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Original Research Article

Mapping of Global 100 Top-cited Articles on *Moringa oleifera* Lam. from Documents Indexed in Web of Sciences Database

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ABSTRACT

Bibliometric analysis is an important tool used for unraveling and mapping the cumulative scientific knowledge and evolutionary nuances of established domains by logically interpreting vast amounts of unstructured data. A lot has been done in various fields, however, no bibliometric report is yet made on *Moringa oleifera*. *M. oleifera* Lam is a multi-purpose herbal plant that has been traditionally used for thousands of years as human food as well as an alternative for medicinal purposes, with numerous health benefits. This study was designed to map the most frequently cited articles reported on *Moringa oleifera* using bibliometric characteristics while also highlighting the most significant evidence collected in the field over the years. The 100 most cited reports were retrieved from the Web of Science Core Collection database, and were reportedly published between 1980 and 2021 in 56 peer reviewed journals with 15, 300 total citations at an average of 153 times. Water Research Journal is the most-published journal, while India is the most productive country with 18 articles. Also, The University of Agriculture Faisalabad is ranked as the number one institution with seven articles, while Anwar F. from Pakistan made the most contributions, with seven (7) published articles. Moreover, thematic map analytics showing the analysis of the top 250 words revealed that the research direction was *Moringa oleifera* research. These findings provide useful insights in the field of *Moringa oleifera* for scientific communities on historical and most influential publications, research direction, the most productive country, author's productivity and future collaborations to identify the most hotspot research paths in the future.

***Keywords*:** *Moringa oleifera*, Bibliometric analysis, Citations, H-index, Web of Science Core Collection.

Introduction

Moringa oleifera is the most widely cultivated species of a monogeneric family reported by many countries in the tropics.[1] It is referred to as the "Miracle Tree" due to its high nutrient value.[2] This is in addition to it being traditionally used as medicine to treat a variety of inflammatory-mediated diseases, including cardiovascular disease and diabetes.[3–6] Additionally, the crude aqueous leaf extract of *Moringa oleifera* exerts antiproliferative effects on A549 lung carcinoma cells by increasing oxidative stress, DNA fragmentation, and inducing apoptosis.[7] Further evidence shows that *Moringa oleifera* leaves have also been used for the production of soups, foods, bread, cakes, and yogurts. [8,9] Recently, mature *Moringa oleifera* leaf extracts have been used to protect goat meat patties from oxidative rancidity, [10] as well as being reported to have a significant cardioprotective effect due to its antioxidant, antiperoxidative, and myocardial preservative properties. [11] Interestingly, *Moringa oleifera* has been recognized by traditional medicine practitioners to have attributes to curing effect in tumors,[12,13] treating malnutrition, HIV/AIDS-related symptoms, bronchitis, ulcers, malaria, and fever,[14–16] lowering the risk of cancer,[17,18] and possessing antimicrobial activity against bacteria, fungi, and yeasts at different concentrations.[19] In addition, *Moringa oleifera* has also been reported to have environmental applications for the treatment of wastewater[20] and to flocculate contaminants and purify drinking water.[21–24] Furthermore, the powder has been used in animal production, especially in bovine reproduction, and the effect on the estrus cycle, uterine contraction, and conception.[25–27] Bibliometrics is a branch of quantitative science that assesses the effectiveness of research using techniques like citation analysis. By counting how many times an article has been cited, citation data are used to measure an article's impact over a period of time.[28] Several works have been previously reported on bibliometric analysis including neem,[29,30] Gum Arabic,[31] microplastics,[32] just to mention a few. In this work, the bibliometrics tools, widely used to map the literature around scientific research fields, were employed in the *Moringa oleifera* research field.[33,34] The analysis can assist in gaining a better understanding of the research focus as well as future research development trends in *Moringa*. A large number of papers have been published in areas that have given historical perspectives for researchers in the world of *Moringa oleifera*, but to the best of our knowledge, there is yet a study of bibliometric analysis conducted, hence, this work tends to provide

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the historical overview of *Moringa oleifera* through a bibliometric perspective using documents indexed in the Web of Science Core Collection database to identify the top-most cited articles in the field of *Moringa oleifera*.

Materials and Methods

Study design

To achieve the objectives of this retrospective study, we used the Web of Science Core Collection database of Clarivate Analytics (formerly known as Thomson Reuters and the Institute for Scientific Information), updated on December 5, 2021. The search phrase is: title "*Moringa oleifera**" or "Drumstick tree " in the title field, for document types: "Articles" or "Reviews," and timespan "1900−2021". The data was retrieved, and the following characteristics were reported: study name, author listing, journal name, year, citation count, and country of origin, while the 2020 journal impact factors (IF) were retrieved from the InCites Journal Citation Reports website for the year 2020. Two independent researchers screened titles based on the title of the article for relevance, yielding our final list of the top 100 most cited articles, as ranked by number of times cited. Finally, the 100 most frequently cited articles were saved as "Plain text," "Bib text," or "Excel.CSV" for further investigation. The details for the retrieval of the 100 most-cited articles are outlined in Figure 1 and Table 1.

Statistical Analysis

The statistical analyses were conducted using HistCite 35, the Bibliometrix app using R-studio cloud 36, VOS viewer 37 and OrignPro 2018.

