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Research Article

Growth, Indexing and Authorship Pattern of Poultry Industry Research Publications

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ABSTRACT
This study analyzes the impact of Poultry industry Research Publications indexed in the Scopus database during the period 2008 to 2017. The analysis revealed that the total of 4248 documents indexed in the database during the selected period of study. The highest productive year is 2017 with 610 publications (14.36%) and the lowest is 2008 with 268 publications (6.31%). The Exponential growth rate is found to be highest in the years 2012 and 2014 with the value 0.226. The mean Degree of collaboration, Collaborative index, Collaborative coefficient is found to be 0.89, 4.62 and 0.66 respectively. Average citations per paper are 12.28 and the average Publication efficiency index is 1.15. The study also tests the scientific productivity of authors through Lotka's law.

Keywords: Scientometric, Citation, Poultry, Authorship pattern, Lotka's Law, Kolmogorov Test.

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INTRODUCTION

The poultry industry is one of the rapidly growing agricultural sub-sectors at the global level. This industry deals with the farming of birds like ducks, chickens, geese and turkeys for the requirement of meat and egg. Among these chickens being the most numerous. Poultry makes a significant contribution to food and nutrition, by supplying proteins, energy and micro-nutrients to human beings with short production cycle and the ability to convert a wide range of wastes as well as Agri-food-products into meat and egg, which are consumable by humans. The global poultry industry is expected to continue to grow since it needs for meat and eggs are influenced by a growing population and rising incomes. It is the most common animal food consumed at a global level. When its role in nutrition is identified, it also used a threat to human health, mainly for infectious diseases because of its role in antimicrobial resistance. So, scientists across the globe are doing a lot of research associated with poultry. In this context, this study evaluates the global scientific output of the poultry industry from the Scopus database during the period from 2008 to 2017.

Review of Literature

Review of literature helps the researcher to understand research areas already covered, methods used in similar studies and also helps to locate the research gaps. The review shows that there is no Scientometric study has been done so far about the growth, Indexing and authorship pattern of Poultry Industry Research Publications. In the article 'Growth of Literature and Collaboration of Authors in MEMS literature', Tamizhchelvan, M. and Bathrinarayanan, A. L.[1] analyzed 25 years'author collaborations, Collaborative Index, Collaborative Coefficient, Modified Collaborative Coefficient for G8 countries, BRIC countries as well as Global level. Chitra, V. and Jeyshankar, R.[2] measured the collaborative works of authors in the paper 'Growth of Literature in Neuroscience: A Scientometric study (1972-2011).' This study was based on the data extracted from the Scopus database for the time span of 1972 to 2011. Sab, M. C., Kumar, P. D. and Biradar, B. S.[3] examined the total citations and Publication Efficiency Indices of Chemical Science Research publications of India from 2002 to 2011. The results indicated that the PEI (1.29) and total citations (9844) were found to be highest in the year 2011. Vivekanandhan, S., Sivasamy, K. and Bathri Narayanan, A. L.[4] examined the yearly Average Citations per paper and Publication Efficiency Indices of Pollution Control Research Output of India from Scopus Database from 2003 to 2014. Prabakar, S., Nagarajan, M. and Thirumagal, A.[5] in their study about 'Scientometric Analysis on the Literature Output on Unemployment', applied and tested Lotka's Law. The Kolmogorov

Smirnov Test revealed that Lotka's law is not fit to that research productivity.

Objectives of the study

1. To measure the Exponential growth rate of publications
2. To calculate Degree of collaboration, collaborative index and collaborative coefficient of publications
3. To measure Average citations per paper and Publication efficiency Index
4. To test the Scientific productivity of authors by applying Lotka's Law
5. To test Lotka's law with Kolmogorov-Smirnov test.

Methodology

The data for this study were retrieved and downloaded from the Scopus online database(http://www.scopus.com). A keyword, such as "Poultry Industry' 'was used in "keyword" tag, "source title tag" and further search has been restricted to the period 2008-2017 by using "date range tag." For downloading the global publications of poultry Industry for ten years, this becomes the main search string. All extracted bibliographical data were exported to CSV excel file. Exported data sorted out and tabulated using Microsoft Excel Spreadsheet. Appropriate statistical tools were used for measuring and analyzing the downloaded data.

