

## A measure of research productivity of Nigerian universities: a bibliometric analysis

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### Abstract

The need for sustainable evaluation of the research process and performance in Nigerian universities cannot be overemphasised. The present study used bibliometric analysis with publication output as a major indicator to evaluate research performance and productivity in Nigerian universities. The research results revealed that the first generation universities owned by the federal government are the five most productive universities in Nigeria. Biotechnology and applied microbiology is the most productive subject area, while research in basic sciences (physics, mathematics and chemistry) is low since these subjects are not among the top 20 subject areas in Nigeria. The results also revealed significant growth and progress in research and publications in Nigerian universities in the late 2000s. In terms of citation count and analysis, the University of Ibadan tops the list with 7.5 cites per article and a 38 h-index. It is recommended that more resources should be put into research in the basic sciences for effective scientific/technological development in Nigeria. It is further recommended that the National Universities Commission (NUC) generate relevant parameters/indicators for the national evaluation and ranking of Nigerian universities. Developing a national database of all the researchers, with their publications, at Nigerian universities is highly recommended.

### Introduction

Universities are established so that academic staff (referred to in this paper as “researchers”) can impart knowledge for societal development through teaching and research. According to Gomez, Bordons, Fenandez and Morillo (2007), universities play a significant role in the advancement of science in most countries by contributing “to the production of new knowledge, its transmission, its dissemination and its use in technical innovation”. These authors contend that university research is essential in developing the industrial, social and cultural values of a nation. The quality of research that is carried out in a given university determines to a large extent the quality of knowledge that is imparted to the larger society. Publication output is one of the critical indicators of the research productivity of researchers at universities. Thus productivity is defined by most scholars in terms of publication output by counting the number of papers that are produced by individual or groups of researchers, universities, countries/regions and disciplines over a period of time (Ani, Esin & Inyang, 2003; Pienta, 2004; Bottle, Hossein, Bottle & Adesanya, 1994).

Experts use publications count in the assessment and evaluation of research performance of individual researchers, universities, countries/regions and disciplines. Bottle et al (1994) conducted a comparative study of the productivity of senior academic chemists in the United Kingdom (UK) and the productivity of their counterparts at American universities between 1980 and 1991. They used the Web of Science as their database. Their findings indicated no apparent “significant difference in productivity between the two countries, UK and USA”. However, in the same study it was found that the British chemists published significantly more papers than their Nigerian counterparts over the same period. Pienta (2004) used two databases – the Web of Science and the ACS Directory of Graduate Research (DGR) (a database that “lists faculty and publications from all colleges and universities in the US and

Canada that grant master's and doctoral degrees") – to show that differences exist between individual researchers in the field of chemical education in the United States (US). Dhawan and Gupta (2007), from data collected with the Web of Science, found that of the 1307 institutions in India that participated in physics research between 1993 and 2001, 64 "were rated as high productivity institutions (HPIs) with each publishing at least 100 papers during 1993-01".

A productivity analysis by Markusova, Jansz, Libkind and Varshavsky (2007), for which a combination of data sources was used, indicated clinical medicine as the most productive scientific discipline in the USSR/Russia and the US in 1988 and 2001. Thus productivity measure has helped scholars to stay abreast of trends in scientific/technological progress and development, and is used as a tool for the allocation of resources in research. Productivity measure can be used in policy formulation on a global, international, national and institutional level in tackling inefficiency in research among researchers and universities. It is used by most governmental agencies/organizations for funding of research to generate effective knowledge in different disciplines.

Dore, Ojasoo, Okubo, Durand, Dudognon and Miquel (1996), in a study of publication patterns of 48 countries between 1981 and 1992 for which they used the Web of Science, found that the US was the most productive country in the world in terms of research; in Africa, South Africa was ahead of Egypt and Nigeria, while clinical medicine was the most productive discipline with 18.6% of the total publication output. A recent study by Pouris and Pouris (2007) has confirmed South Africa (30.1%) and Egypt (20.2%) as the two leading countries in African research, followed by Morocco (7.9%) and Nigeria (5.9%). It has been observed that there is paucity of literature in productivity measure and the evaluation of research performance in Nigeria, and the present study is intended to fill this gap.

