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Andrographis paniculata Global Publications Output: A Bibliometric Assessment during 2003-18

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ABSTRACT

The present study examined 1432 global publications on *Andrographis paniculata* plant, as indexed in Scopus bibliographical and citation database during 2003-18, with a view to understand their growth rate, global publication share, citation impact, international collaborative papers share, distribution of publications by broad subjects, productivity and citation profile of top organizations and authors, preferred media of communication and bibliographic characteristics of high cited papers. The global publications registered an annual average growth rate of 10.03% and its citation impact averaged to 16.78 citations per paper. Amongst 73 participitating countries on the subject, the top 10 countries contributed 96.93% global publication share and 98.17% global citation share during 2003-18. India alone contributed the global share of 46.13%, followed by China and Malaysia (together 23.39% global share) and other top 7 countries have global share ranged from 1.96% to 6.63% during 2003-18. Four countries among top 10, registered world average of 17.0 citation per paper and 1.01 relative citation index: U.K. (45.89 and 2.73), Taiwan (32.27 and 1.92), USA (30.65 and 1.83) and Thailand (22.87 and 1.36) during 2003-18. Pharmacology, toxicology and pharmaceutics contributed the largest publications share of 50.98%, followed by medicine biochemistry, genetics and molecular biology, agricultural and biological sciences and chemistry (from 13.41% to 33.24%) and immunology and microbiology, environment science and veterinary science (from 2.30% to 7.05%) during 2003-18. Among 301 organizations and 413 authors contributing to global *Andrographis paniculata* research, the 15 most productive global organizations and authors together contributed 22.07% and 10.75% global publication share and 23.66% and 11.35% global citation share respectively during 2003-18. Universiti Putra Malaysia (55 papers), Mahidol University, Thailand (31 papers) and Universiti Sains Malaysia (28 papers) were the leading contributing organizations. D. Talei and A.Valdiani (17 papers each) and A.E. Nugroho (13 papers) were the leading productive authors. Journal of Ethnopharmacology (with 54 papers), International Journal of Pharmacy and Pharmaceutical Sciences (31 papers) and Phytotherapy Research (27 papers), were the three leading journals contributing research on this subject. Amongst 1413 journal papers (in 145 journals) in global *Andrographis paniculata* research, the top 15 most productive journals contributed 22.36% share of total journal publication output during 2003-18. Thirty Eight publications were found to be high cited, as they registered citations from 102 to 842 during 2003-18 and they together received 6356 citations, which averaged to 164.63 citations per paper.

Key words: *Andrographis paniculata*, Medicinal plant, Global publications, Scientometrics, Bibliometrics.

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INTRODUCTION

Andrographis paniculata, commonly known as the "king of bitters," is an herbaceous plant in the Acanthaceae family and is found throughout tropical and subtropical Asia, Southeast Asia and India. It is an important medicinal plant and widely used around the world. The plant is found in variety of habitants (plains, hill slopes, wastelands, farms, dry or wet lands, sea, shores and even road sides). Native population of the plant are spread throughout South India and Sri Lanka. The plant is also available in Northern India, Java, Malaysia, Indonesia, West Indies and in America as an induced species. The plant also occur in Hong Kong, Thailand, Brunei and Singapore, etc.[1] In different languages and regions, it is called or known by varying names: Bhunimba (Sanskrit), Kalmegh (in Hindi), Chuan-Xin-Lian (in China), Fah Tha Lai (in Thailand), "Hempedu bumi" (in Malaysia), Senshinren (in Japan) and green chiretta(in Scandinavian countries).[2]*Andrographis paniculata* is a lanky - growing plant. It is annual, profurely branched erect herb with a tap root. Leaves are green lanceolate glabrous with slightly undulate margins acuminate apex with a tapering base. Flowers are small and solitary; corolla whitesh or light pink in colour with fine hairs and are splashed with purple on the petals. Fruit, a capsule, linear oblong and acute at both ends, has seeds neumerous.[1]