ANALYSIS AND RESULTS

Exponential Growth Rate of Poultry Industry Research Publications

Exponential growth is exhibited when the rate of change per instant or unit of time. That is the growth rate becomes more rapid in proportion to the total number of publications.

The exponential growth rate derived from the formula,

$N_{(t)}=N_{(0)}e^{rt}$

Where, $N_{(t)}$ = Final number of publications

$N_{(0)}$ =Initial number of publications

r = Exponential growth rate

t = Time

$\therefore$ Exponential Growth Rate, $r=\frac{\left(\ln\left(\frac{N_t}{N_0}\right)\right)}{t}$

The analysis clearly displayed that rapid changes found in the growth rate of poultry industry research publications. From Table 1, it is observed that fluctuations in the exponential growth rates are found in the sample study years and negative growths are observed in the years 2013 and 2015. The mean exponential growth rate during the period is 0.091. The highest values of exponential growth rates are found in the years 2012 and 2014 with a value of 0.226. Here the growth of publications of this literature is exponential in nature.

Table 1: Exponential Growth Rate.

Sl.No.	Year	Publications	$N_{(t)}/N_0$	Exponential Growth Rate
1	2008	268		----
2	2009	317	1.183	0.168
3	2010	341	1.076	0.073
4	2011	343	1.006	0.006
5	2012	430	1.254	0.226
6	2013	395	0.919	-0.085
7	2014	495	1.253	0.226
8	2015	468	0.945	-0.056
9	2016	581	1.241	0.216
10	2017	610	1.050	0.049
	Total	**4248**		**0.822**
	Mean			**0.091**

Degree of Collaboration, Collaborative Index and Collaborative Coefficient

The degree of collaboration in discipline was defined as the ratio of the number of collaborative research papers to the total number of research papers published in the discipline during a certain period of time. The formula of Degree of collaboration suggested by Subramanyam[6] and can be written as,

$$DC=\frac{N_m}{N_m+N_s}$$

Where,

DC - degree of collaboration in a discipline,

N_m is the number of multiple-authored research papers in the discipline published during a year,

N_s is the number of single-authored research papers in the discipline published during the same year.

Collaborative index (Lawani 1980)[7] is the mean number of authors per paper. It has no upper limit and cannot be expressed as a percentage. It can be calculated from the formula,

$$CI=\frac{\sum_{j=1}^{A} if_j}{N}$$

The methodology of Collaborative coefficient has been suggested by Ajiferuke (1988).[8] It is based on the counting of fractional productivity defined by Price and Beaver. It can be expressed mathematically as,

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

Where,

fj is the number of jointly authored papers published in the discipline during a certain period of time.

j is the number of authors.

A is the greatest number of authors per paper in the discipline during a certain period of time.

N is the total number of research papers published in the discipline during a certain period of time.

According to Ajiferuke that CC will indicate zero when single-authored papers dominate and counted 1-1/j then j authored papers being dominated. This implication shows that higher the value of CC means higher the probability of multi or mega authored papers.

Table 2 shows that three authored paper dominate with 614(14.46%) publications followed by four authored papers with 602 (14.17 %) of the total number of publications. The single-authored paper publishes 430 numbers (10.12%) of the total number of articles during the study period. The lowest number of articles published by 11 and more authored pattern, that is 49 (1.18%).

