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Webometric analysis of the visibility, reach and impact of food science research publications: institute of agricultural research and training, ibadan (1972-2023)

Abstract

This study evaluated the visibility, reach and impact of Food Science research publications from the Institute of Agricultural Research and Training (IAR&T) in Ibadan, Nigeria, over the period 1972-2023. Utilizing webometric analysis, data were collected from Google Scholar, Research Gate, and Scopus, focusing on citation metrics, article counts, and online engagement. A total of 745 scholarly articles across various food science disciplines, including Food Microbiology, Human Nutrition, Meat Science, Nutritional Biochemistry, and Food Science Technology and Biotechnology, were analyzed. The study incorporated log file data from the 14 food scientists' profiles, examining a total of 9,392 cited works. These citations were derived from materials indexed by Google Scholar (5,221 citations), Research Gate (3,358 citations) and Scopus (813 citations). Findings revealed that Food Science Technology and Biotechnology had the highest number of articles and citations, with 257 articles (64.4% of total) on Google Scholar and 3,108 citations (60% of total). Research Gate showed 171 articles (65% of total) with 2,249 citations (67% of total), while Scopus recorded 52 articles (63% of total) with 449 citations (55.2% of total). A paired t-test measuring the evolution of access and growth in published works indicated a statistically significant increase ($p < 0.05$) across all specializations in Food Science. Citations for Food Science/Technology and Biotechnology rose from 19 (1%) in 1972-1997 to 3,089 (99%) in 1998-2023, highlighting substantial growth in visibility and usage. The geographical distribution analysis showed that Africa had the highest citation metrics, followed by Europe, North America with Asia and South America having relatively lower impact. The study underscores the critical role of digital platforms in enhancing research impact and suggested that improved dissemination strategies are needed, particularly for areas with lower reach such as food Microbiology. These findings provided valuable insights for researchers aiming to enhance the visibility and impact of scientific research in food Science.

Keywords: webometric-analysis, citation metrics, digital platforms, food science research, visibility

Volume 12 Issue 2 - 2024

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Received: August 07, 2024 | **Published:** October 02, 2024

Introduction

The visibility and reach of scholarly works are critical metrics for assessing the impact of research output. In the field of food science, ensuring that research outputs are visible with adequate reach is particularly important, given the direct implications for food security, safety, and quality. According to Linnemann et al,.[1] food products developmental research is driven by consumers that needs adequate information to newly technology deployed and published in scholarly publications, a large chunk of these technological findings and research output have been deployed, disseminated and published in scientific journals. In the digital age, the landscape of scholarly communication through scientific journals has evolved significantly. Traditional print journals have given way to digital platforms, which offer broader dissemination and easier access to research findings. This shift has brought about changes in how research impact is measured, with citation metrics and profile activations on platforms such as Google Scholar, Research Gate, and Scopus becoming key indicators of a researcher's visibility and influence. The influence a scholarly work receives is a relatively determined by its visibility and reach. Therefore, visibility and the degree of engagement to scholarly work is of prior importance to investigate the ease with which research outputs can be accessed by the intended audience, and the degree of engagement these works received, typically measured through citations and online interactions. High visibility and increased degree of engagement enhance the visibility of research, ensuring that findings reach a broader audience, including policymakers, practitioners, and fellow researchers. While, they contribute to the professional advancement of scientists, as higher citation metrics often correlate with career progression and funding opportunities. In the context of food science, greater visibility and attention to research can lead to more rapid dissemination and application of innovations that address critical issues in food security and agricultural productivity.

This review focuses on the impact and reach of food science research conducted by the Institute of Agricultural Research and Training (IAR&T) from 1972 to 2023, using webometric analysis to measure the dissemination and influence of their scholarly outputs.

