

# Moringa oleifera: A Bibliometric Analysis of India's Publications During 1980-2019

BM Gupta<sup>1\*</sup>, KK Mueen Ahmed<sup>2</sup>

<sup>1</sup>Formerly with CSIR-NISTADS, New Delhi, INDIA.

<sup>2</sup>Phcog.Net, Bengaluru, Karnataka, INDIA.

## ABSTRACT

The study examines India's research publications on *Moringa oleifera* plant during 1980-2019, as indexed in Scopus database, focusing on aspects, such as growth characteristics, research quality and impact, extent of international collaborative papers, distribution by broad subjects and significant keywords, leading organizations, authors and journals and features of its high-cited papers. The study found that CFTRI - Mysore (21 papers), University of Calcutta (18 papers) and Banasthali Vidyapeeth (15 papers) were the most productive organizations and National Botanical Research Institute, Lucknow (79.27 and 4.12), Sri Venkateswara University, Tirupati (55.82 and 2.90) and Banaras Hindu University, Varanasi (40.7 and 2.12) were the most impactful organizations in terms of citation per paper and relative citation index. A. Mehta (10 papers), V. Sharma (10 papers) and D. Guha (9 papers) were the most productive authors and S.J.S. Flora (103.33 and 5.38), A. Urooj (36.50 and 1.90) and A.A. Mehta (20.5 and 1.59) were the most impactful authors in terms of citation per paper and relative citation index. *International Journal of Pharmacy and*

*Pharmaceutical Sciences* (21 papers), *Asian Journal of Pharmaceutical and Clinical Research* and *Journal of Ethnopharmacology* (19 papers each) were the leading journals contributing to the field. *Journal of Ethnopharmacology* (75.0), *Phytotherapy Research* (52.75) and *Indian Journal of Experimental Biology* (33.33) were found to be most impactful journals in terms of citation per paper.

**Key words:** *Moringa oleifera*, Medicinal plant, Indian publications, Scientometrics, Bibliometrics.

## Correspondence

Dr. BM Gupta

Formerly with CSIR-NISTADS, New Delhi 110 012, INDIA.

Phone: +91 9888378275

Email: bmgupta1@gmail.com

DOI: 10.5530/jyp.2020.12.62

## INTRODUCTION

*Moringa oleifera* is a versatile horticulture tree with important medicinal, nutritional and industrial applications, widely distributed and used in India. *Moringa*, is the sole genus in the flowering plant family Moringaceae. The name is derived from murungai, the Tamil word for drumstick and the plant is commonly referred to as the drumstick tree. It contains 13 species from tropical and subtropical climates that range in size from tiny herbs to massive trees.<sup>1</sup> The most widely cultivated species is *Moringa oleifera*, first described by French naturalist Jean-Baptiste Lamarck in 1785]. It is a fast-growing, drought-resistant tree of the family Moringaceae, native to the Indian subcontinent.<sup>2</sup> The moringa tree is grown mainly in semi-arid, tropical and sub-tropical areas.

The *Moringa* tree originated in India and was introduced to Africa from India and other countries as a health supplement. Presently, this species of *Moringa* grows in the wild or is cultivated in Central America and the Caribbean, northern countries of South America, Africa, Southeast Asia and various countries of Oceania. Its common names include *Moringa*, drumstick tree (from the long, slender, triangular seed-pods), horseradish tree (from the taste of the roots, which resembles horseradish) and ben oil tree or benzolive tree (from the oil which is derived from the seeds.<sup>2</sup>

*Moringa oleifera* is considered as a multipurpose tree and cultivated throughout the tropics and marketed as a dietary supplement, health food or source for herbalism practices. The fruit pods of *Moringa oleifera* ("drumsticks") are consumed as food in many parts of the world, but particularly in South Asia. The leaves are commonly used to make tea. Oils are made from the seeds, while powders can be made from the leaves and roots.<sup>2</sup>

Almost all parts of moringa are edible with regional uses varying widely: Immature seed pods, called "drumsticks", Leaves, Mature seeds, Oil pressed from seeds, Flowers and Roots. The leaves are the most nutritious part of the plant, being a significant source of B Vitamins, Vitamin C, pro-vitamin A as beta-carotene, Vitamin K, manganese and protein. The leaves are cooked and used like spinach and are commonly dried and crushed into a powder used in soups and sauces<sup>2</sup> or as a supplement for pets.<sup>2</sup> The immature seed pods, called "drumsticks", are commonly consumed in South Asia, cooked and remain particularly high in Vitamin C and also a good source of dietary fiber, potassium, magnesium and manganese.<sup>2</sup> The seeds are eaten like peas or roasted like nuts; contain high levels of vitamin C and moderate amounts of B vitamins and dietary minerals. Mature seeds yield 38–40% edible oil called ben oil from its high concentration of behenic acid. The roots are shredded and used as a condiment with sharp flavor qualities deriving from significant content of polyphenols.<sup>2</sup>