Andrographis paniculata is a herb commonly used in Siddha, Ayurveda, Unani and homoeopathy medicines in India and some other countries as home remedy in traditional system of medicine and as tribal medicine well as as for various diseases.[1,3] *Andrographis paniculata* is used traditionally for the treatment of array of diseases such as cancer, diabetes, high blood pressure, ulcer, leprosy, bronchitis, skin diseases, flatulence, colic, influenza, dysentery, dyspepsia and malaria for centuries in Asia, America and Africa continents.[4] This plant is also traditionally used for the treatment of common cold, diarrhoea, fever due to several infective cause, jaundice, as a health tonic for the liver and cardiovascular health and as an antioxidant. It is also used to improve sexual dysfunctions and serve as a contraceptive. It is ethnobotanically used for the treatment of snake bite, bug bite, diabetes, dysentery, fever and malaria.[2] The plant has Ayurvedic properties like Rasa-Tikta, Guna-Laghu, Ruksha, Veerya-Ushna, Vipaka-Katu, Doshaghnata-Kaphapittashamaka. Traditionally it is used as carminative, liver stimulant, pttasaraka, laxative, an-

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thelmintic, blood purifier, anti-inflammatory, swedajanana, antileprotic and antipyretic, etc.[3] *Andrographis paniculata* shows a wide spectrum of pharmalogical activities in various forms: powder, extracts or its isolated compounds. Medical products or medicines fortified with plant extracts and its isolated compounds have been available in national and global market for controlling various diseases.[1] *Andrographis paniculata* possesses several photochemical constituents or isolates (particularly in its aerial parts) with unique and interesting biological properties. The major chemical constituents present in *Andrographis paniculata* are lactones, diterpenoids, diterpene glycosides, flavonoides and flavonoid glycosides and polyphenols. The isolates from *Andrographis paniculata* particularly andrographolide, neoandrographolide, dehydroandhrographolide and isoandrographolide andrographiside andropanoside are most important bioprotectants with wide range of theuapeutic applications.[1]

Andrographis paniculata has been reported to have a broad range of pharmacological effects including anticancer, antidiarrheal, antihepatitis, anti-HIV, antihyperglycemic, antimicrobial, antimalarial antioxidant, cardiovascular, cytotoxic, hepatoprotective, immunostimulatory and sexual dysfunctions.[5] It also reported to possess inflammatory, heptoprotective, astringent, anodyne, alaexipharmic and antipyretic properties that help in arresting dysentery, cholera, diabetes, influenza bronchitis, swellings and itches, piles and gonorrhea. In addition, flavonoids present in plant extracts showed potent inhibition of collagen, archidonic acid, thrombin and platlet activation factor induced platlet aggregation. The extract from this plant also protect lipids, haemoglobin and red blood cells from lipid peroxidation. It also prevents oxidation damage and inhibits binding to toxic metabolites to DNA.[1] It is also used for the treatment of hepatomegaly (liver enlargement) splenomegaly (spleen enlargement), chronic fever and constipation. It has cholagogue action, so it promotes the discharge of bile from liver and gall bladder. Therfore it improves appetite and metabolism in the body.[6]

Table 1: Annual and Cumulative Growth in *Andrographis paniculata* Publications during 2003-18.

Publication Period	World		
	TP	TC	CPP
2003	36	1115	30.97
2004	34	2164	63.65
2005	33	1802	54.61
2006	54	1788	33.11
2007	53	1831	34.55
2008	60	1684	28.07
2009	80	1643	20.54
2010	97	1983	20.44
2011	143	2239	15.66
2012	132	2207	16.72
2013	126	2373	18.83
2014	124	1147	9.25
2015	137	899	6.56
2016	106	614	5.79
2017	103	400	3.88
2018	114	146	1.28
2003-10	447	14010	31.34
2011-18	985	10025	10.18
2003-18	1432	24035	16.78

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

Despite the global importance of *Andrographis paniculata* plant research in diverse medical applications and the publication of few literature reviews, there is still no trace of any bibliometric study that demonstarates the research trends on this subject. However, there are few other bibliometric studies available in global literature, which provides quantitatively and qualitatively analyzis on global and Indian literature on individual medicinal plants: *Aloe vera*,[7] *Azadrachta indica*,[8] *Curcuma longa*,[9] *Glycyrrhiza glabre*,[10] *Nigella sativa*,[11] *Ocimum santum*,[12] *Phyllanthis emblica*,[13] *Tinospora cordifolia*,[14] *Withania somnifera*,[15] *Rhodiola rosea*[16] and *Terminalia arjuna*.[17]

In order to fill this existing gap in the literature, the present study utilizes bibliometric techniques to explore the patterns and trends on *Andrographis paniculata* plant publications output. The goal here is to study the *Andrographis paniculata* publications between 2003 and 2018. Employing the Scopus database, the paper empirically investigates 1432 documents on *Andrographis paniculata* published during this period.