The role of IAR&T

The Institute of Agricultural Research and Training (IAR&T) has played a significant role in advancing agricultural research in Nigeria. Over the past five decades, IAR&T has produced a substantial body of research in various specializations within food science, including

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food microbiology, human nutrition and meat science, nutritional biochemistry, and food science technology and biotechnology.[2] This study examines the visibility, degree of engagement and reach of these research outputs, providing insights into their impact and identifying areas for improvement. This study focuses on the Institute of Agricultural Research and Training (IAR&T), a prominent institution in agricultural research and a university-based research Institute, in Ibadan, Nigeria. It examines the visibility factors and degree of engagement of published works by research scientists in food science from 1972 to 2023. Throughout its history, the Institute of Agricultural Research and Training (IAR&T) has made significant strides in advancing agricultural research in Nigeria. The institute's scientists have produced groundbreaking research and innovative technological advancements across agriculture and related fields. These achievements are showcased in institutional publications and scholarly journals. However, there has been minimal effort to track how frequently these publications are accessed, cited, and their overall influence on researchers and online users. This gap highlights the need to evaluate the reach and impact of the institute's research outputs.

Problem statement

In today's digital age, the dissemination of scientific knowledge increasingly depends on the visibility, reach, and impact of research publications within online platforms. However, many research institutes, particularly in the developing world struggle with enhancing the discoverability of their research outputs. The Institute of Agricultural Research and Training (IAR&T), Ibadan, like many institutions face challenges in ensuring that its food science research publications gain sufficient visibility, reach a global audience, and generate meaningful academic and practical impact. There is limited online presence of many African research outputs due to factors such as low engagement with open-access repositories and underutilization of digital communication strategies. Moreover, Webometrics which evaluates web visibility, usage, and impact of academic content, remains under-explored in many African institutions, leading to an underrepresentation of their scientific contributions in global research ecosystems. While few studies have explored the influence and reach of Google Scholar in comparison with other database such as Scopus but have not focused exclusively on comparing the impact of food Science published works across continents. This study will therefore utilize webometric analysis to investigate the visibility, reach, and impact of food science research publications produced by the scientists from IAR&T, Ibadan, Nigeria. By examining the online presence, citation metrics, and usage statistics, this research seeks to provide insights into the factors limiting the global impact of the institute's research.

Literature review

The landscape of scholarly communication has evolved significantly with the advent of digital platforms. The visibility and degree of engagement published works received from scholars are critical metrics for assessing their reach and impact. Existing literature on visibility and degree of engagement in scholarly publishing provides a valuable context for this study. Several researchers have explored these themes across different disciplines, highlighting the importance of digital platforms and the factors influencing research visibility. Baffy et al,.[3] emphasized that research scientists prioritize publishing in high-impact journals to enhance visibility and citation metrics, which are vital for career progression and obtaining research funding. Their study highlights the evolving landscape of scholarly communication and the critical role of digital platforms in increasing research visibility and engagement. Rowley et al,.[4] examined the factors influencing researchers' decisions on where to publish their work. Their findings, indicate that journal visibility and indexing in prominent databases significantly affect publication choices, which in turn influence their reach and impact rates.

Most published works in scholarly journals is a product of technological advancement published by scholars to help other scholars and web navigators, at all times have unhindered access to literature and scholarly works that advance food sufficiency and food safety.[5] The University of Minnesota (2023) provided a career guide for food scientists, examining the role of visibility and in professional development in a research. This guide highlights the increasing importance of digital platforms in enhancing the impact and reach of research outputs. Minnesota's report indicates that between 2021 and 2023 the demand for information on food science was expected to grow at a rate of 8% greater than any other fields of science globally. Report has espoused, that the research activities and inputs of Agricultural food scientists are essential in advancing food security, safety, and quality, while their technological innovations boost agricultural productivity and food processing.

Disseminating these technological output and findings is crucial for effective usage in scientific community and society at large.[6] A Webometric evaluation of citation from databases such as Google Scholar, Research Gate and Scopus, provide valuable insights into the impact and reach of scientific publications. Over the years, the Institute of Agricultural Research and Training (IAR&T) has significantly contributed to agricultural research in Nigeria. The research scientists in the Institute have generated research outputs that are novel and of great innovative technological breakthroughs in agricultural research and related disciplines. These technological breakthroughs are reflected through institutional publications and scholarly journals. However there has been little effort to document how well these published literatures were accessed, cited and their impact on scholars and other web navigators. This gap underscores the need to investigate the visibility, level of reach and usage of food science information disseminated on digital platforms through published works to determine impacts. Therefore, the trust of this work is to track the rate of online visibility and usage metrics of published articles and technological innovation of food scientists in the Institute of Agricultural Research and Training over the last 5 decades. The analysis covers multiple dimensions, including citation metrics, article counts, and profile activations and impact on digital platforms.