Nigerian universities are classified into federal universities, state universities and (recently) private universities (a law to establish private universities was promulgated by the federal government of Nigeria in 1993). The federal universities are categorised into three basic groups:

- First generation universities. Five universities were established between 1948 and 1962.
- Second generation universities. Eight universities were established between 1970 and 1975.
- Third generation universities. These are universities that were established between 1980 and 1992 and are basically specialised universities (i.e. universities of science and technology and universities of agriculture).

The federal and state universities in Nigeria are referred to as public universities. The establishment of state universities began in 1979 with Rivers State University of Science and Technology in Port Harcourt, while the first three private universities were founded in 1999. Currently, there are 36 federal universities, 36 state universities and 41 private universities in Nigeria (National Universities Commission, 2011). The National Universities Commission (NUC) is a regulatory agency for all Nigerian universities which sets general standards for academic programmes and courses in the universities and issues licenses for the establishment of new universities. The NUC has been in the forefront of working for modalities for the evaluation of research performance in Nigerian universities and the national ranking of the universities in view of their abysmal performance in the global and webometric ranking of world universities. Nigerian universities generally lag behind other universities in terms of the global ranking of universities; In Africa, only a few universities in Nigeria make the list of top

100 universities (4International Colleges & Universities, 2010). This paper provides a basis and modalities for the national ranking of universities in Nigeria, with the aim of helping to generate local parameters/indicators for the future ranking of Nigerian universities that are in line with the global trend in “comparative analyses of performance of universities at national level” (Visser, Medina & Moed, 2007).

### **Objectives**

The objectives of the study are similar to that of Gomez et al (2007) and can be outlined as follows:

1. To identify the most productive universities in Nigeria and their publication output per year
2. To identify main subject areas of research by Nigerian researchers
3. To determine the trend in publication output in Nigerian universities between 2000 and 2010
4. To determine the sources of publication by Nigerian researchers
5. To assess the citation count and impact of the most productive universities in Nigeria
6. To find out the main language of publication by Nigerian researchers

### **Methodology**

Three databases on the Web of Science portal were used to obtain data for this study. These databases are the Science Citation Index (SCI), the Social Science Citation Index (SSCI) and the Arts and Humanities Citation Index (AHCI). From several bibliometric indicators of research performance evaluation (such as publication output, citation analysis, impact factor and patent), only publication output and citations count and impact were used for the present study. The choice of publication output and citation count and impact is due to the fact that they are the commonest bibliometric indicators that are used in research output and impact assessments. As Pienta (2004) opines, publication output and citation impact are among the performance indicators that are generally considered as objective and quantitative when measuring research output and impact. This observation has also been made by Lancaster (1991), the Committee on Science, Engineering, and Public Policy (COSEPUP) (2004), Garfield (1996) and Jacobs (2000). Besides the use of opinion polls, Brown (1993) identifies three main approaches to evaluating scientific productivity besides the use of opinion polls, namely: peer review, the analysis of competition for funds and citation analysis.

Given that there is no national bibliographic or citation database in Nigeria that can be used to evaluate research output in the country, we opted to use a common source of data – the Web of Science – for this study. According to Abrahams, Burke and Mouton (2010), the Web of Science currently indexes articles across the world in over 10 000 journals in all fields of science. It also indexes publications in the social sciences as well as in the arts and humanities. Abrahams et al (2010) observe the following about the Web of Science: “as [an] original bibliometric database, it is regarded by most scholars as the benchmark for international visibility”. The portal has added two other databases, namely Conference Proceedings Citation Index – Science (CPCI-S) (which indexes peer-reviewed conference proceedings from 2005) and Conference Proceedings Citation Index – Social Science & Humanities CPCI-SSH) (which covers proceedings published since 2005). Thus the choice of