Table 1: Main information about bibliographic collection

Description	Results	Description	Results
Timespan	1980:2018	Author's Keywords (DE)	322
Sources (Journals, Books, etc)	56	Authors	
Documents	100	Authors	367
Average years from publication	13.8	Author Appearances	453
Average citations per documents	153.0	Authors of single-authored documents	2
Average citations per year per doc	12.35	Authors of multi-authored documents	365
References	3202	Authors Collaboration	
Document Types		Single-authored documents	2
Article	90	Documents per Author	0.272
Review	10	Authors per Document	3.67
Document Contents		Co-Authors per Documents	4.53
Keywords Plus (ID)	400	Collaboration Index (CI)	3.72

Results and Discussion

Annual trend and citations of top 100 cited studies

The top 100 articles were revealed to have been published between the year 1980 and 2021. The trend of the top 100 cited articles and average mean of total citations during the study period are presented in Figure 2. From the figure, it could be observed that there was a progression in the number of publications from 1980, peaking in 2008, followed by a slight up-and-down trend which thereafter dropped in 2019. The mean total citation, on the other hand, was observed to be increasing yearly, peaking in 2018. However, no top-cited article was recorded after the year 2019, possibly indicating a decline in *Moringa oleifera* research-related studies.

Top-cited articles on Moringa oleifera

Highly cited articles on *Moringa oleifera* are good indicators of advanced ideas and developments for further research in the field (Table S1). The co-citation times of "Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves," was observed to have ranked Number 1, indicated the importance of Moringa leaves as an antioxidant,[38] followed by its usage for an impressive range of medicinal uses with high nutritional value in many tropical and subtropical countries, rated as Number 2, and its excellent coagulation properties for treating water and wastewater,[39] rated as Number 3.

Corresponding Author's Country

The extracted data on *Moringa oleifera* identified India as the most productive country with NP = 18 articles, followed by Pakistan with NP = 11 articles, and Malaysia (NP=10 articles). In terms of Multiple Country Publication (MCP), India, the United States of America (USA), China, and Egypt have the most collaborations between countries, as reportedly shown in Figures 3 and 4.

Productive Journals

The 100-top cited Moringa articles were published in 56 journals, predominantly in Water Research with (NP=8; TC=1635), followed by the Journal of Ethnopharmacology with (NP=7; TC: 956), and Food Chemistry with (NP=5; TC: 677). Table S2 shows the list of the most active and influential journals based on the Journal Impact Factor (JIF), the article influence score normalized, the Eigenfactor score, and the 5-year impact factor.

Authorship analysis

Of the 376 authors that contributed, authors with ≥4 documents were identified and listed in Table 2. In the table, the most prolific of them is Anwar F from Pakistan with the highest publication count and highest H-Index (NP, 7; TC, 1644; H-index 7), followed by Becker K from Germany, Bhanger, MI from Pakistan, and Muchenje, V from South Africa with (NP, 4; TC, 1365; H-index 4), (NP, 4; TC, 544; H-index 4), and (NP, 4; TC, 564; H-index 4), in that order, respectively.

Topic dendrogram analysis

Figures 5(A and B) show the topic dendrogram that were used to identify the hierarchical relationship between *Moringa oleifera*-related topics during the study periods. The factorial analysis with multidimensional scaling method was employed to show the arrangement of 50 different keywords by topic in three main clusters to give an in-depth understanding of the research topics (A, Authors Keywords), which outlines the information comprising the list of terms that gives the best representation of the content of authors' documents (B, Keyword Plus).

Word cloud analysis

The most frequent research topics based on the KeyWords Plus analysis were terms including "tree" (12), "leaves" (11), "in-vitro" (9), "seed oil" (9), "antioxidant properties" (8), "plant" (8), "extract" (7), "leaf extract" (7), and "water" (7), as shown in Figure 6, while the changes in the number of KeyWords over the years are presented in Figure 7.

Institutional analysis

The findings of the most active institutions are shown in Table 3. The University of Agriculture Faisalabad (UAF) in Pakistan is the top ranking institution in *Moringa oleifera* related research (NP = 7), followed by Universiti Putra Malaysia (UPM) in Malaysia (NP = 5) articles.

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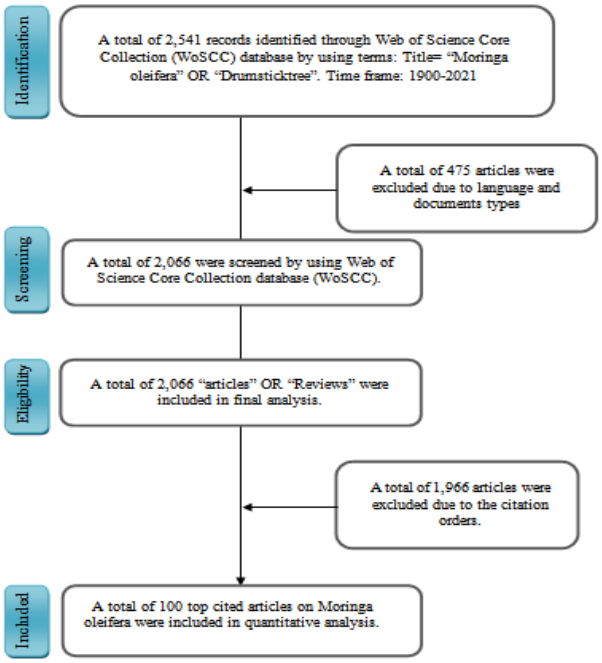

Figure 1: Details showing the information retrieval pathway for the 100 top cited articles

It could be seen that of the ten institutions identified, eight (8) are from Asia, one (1) from Africa (University of Fort Hare, South Africa), and the remaining one (1) from Europe (University of Hohenheim, Stuttgart, Germany), indicating that the *Moringa oleifera* research has been very prominent in the Asian countries.