The specific aim here is to study the distribution of its global publication output and of 10 most productive countries: by document type and source, growth rate of its annual and cumulative output, the share of international collaborative publications, broad subject-wise scatter across sub-fields, identification of significant keywords, publication output and citation impact of top 15 global organizations, authors and journals and characteristics of high cited publications.

METHODS

In this study, a search string was formulated in which "*Andrographis paniculata*" was used as a keyword to search "Keywords" and "Title of Paper" fields of Scopus database for the period 2003 to 2018. The database search string produced 1432 documents related to *Andrographis paniculata* plant. This search string was applied first for searching global publication data on *Andrographis paniculata* and then further restricted to individual country by name in "country tag" one by one to ascertain publication output of top 10 most productive countries (including India). The first search string was subsequently refined, using analytical tags in Scopus database, by "subject area tag", "country tag", "source title tag", "journal title name" and "affiliation tag", to get data/information on the distribution of publications output by subject, collaborating countries, author-wise, organization-wise and journal-wise, etc. citations to publications were also collected from date of publication till August 2019. No language or document type limitations were set.

(KEY("*Andrographis paniculata*") OR TITLE("*Andrographis paniculata*")) AND PUBYEAR > 2002 AND PUBYEAR < 2019

ANALYSIS

The world scholarly community have produced 1432 publications on *Andrographis paniculata* plant during 2003-18 as indexed in Scopus database. The *Andrographis paniculata* annual publications registered an average growth rate 10.03%, up from 36 in the year 2003 to 114 in the year 2018. The annual publications was minimum (36) in year 2003 and maximum (143) in 2011. It first increased from 2003 to 2011 and then decreased up to 2018. The *Andrographis paniculata* cumulative global output registered 120.36% growth, up from 447 during 2003-10 to 985 during 2011-18. *Andrographis paniculata* cumulative research output registered the citation impact per paper (CPP) of 16.78 during 2003-18, which, however, decreased from 31.34 CPP to 10.18 CPP from 2003-10 to 2011-18. Amongst document types, articles (1177, 81.49%) and reviews (198, 12.83%) constitute the largest output with 95.32% share in the global output. Conference papers, editorials, short notes, book chap-

ters, short surveys and erratum constitutes the second largest category with 4.55% share of global output. Others marginally contributed are books and letters with each 0.07% share (Table 1).

Leading Countries in Research on *Andrographis paniculata*

In *Andrographis paniculata* global research output, 73 countries evenly participated during 2003-18. 55, 10 and 7 countries contributed 1-10, 11-20 and 21-50 papers each, as against 3, 2 and 1 country contributing 51-100, 101-170 and 663 papers each. The contribution of top 10 countries ranges from 28 to 663 publications each on *Andrographis paniculata* during 2003-18 (Table 2). The 96.93% of global publication share and 98.17% of the global citation share have been contributed by top 10 countries during 2003-18. India alone contributed 46.13% of the global publication share. China and Malaysia together contributed 23.39% global share and all other 7 top countries contributed from 1.96% to 6.63% during 2003-18. The global publication share registered increasing trend in Indonesia, Malaysia, Iran, India and Bangladesh (from 0.57% to 4.00%), as against decrease in Taiwan, China, U.K., Thailand and USA (from 0.88% to 5.09%) from 2003-10 to 2011-18. Four countries, among top 10, registered above the world average of 17.0 citation per paper and 1.01 relative citation index: U.K. (45.89 and 2.73), Taiwan (32.27 and 1.92), USA (30.65 and 1.83) and Thailand (22.87 and 1.36) during 2003-18. India has though emerged as one of the world most significant contributor on *Andrographis paniculata* research, however, its performance in relative citation index has been slightly below the world average (0.90).

The international collaborative output as a national share in the country-wise output of top 10 countries on *Andrographis paniculata* varied widely from 11.92% (India) to 70.97% (Iran) with the average share of 23.85% during 2003-18. Most surprisingly, India's international collaborative share in its national output however, has been comparatively the lowest.