the Web of Science to conduct the current study will put Nigerian universities on the same level as other universities internationally for the evaluation of their research performance. This study was limited to published journal articles since they are the basic means of communicating research findings. A search query (CU=Nigeria) was performed using the Advanced Search platform to retrieve all articles containing the word “Nigeria” in the country of origin field. The search was limited to articles that were published between 2000 and 2010. An analysis of the records using the Web of Science’s in-built Analyse option was conducted according to the *publication year* to exclude records of articles that fell outside the 2000 to 2010 period, which was the subject of this study. It was observed that even if a searcher limited the period of study to specific years, the search would still have retrieved records of articles that were published in years that were not the subject of analysis, hence the aforementioned analysis by year of publication. The Analyse option was used to identify the most productive universities, trends in the publication of research in Nigeria, the subject focus of research by Nigerian researchers, and language of publication. Efforts to identify the most productive institutions in terms of research in Nigeria were limited to universities only. The results for university teaching hospitals were merged with their parent institutions, for example the articles that bore the name of the University College Ibadan were merged with those that were published by the University of Ibadan. Non-university institutions such as the Institute of Tropical Agriculture, Cocoa Research Institute of Nigeria and Federal Polytechnic (which featured among the top institutions) were excluded from the analysis. However, when analysing the most researched subject areas (language of publication, trend of publication and sources of publication), no distinction was made since we were mostly concerned with the most common variables as opposed to the number of articles for each variable. We noted, however, that the number of articles provided us with the most productive variables. Our assumption was that the same variables would apply to research performance by universities in Nigeria and therefore give us a reasonably fair picture of the subject areas of research, language of publication, trend of publication and sources of publication. The Create Citation Report option on the results interface of the Web of Science portal was used to obtain citation counts, average citations per paper and the h-index for each top-ranked university in Nigeria – the purpose of which was to assess and compare the impact of research among the universities under investigation.

## Results

The results of the study are presented and discussed under the following sub-headings: publication output by Nigerian universities per year; subject areas of research by Nigerian researchers; trends in publication output in Nigeria; sources of publication; citation count and analysis of top universities; and language of publication.

### *Publication output by Nigerian universities per year*

The results of the study in table 1 show the productivity of the top 20 universities in Nigeria in terms of their publication output as an indicator of research output. The table shows that the University of Ibadan was the most productive with a total of 2 310 articles, which accounted for 17.1% of the total number of publications that was produced in Nigeria. In the second place was the Obafemi Awolowo University (which published 1 352 [10.0%] articles, followed closely by the University of Nigeria (1 044, 7.7%), Ahmadu Bello University (854, 6.3%) and the University of Lagos (813, 6.0%). In terms of the average number of articles per year, the University of Ibadan produced 210 articles, followed by the Obafemi Awolowo University (122.9), the University of Nigeria (94.9), Ahmadu Bello University (77.6) and the University of Lagos (73.9).