Thematic Map Analysis of the top 250 Words

Thematic analysis of research hot topics for author key words with a minimum frequency of 5 shows the main research was focused on "natural coagulants, *Moringa oleifera*, biosorption, antioxidant activity, biodiesel, composition, moringaceae, phytochemicals, and diabetes," as presented in Table S3.

Visualized Analysis of Journals co-citations

Using the minimum threshold of ten (10) documents from the journals, 70 were able to meet the threshold, which were thereafter categorised into 4 clusters with links (L = 1442) and total link strength (TLS = 20037). Of the 70 journals, the top journals with the greatest total link strength were Journal of Agr Food Chem, which has the highest (TLS = 3684), followed by Journal of Ethnopharmacology (TLS = 2629), Food Chem (TLS = 2372) and Water Res (TLS = 1657), in that order, respectively, as shown in Figure 8.

Co-citation analysis and cited authors

For the authors with the minimum threshold of 10 documents, only 35 were able to meet the threshold and were presented in 4 clusters with (L = 440), and (TLS = 2874). The top four authors with the highest total link strength were Anwar, F (TLS = 455), Faiz, S (TLS = 368), and Giani, AH (TLS = 300) as shown in Figure 9.

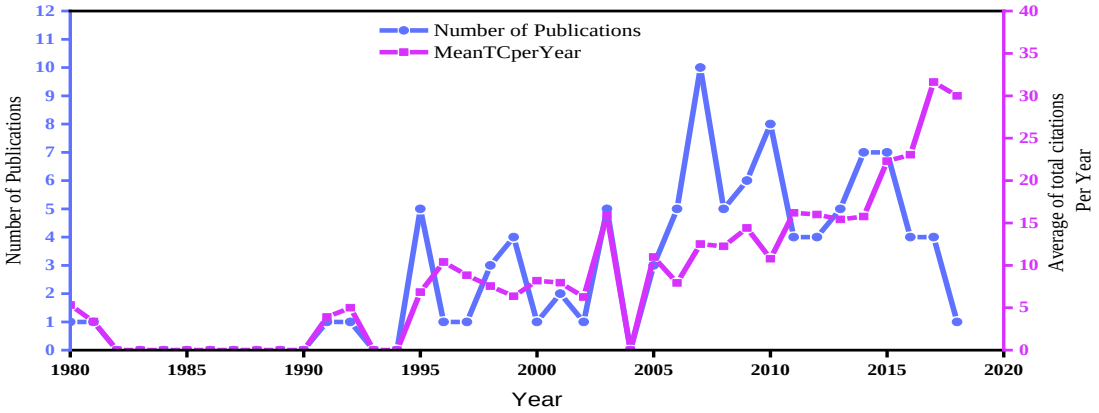

Figure 2: Annual trend of top 100 articles on *Moringa oleifera*

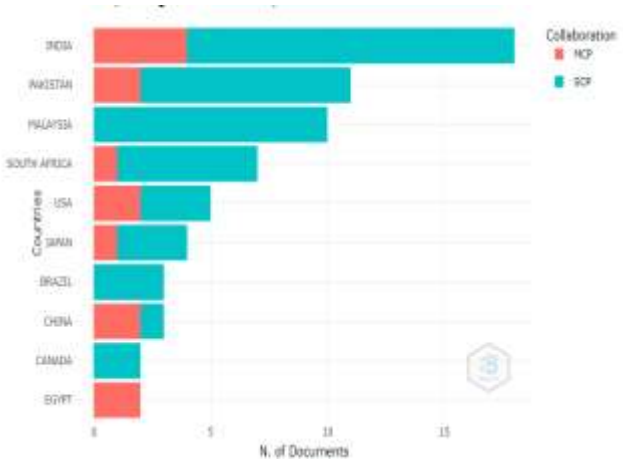

Figure 3: Top Corresponding Author's Country with more than 2 articles in *Moringa oleifera* based on the articles (NP), Single Country Publication (SCP), and Multiple Country Publication (MCP).

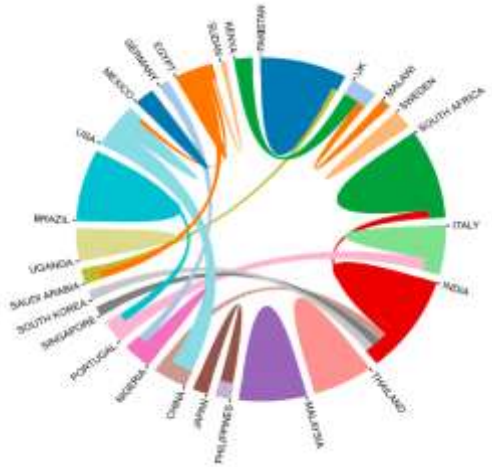

Figure 4: Inter-State relationship analysis between countries in *Moringa oleifera*.