Objectives

I. To evaluate the visibility, citation metrics and usage of IAR&T Food science research publications on Google Scholar, Research Gate, and Scopus

II. To measure the evolution of access and the growth in reach of the published works from 1972- 2023

III. To identify the geographical spread, impact and reach of food science research publications across different continents

IV. To highlight challenges in scholarly aggregation and proffer solutions to improve the visibility, reach and impact of food science research.

Methodology

This study utilized a webometric approach, specifically employing web citation quantitative analysis, to investigate the scholarly output of research scientists in the field of Food Science at the Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University, Nigeria. Data were collected from web-based academic

publications and citations using three search engines: Google Scholar, Research Gate, and Scopus. Additionally, the study incorporated log file data from 14 food scientists' profiles to complement the web-based data. The research publications of the 14 food scientists were purposefully sampled, representing the entire population of food scientists within IAR&T. The 14 food scientists' sample size official designations were elicited and classified in each of the 4 specific discipline instead of their names for confidentiality purpose. A paired t-test was conducted to measure the evolution of access and growth in published works between the periods 1972-1997 and 1998-2023. This t- test was limited to the Google Scholar platform due to its extensive history of indexing scholarly works, ensuring comprehensive coverage of the study's five-decade scope.

Statistical analysis

Data were obtained from web-based academic publications and citations using three search engines and were analyzed using one way analysis of variance (ANOVA). Mean values were separated using t-test and the significant difference were adjudged at $P < 0.05$.

Results and discussion

A total, 5,806 cited works were abstracted and examined from the 745 articles A total of 745 scholarly articles in Food Science and its constituent fields in Food Microbiology, Food/Human Nutrition and Meat Science, Nutritional Biochemistry and Microchemistry, Food Science Technology, and Biotechnology were analyzed. All the 745 scholarly articles were selected to ensure accurate representation from the web-based databases. In total, 5,806 cited works were abstracted and examined from the 745 articles.

The data obtained from the visibility, citation metrics and the usage of Food Science reach publications were displayed in Figure 1, 2.

The results obtained from Figure 1, 2 demonstrated that there was significantly higher visibility of published articles in Food Science Technology/Biotechnology in Google Scholar than Research gate. While Scopus has the least published articles and citations across all the food science disciplines.

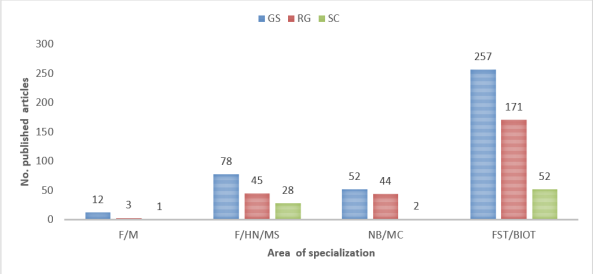

Figure 1 Number of published articles in different areas of specialization.

F/M, food microbiology; F/HN/MS, food/human nutrition and meat science; NB/MC, nutrition biochemistry and microchemistry; FST/BIOT, food science technology/biotechnology

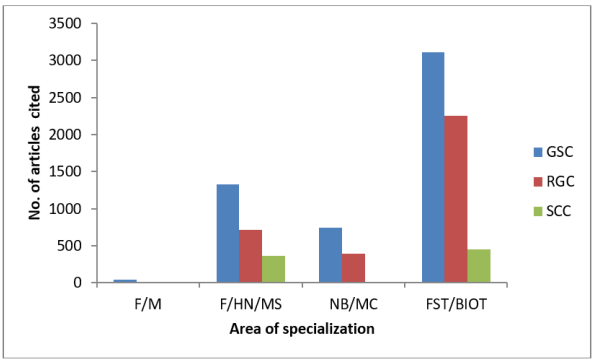

Figure 2 Published articles cited in different areas of specialization.