DC indicates the degree of collaboration in Poultry industry research publications. If the DC is greater than 0.5 then multiauthored papers dominate over single authored papered papers. If DC is less than 0.5, then single-authored papers dominate over multiauthored papers. If DC is equal to 0.5 means both single and multiauthored papers are equal in numbers. From the analysis in Table 2, it is observed that the Degree of collaboration is greater than 0.8 in all years and the highest value of DC is found in the year 2017 with the value 0.96 and lowest values are in the years 2008 and 2009 with the same value 0.82. The mean degree of collaboration during the selected period of study is 0.89 and it is clearly visible that multi-authored papers dominate the single-authored papers of poultry industry research publications. i.e., 89% of collaborative authors articles published in this era. Collaborative Index is the simplest index used to express the literature output which is to be interpreted the mean number of authors per joint papers. Table 2 shows that that CI is highest in the year 2017 (5.61) lowest in the year 2009 (3.96) and the mean collaborative index is during the study time is 4.62. The analysis demonstrates that the value of CI increased as per the jointly authored papers dominates over single-authored papers. The values of CC show the fractional productivity of this literature publications. Similar to DC and CI, CC is also found to be highest in the year 2017(0.75) and lowest in the year 2009 (0.59). Mean value of CC during the time period is 0.66. The implications indicate that the value of DC, CI and CC increased as per the multi or joint-authored papers increases.

Table 2: Authorship Pattern, DC, CC & CI.

Years	Single authored Paper	Two authored Paper	Three authored Paper	Four authored Paper	Five authored Paper	Six authored Paper	Seven authored Paper	Eight authored Paper	Nine authored Paper	Ten authored Paper	11 & more authored Papers	Total no.of papers	DC	CI	CC
2008	49	38	41	42	38	22	9	11	4	10	4	268	0.82	3.99	0.60
2009	58	58	41	46	37	30	10	12	10	12	3	317	0.82	3.96	0.59
2010	50	50	65	51	30	32	17	20	9	14	3	341	0.85	4.18	0.62
2011	42	63	54	44	43	33	21	7	17	16	3	343	0.88	4.28	0.64
2012	41	72	71	59	52	54	24	22	13	20	2	430	0.90	4.42	0.66
2013	30	52	62	56	45	43	36	31	12	23	5	395	0.92	4.86	0.70
2014	54	63	70	71	70	39	40	33	17	35	3	495	0.89	4.72	0.67
2015	44	50	69	69	56	50	38	31	16	41	4	468	0.91	4.96	0.69
2016	35	62	76	80	76	86	47	36	29	45	9	581	0.94	5.22	0.72
2017	27	59	65	84	77	70	77	39	37	61	14	610	0.96	5.62	0.75
Total	**430**	**567**	**614**	**602**	**524**	**459**	**319**	**242**	**164**	**277**	**49**	**4248**	**8.89**	**46.20**	**6.64**
%	**10.12**	**13.35**	**14.46**	**14.17**	**12.34**	**10.81**	**7.51**	**5.70**	**3.86**	**6.52**	**1.18**	**100**	**0.89**	**4.62**	**0.66**
													Mean values ↑		

Publication Efficiency Index

Publication efficiency index (PEI) is used for measuring Relative research effort. It is based on the citations received to the research publications by the authors. Publication efficiency index is calculated by the formula given by Guan, J. and Ma, M. (2007).[9]

$$PEI = \frac{TNC_i / TNC_t}{TNP_i / TNP_t}$$

Where,

TNC_i=Total number of Citations in a particular year 'i'

TNC_t =Total number of Citations for all the years

TNP_i = Total number of Publications in a particular year 'i'

TNP_t = Total number of Publications for all the year

Table 3 shows the year-wise PEI as well as Average Citations Per Publications. If the value of PEI > 1, denotes that impact of publication and research effort is higher to that particular year. In contrast, the value of PEI is less than one means that despite the research effort made by that year the impact of research is low. Here, PEI is higher than one in the years 2008 to 2013 and similarly, Average citations per publication are also found to be higher in the same years. So, the research effort in the field of study is found be made a good impact in these years. The value of PEI and ACPP is highest in the year 2008 with the values 2.21 and 23.56 consecutively which point out that outstanding impact is made by poultry industry publications in the scientific community during that particular years. On the other hand, the least research impact is seen in the year 2017 since PEI value is only 0.18. Average citations per publication during the analysis period are 12.28 and Average PEI is 1.15. Implications specified that relative research effort made by the scientists in this literature during the prescribed study period is found to be made a significant impact in the research community.

Table 3: ACPP & PEI.

