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Bibliometric Analysis of Biotechnology Research in Nigeria

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Introduction

Biotechnology as a field of study, according to the Organization for Economic Cooperation and Development (OECD), can be defined as the "act of applying science and technology to living organisms also parts, products, and models in order to alter living or non-living materials for the production of knowledge, goods and services" (OECD, 2001). It is fast-growing research, and for the last three decades, it has been gaining momentum in various research institutions (Sevukan & Jaideep, 2008). So it has been making a serious impact in diverse areas such as Information technology, biology, biochemistry, medicine, and agriculture (Sevukan & Jaideep, 2008).

Nigeria, being the most populous African country that has a population of about 190.9 million with an annual growth rate of 2.9 percent according to the Nigerian National Bureau of Statistics as of 2017 (IITA, 2009; National Bureau of Statistics, 2017), has a huge consumer for Biotechnology product and services. In light of this, Nigeria requires research and development (R&D) in biotechnology.

The genesis of biotechnology in Nigeria can be traced back to the establishment of the National Development Biotechnology Agency (NABDA) under the Federal Ministry of Science and Technology's supervision with the main objective to speed up biotechnological methods, culture, and application in Nigeria. Since the inception of this body, she has been working with other institutions like the International Institute for Tropical Agriculture in making the nation feel the impact of biotechnology (NABDA, 2001). Another major development of biotechnology in Nigeria was when the country tried to get a stable ground for biotechnology when the Federal government signed the biosafety bill into law in Nigeria in 2015. In addition, the National Biosafety Management Agency (NBMA) monitors the safe application of biotechnology in Nigeria, also with the mandate to promote biotechnology in all sectors of the country (NBMA, 2016).

Although biotechnology development in Nigeria is not without its drawbacks and problems, one of the challenges is the court case between NBMA and activists led by the Health of Mother Earth Foundation (HOMEF) in 2017 over Bt cotton and genetically improved maize (Alliance for Science, 2017). Thus, the main objective of the research paper is to quantify and analyze the research output of biotechnology in Nigeria. The second section of this paper discusses the methodology used in this research, while the third section showcases the results, followed by the discussion of the results in the fourth section, and finally, the conclusion is drawn in the fifth section.

Materials and Methods

The data used to pinpoint the bibliometric analysis in this research were retrieved from the Scopus database, one of the world's highest international multi-disciplinary abstract and indexing databases (Bajawa & Yaldram, 2013; Elsevier, 2016). Scopus database started in the year 2004. The choice was made based on the number of studies done in retrospective times that analyzed the coverage difference between other databases, including Google Scholar, Web of Science, CSA Illumina, and Scopus database (Archambault et al., 2009; Lopez-Illescas, 2009). In addition, Norris analyzed differences in these databases and concluded, "Scopus offers the best coverage from amongst these databases" (Norris & Oppenheim, 2012).

Several studies have been done using bibliometric data analysis techniques to present an overview of the discipline (Elsevier, 2016; Bajawa & Yaldram, 2012; Zhu and Willet, 2011). In this research, we have investigated various aspects of research growth in biotechnology in Nigeria. The factors that are considered include (1) growth in publications as measured by the relative growth rate (RGR) and doubling time (DT), (2) productivity and quantification of research output for different institutions of the country. In order to broaden the

research, data were retrieved based on search string "bio*" for the period of 1988 - 2018, and the country was limited to Nigeria. The initial output data were cleaned by removing irrelevant and duplicate records, then journals with zero impact factors were removed. Finally, 14,783 publications were considered for further analysis.

Results

Preferred Journals and Areas of Research

This research covers a period of 30 years (1988 - 2018). A total of 14,783 publications related to biotechnology in Nigeria was published in 159 journals. Out of these publications, 816 were in the form of reviews, 580 were conference proceedings,

and another 235 in book chapters. Of the total publications, almost 3 percent appeared in local Nigerian journals (all with a positive impact factor). A list of the top 20 journals preferred by Nigerian researchers is presented in Table 1.

The number of research publications in different areas of biotechnology is listed in Table 3.

Biotechnology research in Nigerian is dominated by the medical sector, with 19.92 percent of the total publications are in this field, followed by agricultural and biological sciences (17.08 %), biochemistry, genetics, and molecular biology (10.98 %) and Environmental Science (9.73 %). The classification of subjects is based on the one provided by Scopus.