With its high nutritive values, every part of the tree is suitable for either nutritional or commercial purposes. The leaves are rich in minerals, vitamins and other essential phytochemicals. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, anti-diabetic and anti-microbial agent. *M. oleifera* seed, a natural coagulant is extensively used in water treatment. The scientific effort of this research provides insights on the use of *Moringa* as a cure for diabetes and cancer and fortification of *Moringa* in commercial products.<sup>3</sup>

Different parts of this plant contain a profile of important minerals and are a good source of protein, vitamins, beta-carotene, amino

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

acids and various phenolics. The *Moringa* plant provides a rich and rare combination of zeatin, quercetin, beta-sitosterol, caffeoylquinic acid and kaempferol. In addition to its compelling water purifying powers and high nutritional value, *Moringa oleifera* is very important for its medicinal value. Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, antiinflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in South Asia.<sup>4</sup>

Moreover, *M. oleifera* seeds are widely used in water and effluent treatment, for their coagulation, flocculation and sedimentation properties, their ability of improving water quality, by reducing organic matter and microbial load, with special applicability in intensive animal production systems, such as aquaculture. In addition, due to its high nutritional value and several medicinal properties, this tree may act as a nutritional and medical alternative for socially neglected populations.<sup>5</sup> India is the largest producer of *Moringa*, with an annual production of 1.2 million tons of fruits from an area of 380 km<sup>2</sup>.<sup>2</sup> In terms of economic value, most of the production and international trade of *Moringa oleifera* comes from India, in canned produce, fresh fruits, oil, seeds and leaf powder.<sup>3</sup> India has an annual production of 1.1-1.3 million tons of tender pods.<sup>6</sup>

## Literature Review

Uptill now, only two bibliometric studies have been published on *Moringa oleifera*. Mainenti<sup>7</sup> examined the global research output of *Moringa oleifera*, using three bibliographical databases namely Scopus, Web of Science and Google during 1935-2018. The author analyzed distribution by publication type, keyword frequency, country, subjects, organizations, authors and journals. It identified most prolific keywords, subjects, organizations, authors, journals and high-cited papers. The study revealed the intellectual landscape and highlighted emerging topics and trends. Dou and Kister<sup>8</sup> examined the 314 publications and patent Information (356 patents from 171 families) of *Moringa oleifera* during 2000-14, using PubMed and EPO (European Patent Office) databases. From the PubMed database, the authors examined literature growth, leading countries, authors, journals and keywords and also collaborative linkages among countries, authors and keywords. The patents were studied by filing country distribution, patent assignees (applicants) applications and important properties. The names of important organizations, researchers and companies were also identified.

Similar bibliometric studies have been carried out on other medicinal plants, such as *Aegle marmelos*,<sup>9</sup> *Aloe vera*,<sup>10</sup> *Andrographis paniculata*,<sup>11</sup> *Azadirachta indica*,<sup>12</sup> *Curcuma longa*,<sup>13</sup> *Glycyrrhiza glabra*,<sup>14</sup> *Nigella sativa*,<sup>15</sup> *Ocimum sanctum*,<sup>16</sup> *Phyllanthis emblica*,<sup>17</sup> *Rhodiola rosea*,<sup>18</sup> *Tinospora cordifolia*<sup>19</sup> and *Withania somnifera*.<sup>20</sup>

Since India is the largest contributor to global *Moringa oleifera* research and as yet no bibliometric study has been published on the bibliometric assessment of India's research in this area, as a result we felt the need to undertake the present study.

## Objectives

The present study examines the India's output on *Moringa oleifera* during 1980-2019, with the following objectives: (i) To study the distribution of India's publication by document and source type, (ii) to study the annual average growth rate, citation impact and collaboration features of India's publication; (iii) To study the distribution of India's publications by broad subject fields and to identify the significant keywords; (iv) To

study the top India organizations and authors in the subject; (iv) To study the distribution of papers by source journals and to identify the leading journals; and (v) To study the characteristics of highly-cited papers.

## Methodology

For the present study, the *Moringa oleifera* publications originating from India was retrieved and downloaded from the Scopus database (<http://www.scopus.com>) during 1980-2019. A search strategy was formulated, where the keyword "*Moringa oleifera*" was searched in two database tags, namely "keyword tag" and "Article Title tag" and the search output refined by period "1980-2019" using "date range tag". This main search strategy was further refined by country to identify top 10 most productive countries (including India) on *Moringa oleifera*. The main string for generating India's output (as shown below) was further refined with existing provisions in Scopus database to generate various kinds of publications statistics presented in the study. Citations to publications were counted from date of their publication till 15 January 2020. The study analyzed the publications data across a series of raw and relative bibliometric indicators with a view to understand the dynamics of India's *Moringa oleifera* research output.