Distribution of Research Output by Subject

The global *Andrographis paniculata* research output (as reflected through Scopus database classification) published during 2003-18 is distributed across seven sub-fields. Pharmacology, toxicology and pharmaceutics have contributed the most significant publications share (50.98%). Medicine, biochemistry, genetics and molecular biology, agricultural and biological sciences and chemistry showed medium-level contributions (from 13.41% to 33.24%). Other three sub-fields namely, immunology and microbiology, environment science and veterinary science showed the least contribution (from 2.30% to 7.05%) during 2003-18. On measuring the change in research activity (as reflected in activity index) from 2003-10 to 2011-18, only two subjects namely, medicine and environment science showed increase by 3.51 and 2.08, as against decline by all other subjects from 3.03 to 41.40 during the above periods. Environment science registered the highest citation impact per paper (21.83) and Veterinary science the least (13.30) during 2003-18 (Table 3).

Profile of 15 Most Productive Global Organizations

Three Hundred One (301) organizations participated in global *Andrographis paniculata* research during 2003-18, of which 213 contributed 1-5 papers each, 64 organizations 6-10 papers each, 21 organizations 11-20 papers each, 2 organizations 21-50 papers and 1 organization 55 papers. Amongst 301 organizations, the top 15 organizations productivity varied from 14 to 55 papers. Together these top 15 contributed 22.07% and 23.66% global publication and citation share, respectively during 2003-18. Among top 15 organizations, 5 were from India, 4 from Malaysia, 2 each from China and Thailand and 1 each from Taiwan and Indonesia.

On further analysis, it was found that only three organizations among top 15, namely Universiti Putra Malaysia (55 papers), Mahidol University, Thailand (31 papers) and Universiti Sains Malaysia (28 papers) registered publications output greater than the group average of 21.07 during 2003-18; Six organizations, namely Jadavpur University, Kolkata, India (37.06 and 2.21), Mahidol University, Thailand (29.68 and 1.77), China Medical University, Taichung, Taiwan (28.83 and 1.72), Sri Venkateswar University, Tirupathi, India (23.33 and 1.39), Khon Kaen University, Thailand (23.30 and 1.39) and Universiti Sains Malaysia (20.14 and 1.20) registered citation impact above the group average of 18.00 citations per publication and 1.07 relative citation index during 2003-18; and five organizations, namely Universiti Putra Malaysia (56.36%), Khon Kaen University, Thailand (35.00%), Universiti Sains Malaysia (28.57%), Sri Venkateswar University, Tirupathi, India and Shanghai University of Traditional Medicine, China (26.67% each) contributed international

Table 2: Profile of Top 10 Most Productive Countries Global Publications Output on *Andrographis paniculata* during 2003-18.

S.No	Name of the Country	Number of Papers			Share of Papers			TC	CPP	ICP	%ICP	RCI
		2003-10	2011-18	2003-18	2003-10	2011-18	2003-18			2003-18		
1	India	204	459	663	45.64	46.60	46.30	9995	15.08	79	11.92	0.90
2	China	57	113	170	12.75	11.47	11.87	2165	12.74	35	20.59	0.76
3	Malaysia	43	122	165	9.62	12.39	11.52	2470	14.97	65	39.39	0.89
4	Thailand	35	60	95	7.83	6.09	6.63	2173	22.87	28	29.47	1.36
5	USA	45	49	94	10.07	4.97	6.56	2881	30.65	58	61.70	1.83
6	Indonesia	8	57	65	1.79	5.79	4.54	498	7.66	11	16.92	0.46
7	Taiwan	18	31	49	4.03	3.15	3.42	1581	32.27	12	24.49	1.92
8	Iran	3	28	31	0.67	2.84	2.16	272	8.77	22	70.97	0.52
9	Bangladesh	7	21	28	1.57	2.13	1.96	274	9.79	4	14.29	0.58
10	U.K.	13	15	28	2.91	1.52	1.96	1285	45.89	17	60.71	2.73
	Total	433	955	1388	96.87	96.95	96.93	23594	17.00	331	23.85	1.01
	World	447	985	1432				24035	16.78			
	Share of 10 Countries in World Total	96.87	96.95	96.93				98.17				

TC=Total Citations; CPP=Citations Per Paper; ICP=International Collaborative Papers; RCI=Relative Citation Index

Table 3: Distribution of Global Publications on *Andrographis paniculata* by Broad Subject during 2003-18.