Table 1. Acronyms in the Text

S.no	Acronyms	Full Meaning
1	UI	University of Ibadan
2	UNN	University of Nigeria
3	OAU	Obafemi Awolowo University
4	UNILAG	University of Lagos
5	ABU	Ahmadu Bello University
6	UNIBEN	University of Benin
7	UNILORIN	University of Ilorin
8	FUTA	Federal University of Technology, Akure
9	UNIPORT	University of Port Harcourt
10	IITA	International Institute of Tropical Agriculture IITA, Ibadan
11	UCH	University College Hospital, Ibadan
12	LAUTECH	Ladoke Akintola University of Technology
13	UNICAL	University of Calabar
14	CU	Covenant University
15	UNIZIK	Nnamdi Azikiwe University
16	LASU	Lagos State University
17	UNIMAID	University of Maiduguri
18	UNIJOS	University of Jos
19	UNIUYO	University of Uyo
20	OOU	Olabisi Onabanjo University
21	FUTO	Federal University of Technology, Owerri
22	D_t	Doubling time
23	TP	Total publications
24	TC	Total citations
25	ACPP	Average citation per paper
26	RGR	Relative growth rate

Table 2. Top 20 Biotechnology Journals per Number of Publications

	Journal	Number of Publications	Impact factor (2018)
1	<i>African Journal of Biotechnology</i>	434	0.44
2	<i>African Journal of Biomedical Research</i>	189	0.13
3	<i>African Journal of Medicine And Medical Sciences</i>	181	0.07
4	<i>West African Journal of Medicine</i>	158	0.67
5	<i>Agricultural Engineering International CIGR Journal</i>	132	0.24
6	<i>Nigerian Journal of Clinical Practice</i>	121	0.42
7	<i>Pakistan Journal of Nutrition</i>	112	0.20
8	<i>Malaria Journal</i>	93	2.48
9	<i>Nigerian Postgraduate Medical Journal</i>	91	0.43
10	<i>Environmental Monitoring And Assessment</i>	89	1.00
11	<i>PLOS ONE</i>	85	1.95
12	<i>Journal of Ethnopharmacology</i>	78	1.07
13	<i>Bioresource Technology</i>	77	4.35
14	<i>Asian Pacific Journal of Tropical Biomedicine</i>	76	1.30
15	<i>Comparative Clinical Pathology</i>	70	0.32
16	<i>European Journal of Scientific Research</i>	66	0.21
17	<i>Nigerian Journal of Medicine Journal of The National Association of Resident Doctors of Nigeria</i>	63	0.05
18	<i>Pakistan Journal of Biological Sciences</i>	63	0.16
19	<i>Annals of African Medicine</i>	62	0.38
20	<i>BMC Public Health</i>	62	2.05

Table 3. Subject Area Classification of Biotechnology Publications in Nigeria

	Subject	No. of Publications	% of Total
1	Medicine	5009	19.92
2	Agricultural and Biological Sciences	4296	17.08
3	Biochemistry, Genetics and Molecular Biology	2760	10.98
4	Environmental Science	2448	9.73
5	Pharmacology, Toxicology and Pharmaceutics	1952	7.76
6	Immunology and Microbiology	1412	5.61
7	Engineering	1106	4.40
8	Energy	803	3.19
9	Chemistry	756	3.01
10	Earth and Planetary Sciences	686	2.73
11	Chemical Engineering	681	2.71
12	Social Sciences	475	1.89
13	Materials Science	446	1.76
14	Computer Science	354	1.41

15	Veterinary	351	1.40
16	Nursing	329	1.31
17	Multi-disciplinary	309	1.27
18	Physics and Astronomy	231	0.91
19	Mathematics	199	0.79
20	Neuroscience	119	0.47
21	Business, Management and Accounting	97	0.39
22	Health Professions	81	0.32
23	Dentistry	67	0.26
24	Arts and Humanities	65	0.26
25	Economics, Econometrics and Finance	61	0.24
26	Psychology	30	0.12
27	Decision Sciences	24	0.10

Growth of publications

The growth in the number of publications is measured by means of two related parameters viz. RGR and D_t (Mahapatra, 1985). RGR in classical growth analysis is defined as: $RGR = (\ln S_2 - \ln S_1) / (t_2 - t_1)$. Here S_2 and S_1 are the cumulative publications in 2 years t_2 and t_1 . In the present analysis, $t_2 - t_1$ is taken as one year. RGR can then be expressed as $RGR = \ln (S_2/S_1)$. The D_t is the time required for publications to double in number for a given RGR. D_t is expressed as: $D_t = (t_2 - t_1) \ln 2 / (\ln S_2 - \ln S_1)$ or $D_t = \ln 2 / RGR$.