F/M, food microbiology; F/HN/MS, food/human nutrition and meat science; NB/MC, nutrition biochemistry and microchemistry; FST/BIOT, food science technology/biotechnology

Food science disciplines

As shown in Table 1, the citation metric and the reading index of published articles in food Microbiology is stated given parameters of impact factors H-index, i-index and read indices

Table 1 Web-citations and read index of food microbiology

S P	No. of articles			No. of citations google scholar		Total citations GS / RG/SC 1972- 2023			Un-cited articles GS	Total articles not cited RG		Scopus	GS	RG
	GS	RG	S	1972 – 1997	1998 – 2023	GS	RG	S	1972 – 2023	1972– 2023	1972– 2023	H-Index	I-10 Index	Read Indices
SRF	7	-	-	-	9	9	-		3	-	3	-	-	-
R.F II	5	3	1		31	31	2	1	2	2	4	1	3	242
JRF	-	-	-	-		-	-		-		-	-	-	-
Total	**12**	**3**	**1**	**-**	**40**	**40**	**2**	**1**	**5**	**2**	**7**	**1**	**3**	**242**

SRF, senior research fellow; RF II, research fellow II; JRF, junior research fellow

Food/Human Nutrition and Meat Science as captured in Table 2 provided the total records of the read indices and impact factors of published literature

Table 2 Web-citations and read index of food/human nutrition & meat science

S P	No. of articles			No. of citations google scholar		Total citations GS / RG/SC 1972- 2023			Un-cited articles GS	RG	Total article not cited	Scopus	GS	RG
	GS	RG	S	1972 – 1997	1998 – 2023	GS	RG	S	1972 – 2023	1972– 2023	1972– 2023	H-Index	I-10 Index	Read Indices
R.P	71	41	24	37	1,265	1,302	718	347	3	3	6	9	31	30,072

Citation: Oluranti SA, Omenna EC, Abubakar HO, et al. Webometric analysis of the visibility, reach and impact of food science research publications: institute of agricultural research and training, ibadan (1972-2023). *MOJ Food Process Technol.* 2024;12(2):167–173. DOI: 10.15406/mojfpt.2024.12.00315

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Table 2 Continued...

S P	No. of articles			No. of citations google scholar		Total citations GS / RG/SC 1972- 2023			Un-cited articles		Total article not cited	Scopus	GS	RG
									GS	RG				
G.A	-	1			-	-	-	-	-	1	1	-		36
SRF	7	3	4		28	28	-	15	6	2	8	3	1	-
Total	**78**	**45**	**28**	**37**	**1,293**	**1330**	**718**	**362**	**9**	**6**	**15**	**12**	**32**	**30,108**

RP, research professor; GA, graduate assistant; SRF, senior research fellow

Table 3 presented the details of published literature and respective citations across the three web search machines in the field of Nutritional Biochemistry & Microchemistry

Table 3 Web-citations and read index of nutritional biochemistry & microchemistry

S P	No. of articles			No. of citations google scholar		Total citations GS / RG/SC 1972- 2023			Un-cited articles		Total articles not cited	Scopus	GS	RG
									GS	RG				
	GS	RG	S	1972 – 1997	1998 – 2023	GS	RG	S	1972 – 2023	1972– 2023	1972– 2023	H-Index	I-10 Index	Read Indices
RP	20	11	-	138	291	429	242	-	4	1	5	-	10	-
RFII	6	4	-	-	7	7	21	-	4	1	5	-	-	384
RF I	21	16	1	-	197	197	60	1	8	5	13	1	4	2970
SRF	5	13	1	-	110	110	66	-	-	1	1	1	4	10199
Total	**52**	**44**	**2**	**138**	**605**	**743**	**389**	**1**	**16**	**8**	**24**	**2**	**18**	**13,553**