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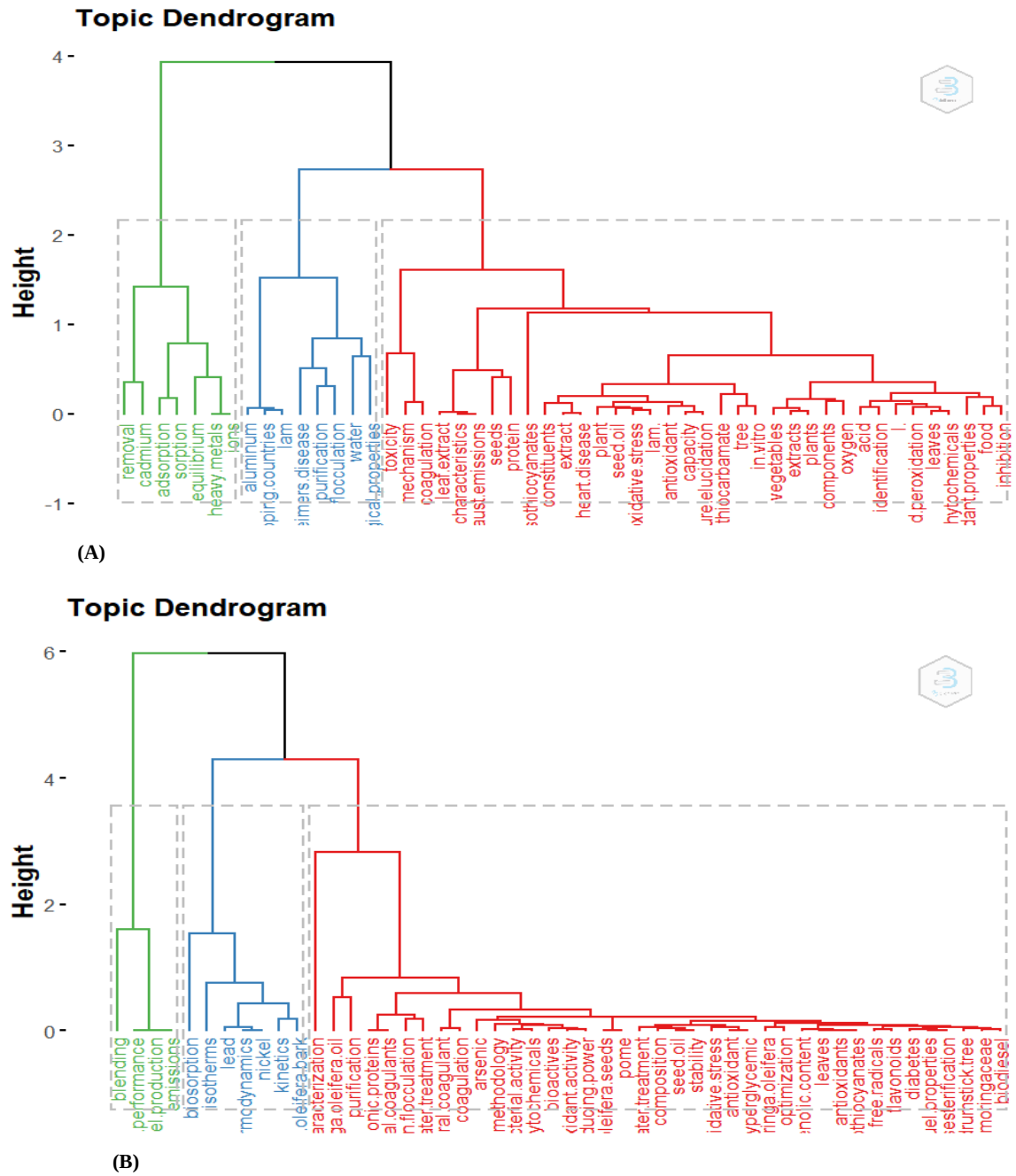

Figure 5: Multiple Correspondence Anlaysis (MCA): Using a conceptual structure for 50 number of terms of Authors Keyword (A), and Keyword Plus (B) using factorial analysis and distributed in three clusters.

Table 2: Authors contributed to at least (NP≥4) more in *Moringa oleifera*

Author (n=376)	Country	(h_index)[b]	TC	NP	1st author	2nd author	3rd or last author	PY_start−PY end
Anwar, F	Pakistan	7	1644	7	5	2	0	2003~2011
Becker, K	Germany	4	1365	4	0	2	1	1996~2003
Bhanger, MI	Pakistan	4	544	4	1	2	1	2003~2007
Muchenje, V	South Africa	4	564	4	0	0	4	2011~2018
Reddy, AVR	India	4	601	4	0	0	4	2010~2012
Reddy, DHK	India	4	601	4	4	0	0	2010~2012
Seshaiah, K	India	4	601	4	0	2	2	2010~2012

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Table 3: Most Influential Institutions with more than 3 articles in *Moringa oleifera*

Institution	Number of Articles	Percent	TC
Univ Agr Faisalabad	7	7.0	1577
Univ Putra Malaysia	5	5.0	667
Bhabha Atom Res Ctr	4	4.0	601
Sri Venkateswara Univ	4	4.0	601
Univ Ft Hare	4	4.0	564
Univ Hohenheim	4	4.0	1365
Univ Sindh	4	4.0	544
Aga Khan Univ	3	3.0	933
Hiroshima Univ	3	3.0	488
Univ Malaya	3	3.0	358