(KEY("Moringa oleifera") OR TITLE("Moringa oleifera")) AND (EXCLUDE (PUBYEAR, 2020))

## ANALYSIS AND RESULTS

The India's research output on *Moringa oleifera* plant resulted in 819 publications during 1980-19. The annual number of publications remained low and study till 1996 and the starting increasing up to 2014 and the again decreased till 2019. India's twenty-year cumulative publications increased from 38 during 1980-99 to 781 during 2000-19, registering 1955.26% absolute growth. The total publications from India on *Moringa oleifera* registered citation impact per paper (CPP) of 19.20 during 1980-19, which decreased from 29.20 CPP (1980-1999) to 18.70 (2000-19) (Table 1). Of the total publications, 85.96% (704) appeared as articles, 8.79% (72) as reviews, 2.93% (24) as conference papers and other categories contributed less than 1.0%: letters (0.72%), book chapters (0.49%), data paper and editorial (0.24% each), erratum, note, short survey, retracted and undefined (0.12% each).

The share of international collaborative papers (ICP) in India's output on *Moringa oleifera* was 10.38% during 1980-2019, which increased from 2.63% during 1980-99 to 10.76% during 2000-19. The 85 India's international collaborative papers together received 2607 citations, averaging to 30.67 citations per paper. Among India's ICP, USA contributed the largest share (20.0%), followed by South Korea (12.94%), Saudi Arabia (10.59%), Japan and South Africa (7.06% each), Singapore (5.88%), Canada, China, Mexico, Pakistan, U.K. and Australia (4.71% each).

## Subject-Wise Distribution of Research Output

Pharmacology, toxicology and pharmaceuticals is the most dominating subject contributing to India's research on *Moringa oleifera* (41.27%), followed by biochemistry, genetics and molecular biology (24.18%), agricultural and biological sciences (21.61%), medicine (18.56%), environmental science (3.19%), chemistry (11.60), energy (5.25%) and immunology and microbiology (3.79%) during 1980-2019. Except pharmacology, toxicology and pharmaceuticals, all other subjects witnessed decrease in activity index values during 1980-99 to 2000-19. Chemistry, among various subjects, registered the highest citation impact per paper of 23.24 and energy subject the least (10.88) (Table 2).

**Table 1: India's Research Publications on *Moringa oleifera* during 1980-19.**

Publication Period	India				
	TP	TC	ICP	%ICP	
1980	1	244	244.0		
1982	1	41	41.0		
1984	1	0	0.0		
1986	1	5	5.0		
1987	3	28	9.3		
1988	6	84	14.0		
1989	1	10	10.0		
1990	1	19	19.0		
1992	2	80	40.0		
1994	2	71	35.5		
1995	3	193	64.3	1	33.33
1996	1	12	12.0		
1997	5	65	13.0		
1998	4	111	27.8		
1999	6	146	24.3		
2000	4	133	33.3	1	25.00
2001	4	128	32.0		
2002	1	130	130.0		
2003	9	853	94.8	1	11.11
2004	7	133	19.0	1	14.29
2005	17	904	53.2	1	5.88
2006	14	698	49.9		
2007	31	1046	33.7	4	12.90
2008	17	507	29.8	1	5.88
2009	35	1348	38.5	2	5.71
2010	36	873	24.3	3	8.33
2011	70	2004	28.6	10	14.29
2012	71	2093	29.5	3	4.23
2013	71	1082	15.2	7	9.86
2014	80	956	12.0	6	7.50
2015	54	569	10.5	9	16.67
2016	65	560	8.6	9	13.85
2017	54	350	6.5	3	5.56
2018	63	177	2.8	11	17.46
2019	78	90	1.2	12	15.38
1980-1999	38	1109	29.2	1	2.63
2000-19	781	14634	18.7	84	10.76
1980-19	819	15743	19.2	85	10.38

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper

## Significant Keywords

A number of significant keywords (50) have been identified from the literature on *Moringa oleifera*, which throws some light on the trends of research in this field. The keywords are arranged in the decreasing order of appearance in the literature (Table 3).

## Top 15 Most Productive Indian Organizations

In all 264 organizations participated in India's research on *Moringa oleifera*: 227 organizations published 1-5 papers each, 25 organizations 6-10 papers each and 12 organizations 11-21 papers. The top 15 organizations published 10 to 21 papers and together account for 23.08% (189) India's publications share and 32.76% (5157) India's citations share during 1980-2019. On further analysis, it was observed that (Table 4):

- Five organizations registered their publication productivity above the group average (12.60) of all organizations: CFTRI - Mysore (21 papers), University of Calcutta (18 papers), Banasthali Vidyapeeth (15 papers), University of Mysore and University of Rajasthan, Jaipur (13 papers each);
- Five organizations registered their citation per paper and relative citation index above the group average (27.29 and 1.42) of all organizations: National Botanical Research Institute (NBRI), Lucknow (79.27 and 4.12), Sri Venkateswara University, Tirupati (55.82 and 2.90), Banaras Hindu University, Varanasi (40.7 and 2.12), Annamalai University (38.8 and 2.02) and Lallubhai Motilal College of Pharmacy, Ahmedabad (28.42 and 1.48).

