rats	73
18.	Phenotype	70
19.	Plants	69
20.	Reproducibility of Results	67
21.	Aged	67
22.	Plant Diseases	65
23.	Food Contamination	64
24.	Genetic Variation	64
25.	Dose-Response Relationship	62

Zipf Law is the governing of relation between the rank of a word and frequency of its appearance in a long text. If “r” is a rank of a word and “f” is its frequency the Zipf’s Law stated as flow

$$r f = c$$

For this Pepper research 5,606 key words are used. To execute the Zipf’s Law, 20 words are selected.

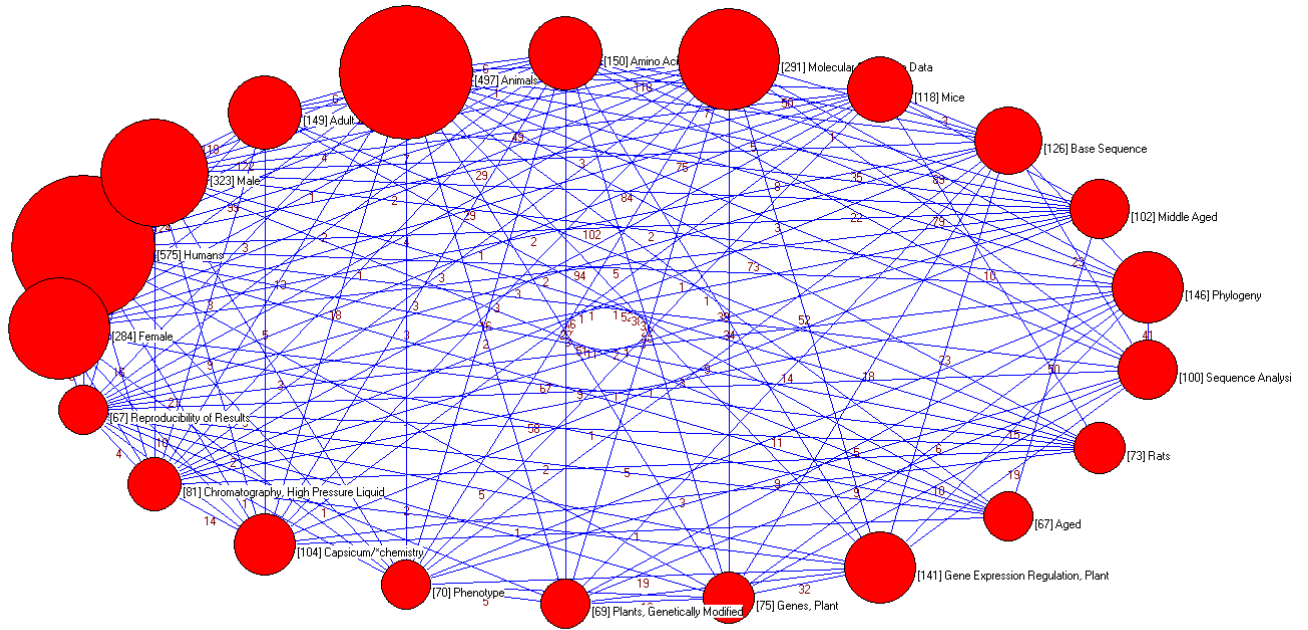
Diagram -1
Zipf law for Pepper Research



3.10 Co-Word analysis:

Co-word analysis is the article's keywords occurring within the same paper. Out 2475 articles 11,546 keywords are used. "MH" field was selected in the old tag. Then .doc file and .out file was find out. After, that .oux was created. The top twenty one keywords were selected. On the basis of .coc file and .net was created. Then .cit file and .vec file was made. The .net file and .vec was called from pajek. The network was created. The below image shows, the keywords and number of times occurred in the bracket with red color circle. The size of the ball represent the number of times of the word occurred. For example [575] Human and [497] Animals keyword appeared. It is very clear in the image. Added to that we are getting links. [284] Female keyword is seemed **94 publications** with the co-word of [102] Middle Aged.

Image – 2
Vector Analysis of Co-word of Pepper Research



This tables shows the specific word used with another word in the number of records again and again.

Table – 10
Co-word Analysis

S.No	Word or Keyword	Co-word	No. of Records Occurred
1.	Amino Acid Sequence	Molecular Sequence Data	145
2.	Adult	Female	124
3.	Animals	Humans	122
4.	Adult	Male	119
5.	Animals	Mice	118
6.	Base Sequence	Molecular Sequence Data	102
7.	Humans	Middle Aged	102
8.	Animals	Female	99
9.	Female	Middle Aged	94
10.	Molecular Sequence Data	Phylogeny	89

11.	Male	Middle Aged	84
12.	Molecular Sequence Data	Sequence Analysis, DNA	79
13.	Adult	Middle Aged	75
14.	Animals	Rats	73
15.	Aged	Humans	67

3.11 Relative Growth Rate (RGR):

Now a day's scientific research is going tremendous manner. Lot of man power and finance also involved. Relative Growth Rate (RGR) over the particular period of interval can be considered from the following equation:

$$1 - 2^{\bar{R}} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1}$$

“ whereas

$1 - 2^{\bar{R}}$ = mean relative growth rate over the specific period of interval

$\log_e W_1$ = log of initial number of articles/pages

$\log_e W_2$ = log of final number of articles/pages after a specific period of interval

$T_2 - T_1$ = the unit difference between the initial time and the final time

aa^{-1} = average no. of articles

The year can be take here as the unit of time. The Relative Growth Rate for the articles and pages can be calculate separate.