Moringa has been used in many tropics and subtropics countries in recent years due to its impressive range of medicinal properties and high nutritional value.[1] The leaves of the tree have reportedly been used for chronic hyperglycemia and dyslipidemia, [4,40] in addition to its multipurpose usage as an herbal plant for humans and as an alternative medicine. [41]Currently, there is a great need to enhance the understanding of the *Moringa* research directions; therefore, the current investigation is aimed at providing the scientific communities with critical and quantitative information on the research progress in Moringa from its first published document in the WoSCC database. According to results from our analysis, most of the top-cited articles in Moringa studies were published after 2006, with the largest subset consisting of studies published between 2007 and 2010. The increase in the number of landmark publications during this period of time likely reflects the importance of *Moringa* research and the growing interest the scientific community has towards it. There are facts that in 2007, most studies focused on Moringa as a food plant with medicinal uses and the identification of physico-chemical characteristics of *Moringa oleifera* seeds and seed oil,[1,42,43]

Figure 6: Word cloud of the top 100 most frequency keyword Plus

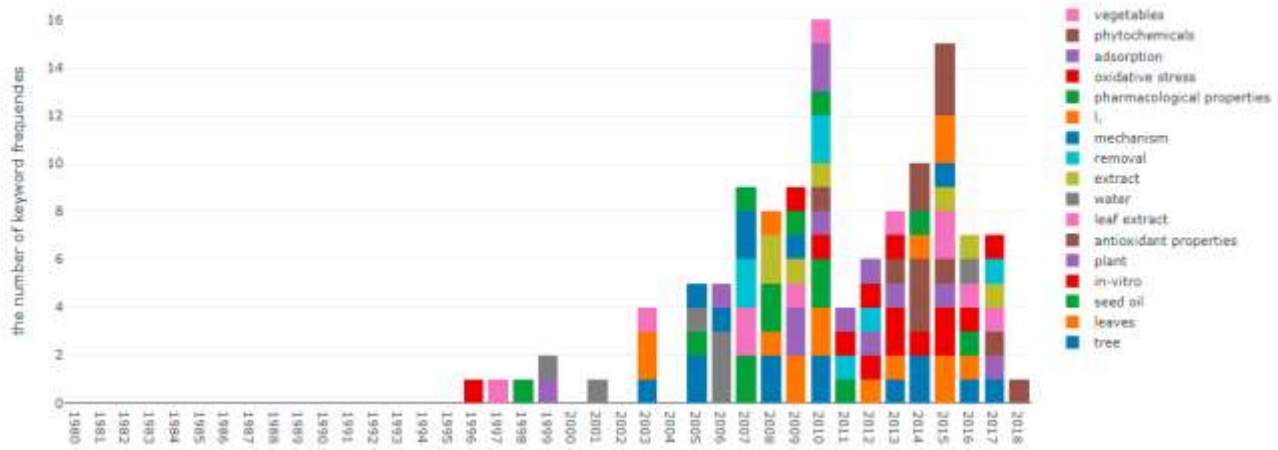

Figure 7: Changes in the number of KeyWords over the years

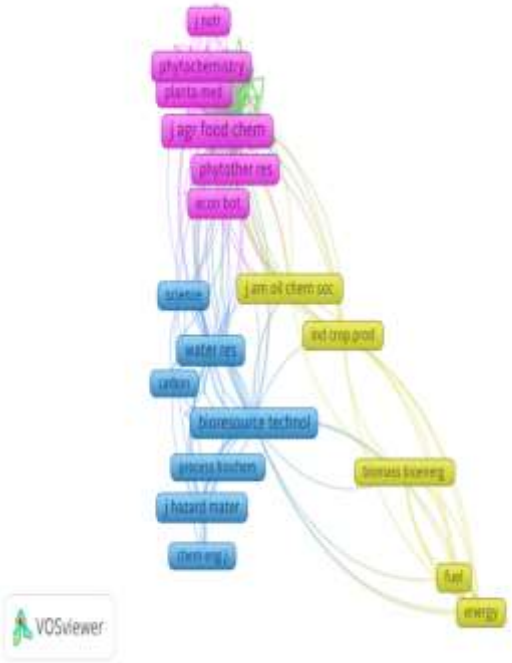

Figure 8: Co-citation analysis of cited journals based on total link strength (TLS).

Figure 9: Co-citation analysis of cited authors based on total link strength (TLS).

Moringa oleifera leaf extract as a high-fat diet for rats,[44] the Moringa seed oil for its frying quality and stability, [45] water research,[46–48] and Moringa leaf extract playing potential therapeutic roles in the treatment of various types of cancer as antimicrobial, anticancer, anti-inflammatory, and antidiabetic.[49] Similarly, significant advancements in *Moringa oleifera* research were also reported in 2010 in many areas, including phytochemicals,[50] and nutrients value.[51] Most of the research on the chemical characteristics of this plant and its products has mainly focused on the seed oil, with very little focus on the rest of the plant,[11,42] despite its remarkable usage in human health.[52] Other studies have suggested that *Moringa oleifera* seeds can be used as a coagulant in water and wastewater treatment, but only after the active proteins[53] have been adequately purified. This can be a solution for people in developing and third-world countries who are facing potable water supply problems due to inadequate financial resources.[54] Other published articles highlighted *Moringa oleifera* as a food plant with multiple medicinal uses[1] and *Moringa* as a possible source of biodiesel.[55] An analysis of the keywords is a good indicator for evaluating the Moringa research by identifying the author's keywords and achievements as well as providing general information and ideas concerning research developments. The keyword analyses were demonstrated in different clusters. The most common keywords included "developing countries" during 1980-1999, followed by "aater" in 2000-2005. In addition, *Moringa* have been observed to have more international research projects than other fields such as Gum Arabic.[31] More importantly, our analysis revealed that majority of the 100 top-cited articles in Moringa were published in the Journal of Ethnopharmacology, Water Research, and Food and Chemical Toxicology, respectively. These journals are considered the most influential based on total citation scores, and their h-indexes were also found to have a significant influence on the number of article productions. Although this is the first bibliometric study of the 100 most cited studies on *Moringa*, it provides a comprehensive analysis in addition to being objective during the trend analysis; however, the current study has some limitations inherent in the bibliometric methodology. Firstly, one WoSCC database was used without employing multiple search engines (PubMed, Ovid, Scopus, and Google Scholar). Secondly, only articles and reviews were included, and thirdly, we limited our searches to the English database, where a linguistic bias may exist. Despite all these limitations, this study is meant to fill the gap in literature and knowledge on the uses and importance of the *Moringa oleifera* plant that could be practically utilized in all aspects of life globally. Furthermore, the increase in published documents on *Moringa oleifera* is an indicator for its value and characteristics in animal, human, pharmaceutical, and environmental fields.