A constant value for RGR in each year subsequently is an indication that the growth rate is exponential. The D_t is a characteristic time for this exponential growth. Table 4 indicates the annual number of biotechnology publications, their cumulative number, RGR, and D_t for the period 1988–2018. Starting from 86 publications in 1988 to 14,783 in 2018, the data indicate a significant increase in the number of publications per year.

When the data retrieved from Scopus were analyzed, it was discovered that Scopus included the top Nigerian research journals, i.e., *Nigerian Journal of Clinical Practice* in 2005, *Nigerian Postgraduate Medical Journal* in 2000, *Nigerian Journal of Medicine*, *Journal of The National Association of Resident Doctors of Nigeria* in 2001, *Nigerian Journal of Physiological Sciences* (2006), *Nigerian Journal of Parasitology* in 2010. The inclusion of these top journals is reflected in the increase in the number of publications for the last decades. The growth rate of publications (Figure 1a) over the previous 30 years (1988–2018) is an impressive 17 percent.

Quality of Publications

The number of citations that a paper receives is a good measure of its quality and importance. In columns six and seven of Table 6, the number of citations a paper received for that year is listed, and the average citations per paper (ACCP), respectively. The citations already reported in a certain year are not included in the subsequent year. Figure 1b shows the growth trend in the number of citations. For the period 2012–2018, the number of citations to biotechnology publications is low.

Table 4. Nigerian Biotechnology Research Output, Relative Growth Rate, Doubling Time, Citations

Years	Number of Publications	Cumulative	RGR	Dt	Citation	Citations per paper
1988	86				973	11.31
1989	97	183	0.76	0.92	1298	13.38
1990	127	310	0.53	1.32	1786	14.06
1991	118	428	0.32	2.15	1220	10.34

1992	115	543	0.24	2.91	1679	14.60
1993	105	648	0.18	3.92	1717	16.35
1994	100	748	0.14	4.83	1181	11.81
1995	78	826	0.10	6.99	1323	16.96
1996	127	953	0.14	4.85	1714	13.50
1997	113	1066	0.11	6.19	1876	16.60
1998	152	1218	0.13	5.20	2578	16.96
1999	130	1348	0.10	6.83	2353	18.10
2000	152	1500	0.11	6.49	2241	14.74
2001	148	1648	0.09	7.37	2820	19.05
2002	188	1836	0.11	6.42	2569	13.66
2003	237	2073	0.12	5.71	4284	18.00
2004	265	2338	0.12	5.76	5029	18.98
2005	310	2648	0.12	5.57	5982	19.30
2006	457	3105	0.16	4.35	8307	18.18
2007	552	3657	0.16	4.24	9337	16.91
2008	641	4298	0.16	4.29	10938	17.06
2009	751	5049	0.16	4.30	9083	12.09
2010	794	5843	0.15	4.75	11478	14.46
2011	947	6790	0.15	4.61	11834	12.50
2012	923	7713	0.13	5.44	8808	9.54
2013	921	8634	0.11	6.14	8108	8.80
2014	1027	9661	0.11	6.17	9737	9.48
2015	1015	10676	0.10	6.94	7929	7.81
2016	1169	11845	0.10	6.67	8458	7.24
2017	1323	13168	0.11	6.54	5894	4.46
2018	1615	14783	0.12	6.00	2707	1.68

Figure 1a. Publications in Biotechnology, 1988–2018.