## Top 15 Most Productive Indian Authors

In all 310 authors participated in India's research on *Moringa oleifera*: 292 authors published 1-5 papers each and 18 authors 6-10 paper each. The top 15 authors published 6 to 10 papers and together account for 14.53% (119) India's publications share and 20.10% (3164) India's citations share during 1980-2019. On further analysis, it was observed that (Table 5):

- Nine authors registered their publications output above the group average of 7.93: A.A. Mehta and V.Sharma (10 papers each), D. Guha, R. Paliwal and S. Shukla (9 papers each), S.G. Mahajan, R. Mathur, A.Q. Prakash and A. Urooj (8 papers each);
- Seven authors registered their citation per paper and relative citation index above the group average (26.59 and 1.38) of all authors: S.J.S. Flora (103.33 and 5.38), A. Urooj (36.50 and 1.90), A.A. Mehta (20.5 and 1.59), S.G. Mahajan (30.38 and 1.58), R.K. Saini (28.57 and 1.48).

## Medium of Communication

Journals contributed the largest share (97.56%, 799 papers) of India's publications on *Moringa oleifera* followed by book series and conference proceedings (0.85%, 7 papers each), books (0.49%, 4 papers) and trade publications (0.24%, 2 publications) during 1980-19.

315 journals unevenly participated in research on *Moringa oleifera* by contributing 799 articles in journal medium: 162 published 1 papers each, 75 published 2 papers each, 36 published 30 papers each 15 published 4 papers each, 11 published 5 papers each, 17 published 6-10 papers each and 8 published 11-21 papers each during 1980-2019.

The top 15 most productive journals accounted for 24.16% share of total India's journal output during 1980-19. However, their individual contribution varied from 7 to 21 papers per journal. The top 4 most productive journals were: *International Journal of Pharmacy and Pharmaceutical Sciences* (21 papers), *Asian Journal of Pharmaceutical and Clinical Research* and *Journal of Ethnopharmacology* (19 papers each) and *International Journal of Pharma and Bio Sciences* (18 papers). The top 4 most impact journals in terms of citations per paper were:

**Table 2: Subject-Wise Breakup of India's Publications on *Moringa oleifera* during 1980-19.**

S.No	Subject*	Number of Papers (TP)			Activity Index		TC	CPP	%TP
		1980-1999	2000-19	1980-19	1980-1999	2000-19			
1	Pharmacology, toxicology and pharmaceuticals	21	317	338	133.91	98.35	5781	17.10	41.27
2	Biochemistry, genetics and molecular biology	7	191	198	76.20	101.16	3330	16.82	24.18
3	Agricultural and biological sciences	8	169	177	97.41	100.13	3862	21.82	21.61
4	Medicine	7	145	152	99.26	100.04	3385	22.27	18.56
5	Environmental science	3	105	108	59.87	101.95	2314	21.43	13.19
6	Chemistry	3	92	95	68.06	101.55	2208	23.24	11.60
7	Energy	0	43	43	0.00	104.87	472	10.98	5.25
8	Immunology and microbiology	1	30	31	69.52	101.48	521	16.81	3.79
	World Output	38	781	819					

There is overlapping of literature covered under various subjects  
 TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper

**Table 3: List of Significant Keywords appeared in Literature on *Moringa oleifera* during 1980-2019.**

S.No	Keyword Name	Frequency	S.No	Keyword Name	Frequency
1	<i>Moringa oleifera</i>	748	26	Plant Leaves	37
2	Plant Extract	396	27	<i>Staphylococcus aureus</i>	37
3	Plant Leaf	198	28	Anti-microbial Activity	36
4	Medicinal Plant	161	29	Phenol Derivatives	36
5	Antioxidant Activity	107	30	Phytotherapy	36
6	Phytochemistry	98	31	Alkaloids	35
7	Plant Seed	82	32	Wound Healing	35
8	Drug Screening	68	33	Seeds	34
9	Moringa	62	34	Proteins	34
10	Flavonoids	70	35	Catalase	31
11	Oxidation Stress	57	36	Tannin Derivatives	30
12	Anti-bacterial Activity	56	37	Liver Protection	30
13	Anti-inflammatory Activity	55	38	Anti-diabetic Activity	26
14	<i>In vitro</i> Study	55	39	Anti-fungal Activity	26
15	Bark	50	40	Diabetes Mellitus	26
16	Fruit	49	41	Saponins	25
17	Plant Root	47	42	Water Treatment	24
18	Traditional Medicine	47	43	Ayurveda	22
19	Methanol	46	44	Analgesic Activity	21
20	Ascorbic Acid	45	45	Immunomodulation	21
21	Anti-neoplastic Activity	42	46	<i>In vivo</i> Study	19
22	Enzyme Activity	42	47	Inflammation	19
23	<i>Escherichia coli</i>	42	48	Paw Edema	19
24	Coagulation	38	49	Plant Stem	19
25	Flower	38	50	Phenol	19