Conclusion

Our findings provide baseline information and insights from 100 top studies in Moringa. So far, India has been the most significant contributor in the Moringa fields, as evidenced by the research papers published during 1980-2021, which received funding from public and governmental institutions. The study also revealed inadequate international collaborations between countries and researchers working on *Moringa* research. Therefore, our study looks forward to enhancing the international cooperation between authors and experts to exchange more information and enhance knowledge on *Moringa* due to its traditional and medical uses for incredible health benefits.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

Table S1: Top 100 cited articles on *Moringa oleifera*

Rank	Title	TC
1	Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (Moringa oleifera Lam.) leaves	771
2	Moringa oleifera: A food plant with multiple medicinal uses	735
3	Active Agents and Mechanism of Coagulation of Turbid waters using Moringa-Oleifera	402
4	Moringa oleifera oil: A possible source of biodiesel	329
5	Quality of water treated by coagulation using Moringa oleifera seeds	318
6	Antioxidant Activity and total Phenolic Content of Moringa oleifera Leaves in two Stages of maturity	268
7	Nutritional value and antinutritional components of whole and ethanol extracted Moringa oleifera leaves	260
8	Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose trees Moringa oleifera L. (horseradish tree) and Moringa stenopetala L.	244
9	A simple purification and activity assay of the coagulant protein from Moringa oleifera seed	234
10	In vitro and in vivo antioxidant properties of different fractions of Moringa oleifera leaves	232
11	Nutritional characterization of Moringa (Moringa oleifera Lam.) leaves	228
12	Cultivation, Genetic, Ethnopharmacology, Phytochemistry and Pharmacology of Moringa oleifera Leaves: An overview	224
13	Oxidative DNA damage protective activity, antioxidant and anti-quorum sensing potentials of Moringa oleifera	219
14	Drumstick (Moringa-Oleifera) - A Multipurpose Indian Vegetable	218
15	Nutrients and antiquality factors in different morphological parts of the Moringa oleifera tree	212
16	ZnO nanoparticles via Moringa oleifera green synthesis: Physical properties & mechanism of formation	198
17	Therapeutic potential of Moringa oleifera leaves in chronic hyperglycemia and dyslipidennia: a review	195
18	Maximizing total phenolics, total flavonoids contents and antioxidant activity of Moringa oleifera leaf extract by the appropriate extraction method	194
19	Isolation and Characterization of a Flocculating Protein from moringa-Oleifera lam	191
20	Green synthesis of NIO nanoparticles using Moringa oleifera extract and their biomedical applications: Cytotoxicity effect of nanoparticles against HT-29 cancer cells	184
21	Isolation and characterization of coagulant extracted from Moringa oleifera seed by salt solution	181
22	Some physico-chemical properties of Moringa oleifera seed oil extracted using solvent and aqueous enzymatic methods	179
23	An antitumor promoter from Moringa oleifera Lam.	177
24	Biosorption of Pb2+ from aqueous solutions by Moringa oleifera bark: Equilibrium and kinetic studies	176
25	Analytical characterization of Moringa oleifera seed oil grown in temperate regions of Pakistan	175
26	Hypocholesterolemic effects of crude extract of leaf of Moringa oleifera Lam in high-fat diet fed wistar rats	172
27	The in vitro and ex vivo antioxidant properties, hypolipidaemic and antiatherosclerotic activities of water extract of Moringa oleifera Lam. leaves	170
28	Improvement of extraction method of coagulation active components from Moringa oleifera seed	170
29	Effect of season and production location on antioxidant activity of Moringa oleifera leaves grown in Pakistan	169
30	Anti-fungal activity of crude extracts and essential oil of Moringa oleifera Lam	168
31	Review of the Safety and Efficacy of Moringa oleifera	168
32	Profiling selected phytochemicals and nutrients in different tissues of the multipurpose tree Moringa oleifera L., grown in Ghana	164
33	Comparative evaluation of performance and emission characteristics of Moringa oleifera and Palm oil based biodiesel in a diesel engine	159
34	Frying quality and stability of high-oleic Moringa oleifera seed oil in comparison with other vegetable oils	159