**Table 1: Top 20 universities in Nigeria and publication output**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Av/yr
Univ Ibadan	127	109	131	125	130	174	186	278	385	335	330	2310	210.0
Obafemi Awolowo Univ	75	59	77	80	87	116	139	166	214	198	141	1352	122.9
Univ Nigeria	61	57	61	54	61	70	66	90	161	171	192	1044	94.9
Ahmadu Bello Univ	64	58	60	74	62	57	54	84	127	100	114	854	77.6
Univ Lagos	40	23	38	35	49	56	66	109	149	132	116	813	73.9
Univ Benin	46	36	39	40	34	52	74	104	118	133	100	776	70.5
Univ Agr	32	37	29	32	42	54	50	78	109	71	90	624	56.7
Fed Univ Technol Akure	1	8	23	16	23	49	49	60	62	67	55	413	37.5
Univ Calabar	30	26	24	17	25	34	25	39	48	46	57	371	33.7
Univ Port Harcourt	15	10	13	17	22	35	41	49	42	56	43	343	31.2
Olabisi Onabanjo Univ	0	1	2	12	24	33	32	46	54	54	55	313	28.5
Univ Jos	40	24	22	12	22	24	29	25	39	36	36	309	28.1
Ladoke Akintola Univ Technol	13	7	11	19	16	26	21	45	46	52	45	301	27.4
Lagos State Univ	4	8	8	13	14	22	22	34	42	69	55	291	26.5
Univ Maiduguri	29	22	26	15	15	13	20	23	29	43	37	272	24.7
Univ Uyo	11	10	15	11	11	15	20	22	38	61	53	267	24.3
Rivers State Univ	14	11	24	18	19	19	28	43	28	23	18	245	22.3
Sci & Technol Fed Univ Technol Owerri	2	6	14	10	17	24	25	38	35	20	28	219	19.9
Nnamdi Azikiwe Univ	25	12	17	10	8	10	11	14	30	30	29	196	17.8

An examination of the universities according to sponsoring agencies showed that public universities (ie state and/or federally-owned universities) performed better than private universities. A similar pattern was observed by Gomez et al (2007), who examined the performance of public (federal and state) and private Spanish universities. They explained the public universities better performance in research as follows: "... public universities are older than private ones and show a larger size as measured through the number of students and professors". The same factors might have influenced the pattern in Nigeria. From the results in table 1, it is clear that the top 20 universities were public universities. This shows that the productivity of Nigerian universities might be influenced by ownership, generation, the size/nature of the universities (i.e. conventional and specialised) and the year of their establishment. This might explain why no private universities that had been established more recently and were smaller than the public universities made it to the top 20 universities in Nigeria.

It was also observed that all five first generation universities were among the top universities in Nigeria. In fact, all five most productive universities in Nigeria were first generation universities. These universities are conventional in nature, with large student populations and a number of experienced researchers. These universities are also better funded and equipped than the other universities. For instance, the University of Ibadan (which is the oldest university in Nigeria) has the following characteristics: it receives special funding from the federal government; it has the largest number of postgraduate students; it attracts the highest number of external grants for research by seasoned researchers; and it is involved in international collaborations, among other things. This can explain why the University of Ibadan was the most productive university in Nigeria from 2000 to 2010.



*Subject areas of research by Nigerian researchers*

The results of the evaluation of research and publication output in terms of subject areas as described by the Web of Science are presented in table 2 below.

**Table 2: Publication output per subject category in Nigeria, 2000–2010 (N=13493)**

<b>Subject category</b>	<b>No of articles</b>	<b>Percentage</b>
Biotechnology & Applied Microbiology	1389	10.29
Food Science & Technology	1032	7.65
Public, Environmental & Occupational Health	909	6.74
Pharmacology & Pharmacy	758	5.62
Plant Sciences	711	5.27
Environmental Sciences	678	5.02
Tropical Medicine	670	4.97
Medicine, General & Internal	653	4.84
Agronomy	538	3.99
Agriculture, Multidisciplinary	511	3.79
Chemistry, Medicinal	501	3.71
Multidisciplinary Sciences	477	3.54
Chemistry, Applied	358	2.65
Veterinary Sciences	353	2.62
Obstetrics & Gynecology	328	2.43
Engineering, Chemical	323	2.39
Pediatrics	284	2.10
Energy & Fuels	282	2.09
Nutrition & Dietetics	265	1.96
Parasitology	264	1.96

Biotechnology and applied microbiology is the most researched subject area in Nigeria and, by implication, in Nigerian universities. It is obvious from the results that scientific, medical, technological and agricultural subject areas dominate the top 20 subject areas in Nigeria. In fact, over 50% of the total number of articles that were published in Nigeria was in the six top-ranked subject categories, which implies that the subjects can be considered as the core areas of research in Nigeria and at Nigerian universities. It is important to note that Nigeria is not doing well in terms of the basic sciences (such as physics, mathematics and chemistry). This leads us to believe that the pattern can be reversed if more attention is given to effective and sustainable research in the basic sciences since they are pivotal in the technological development and innovation of any nation.