RP, research professor; RF II, research fellow II; RF I, research fellow I

As shown in Table 4, the citation metric and the reading index of published articles in food Microbiology is stated given parameters of impact factors H-index, i-index and read indices

Table 4 Web-citations and read index of food science technology & biotechnology

S P	No. of articles			No. of citations Google Scholar		Total citations GS / RG/SC 1972- 2023			Un-cited articles		Total articles not cited	Scopus	GS	RG
									GS	RG				
	GS	RG	S	1972 – 1997	1998 – 2023	GS	RG	S	1972 – 2023	1972– 2023	1972– 2023	H-Index	I-10 Index	Read Indices
RP	82	82	23	-	1277	1277	952	191	1	-	1	7	33	133, 912
PRF	42	30	9	-	142	142	299	88	4	-	4	3	11	17,761
RP	124	52	20	19	1,660	1679	994	170	10	5	15	7	29	22,975
R.F I	9	7	-	-	10	10	4	-	6	5	11	-	-	2250
Total	**257**	**171**	**52**	**19**	**3089**	**3108**	**2249**	**449**	**21**	**10**	**31**	**17**	**73**	**176, 898**

RP, research professor; PRF, principal research fellow; RP, research professor; RF I, research fellow I

The summation of data aggregated from Figure 1, 2 and Table 1–4 is presented in Table 5 given the total summation of citations and impact indices of the four disciplines on all the web-machines

Table 5 Summation of web-metric indices and research impact of food science discipline

Research impact (GS i-10 index and Scopus h-index)

Table 5 factorized the scholarly impact of the food science research publication across the four specializations using the Google Scholar (GS) i-10 index and Scopus (SC) h-index. The 3 researchers in Food Microbiology has 12 published articles in GS, receiving 40 citations and 3 (GS) i-10 Index and 1 Scopus h-index. Result shows low impact in both platforms indicating only few cited papers has at least 10 citations or have been cited at least h times. Followed by Nutrition Biochemistry and Microchemistry has 52 published articles with 743 citations and 18 (GS) i-10 Index and 2 Scopus h-index. While the 2 Scopus h-index shows a modest presence of highly cited papers, the 18 GS i-10 index indicates strong impact on Google Scholar. The 32 GS i-10 Index and 12 Scopus h-index in Food/Human Nutrition and Meat Science show significant research activity with multiple papers with at least 10 citations, while the 12 Scopus h-index shows limited cited papers but better visibility than Food Microbiology. The Food Science Technology/Biotechnology field has the highest research output with 257 (GS), 52 (SC) articles of 3108(GS), 449(SC) citations. This field 73 GS i-10 Index and 17 Scopus h-index is substantially higher compared to other specializations in Food science, suggesting significant influence and impact of the cited papers.

The study inferred that food science research publications has stronger presence and impact on Google Scholar i-10 index compared to Scopus h-index globally, with 73 (58%) in Food Science and Technology/Food Biotechnology, 32 (25.3%) in Food and Human Nutrition/Meat Science, 18 (14.3%) Nutrition Biochemistry/ Microchemistry and 3(2.4%) in Food Microbiology out of 126 total i-10 index. The Google Scholar i-10 index is invariance to Scopus h-index which is relatively low with 17(53%) Food Science Technology / Food Biotechnology, Food and Human Nutrition /Meat 12(38%), Nutrition Biochemistry/ Microchemistry 2(6%) and Food Microbiology 1(3%) out of the 32 total impact metrics in Scopus.

The limited citations and impact metrics on Scopus in specific discipline such as food Microbiology and Nutrition Biochemistry/ Microchemistry is corroborated by Adriaanse et al,.[7] whose study had established few citations count and low impact metrics on Scopus compared to Google scholar. While Martin et al,.[8] and Visser et al,.[9] both findings discovered that there was wider coverage of interdisciplinary contents in food science disciplines in Google Scholar through retrieval of more citations and covering of larger range of published works compared to Scopus. This analysis suggested focusing on increasing the visibility and citation rates on Scopus by food scientists through adequate utilization of digital global search engines and active collaboration with the global scientific network machines to enhance the overall research impact.