**Table 4: Scientometric Profile of Top 15 Organizations in *Moringa oleifera* during 1980-2019.**

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	%ICP	RCI
1	Central Food Technological Research Institute (CFTRI), Mysore	21	526	25.05	14	4	19.05	1.30
2	University of Calcutta	18	443	24.61	10	1	5.56	1.28
3	Banasthali Vidyapeeth	15	181	12.07	9	0	0.00	0.63
4	University of Mysore	13	350	26.92	6	2	15.38	1.40
5	University of Rajasthan, Jaipur	13	220	16.92	8	1	7.69	0.88
6	Lallubhai Motilal College of Pharmacy, Ahmedabad	12	341	28.42	9	0	0.00	1.48
7	Jadavpur University, Kolkata	12	224	18.67	6	1	8.33	0.97
8	Sri Venkateswara University, Tirupati	11	614	55.82	8	3	27.27	2.90
9	Vellore Institute of Technology	11	109	9.91	4	5	45.45	0.52
10	Bharathiar University	11	259	23.55	5	2	18.18	1.23
11	National Botanical Research Institute (NBRI), Lucknow	11	872	79.27	8	1	9.09	4.12
12	SRM Institute of Science and Technology	11	128	11.64	4	0	0.00	0.61
13	Banaras Hindu University, Varanasi	10	407	40.70	6	1	10.00	2.12
14	Annamalai University	10	388	38.80	4	1	10.00	2.02
15	Siksho o Anusandhan Deemed University	10	95	9.50	5	0	0.00	0.49
	Total of 15 organizations	189	5157	27.29	7.07	22	11.64	1.42
	Total of India	819	15743	19.22				
	Share of Top 15 in India's Total	23.08	32.76					

**Table 5: Scientometric Profile of Top 125 Most Productive Authors in *Moringa oleifera* during 1980-2019.**

S.No	Name of the Author	Affiliation of the Author	TP	TC	CPP	HI	ICP	%ICP	RCI
1	A.A. Mehta	L.M. College of Pharmacy, Ahmedabad	10	305	30.50	8	0	0.00	1.59
2	V. Sharma	Banasthali Vidyapeeth	10	140	14.00	7	0	0.00	0.73
3	D. Guha	University of Calcutta	9	176	19.56	5	0	0.00	1.02
4	R. Paliwal	Banasthali Vidyapeeth	9	134	14.89	7	0	0.00	0.77
5	S. Shukla	Jiwaji University, Gwalior	9	121	13.44	6	0	0.00	0.70
6	S.G. Mahajan	L.M. College of Pharmacy, Ahmedabad	8	243	30.38	7	0	0.00	1.58
7	R. Mathur	Jiwaji University, Gwalior	8	120	15.00	6	0	0.00	0.78
8	A.Q. Prakash	Jiwaji University, Gwalior	8	119	14.88	6	0	0.00	0.77
9	A. Urooj	University of Mysore	8	292	36.50	4	2	25.00	1.90
10	S. Dey	University of Calcutta	7	146	20.86	7	1	14.29	1.09
11	C. Radha	CFTRI-Mysore	7	177	25.29	5	2	28.57	1.32
12	R.K. Saini	CFTRI-Mysore	7	200	28.57	7	1	14.29	1.49
13	N.P. Shetty	CFTRI-Mysore	7	200	28.57	7	1	14.29	1.49
14	S.J.S.Flora	Defense R&D Establishment	6	620	103.33	5	0	0.00	5.38
15	P. Giridhar	CFTRI-Mysore	6	171	28.50	6	1	16.67	1.48
	Total of 15 authors		119	3164	26.59	6.2	8	6.72	1.38
	Total of India		819	15743	19.22				
	Share of 15 Authors in India's Total Output		14.53	20.10					