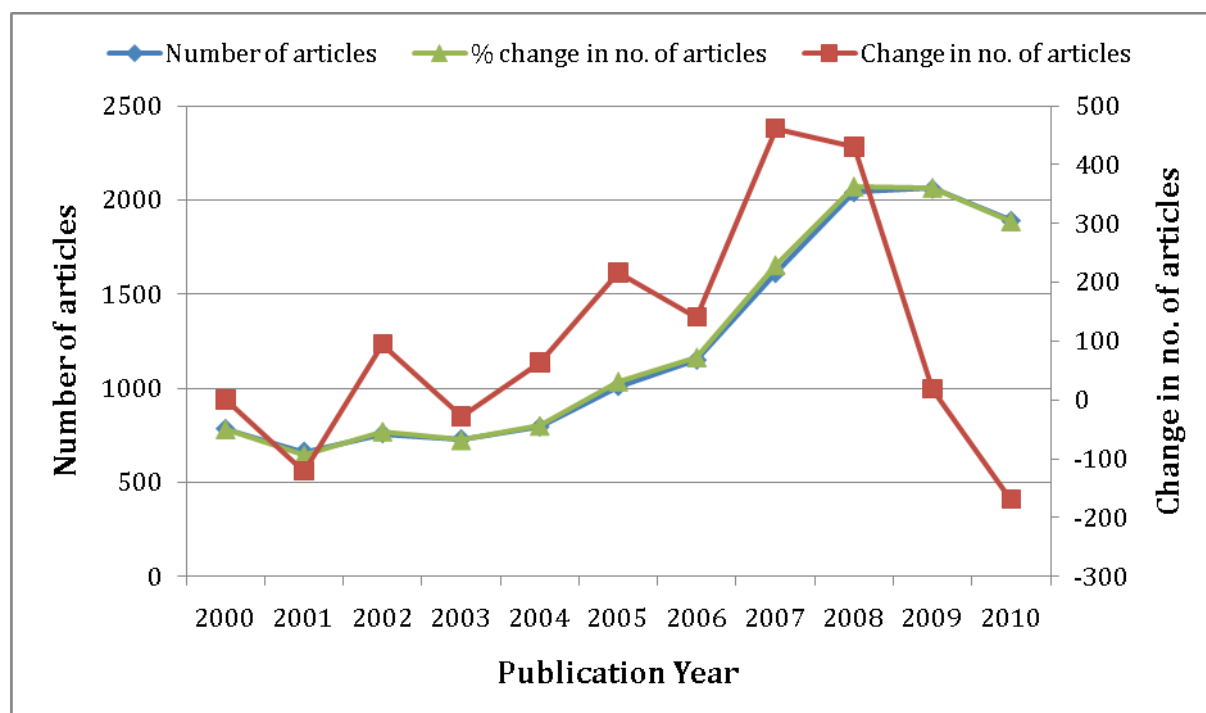
Another factor that might have led to the sciences performing better than the social sciences and arts and humanities is the coverage of Nigerian research in the citation databases that were used in this study. An analysis of the Nigerian research (according to the citation index in which the articles are indexed) revealed that overall the Science Citation Index (SCI) yielded a total of 12 545 articles, while the Social Sciences Citation Index (SSCI) and the Arts and Humanities Citation Index (AHCI) produced 1 411 and 166 articles respectively. As the analysis of articles by the sources of publication (i.e. journals) will reveal later in this paper, the majority of the Nigerian journals that were covered in the three databases were science-based; only two journals were social sciences-based and none was arts and humanities-based.