S.No	Subject*	Number of Papers (TP)			Activity Index		TC	CPP	%TP
		2003-10	2011-18	2003-18	2003-10	2011-18		2003-18	
1	Pharmacology, Toxicology and Pharmaceutics	245	485	730	107.52	96.59	13307	18.23	50.98
2	Medicine	145	331	476	97.59	101.09	7929	16.66	33.24
3	Biochemistry, Genetics and Molecular Biology	123	263	386	102.08	99.05	8122	21.04	26.96
4	Agricultural and Biological Sciences	95	183	278	109.47	95.70	3849	13.85	19.41
5	Chemistry	77	115	192	128.48	87.08	3885	20.23	13.41
6	Immunology and Microbiology	32	69	101	101.50	99.32	1642	16.26	7.05
7	Environment Science	20	45	65	98.57	100.65	1419	21.83	4.54
8	Veterinary Science	11	22	33	106.79	96.92	440	13.33	2.30
	World Output	447	985	1432			24035	16.78	

There is overlapping of literature covered under various subjects

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

Table 4: Top 15 Global Organizations: Contribution and Citation Impact on *Andrographis paniculata* during 2003-18.

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	%ICP	RCI
1	Universiti Putra Malaysia	55	762	13.85	13	31	56.36	0.83
2	Mahidol University, Thailand	31	920	29.68	13	4	12.90	1.77
3	Universiti Sains Malaysia	28	564	20.14	12	8	28.57	1.20
4	Central Institute of Medicinal and Aromatic Plants, Lucknow, India	20	240	12.00	9	1	5.00	0.72
5	Khon Kaen University, Thailand	20	466	23.30	10	7	35.00	1.39
6	Ministry o Education, China	18	170	9.44	7	3	16.67	0.56
7	China Medical University, Taichung, Taiwan	18	519	28.83	11	2	11.11	1.72
8	Jadavpur University, Kolkata, India	17	630	37.06	9	3	17.65	2.21
9	Annamalai University, Tamil Nadu, India	17	204	12.00	8	3	17.65	0.72
10	Universitas Gadjah Mada, Indonesia	17	163	9.59	6	1	5.88	0.57
11	Universiti Kebangsaan Malaysia	16	140	8.75	7	3	18.75	0.52
12	Sri Venkateswar University, Tirupathi, India	15	350	23.33	9	4	26.67	1.39
13	Shanghai University of Traditional Medicine, China	15	252	16.80	9	4	26.67	1.00
14	Bharathiar University, India	15	158	10.53	7	1	6.67	0.63
15	Universiti Teknologi Malaysia	14	149	10.64	4	3	21.43	0.63
	Total of 15 organizations	316	5687	18.00	8.93	78	24.68	1.07
	Total of World	1432	24035	16.78				
	Share of top 15 organizations in World total output	22.07	23.66					

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index

collaborative publications share above the group average of 24.68% during 2003-18 (Table 4).

Profile of Top 15 Most Productive Authors

In *Andrographis paniculata* global research, four hundred thirteen (413) authors participated during 2003-18, of which 337 contributed 1-5 papers each, 43 authors 6-10 papers each and 3 authors 13-17 papers each. Amongst 413 authors, the top 15 authors productivity varied from 8 to 17 papers. Together these top 15 authors contributed 10.75% and 11.35% global publication and citation share, respectively during 2003-18. Among top 15 authors, 6 were from Malaysia, 4 from India, 2 each from Taiwan and Thailand and 1 from Indonesia.

On further analysis, it was found that only three authors among top 15, namely D. Talei and A. Valdiani (17 papers each) and A.E. Nugroho (13 papers) registered publication output above the group average of 10.27 during 2003-18; Five authors registered above average 17.71 average citation per paper and 1.06 relative citation index: P.K. Mukherjee (61.11 and 3.64), J. Satayavivo (30.22 and 1.80), G. Elango (26.56 and 1.58), A. Bagavan (25.13 and 1.50), C. Aromdee (18.50 and 1.10); and five authors, namely Y.M.Goh (100.0%), A.Q. Sazli (80.0%), D. Talei (76.47%), A. Valdiani (76.47%) and M.A. Kadir (75.0%) contributed international

Table 5: Top 15 Most Productive Authors: Contribution and Citation Impact on *Andrographis paniculata* during 2003-18.