Scholarly aggregation of food science research publications

This study identified gaps in the aggregation of published works with low activation of scientists' profile accounts on the web search engines (Google Scholar, Research Gate and Scopus). The profile status of researchers in Food science in the summation Table 6 revealed that only 3 scientists have activated their profiles on Google Scholar out of 8 scientists each on Research Gate and Scopus have activated their profiles out of 14 total research scientists in Food Science and its constituents

Table 6 Evolution of access and growth in food science research publications from 1972-1997 and 1998-2023 on google scholar

Disciplines	Google scholar			
	Citation Trend 1972 – 1997	%	Citation Trend 1998 – 2023	%
Food science/technology, biotechnology	19	9.79%	3089	61.45%
Food/ human nutrition and meat science	37	19.07%	1293	25.72%
Nutrition biochemistry & microchemistry	138	71.13%	605	12.04%
Food microbiology	-	0%	40	0.80%
Total	194	100%	5027	100%

The increasing availability and expansion of research output within the field of food science is given below

The paired t-Test conducted in Table 6, measured the evolution of access and growth in the published works on Google Scholar from (1972-1997 and 1998- 2023). The results of the two periods 1972-1997 and 1998-2023 indicated a statistically significant increase ($p < 0.05$) across all specializations in food science. Food Science/Technology and Biotechnology citations increased from 19(9.79%) citations in 1972-1997 to 3,089 (61.45%) in 1998-2023. Food/Human Nutrition and Meat Science citations rose from 37 (19.07%) to 1,293 (25.72%). Nutrition Biochemistry and Microchemistry citations grew from 138 (71.13%) to 605 (12.04%), while study also revealed that uncited field of Food Microbiology grow from the level of zero 0%, obscurity 0.08 visibility and growth. This substantial growth in citations demonstrates adequate visibility and increased usage of published works in food science over the past five decades. The growth in citations indicate an improvement in the quality and relevance of research conducted by food scientists. The significant rise in citations in 5 decades reflects that research outputs have reached a wider audience and are being utilized more frequently in the scientific community. The increase in citations over time underscores the importance of search Google Scholar marching in disseminating research which have played crucial role in making research more accessible and discoverable. This result is corroborated by Milojevice et al,.[10] whose work discovered significant rise in access, growth, and usage of research publications across food science and related disciplines while Bornmann et al,.[11] provided a comprehensive analysis of the growth in the number of scientific publications over time which is facilitated by open access search engines.

Geographical spread, impact, and reach of food science research publications

Table 7 provided a comprehensive analysis of the geographical spread, impact and reach of citations from Google Scholar (GS) and Research Gate (RG) across the five continents of Africa, Europe, North America, Asia and South America. Africa Dominates in both GS and RG citations, indicating strong regional research activity and recognition. With over 2,610 (49.99%) GS citations and 1,192 (35.49%) RG citations coming from Africa, it shows that the region has a significant impact on the overall citation metrics for IAR&T's scholarly outputs. This substantial presence underscores the growing contribution of African researchers to global food science literature. This result has established high prominence of African scholars in regional citation on Google Scholar and Research Gate and this is corroborated in Harzing et al,.[12] whose work reported that Google Scholar and Research Gate offered better coverage for emerging regions like Africa compared to Scopus which focused on publications from Europe and North America. Result also indicated that Europe holds the second-highest percentage of citations in both GS 1,203 citations (23.04%) and RG: 490 citations (14.59%), indicating a robust presence and influence in this region. The significant contribution from Europe underscores the importance of this region in disseminating and recognizing IAR&T's research output in food science. Europe's significant citation count reflects its established research infrastructure and continued focus on food science. North America: GS: 883 citations (16.91%) RG: 745 citations (22.18%). North America shows a strong presence on RG, indicative of active research dissemination and degree of engagement within the scientific community. Asia: GS: 365 citations (6.99%) RG: 348 citations (10.36%). Asia's growing contribution to the field is evident, particularly in Food Science/Technology and Nutrition Biochemistry. South America: GS: 160 citations (3.06%) RG: 584 citations (17.39%). With the lowest percentage of citations in South America represents a relatively smaller impact region for IAR&T's research. Indicates a potential area for growth, where targeted strategies could help increase visibility and citation rates. These insights are crucial for guiding future strategies to enhance the global reach and impact of IAR&T's research, ensuring broader dissemination and recognition across all regions.