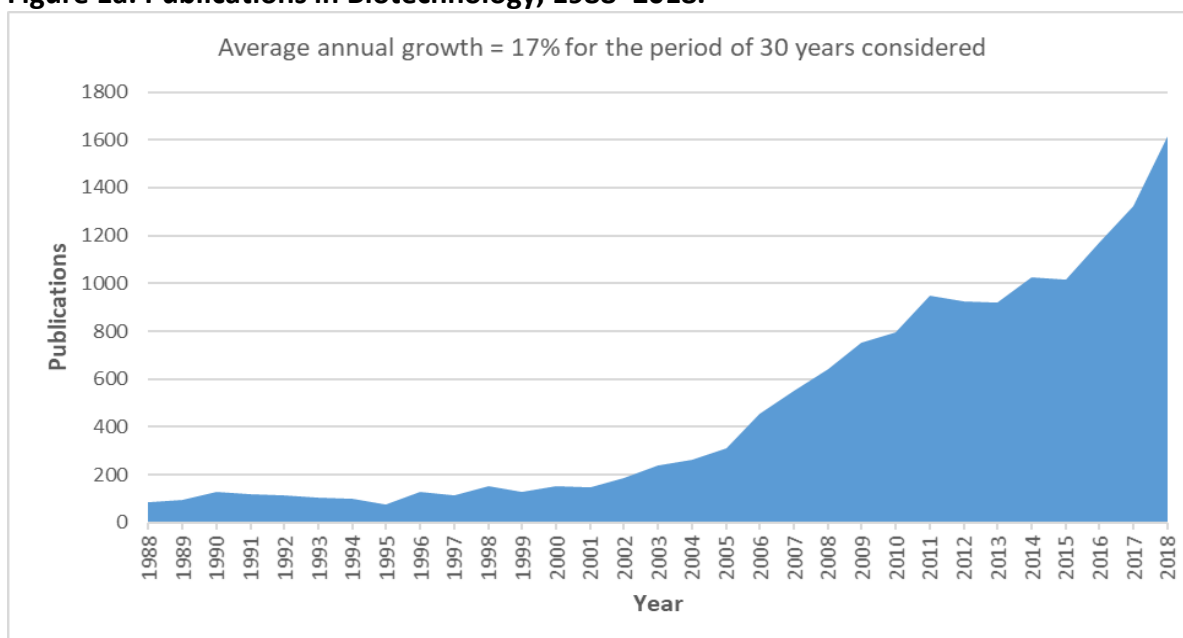
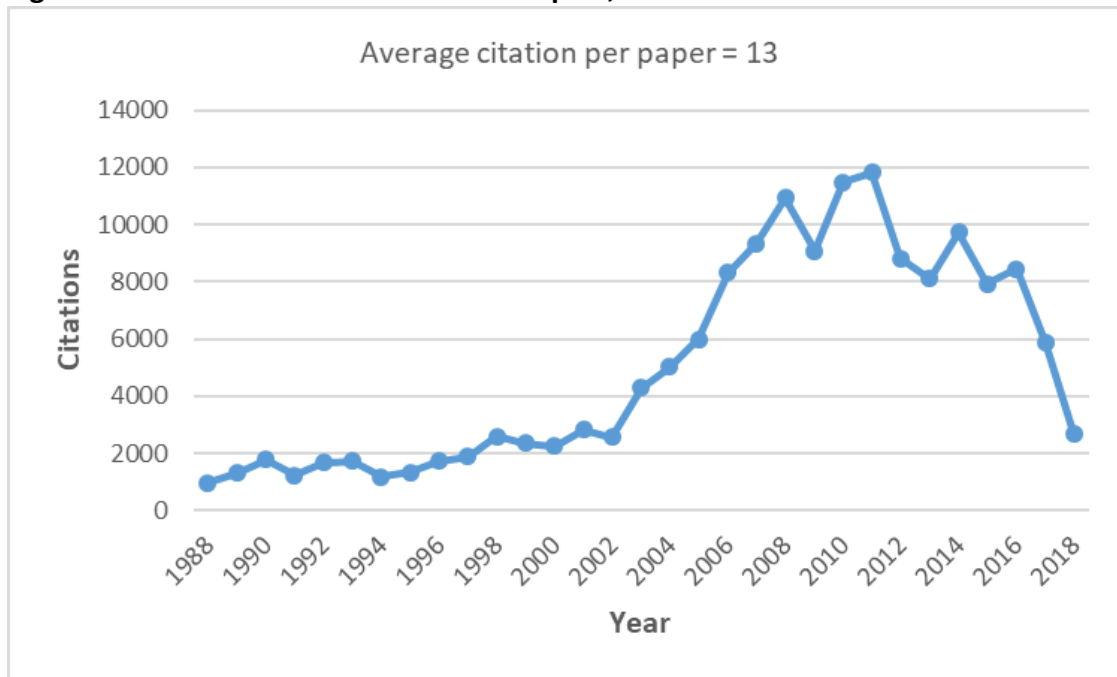


Figure 1b. Total Citations of Published Papers, 1988–2018



In Table 5, we present the total publications (TP), total citations (TC), ACPP for the top 20 Nigerian institutions with biotechnology publications for the period 1988–2018.