*Trends in publication output in Nigeria and Nigerian universities*

Figure 1 shows the trends in publication output in Nigeria by publication year from 2000 to 2010, while table 1 shows the trends in publication output of the top 20 universities. The two illustrations have similar patterns. In fact, a Pearson correlation test that was conducted (using the Microsoft Excel in-built formula “=Pearson( $x$ ,  $y$ )”) between the universities’ individual total production per year ( $x$ ) against the aggregated number of publications in Nigeria per year ( $y$ ) produced the Pearson product moment correlation coefficient of  $r=0.992$  for the University of Ibadan. The  $r$  values for the other top-ranked universities in table 1 were as follows: the Obafemi Awolowo University ( $r=0.944$ ); the University of Nigeria ( $r=0.929$ ); the Ahmadu Bello University ( $r=0.881$ ); the University of Lagos ( $r=0.989$ ); the University of Benin ( $r=0.980$ ); the University of Agriculture ( $r=0.928$ ); Federal University of Technology Akure ( $r=0.883$ ); University of Calabar ( $r=0.901$ ); University of Port Harcourt ( $r=0.891$ ); Olabisi Onabanjo University ( $r=0.929$ ); University of Jos ( $r=0.628$ ); Ladoké Akintola University of Technology ( $r=0.967$ ); Lagos State University ( $r=0.943$ ); University of Maiduguri ( $r=0.704$ ); University of Uyo ( $r=0.911$ ); Rivers State University of Science and Technology ( $r=0.480$ ); Federal University of Technology Owerri ( $r=0.745$ ); and Nnamdi Azikiwe University ( $r=0.738$ ). Except for the Rivers State University of Science & Technology, which recorded a correlation coefficient below 0.5 (thereby showing a weak relationship), all the universities had a correlation value higher than 0.7. If each of the values was rounded up to the nearest whole number, each of the universities would have recorded a correlation coefficient value of 1(one), which implies a perfect relationship between the individual university’s total production per year and the aggregated number of publications in Nigeria per year.

The results in both cases (ie individual and aggregated) reveal a significant increase in publication output in the late 2000s, although with a slight decrease in 2010. This shows that there is a significant level of growth in research and publication output in Nigeria in general and in Nigerian universities in particular, and this needs to be improved upon if the country wants to achieve higher rates of national development. The pattern of increased activity in research might be attributable to the relative improvement in government funding for education, training and research through better budgetary allocation of funds to universities. We believe that if this trend persists, research output will continue to increase. There is a need for private sector intervention whereby multinational companies could sponsor research in universities in key subject areas that are pertinent for sustainable national development.

A close examination of figure 1 below reveals that whereas the national research output has continued to increase, this growth has had mixed patterns in some periods (e.g. 2006 and 2008), with recorded drops in the number of articles from the previous period. The line graph representing the change in the number of articles attests to this pattern. It can therefore be said that the growth of research output in Nigeria, and by extension in Nigerian universities, is linear in nature and not exponential.



**Figure 1: Trends in publication output in Nigeria, 2000–2010**

#### *Sources of publication*

Table 3 shows the journals in which Nigerian researchers publish their research articles. The leading journal in terms of the number of articles was the *African Journal of Biotechnology*, which published a total of 1 123 articles (accounting for 8.32% of the total Nigerian publication output between 2000 and 2010). *Tropical Doctor* came a distant second with 201(1.49%) articles, followed by the *Nigerian Journal of Clinical Practice* (199, 1.47%), *Scientific Research and Essays* (184, 1.36%) and the *African Journal of Agricultural Research* (160, 1.19%). The top 20 journals (listed in table 3) published approximately 25% of Nigeria's total number of publications and can therefore be considered the core journals in which Nigerian researchers publish their research findings.