35	Biosorption of Ni(II) from aqueous phase by Moringa oleifera bark, a low cost biosorbent	155
36	Antiproliferation and induction of apoptosis by Moringa oleifera leaf extract on human cancer cells	153
37	Pharmacological properties of moringa-oleifera .2. Screening for antispasmodic, antiinflammatory and diuretic activity	145
38	Optimization of Cd(II), Cu(II) and Ni(II) biosorption by chemically modified Moringa oleifera leaves powder	143
39	Coagulation mechanism of salt solution-extracted active component in Moringa oleifera seeds	137
40	The Antibiotic Principle of Seeds of Moringa Oleifera And Moringa Stenopetala	135
41	Biosorption studies on shelled Moringa oleifera Lamarck seed powder: Removal and recovery of arsenic from aqueous system	134
42	Effect of Moringa oleifera Lam. leaves aqueous extract therapy on hyperglycemic rats	133
43	Polyphenolic content and antioxidant properties of Moringa oleifera leaf extracts and enzymatic activity of liver from goats supplemented with Moringa oleifera leaves/sunflower seed cake	128
44	Biosorption of Pb(II) from aqueous solutions using chemically modified Moringa oleifera tree leaves	127
45	Characterization of Moringa oleifera variety Mbololo seed oil of Kenya	126
46	Health Benefits of Moringa oleifera	124
47	Evaluation of nutritional quality of moringa (Moringa oleifera Lam.) leaves as an alternative protein source for Nile tilapia (Oreochromis niloticus L.)	122
48	Effect of fruits of Moringa oleifera on the lipid profile of normal and hypercholesterolaemic rabbits	122
49	Phenolic composition, antioxidant and antimicrobial activities of free and bound phenolic extracts of Moringa oleifera seed flour	120
50	Characterization of Moringa oleifera seed oil variety Periyakulam 1""	119
51	Optimization of extraction method to obtain a phenolic compounds-rich extract from Moringa oleifera Lam leaves	118
52	Chemical composition, fatty acid content and antioxidant potential of meat from goats supplemented with Moringa (Moringa oleifera) leaves, sunflower cake and grass hay	118
53	Pharmacological properties of moringa-oleifera .1. Preliminary screening for antimicrobial activity	117
54	Interprovenance variation in the composition of Moringa oleifera oilseeds from Pakistan	114
55	Moringa oleifera as an Anti-Cancer Agent against Breast and Colorectal Cancer Cell Lines	113
56	Application of response surface methodology for optimizing transesterification of Moringa oleifera oil: Biodiesel production	112
57	Bioactive Components in Moringa Oleifera Leaves Protect against Chronic Disease	111
58	Evaluation of antidiabetic and antioxidant activity of Moringa oleifera in experimental diabetes	110
59	Properties and use of Moringa oleifera biodiesel and diesel fuel blends in a multi-cylinder diesel engine	110
60	Phytochemicals and uses of Moringa oleifera leaves in Ugandan rural communities	109
61	Pretreatment of palm oil mill effluent (POME) using Moringa oleifera seeds as natural coagulant	109
62	Removal of Zn(II) ions from aqueous solution using Moringa oleifera Lam. (horseradish tree) biomass	108
63	Moringa oleifera: bioactive compounds and nutritional potential	108
64	The Antidiabetic Effect of Low Doses of Moringa oleifera Lam. Seeds on Streptozotocin Induced Diabetes and Diabetic Nephropathy in Male Rats	108
65	Agroforestry waste Moringa oleifera petals mediated green synthesis of gold nanoparticles and their anti-cancer and catalytic activity	108
66	Niaziminin, a thiocarbamate from the leaves of Moringa oleifera, holds a strict structural requirement for inhibition of tumor-promoter-induced Epstein-Barr virus activation	108
67	Coagulation-flocculation process for POME treatment using Moringa oleifera seeds extract: Optimization studies	107