The University of Ibadan (UI) tops the table. The University has University College Hospital (UCH) affiliated to it, thus contributing towards this field. UI

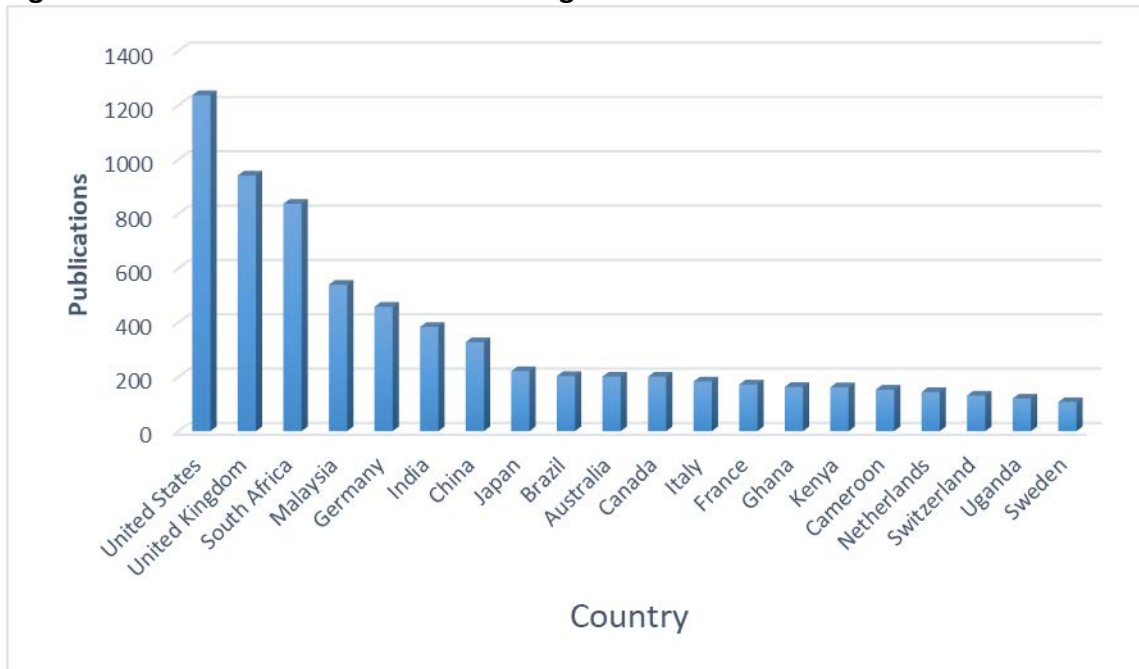
is the first and leading university in the country. UI is closely followed by the University of Lagos (UNILAG); just like UI, UNILAG has the University of Lagos College of Medicine attached, while the University of Nigeria (UNN) comes after. The Medical sector dominates the field of biotechnology in the country.

Table 5. Top 20 Nigerian Institutions per Biotechnology Publications, Citations, Indices

	Institution	TP	TC	ACPP
1	UI	2545	29906	11.75
2	UNILAG	1237	8370	6.77
3	UNN	1115	481	0.43
4	OAU	1111	10837	9.75
5	ABU	760	256	0.34
6	UNIBEN	688	6351	9.23
7	UNILORIN	661	5504	8.33
8	FUTA	548	5502	10.04
9	LASU	508	1061	2.09
10	UNIPORT	487	5176	10.63
11	IITA	472	9423	19.96
12	LAUTECH	396	3778	9.54
13	UNICAL	388	4396	11.33
14	CU	376	2540	6.76
15	UNIZIK	317	190	0.60

16	UNIMAID	292	3998	13.69
17	UNIJOS	275	3077	11.19
18	UNIUYO	272	2595	9.54
19	OOU	270	2350	8.70
20	FUTO	232	2088	9.00

Figure 2. Research Publications with Foreign Collaboration



Collaboration with Foreign Partners

Figure 2 represents the distribution of the number of publications involving collaboration with the top 20 foreign partners. The total number of these publications is 9,813, which is about 66 percent of the total.

Discussion

The trend of biotechnology research in Nigeria shows that it has a major impact on the health and agricultural sectors. However, based on the quantitative analysis done in the last two sections, it can be observed that among the top 20 institutions contributing to biotechnology research in Nigeria, only one research institute also made that list of the most productive institution in publication quality. It can be said logically that more research institutes will lead to an increase in quality research production.

Conclusion

Tracing the research in the field of biotechnology in Nigeria from 1988, the number of research publications in the field of biotechnology has shown a rising trend. From 86 publications in 1988, the number increased to 14,783 for 2018. The majority of these publications (19.92%) are related to medicine, followed by agricultural and biological (17.08%), biochemistry, genetics, and molecular biology (10.98%), and environmental science (7.93%). The concentration of research is mainly in universities. Among the top 20 institutions contributing to biotechnology research, 19 are universities, and the remaining one is an R&D organization. It was found that 63.38 percent of the publications have foreign collaborators associated with them.

The University of Ibadan has the highest number of publications (2,545), although IIT and UNIMAID, with an ACPP of 19.96 and 13.69 respectively, show a better quality of publications.

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