**Table 6: Top 15 Most Productive Journals in India's Research in *Moringa oleifera* during 1980-2019.**

S.No	Name of the Journal	Total Papers			TC	CPP
		1980-99	2000-19	1980-2019	1980-2019	
1	International Journal of Pharmacy and Pharmaceutical Sciences	0	21	21	184	8.76
2	Asian Journal of Pharmaceutical and Clinical Research	0	19	19	173	9.11
3	Journal of Ethno-pharmacology	4	15	19	1425	75.00
4	International Journal of Pharma and Bio Sciences	0	18	18	129	7.17
5	Asian Pacific Journal of Tropical Biomedicine	0	15	15	456	30.40
6	Indian Journal of Experimental Biology	1	14	15	500	33.33
7	International Journal of Pharmaceutical Sciences. Review and Research	0	12	12	81	6.75
8	International Journal of Pharmtech Research	0	12	12	114	9.50
9	Research Journal of Pharmaceutical Biological and Chemical Sciences	0	11	11	14	1.27
10	Pharmaceutical Biology	2	8	10	116	11.60
11	Journal of Food Science and Technology	0	9	9	162	18.00
12	Research Journal of Pharmacy and Technology	0	9	9	24	2.67
13	Desalination and Water Treatment	0	8	8	50	6.25
14	Phytotherapy Research	4	4	8	422	52.75
15	Indian Drugs	1	6	7	19	2.71
	Total of 15 journals	12	181	193		
	Total of journal output	39	760	799		
	Share of top 155 journals in total journal output	30.77	23.82	24.16		

*Journal of Ethnopharmacology* (75.0), *Phytotherapy Research* (52.75), *Indian Journal of Experimental Biology* (33.33) and *Asian Pacific Journal of Tropical Biomedicine* (30.40) (Table 6).

### Highly-cited Papers

Of the total India's output on *Moringa oleifera* (819 publications), only 30 (3.66% share) cumulated 100 to 796 citations per paper (cumulative total 5782 citations) since their publication during 1980-2019, averaging to 192.73 citations per paper.

The distribution of 30 highly cited papers is skewed. Twenty one papers were in citation range 100-166 per paper, 6 papers were in citation range 2011-276, 2 papers in citation range 386-423 and 1 paper received 796 citations.

- Of the 30 highly cited papers, 14 resulted from contribution by single organizations per paper (non-collaborative papers) and 16 from two or more organizations per paper (9 national collaborative and 7 international collaborative papers).
- Among 7 international collaborative highly cited papers, Singapore published 3 papers and USA, Taiwan, South Korea and Oman 1 paper each;
- The 30 highly cited papers belonged to 118 authors and 32 organizations.
- The leading organizations participating in highly cited papers were: Bhabha Atomic Research Center, Bombay, National Botanical Research Institute, Lucknow and Sri Venkateswar University, Tirupati published 4 papers by Avinashilingam University, Coimbatore (3 papers), and University of Mysore (2 papers) and 27 other organizations with 1 paper each;

- The leading authors participating in highly cited papers were: C. Bizer (13 papers), J. Lehmann (9 papers), S. Auer (7 papers), Hellmann, S. (6 papers), Harth, A and Polleres, A. (3 papers each), etc.).
- Of the 30 highly-cited papers, only 30 papers are published in 20 journals, of which 5 papers published in *Journal of Ethnopharmacology*, 3 papers each in *Food and Chemical Toxicology* and *Food Chemistry*, 2 papers each in *International Journal of Food and Nutrition* and *Asia Pacific Journal of Tropical Medicine* and 1 paper each in *Asia Pacific Journal of Cancer Prevention*, *Carbohydrate Polymers*, *Chemical Engineering Journal*, *Desalination*, *Economic Botany*, *Free Radical Biology and Medicine*, *International Journal of Mineral Processing*, *Journal of Chemical and Pharmaceutical Research*, *Journal of Hazardous Materials*, *Journal of Environmental Management*, *Journal of Medicinal Food*, *Mycoses*, *Phytotherapy Research*, *Plant Food and Human Nutrition* and *Soil Biology and Biochemistry*

### SUMMARY AND CONCLUSION

The India's research output on *Moringa oleifera* plant resulted in 819 publications during 1980-19. The annual number of publications remained low and study till 1996 and the starting increasing up to 2014 and the again decreased up to 2019. India's twenty-year cumulative publications increased from 38 during 1980-99 to 781 during 2000-19, registering 1955.26% absolute growth. The total publications from India on *Moringa oleifera* registered citation impact per paper (CPP) of 19.20 during 1980-19, which decreased from 29.20 CPP (1980-1999) to 18.70 (2000-19).

The publication output India's research on *Moringa oleifera* resulted in 819 publications during 1980-2019. Its twenty-year cumulative publications on *Moringa oleifera* registered 1955.26% growth and averaged citation impact per paper of 19.20. Pharmacology, toxicology and pharmaceuticals is the leading subject (41.27%) contributing to India's research on *Moringa oleifera* research, followed by biochemistry, genetics and molecular biology (24.18%), agricultural and biological sciences (21.61%), medicine (18.56%), environmental science (3.19%), chemistry (11.60), energy (5.25%) and immunology and microbiology (3.79%) during 1980-2019.