Table 7 Geographical spread of food science research publications

Specializations	Africa		Europe		North America		Asia		South America		Total Citation	
	GS	RG	GS	RG	GS	RG	GS	RG	GS	RG	GS	RG
Food	20	1	10	0	5	1	3	0	2	0	40	2
microbiology	0.77%	0.08%	0.83%	0%	0.57%	0.13%	0.82%	0%	1.25%	0%	0.77%	0.06%
Food/ human nutrition and	665	145	39	129	493	222	93	120	40	102	1330	718
meat science	25.48%	12.16%	3.24%	26.33%	55.83%	29.80%	25.48%	34.48%	25.00%	17.47%	25.47%	21.38%
Nutrition	371	272	222	9	74	54	52	38	24	17	743	390
biochemistry & microchemistry	14.21%	22.82%	18.45%	1.84%	8.38%	7.25%	14.25%	10.92%	15%	2.91%	14.23%	11.61%
Food science	1554	774	932	352	311	468	217	190	94	465	3108	2249
technology/ biotechnology	59.54%	64.93%	77.47%	71.84%	35.22%	62.82%	59.45%	54.60%	58.75%	79.62%	59.53%	66.95%
Total	**2,610**	**1,192**	**1,203**	**490**	**883**	**745**	**365**	**348**	**160**	**584**	**5,221**	**3,359**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
	49.99%	**35.49%**	**23.04%**	**14.59%**	**16.91%**	**22.18%**	**6.99%**	**10.36%**	**3.06%**	**17.39%**		

The reach and impact of food science research by specializations

This study also inferred that out of all the four specializations in Food Science, the Food Science/Technology and Biotechnology has the highest citation count of GS: 3,108 (59.53%) and RG: 2249 (66.95%) out of the total overall citations 5221(GS) and 3359(RG) spread across the 5 continent with Africa :GS: 1,554 (59.54%)RG: RG: 774 (64.93%), Europe: GS: 932 (35.72%), RG: 352 (29.48%), North America: GS: 311 (11.91%), RG: 468 (39.02%) Asia: GS: 217 (8.31%), RG: 146 (12.25%), South America: GS: 94 (3.60%), RG: 585 (10.00%). This discipline exhibits a dominant presence and significant contributions from Africa, North America, and Europe, highlighting successful research dissemination and recognition. The large citation numbers reflected the relevance and importance of research outputs of Food Science Technology/Biotechnology in these regions.[13]

Food/human nutrition and meat science

The result showed a total citations of (GS: 1,303 (25.47%) and RG: 718 (21.38%) out of the total overall citations 5221(GS) and 3359(RG) spread across the 5 continents. This specialization shows high citation counts, particularly in Africa: GS: 665 (25.48%), RG: 145 (12.16%) and North America: GS: 493 (18.88%), RG: 222(18.46%) indicating robust research activity and global recognition. Europe: GS: 39 (1.49%), RG: 129 (10.73%) (18.46%) Asia: GS: 193 (7.39%), RG: 120 (10.07%) South America: GS: 40 (1.53%), RG: 102 (8.55%). It can be inferred from the above data that Food/Human Nutrition and Meat Science has a noticeable strong presence in Africa and substantial impact in North American, suggesting effective dissemination and recognition of research outputs in these regions while low citation identified in Europe (GS) and Asia (RG) indicated a potential need to increase visibility and engagement.

Nutritional biochemistry and microchemistry

The result highlighted strong regional impact with high citation counts in Africa: GS: 371 (14.21%), RG: 272 (22.82%) out of total citations of (GS: 743 (14.23%) and RG: 390 (11.61%)). These results clearly showed significantly higher ($p<0.05$) contributions and global interest in usage of materials in African continents above other continents sampled. While collaboration and dissemination strategies could further improved reach and visibility with low metric in South America: GS: 24 (15%) RG: 9 (1.84%) in Europe.