YEARS	Total publications	Total No. of Citations	ACPP	PEI
2008	268	6314	23.56	2.21
2009	317	5658	17.85	1.68
2010	341	5857	17.18	1.61
2011	343	6173	18.00	1.69
2012	430	5624	13.08	1.23
2013	395	4825	12.22	1.15
2014	495	4497	9.08	0.85
2015	468	2734	5.84	0.55
2016	581	2331	4.01	0.38
2017	610	1191	1.95	0.18
Total	**4248**	**45204**	**122.77**	**11.54**
		Average	**12.28**	**1.15**

Table 4: Straight Count of Authorship.

Number of works	Number of authors	Total number of works of authors
1	3017	3017
2	326	652
3	94	282
4	25	100
5	10	50
6	10	60
7	2	14
8	3	24
9	3	27
10	1	10
11	0	0
12	1	12
Grand Total	**3492**	**4248**

Application of Lotka's Law

In Poultry industry research publication, it can be noted that while a large number of authors who publish only a single article, a small circle of most prolific authors contributes a large number of publications. For testing the scientific productivity of authors, here used straight count, i.e., only the first author is counted, as they are the main contributors of the works. While taking straight count it is observed that authors are contributed between one to twelve articles. The author Wang Y. contributed 12 articles followed by Frenkel V.S. with 10 articles as the first author and so they are considered as major contributors in this field during the study period. From Table 4, it is can be seen that 3017 authors contributed only single work while 326 authors contributed two articles and so on. Total 3492 authors are found as primary authors of 4248 publications.

Now the Lotka's law can be applied to test in order to examine whether these data fit the law. For this in Table 5, the number of contributions made by the authors is denoted as x and the numbers of authors who publish x number of articles are denoted as y similar data shown in Table 4. The logarithm of frequencies of articles (x) is presented as X and logarithm of frequencies of authors (y) is represented as Y. The product of these calculated in the next two columns. The total of these data is also calculated at the bottom of Table 5. Obtained values of frequencies are calculated in column number 7 of Table 5. The cumulative observed number of frequencies is available in column number 8. Expected number of frequencies

(f_e) calculated in column number 9 of Table 5 from the Lotka's formula (Andrés 2009),[10]

$$f_e = c \times x - n$$

The exponent 'n' of Lotka's formula which denotes to the present distribution of scientific productivity of authors can be calculated from the formula,

$$n = \frac{N\Sigma XY - \Sigma X \Sigma Y}{N\Sigma X^2 - (\Sigma X)^2}$$

The values needed for finding n expect N is available from Table 5. N indicates the number of work considered. Here 12 number of article work is considered. Hence, *N*=12

Inserting the corresponding values in the formula,

$$n = \frac{12 \times 5.517 - 8.680 \times 12.619}{12 \times 7.464 - (8.680)^2} = -3.35$$

The absolute value of n is taken for the calculation of Lotkas formula i.e, *n*=3.35. This value of 'n' reveals whether the data really fit with Lotka's law.

The value of C which indicates the expected number of authors is calculated from the formula,

$$C = \frac{1}{\Sigma 1/x^n}$$

$$= \frac{1}{\sum \frac{1}{1^{3.35} + 2^{3.35} + 3^{3.35} + \cdots + 12^{3.35}}} = \frac{1}{1.144} = 0.874$$

Substituting these values of c and n in Lotkas formula the expected number of frequencies of poultry research publications obtained as in column 9 of Table 5. Cumulative expected frequencies are shown in column 10. The difference between the cumulative observed number of frequencies of publications (column no.8) and cumulative expected number of frequencies of publications (column no.10) is mentioned as D in column number 11. The difference in its absolute value is taken in column D.

From the column 11 of Table 5, it is observed that there is no significant difference between the observed number of frequencies and the expected number of frequencies of publications. The maximum deviation found in the single article productivity with the value 0.010 and only minute differences found in the article productivity of two, three, four, six, eight and ten. An equal number of the observed and expected number of frequencies are found in the years five, seven, nine and twelve. From the results, it is clear that Lotka's law is exactly fit for the poultry industry research publications.