Therefore

$1 - 2^{\bar{R} (aa^{-1} \text{ year}^{-1})}$ can represent the mean RGR per unit of articles per unit of year over a specific period of interval.

$$2006 = \log_e 362 - \log_e 173 / 2006 - 2005$$

$$= 5.89 - 5.15 / 1 = 0.74$$

$$2007 = \log_e 557 - \log_e 362 / 2007 - 2006$$

$$= 6.32 - 5.89 / 1 = 0.43$$

The researcher tried to implement the Relative Growth Rate (RGR) and Doubling Time for Pepper. It is seen from the below Table –11 shows that Relative Growth Rate. From 2006 (0.74) to 2014 (0.15) the rate is decreasing.

Table – 11
Pepper Scientific Relative Growth Rate and Doubling Time

Year	Quantum of Output	Cumulative Total of Output	W ₁	W ₂	$1 - 2^{\bar{R}(\text{aa}^{-1} \text{ year}^{-1})}$ RGR	Dt(a)
2005	173	173		5.15		
2006	189	362	5.15	5.89	0.74	0.93
2007	195	557	5.89	6.32	0.43	1.60
2008	205	762	6.32	6.64	0.32	2.19
2009	214	976	6.64	6.88	0.24	2.85
2010	241	1217	6.88	7.10	0.22	3.09
2011	244	1461	7.1	7.29	0.19	3.71
2012	283	1744	7.29	7.46	0.17	3.98
2013	370	2114	7.46	7.66	0.20	3.53
2014	361	2475	7.66	7.81	0.15	4.50

3.11 Doubling Time (Dt)

There exists a direct equivalence between the relative growth rate and the doubling time. “If the number of articles/pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be logarithms of number 2. If natural logarithm is used this difference has a value of 0.693. Thus the corresponding doubling time is for each specific period of interval.” Baskaran examined the research growth, relative growth rate and doubling time of publications, institution wise and ranking of authors in research productivity of Graph Theory during 2004-2011³.

$$\text{Doubling time (Dt)} = \frac{0.693}{\bar{R}}$$

Therefore,

$$\text{Doubling time for articles Dt (a)} = \frac{0.693}{1 - 2^{\bar{R}(\text{aa}^{-1} \text{ year}^{-1})}}$$

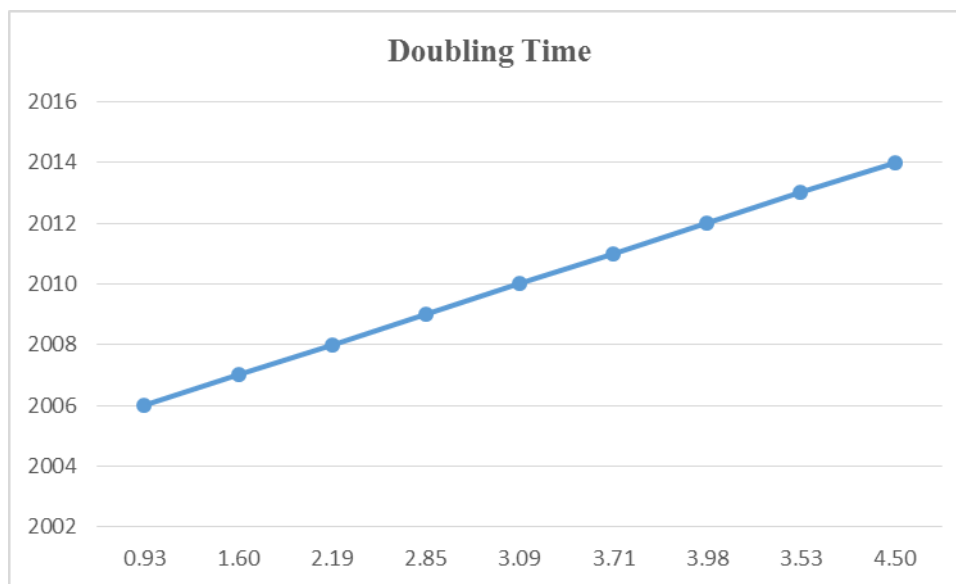
$$2006 = 0.693/0.74 = 0.93$$

$$2007 = 0.693/0.43 = 1.60$$

The Doubling Time for cloud computing research increases from 0.93 to 4.50

Diagram - 2

Doubling time for Research output in Pepper



4. Conclusion

Pepper is widely used in traditional Indian Medicine and as home remedy for sore throat, throat congestion and cough. The polyphenol extracts of alligator pepper, ginger and nutmeg displayed good antioxidant as well as antiglycation potential. They are very safe for consumption.⁹ From the Pubmed Database the 2475 pepper research was done for the year 2005

to 2014. United States is the top most country with the maximum number of publication of 842. India is in the 9th place with 45 examines. It is find out that out of 2475 Pepper publications 2378 (96.08%) articles are published in English language. Journal article contribution is 2083 (84.16%). In the Pepper Research Four authors contributions are high 85 (16%). Single Authors contributions are 24.32%. Bradford's Law of Scattering is applicable in the Pepper research. 32 core journals are grouped in zone-1 published 827 articles accounts for one third of the total output. "J Agric Food Chem" Journal with 101 contributions amounting to the First Rank. According to Lotka's Law large numbers of papers were produced by limited number of authors. 11,041 authors are done research for the year 2005 to 2014. Among them "Hwang BK" contributes 55 results. 11,546 key words were used. Here we applied Zipf's Law with the top most first 20 key words. We can implement Relative Growth Rate and Doubling Time in Pepper Research. The highest Global Citation Score is 69. Airtight storage help to preserve the pepper flavour and aroma for a long period. If it exposed in light it will become as tasteless. Though it is having so many medicinal values only controlled studies have been carried out.

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