264 organizations and 310 authors participated in India's research on *Moringa oleifera* during 1980-2019, of which the top 15 organizations and authors contributed 23.08% and 14.53% to India's publication share and 32.76% and 20.10% India's citation share respectively. The leading Indian organizations in terms of publication productivity were: CFTRI - Mysore (21 papers), University of Calcutta (18 papers), Banasthali Vidyapeeth (15 papers) and University of Mysore and University of Rajasthan, Jaipur (13 papers each). The leading Indian organizations in terms of citation impact per paper and relative citation index were: National Botanical Research Institute (NBRI), Lucknow (79.27 and 4.12), Sri Venkateswara University, Tirupati (55.82 and 2.90), Banaras Hindu University, Varanasi (40.7 and 2.12), Annamalai University (38.8 and 2.02) and Lallubhai Motilal College of Pharmacy, Ahmedabad (28.42 and 1.48). The leading authors in terms of publication productivity were: A.A. Mehta and V.Sharma (10 papers each), D. Guha, R. Paliwal and S. Shukla (9 papers each), S.G. Mahajan, R. Mathur, A.Q. Prakash and A. Urooj (8 papers each). The leading authors in terms of citation impact per paper and relative citation index were: S.J.S. Flora (103.33 and 5.38), A. Urooj (36.50 and 1.90), A.A. Mehta (20.5 and 1.59), S.G. Mahajan (30.38 and 1.58), R.K. Saini (28.57 and 28.50 and 1.48).

The journals medium accounted for 97.56% share in India's research on *Moringa oleifera* during 1980-2019, of which the top 15 most productive journals accounted for 24.16% share of India's output in journals. The top 3 most productive journals were: *International Journal of Pharmacy and Pharmaceutical Sciences* (21 papers), *Asian Journal of Pharmaceutical and Clinical Research* and *Journal of Ethno-pharmacology* (19 papers each). The top 3 most impact journals in terms of citations per paper were: *Journal of Ethno-pharmacology* (75.0), *Phytotherapy Research* (52.75), *Indian Journal of Experimental Biology* (33.33) and *Asian Pacific Journal of Tropical Biomedicine* (30.40).

Only 30 out of 819 India's publications on *Moringa oleifera* during 1980-2019 received 100 to 796 citations per paper. They together received a total of 5782 citations, averaging to 192.73 citations per paper. These 30 papers involved 118 authors and 32 organizations. Among 30 papers, 14 are non-collaborative, 9 national collaborative and 7 internationally collaborative. Singapore published the largest number of papers (3 papers) in 7 international collaborative high cited papers, followed by 1 paper each by USA, Taiwan, South Korea and Oman. The 30 highly-cited papers were published in 20 journals, with 5 papers published in *Journal of Ethnopharmacology*, 3 papers each in *Food and Chemical Toxicology* and *Food Chemistry*, 2 papers each in *International Journal of Food and Nutrition and Asia Pacific Journal of Tropical Medicine* and 1 paper each in other journals.

Different parts of *Moringa* (leaves, flowers, fruits and seeds) possess a great variety of compounds with high nutritional and medicinal content that could make it an ideal complementary and alternative medicine and/or nutritional supplement. The presence of antimicrobial compounds could lead to the development of alternative treatments against infectious diseases. Research has shown that every part of the plant has some medicinal application that could be further develop to produce more affordable medicines. *M. oleifera* is nutritional and medicinally

very active against free radicals formed during oxidative stress due to the strong phytochemical constituents present in virtually all parts of the plant. There is a great potential for the widespread use of this plant

It was observed that research on *Moringa oleifera* is yet to gain wide importance in India. Instead, it is essential that the nutrients of this wonder tree are exploited for a variety of purposes. Although *Moringa oleifera* has great anti-diabetic and anti-cancer properties, but more studies are needed to corroborate the primary mechanisms of *Moringa* as antidiabetic and anticancer agents. The effect of environmental factors affecting the nutrient levels of leaves and other parts of *Moringa oleifera* grown across the India require further analysis. Further research to isolate endophytic fungi and identify the enzymes or proteins from *Moringa oleifera* that are accountable for the anticancer and antidiabetic activity may lead to development of novel therapeutic compounds. Yet another focal area is to evaluate the commercial use of *Moringa oleifera* as a bio-coagulant. It might be a viable alternative for water purification. The demand for snacks in the market is huge. Hence *Moringa* fortification in snacks to eradicate malnutrition has a twin advantage. The can become a great source of income for the nation if this potential for highly nutritional food is exploited by the industries and researchers by undertaking further research to corroborate earlier studies. *Moringa oleifera* is an essential plant in meeting global food security and sustain the livelihoods of many millions of people. Climate change provides both opportunities and challenges for attaining the potential contribution of the wonderful tree for sustainable human development. Strategies need to be developed to address key issues in productivity, crop plant-soil/water/energy resources management and postharvest utilization as food and feed, nutritional and health value addition and trade and commercialization, so that the role of *Moringa* in ensuring sustainable development can be enhanced.