It was noted that the majority of the top 20 journals were based in foreign countries – not only outside Nigeria, but also not in Africa. Similar findings were reported by Onyancha and Ocholla (2008). It has been observed that authors from developing countries prefer to publish in foreign (international) journals, which are regarded as superior in quality to regionally published journals (Onyancha & Ocholla, 2004; Onyancha & Ocholla, 2008). Notwithstanding this observation, five Nigerian journals feature among the top 20 journals listed in table 3. According to the available data, in the 2009 JCR (Journal Citation Reports®), the Institute of Scientific Information's (ISI) citation indexes covers only 10 Nigerian journals, namely: *African Journal of Agricultural Research*; *African Journal of Microbiology Research*; *African Journal of Pharmacy and Pharmacology*; *African Journal of Traditional Complementary and Alternative Medicines*; *International Journal of Physical Sciences*; *Journal of Medicinal Plants Research*; *Scientific Research and Essays*; *Tropical Journal of Pharmaceutical Research*, *African Journal of Business Management* and *African Journal of Library Archives and Information Science*. The last two journals are indexed in the subject area social sciences.

The 10 journals that are indexed in ISI databases constitute a mere 3.1% of the academic/scholarly journals published in Nigeria. According to Ulrich Web's Global Serials Directory (accessed 14 March 2010), Nigeria publishes a total of 326 academic/scholarly journals. Of these journals, 194 are online journals; 184 constitute the refereed journals; and



132 are covered in at least one abstracting and indexing service, while 23 are on open access. It goes without saying that the majority of the publications produced in Nigeria and published in Nigerian journals are not covered in ISI databases, a situation that underestimates the total research output emanating from Nigerian universities. It is because of the ISI's bias in their coverage of African-based journals that some writers have called for the development of an African citation index (see Nwagwu, 2005; Nwagwu, 2007).

**Table 3: Sources for publishing Nigerian research (N=13493)**

<b>Journal</b>	<b>No of articles</b>	<b>Percentage</b>
African Journal of Biotechnology	1123	8.32
Tropical Doctor	201	1.49
Nigerian Journal of Clinical Practice	199	1.47
Scientific Research And Essays	184	1.36
African Journal of Agricultural Research	160	1.19
Journal of Food Agriculture and Environment	158	1.17
Journal of Ethnopharmacology	136	1.01
Journal of the National Medical Association	126	0.93
African Journal of Microbiology Research	110	0.82
Journal of Medicinal Plants Research	107	0.79
International Journal of Physical Sciences	104	0.77
Journal of Home Economics Research	103	0.76
Discovery and Innovation	91	0.67
International Journal of Gynecology and Obstetrics	89	0.66
Journal of Animal and Veterinary Advances	88	0.65
Journal of Obstetrics and Gynaecology	87	0.64
Food Chemistry	80	0.59
Journal of Food Science and Technology-Mysore	79	0.59
African Journal of Pharmacy and Pharmacology	75	0.56
Asian Pacific Journal of Tropical Medicine	74	0.55

#### *Citation count and analysis of top universities*

An analysis of the citation count and impact revealed mixed patterns because some universities performed better than others in citation count, while they performed poorer in terms of citations per paper and/or h-index. The most cited university was the Univ Ibadan which received 16744 citations followed by Obafemi Awolowo Univ (4046), Univ Nigeria (3383), Univ Lagos (2720), Univ Benin (2329) and Ahmadu Bello Univ (2252). In terms of cites per paper, the Univ Ibadan and the Fed Univ Technol Akure posted 7.25 cites per article each followed by the Federal University of Technology Owerri (4.68), University of Calabar (4.55) and University of Jos (4.47). The highest h-index of 38 was scored by the University of Ibadan and the Federal University of Technology Akure. The Univ Nigeria recorded a h-index of 24, followed by Obafemi Awolowo University and University of Lagos with h-indices of 22 and 21 respectively.