68	Effects of storage conditions of Moringa oleifera seeds on its performance in coagulation	105
69	Fully Acetylated Carbamate And Hypotensive Thiocarbamate Glycosides From Moringa-Oleifera	103
70	Phytochemicals of Moringa oleifera: a review of their nutritional, therapeutic and industrial significance	102
71	Soluble Extract from Moringa oleifera Leaves with a New Anticancer Activity	102
72	The use of Moringa oleifera as a natural coagulant in surface water treatment	102
73	Effect of Moringa oleifera lectin on development and mortality of Aedes aegypti larvae	101
74	Innovative physico-chemical treatment of wastewater incorporating Moringa oleifera seed coagulant	101
75	Moringa oleifera Lam prevents acetaminophen induced liver injury through restoration of glutathione level	100
76	Stable, water extractable isothiocyanates from Moringa oleifera leaves attenuate inflammation in vitro	99
77	Determination of flavonoids by LC/MS and anti-inflammatory activity in Moringa oleifera	99
78	Optimizing Physical Parameters Affecting Coagulation of Turbid Water With Moringa-Oleifera Seeds	99
79	Green synthesis of zinc oxide nanoparticles using Moringa oleifera leaf extract and evaluation of its antimicrobial activity	97
80	Effect of Moringa oleifera Lam. root-wood on ethylene glycol induced urolithiasis in rats	97
81	Nutritional Quality of Edible Parts of Moringa oleifera	96
82	Hypotensive constituents from the pods of Moringa oleifera	95
83	Evaluation of the Polyphenol Content and antioxidant Properties of methanol Extracts of the Leaves, Stem, and Root Barks of Moringa oleifera Lam.	95
84	Microwave-assisted extraction of polysaccharides from Moringa oleifera Lam. leaves: Characterization and hypoglycemic activity	95
85	Alkaline catalyzed biodiesel production from moringa oleifera oil with optimized production parameters	94
86	Moringa-Oleifera seeds for Softening hard water	94
87	Physico-chemical characteristics of Moringa oleifera seeds and seed oil from a wild provenance of Pakistan	93
88	Multi-functional application of Moringa oleifera Lam. in nutrition and animal food products: A review	90
89	Removal of cadmium from aqueous system by shelled Moringa oleifera Lam. seed powder	90
90	Nutritional potential of two leafy vegetables: Moringa oleifera and Ipomoea batatas leaves	89
91	Chemical characteristics and fractionation of proteins from Moringa oleifera Lam. leaves	89
92	Facile Synthesis of Three-Dimensional Heteroatom-Doped and Hierarchical Egg-Box-Like Carbons Derived from Moringa oleifera Branches for High-Performance Supercapacitors	89
93	Performance and emission analysis of Jatropha curcas and Moringa oleifera methyl ester fuel blends in a multi-cylinder diesel engine	89
94	Active principle from Moringa oleifera Lam leaves effective against two leukemias and a hepatocarcinoma	88
95	Moringa oleifera Seeds and Oil: Characteristics and Uses for Human Health	86
96	Common bean (Phaseolus vulgaris L.) seedlings overcome NaCl stress as a result of presoaking in Moringa oleifera leaf extract	86
97	Amplified fragment length polymorphism (AFLP) analysis of genetic variation in Moringa oleifera Lam.	86
98	Enhancement of the oxidative stability of some vegetable oils by blending with Moringa oleifera oil	86
99	Concomitant administration of Moringa oleifera seed powder in the remediation of arsenic-induced oxidative stress in mouse	85
100	Adoption of Moringa oleifera to Combat Under-Nutrition Viewed Through the Lens of the Diffusion of Innovations Theory	84

TC: Total Citations

Table S2. Journals that published with ≥ 3 articles in *Moringa oleifera*

Element (n=56)	h_index	TC	NP	IF (2020) [a]	Research domain
Water Research	8	1635	8	11.236	Engineering, Environmental Sciences & Ecology, Water Resources
Journal of Ethnopharmacology	7	956	7	4.36	Plant Sciences, Pharmacology & Pharmacy Integrative & Complementary Medicine
Food Chemistry	5	677	5	7.514	Chemistry, Food Science & Technology Nutrition & Dietetics
Bioresource Technology	4	692	4	9.642	Agriculture, Biotechnology & Applied Microbiology, Energy & Fuels
Food and Chemical Toxicology	4	704	4	6.025	Food Science & Technology, Toxicology
Industrial Crops and Products	4	566	4	5.645	Agriculture
Journal of Agricultural and Food Chemistry	4	1316	4	5.279	Agriculture, Chemistry, Food Science & Technology
Chemical Engineering Journal	3	336	3	13.273	Engineering
Journal of Hazardous Materials	3	386	3	10.588	Engineering, Environmental Sciences & Ecology
Planta Medica	3	338	3	3.356	Plant Sciences, Pharmacology & Pharmacy Integrative & Complementary Medicine

Table S3: Thematic Map analysis of top 250 Words with minimum frequency of 5 in field of Author KeyWords

Cluster_Label_Author KeyWord	**Words (Occurrences)**	**Callon Centrality (R)**	**Callon Density (R)**
Natural coagulant	'Natural coagulant (6), 'coagulation' (5), 'characterization' (3), 'coagulation-flocculation' (3), 'water treatment' (3), 'cationic proteins' (2), 'moringa oleifera seeds' (2), 'natural coagulants' (2), 'pome' (2), 'purification' (2), 'response surface methodology' (2), 'wastewater treatment' (2).	2.28 (22)	233.03 (2)
Moringa oleifera	'Moringa oleifera' (61), 'antioxidant' (6), 'anti-hyperglycemic' (2), 'antioxidants' (2), 'arsenic' (2), 'oxidative stress' (2), 'total phenolic content'(2).	1.79 (21)	276.73 (6)
Biosorption	'Biosorption' (7), 'isotherms' (5), 'kinetics' (3), 'thermodynamics' (3), 'lead' (2), 'Moringa oleifera bark' (3), 'nickel' (3).	0.26 (18)	260.81(4)
Antioxidant activity	'Antioxidant activity' (3), 'free radicals' (3), 'antibacterial activity' (2), 'flavonoids' (2), 'isothiocyanates' (2), 'reducing power' (2).	0.36 (19)	373.14 (13)
Biodiesel	'Biodiesel' (3), 'blending' (3), 'moringa oleifera oil' (3), 'optimization' (3), 'Biodiesel production' (2), 'emissions' (2), 'engine performance' (2), 'fuel properties' (2), 'transesterification' (2).	2.73 (23)	244.44 (3)
Composition	composition' (3), 'seed oil' (2), 'stability' (2),	0.07 (16)	261.90 (5)
Moringaceae	'Moringaceae' (7), 'bioactive' (2), 'drumstick tree' (2), 'leaves' (2).	1.014 (20)	377.62 (14)
Phytochemicals	'Phytochemicals' (2).	0.073 (15)	378.57 (15.5)
Diabetes	'Diabetes' (2)	0.11 (17)	378.57 (15.5)

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