S. No	Name of th Author	Affiliation of the Author	TP	TC	CPP	HI	ICP	%ICP	RCI
1	D. Talei	Universiti Putra Malaysia	17	182	10.71	9	13	76.47	0.64
2	A.Valdiani	Universiti Putra Malaysia	17	182	10.71	9	13	76.47	0.64
3	A.E. Nugroho	Universitas Gadjah, Mada, Indonesia	13	130	10.00	5	1	7.69	0.60
4	A.R. Alimon	Universiti Putra Malaysia	10	85	8.50	6	2	20.00	0.51
5	C.K. Lii	China Medical University Taichang, Taiwan	10	167	16.70	7	1	10.00	1.00
6	A.Q. Sazli	Universiti Putra Malaysia	10	79	7.90	5	8	80.00	0.47
7	H.W.Chen	China Medical University Taichang, Taiwan	9	155	17.22	6	0	0.00	1.03
8	G.Elango	C.Abdul Hakeem College, Malvishram, India	9	239	26.56	9	0	0.00	1.58
9	Y.M.Goh	Universiti Putra Malaysia	9	80	8.89	5	9	100.00	0.53
10	P.K.Mukherje	Jadavpur University, Kolkata, India	9	550	61.11	7	2	22.22	3.64
11	J. Satayavivo	Chulabhorn Research Institute, Thailand	9	272	30.22	5	1	11.11	1.80
12	A.Agarwal	Natural Remedies Pvt. Ltd. Bangalore, India	8	140	17.50	5	0	0.00	1.04
13	C. Aromdee	Khon Kaen University, Thailand	8	148	18.50	6	0	0.00	1.10
14	A.Bagavan	C.Abdul Hakeem College, Malvishram, India	8	201	25.13	8	0	0.00	1.50
15	M.A.Kadir	Universiti Putra Malaysia	8	117	14.63	6	6	75.00	0.87
		Total of 15 authors	154	2727	17.71	6.53	56	36.36	1.06
		Total of World	1432	24035	16.78				
		Share of top 15 authors in World total output	10.75	11.35					

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index

Table 6: Top 15 Most Productive Journals on *Andrographis paniculata* Research during 2003-18.

S.No	Name of the Journal	Number of Papers		
		2003-10	2011-18	2003-18
1	Journal of Ethnopharmacology	26	28	54
2	International Journal of Pharmacy and Pharmaceutical Sciences	13	18	31
3	Phytotherapy Research	0	27	27
4	International Journal of Pharma and Bio Sciences	4	21	25
5	International Journal ofPharmaceutical Sciences Review and Review	1	21	22
6	Planta Medica	13	9	22
7	Asian Pacific Journal of Pharmaceutical and Cinical Research	1	18	19
8	Evidence-based Complementary and Alternate Medicine	1	18	19
9	International Journal of Pharmatech Research	5	13	18
10	Natural Products Communication	5	11	16
11	Medicinal Plants	0	14	14
12	Asian Pacific Journal of TRophical Medicine	0	13	13
13	Research Journal of Pharmaceutical Biological and Chemical Sciences	0	13	13
14	Pharmaceutical Biology	5	7	12
15	Natural Products Research	4	7	11
	Total of 15 journals	78	238	316
	Total global journal output	440	973	1413
	Share of top 15 journals in global journal output	17.73	24.46	22.36

Table 7: List of Significant Keywords on Global *Andrographis paniculata* Research Literature during 2003-18.