## REFERENCES

1. *Moringa*. 2020. <https://en.wikipedia.org/wiki/Moringa>
2. *Moringa oleifera*. 2020. [https://en.wikipedia.org/wiki/Moringa\\_oleifera](https://en.wikipedia.org/wiki/Moringa_oleifera)
3. Lakshmi Priya G, Kruthi D, Devarai SK. *Moringa oleifera*: A review on nutritive importance and its medicinal application. *Food Science and Human Wellness*. 2016;5(2):49-56. <https://doi.org/10.1016/j.fshw.2016.04.001>.
4. Anwar F, Latif S, Ashraf M, Gilani AH. *Moringa oleifera*: A food plant with multiple medicinal uses. *Phytother Res*. 2007;21(1):17-25.
5. Raimunda S, et al. Research advances on the multiple uses of *Moringa oleifera*: A sustainable alternative for socially neglected population. *Asian Pacific Journal of Tropical Medicine*. 2017;10(7):621-30.
6. PROTA. PROTA4U Web database. Wageningen, Netherlands: Plant Resources of Tropical Africa. 2017. <https://www.prota4u.org/database/>
7. Mainenti D. *Moringa oleifera*: A prolific herbal research front. *Information Science* 1. 2018;1-15.
8. Dou H, Kister J. Research and development on *Moringa oleifera* – Comparison between academic research and patents. *World Patent Information*. 2016;47:21-33.
9. Gupta BM, Ahmed KM, Bansal J, Bansal M. A quantitative and qualitative Assessment of *Aegle marmelos* global publications during 2004-18. *Int J Pharma Investig*. 2019;9(3):109-16.10.
10. Gupta BM, Mueen AKK, Dhawan SM, Gupta RG. *Aloe vera* (Medicinal Plant) research: A scientometric assessment of global publications output during 2007-16. *Pharmacogn J*. 2018;10(1):1-8.
11. Gupta BM, Mueen AKK, Bansal J, Bansal M. *Andrographis paniculata* global publications output: A bibliometric assessment during 2003-18. *Int J Pharma Investig*. 2019;9(3):101-8.
12. Gupta BM, Mueen AKK. Research on *Azadirachta indica*: A scientometric assessment of global publications output during 1997-16. *Int J Pharma Investig*. 2018;8 (4):164-72.
13. Mueen AKK, Gupta BM, Gupta R. *Curcuma longa* (Medicinal Plant) research: A scientometric assessment of global publications output during 1997-2016. *Pharmacogn J*. 2018;10(5):998-1006.
14. Gupta BM, Mueen AKK, Gupta RG. *Glycyrrhiza glabra* (Medicinal plant) research: A scientometric assessment of global publications output during 1997-2016. *Pharmacogn J*. 2018;10(6):1067-75.
15. Gupta BM, Mueen AKK. Research on *Nigella sativa*: A scientometric assessment of global publications output during 1989-18. *Int J Pharma Investig*.

- 2018;8(4):173-81.16.
16. Gupta BM, Gupta R, Agarwal A, Goel S. *Ocimum Santum* (Medicinal plant) research: A scientometric assessment of global publications output during 2008-17. *Int J Inf Dissem Technol.* 2018;8(2):67-73.17.
17. Gupta BM, Dhawan SM, Gupta R. *Phyllanthis emblica* (Medicinal plant) research: A scientometric assessment of global publications output during 2008-17. *EC Pharmacol Toxicol.* 2019;7(1):18-28.
18. Ahmed KK, Gupta BM, Bansal J, Bansal M. *Rhodiola Rosea*: A Quantitative and Qualitative Assessment of Global Publications Output during 2003-18. *Int J Pharma Investig.* 2019;9(3):93-100.
19. Gupta BM, Mueen AKK, Gupta RG. Global research on *Tinospora cordifolia* (Medicinal Plant) with special reference to India: A Scientometric Assessment Publications Output during 2001-16. *Int J Pharmacogn Chin Med.* 2018;2(4):1-11.
20. Gupta BM, Mueen AKK. Research on *Withania somnifera* (Ashwaganda): A scientometric assessment of global publications Output during 1995-18. *Int J Pharma Investig.* 2019;9(2):59-66.

**Article History:** Submission Date : 29-05-2020; Revised Date : 02-07-2020; Acceptance Date : 22-08-2020

**Cite this article:** Gupta BM, Ahmed KKM. *Moringa Oleifera*: A Bibliometric Analysis of India's Publications during 1980-2019. *J Young Pharm.* 2020;12(3):207-14.