Food microbiology

The result from Food Microbiology showed relatively low total citation count of (GS: 40, RG: 2) indicating limited reach and impact compared to other disciplines. Citations were very low in South America: GS: 2 (1.25%), RG: 1 (0.08%), (0.13%) in Africa, North America and a zero 0 (0. %) citation on RG both in Asia and South America.

Therefore, in field-specific reach, Food Science/Technology and Biotechnology showed remarkable reach and impact, whereas Food Microbiology needs more attention to improve its visibility and reach. The high citation counts in Africa across all disciplines indicated a robust regional impact, which attested to IAR&T's research outputs as highly relevant and influential within the African context most especially with unprecedented metrics in Food Science/Technology and Biotechnology. This strong presence underscores the effectiveness of dissemination strategies and the importance of research topics to the regional audience. While a relatively lower citation counts in North America suggested opportunities for increased degree of engagement and dissemination efforts.

Research limitation

The generalizability or findings from this study is not without some shortcomings. This study finds low activation of scientists' profile accounts on the web search engines of Google Scholar, Research Gate and Scopus. Only 3 out of 14 scientists had activated their research profiles on Google Scholar and only 8 scientists had active profiles on Research Gate. Due to the non-activation of researchers' profiles, the study, had limited access to comprehensive profile information such as the authors affiliations which invariably restricted the geographical distribution trend analysis to only Google scholar and Research Gate data. This limitation affects the aggregation and visibility of the Food Science publications online. Moreover, the preponderance of Scopus to recent articles more than the Google Scholar and Research Gate has limited the representation of older research publications in the evolution of usage in Scopus.

Conclusion

The results of this study demonstrated that research scientists in Food Science at the Institute of Agricultural Research and Training (IAR&T), Nigeria have significantly increased their publication

output and impact over the past 50 years, thereby contributing to the advancement of food productivity. The paired t-test analysis confirmed a significant difference in citations pattern in Google scholar, indicating a positive evolution in the visibility and impact of food science research. The findings indicated that research outputs from IAR&T have achieved substantial visibility and impact, with notable differences across specializations. Specifically, the fields of Food Science Technology and Biotechnology demonstrated the highest impact, suggesting that targeted efforts in these areas have been successful across the five continents. The results of the geographical distribution of citations reflected various impacts of IAR&T's research across different disciplines and regions. With a strong regional presence in Africa and substantial contributions in Europe, South America, while this study suggested a need for enhanced dissemination efforts in Asia and North America. By addressing these gaps, IAR&T can further elevate its global research productivity and impact, ensuring broader recognition, reach and degree of engagement of its scholarly outputs. However, there remains room for improvement in enhancing the accessibility and citation metrics of research profiles on digital databases. The study also highlighted the importance of active profile management on research databases to further improve visibility and broader the dissemination of technological innovations. Encouraging the activation of profiles on research databases is crucial for improving citation metrics, article counts, and overall research impact. This in turn, will contribute to the usage of food science information resources and value-added technologies. In addition, this study advocates for adequate institutional digital repository to facilitate greater dissemination of research agricultural outputs.

Recommendations

This study hereby recommends the following:

Profile activation

Scientists should activate their Google Scholar accounts and link their articles on Google Scholar, Research Gate, and Scopus. This will ensure effective aggregation, rating, and approximation of their work online. Activated profiles help in aggregating research outputs and improving their discoverability.

Focus on high-impact areas

Continued focus and investment in high-impact areas such as Food Science/Technology and Biotechnology should be maintained. Successful strategies in these areas can be adapted and applied to other specializations with low impact such as Food Microbiology to replicate higher citation rate, reach and impact.

Regular monitoring and evaluation

Research Institutions should implement mechanisms to regularly monitor and evaluate the impact and visibility of their research outputs. This can help to identify trends, gaps, and opportunities for improvement.

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

Funding

None.

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