Kolmogorov-Smirnov Test

The statistical test of Kolmogorov-Smirnov is applied in order to verify whether observed data fit with the theoretical distribution of Lotka's law. Maximum difference (D_{max}) is found in the single article productivity with the value 0.010. This value is taken as for the comparison with critical value (c.v.), whose general formula (Andrés 2009)[10] is: -

$$C.V. = \frac{1.63}{\left[\Sigma y + \left(\frac{\Sigma y}{10}\right)^{\frac{1}{2}}\right]^{\frac{1}{2}}}$$

Table 5: Application of Lotka's Law.

1	2	3	4	5	6	7	8	9	10	11
x	y	X	Y	X^2	XY	y/Σy	Σ(y/Σy)	f_e	Σ f_e	D
1	3017	0.000	3.480	0.000	0.000	0.864	0.864	0.874	0.874	0.010
2	326	0.301	2.513	0.091	0.757	0.093	0.957	0.086	0.960	0.003
3	94	0.477	1.973	0.228	0.941	0.027	0.984	0.022	0.982	0.002
4	25	0.602	1.398	0.362	0.842	0.007	0.991	0.008	0.990	0.001
5	10	0.699	1.000	0.489	0.699	0.003	0.994	0.004	0.994	0.000
6	10	0.778	1.000	0.606	0.778	0.003	0.997	0.002	0.996	0.001
7	2	0.845	0.301	0.714	0.254	0.001	0.998	0.001	0.998	0.000
8	3	0.903	0.477	0.816	0.431	0.001	0.999	0.001	0.998	0.001
9	3	0.954	0.477	0.911	0.455	0.001	0.999	0.001	0.999	0.000
10	1	1.000	0.000	1.000	0.000	0.000	1.000	0.000	0.999	0.001
11	0	1.041	-	1.084	0.000	0.000	0.000	0.000	0.000	0.000
12	1	1.079	0.000	1.165	0.000	0.000	0.000	0.000	0.000	0.000
Total	**3492**	**8.680**	**12.619**	**7.464**	**5.157**					
	Σ y	**ΣX**	**ΣY**	**ΣX2**	**ΣXY**					

Therefore,

$$C.V. = \frac{1.63}{\left[3492 + \left(\frac{3492}{10}\right)^{\frac{1}{2}}\right]^{\frac{1}{2}}} = 0.028$$

Critical value = 0.028

$$D_{max} = 0.010$$

The maximum deviation of column D of Table 5, D_{max} 0.010 is less than the critical value of 0.028. So, it can be interpreted that Alfred Lotka's law fit the author's productivity of poultry industry research publications during the selected period of study.

CONCLUSION

The results of this study helped to discover the type of growth, Collaborative work pattern, Authorship patterns, highest Research impact period, Average Citations Per Paper, Scientific productivities of authors of poultry research publications. The analysis of the Impact of Poultry Industry Research Publications during the prescribed study period shows that the exponential model of growth is found in this area of publication output. Rapid fluctuations are observed year by year. EGR is found to be highest in 2012 and 2014 with the same value 0.226. Mean EGR during the study period is 0. 091. Three authored paper dominate other authorship patterns with 614 (14.46%) publications. The Study indicates that collaborative authorship papers highly dominate single-authored papers. The 89% of total publications are multiauthored publications since the mean value of the Degree of collaboration is 0.89. The lowest collaborative Index and the collaborative coefficient are found in the year 2009 with the values 3.96 and 0.59 respectively. DC, CI and CC is paramount in the year 2017. Publication efficiency index and the Average Citations per publications are topmost in 2008 with the values 2.21 and 23.56 consecutively. The mean value of PEI (1.15) point out that remarkable research effort has been contributed by publications of this area to the scientific community during the study period. One to twelve scientific productivity has been carried out by 3492 authors of this field. The author Wang Y. who contributed 12 articles as first author is considered as the most prolific contributors of this subject. Kolmogorov-Smirnov Test revealed that Lotka's law is well fit for this research productivity of poultry industry research publications.

ABBREVIATIONS

EGR: Exponential Growth Rate; **DC:** Degree of collaboration; **CI:** Collaborative Index; **CC:** Collaborative Coefficient; **ACPP:** Average Citations Per Publication; **PEI:** Publication Efficiency Index.

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