Table 4: Citation count and analysis of Nigerian universities' publication output

	No of articles	No of cites	Cites per article	h-index
Univ Ibadan	2310	16744	7.25	38
Obafemi Awolowo Univ	1352	4046	2.99	22
Univ Nigeria	1044	3383	3.24	24
Ahmadu Bello Univ	854	2252	2.64	17
Univ Lagos	813	2720	3.35	21
Univ Benin	776	2329	3.00	21
Univ Agr	624	1599	2.56	15
Fed Univ Technol Akure	413	1160	7.25	38
Univ Calabar	371	1689	4.55	20
Univ Port Harcourt	343	1163	3.39	17
Olabisi Onabanjo Univ	313	1018	3.25	16
Univ Jos	309	1380	4.47	17
Ladoke Akintola Univ Technol	301	841	2.79	14
Lagos State Univ	291	646	2.22	12
Univ Maiduguri	272	873	3.21	14
Univ Uyo	267	782	2.93	15
Rivers State Univ Sci & Technol	245	640	2.61	11
Fed Univ Technol Owerri	219	1025	4.68	18
Nnamdi Azikiwe Univ	196	500	2.55	10
Delta State Univ	195	273	1.40	8

When we compared the performance of Nigerian universities with their counterparts in countries such as South Africa, we noted that most Nigerian universities' citation count and impact were low. The 2009 Essential Science Indicators (ESI), for instance, records that the University of Cape Town published a total of 9 639 articles, which received a total of 106 960 citations (therefore a posting of 11.10 average citations per paper). The University of Pretoria recorded an average of 6.26 citations per paper from a total of 7 072 articles and 44 275 citations, while the University of Stellenbosch published 6 463 articles between 2000 and 2010 and received 59 472 citations (which accounted for 9.20 citations per paper).

#### *Language of publication*

The predominant language of publication of Nigerian research articles was English, which yielded a total of 13 454 articles and accounted for 99.71% of the total Nigerian publication output. The second-placed language was French – with 29 (0.21%) articles, followed by Spanish (4, 0.03%), German (2, 0.01%), and Turkish (2, 0.01%). Portuguese and Romanian yielded one (0.01%) article each. These findings of the study in terms of the high level of English usage by Nigerian researchers are plausible because English is the national language in Nigeria and is the medium of teaching and instruction throughout the Nigerian education system (i.e. from the universal basic education to tertiary education).

#### **Conclusion and recommendations**

The need for the sustainable evaluation of the research process and performance in Nigerian universities cannot be overemphasised. The present study used bibliometric techniques and more particularly publication output and citation analysis to assess research performance at Nigerian universities. The results revealed that the first generation universities, which are

owned by the federal government, are the most productive universities in Nigeria; biotechnology and applied microbiology is the most productive subject area in Nigeria; and research in the basic sciences of physics, mathematics and chemistry is low. The study also revealed significant growth and progress in research and publication in Nigerian universities in the late 2000s – a situation that correlated with the patterns witnessed in the analysis of the national research output. In terms of citation count and analysis, most universities in Nigeria registered low counts when compared to universities in other African countries such as South Africa. The University of Ibadan topped the list with 7.5 cites per article and a h-index of 38. It was also noted that Nigerian researchers prefer publishing in foreign journals as opposed to the regionally published journals. Nevertheless, a few Nigerian universities featured among the top 20 journals in which Nigerian researchers publish their research findings, which imply that researchers also disseminate their research findings in local journals.

The paper recommends that more resources should be put into research in the basic sciences for effective scientific/technological development in Nigeria. The paper also recommends that the NUC should generate relevant parameters/indicators for the national evaluation and ranking of Nigerian universities in view of the emergence of international rankings of universities such as webometric rankings of world universities in which Nigerian universities significantly lag behind their counterparts internationally and even in Africa. In view of the Web of Science's limited coverage of local journals in Nigeria, it is recommended that the NUC should develop a national database to index Nigerian publications.

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