S.No	Keyword	Frequency	S.No	Keyword	Frequency
1	Andrographis paniculata	1362	31	Fever	65
2	Plant Extract	801	32	Neoandrographtiolide	65
3	Andrographolide	472	32	Plant Leaves	65
4	Medicinal Plants	464	33	Drug Synthesis	64
5	Andrographis	339	34	Inflammation	62
6	Plant Leaf	245	35	Diarrhea	61
7	Diterpenes	245	36	*In vivo* Study	60
8	*In vitro* Study	163	37	Drug Safety	58
9	Drug Effects	154	38	Apoptosis	57
10	Phytochemistry	144	39	Plant Stem	55
11	Drug Efficacy	143	40	Escherichia Coli	55
12	Phytotherapy	138	41	Ethnobotany	53
13	Antioxidant Activity	130	42	Plant Seed	52
14	Drug Isolation	129	43	Cell Line, Tumor	51
15	Herbal Medicine	126	44	Fruit	51
16	Traditional Medicine	118	45	Ayurveda	49
17	Drug Screening	109	46	Bark	49
18	Acanthaceae	108	47	Alkaloids	43
19	Drug Structure	106	48	Antiviral Activity	43
20	Drug Mechanism	103	49	Antiinfective Agents	43
21	Plant Root	98	50	Ascorbic Acid	42
22	Antineoplastic Activity	98	51	Histopathology	41
23	Enzyme Activity	96	52	Molecular Structure	41
24	Antibacterial Activity	89	53	Coughing	40
25	Prorein Expression	85	54	Deooxyandrographolide	39
26	Anti-inflammatory Activity	87	55	Alanjne Amonotrensferase	39
27	Flavnoids	87	56	Alternate Medicine	39
28	Liver Protection	77	57	Anti-diabetic Agent	39
29	Diabetes Mellitus	76	58	Commom Cold	39
30	Diterpenoids	66	59	Liver Disease	39

collaborative publications share above the group average of 36.36% during 2003-18 (Table 5).

Medium of Research Communication

97.99% (1413 papers) global publications on *Andrographis paniculata* appeared in journals and the rest as conference proceedings (0.83%), book series (0.49%), books (0.42%) and trade publication (0.28%) during 2003-18. The top 15 most productive journals reported 11 to 54 papers each on *Andrographis paniculata*; together they accounted for 22.36% (316 papers) of global *Andrographis paniculata* output published in journals during 2003-18. Their global share showed increase from 17.73% to 24.46% share between 2003-10 and 2011-18. The top ranking journal is *Journal of Ethnopharmacology* (with 54 papers), followed by *International Journal of Pharmacy and Pharmaceutical Sciences* (31 papers), *Phytotherapy Research* (27 papers), *International Journal of Pharma and Bio Sciences* (25 papers), *International Journal of Pharmaceutical Sciences Review and Review (22 papers) and Planta Medica* (22 papers), etc. (Table 6).

Significant Keywords

Around 60 significant keywords have been identified from the literature which through light on the research trends in *Andrographis paniculata* research. including on its biological and pharmacological properties and medicinal uses. These keywords are listed in Table 7 in the decreasing order of the frequency of their occurrence in the literature during 2003-18.

Highly Cited Papers

Thirty Eight (38) papers were identified as highly cited as each having 102 to 842 citations range (32 papers each in citation range 102-200, 4 papers in 201-300 citations range each, 1 paper each with 307 and 842 citations) in 16 years during 2003-18. These 38 papers together cumulated to 6356 citations, averaging 164.63 citations per paper. Of the 38 highly cited papers, 20 resulted from the participation of research organizations in their role as stand-alone (non-collaborating) and remaining 18 from two or more research organizations working in their role as collaborating partners per paper (7 national collaborative and 11 international collaborative). Among 38 highly cited papers, the largest participation was seen from India (15 papers), followed by the USA (6 papers), Malaysia, Thailand and U.K. (4 papers each), Taiwan (3 papers), Japan and Singa-

pore (2 papers each), Australia, Brazil, Chile, Czech Republic, France, Hong Kong, Madagascar, Morrocco and Saudi Arabia (1 paper each). These 38 highly cited papers involved the participation of 173 personal authors and 65 research organizations in total across globe. Of the 38 highly cited papers, 23 were published as articles and 15 as review papers. These 38 highly cited papers were published in 26 journals, with 5 papers in *Journal of Ethnopharmacology,* 3 papers in *Planta Medica,* 2 papers each in *International Journal of Food Sciences and Nutrition, Phytochemistry and Phytotherapy Research* and 1 paper each in *Acta Biochimica Polonica, Alternative Medicine Review, Asian Pacific Journal of Tropical Biomedicine, Biological and Pharmaceutical Bulletin, Bioorganic and Medicinal Chemistry Letters, British Journal of Pharmacology, Chinese Medicine, Clinical and Experimental Pharmacology and Physiology, Current Diabetes Reviews International, Current Drug Metabolism, Current Drug Targets, Fitoterapia, Journal of Biological Chemistry, Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences, Journal of Health Science, Journal of Pharmacy and Pharmacology, Journal of Experimental Therapeutics and Oncology, Malaria Journal, Pharmacological Research, The Scientific World Journal and Separation and Purification Technology.*

CONCLUSION

The present study examines global output on *Andrographis paniculata* as indexed in the Scopus database during 2003-18, with a view to study its quantitative and qualitative aspects in the form of bibliometric indicators. It was observed that that the annual and cumulative global output on *Andrographis paniculata* research registered 10.03% and 120.36% growth. Its global citation impact per paper (CPP) averaged to 16.78 citations per paper in 16 years, which decreased from 31.34 CPP to 10.18 CPP from 2003-10 to 2011-18.

Andrographis paniculata global research output came from 73 countries during 2003-18 and the distribution was quiet even. 96.93% of global publication share and 98.17% of the global citation share have come from top 10 countries alone during 2003-18. On one hand 46.130% and 23.39% of the global publication share came from India and China and Malaysia (together), while on the hand 7 other top countries contributed 1.96% to 6.63% global share during 2003-18. U.K. (45.89 and 2.73), Taiwan (32.27 and 1.92), USA (30.65 and 1.83) and Thailand (22.87 and 1.36) registered above the world average of 17.0 citation per paper and 1.01 relative citation index during 2003-18. The international collaborative share of these top 10 countries varied from 11.92% to 70.97%, with Iran registering the highest and India the least share.

Pharmacology, toxicology and pharmaceutics was the most priority subject area on *Andrographis paniculata* research contributing 50.98% global publications share, followed by medicine (33.24%), biochemistry, genetics and molecular biology (26.96%), agricultural and biological sciences (19.41%), chemistry (13.41%), immunology and microbiology (7.05%), etc. during 2003-18. Among broad subjects, the research activities registered increase in medicine and environment science, while in other subjects it showed decline from 2003-10 to 2011-18. Environment science registered the highest citation impact per paper (21.83) and Veterinary science the least (13.30) during 2003-18.

301 organizations and 413 authors participated in global *Andrographis paniculata* research during 2003-18, of which the top 15 most productive research organizations and authors collectively contributed 22.07% and 10.75% global publication share and 23.66% and 11.35% global citation share respectively during 2003-18. The leading organizations in terms of publication productivity were: Universiti Putra Malaysia (55 papers), Mahidol University, Thailand (31 papers) and Universiti Sains Malaysia (28 papers) during 2003-18. The leading organizations in terms of citation impact per paper and relative citation index were: Jadavpur University, Kolkata, India (37.06 and 2.21), Mahidol University, Thailand (29.68 and 1.77), China Medical University, Taichung, Taiwan (28.83 and 1.72), Sri Venkateswar University, Tirupathi, India (23.33 and 1.39), Khon Kaen University, Thailand (23.30 and 1.39) and Universiti Sains Malaysia (20.14 and 1.20) during 2003-18.

The journals medium accounted for 97.99% global share in *Andrographis paniculata* research with top 15 most productive journals accounting for 22.36% of total publications output during 2003-18. Journal of Ethnopharmacology contributed the largest number of papers (54), followed by *International Journal of Pharmacy and Pharmaceutical Sciences (31 papers), Phytotherapy Research (27 papers), International Journal of Pharma and Bio Sciences (25 papers), International Journal of Pharmaceutical Sciences Review and Review (22 papers) and Planta Medica (22 papers), etc* during 2003-18.

Of the total *Andrographis paniculata* global research output, only 38 publications registered high citations, in the range of 102-842 citations per paper and collectively these highly cited papers received a total of 6356 citations, averaging to 164.63 citations per paper. These 38 highly cited papers involved the participation of 173 authors and 65 organizations and were published in 26 journals, of which with 5 papers in *Journal of Ethnopharmacology,* 3 papers in *Planta Medica*, 2 papers each in *International Journal of Food Sciences and Nutrition, Phytochemistry* and *Phytotherapy Research* and 1 paper each in other journals.

It is believed that *Andrographis paniculata* could be useful as highly applied therapeutic agent for a variety of disorders in the near future to cure human diseases as well as some animal diseases. The demand of *Andrographis paniculata* is observed to have greatly increased in the past few years for its overwhelming therapeutic potential. Available data on *Andrographis paniculata* also clearly expresses a broad spectrum of pharmacological properties of this plant. Due to possessing extensive pharmacological activities, the *Andrographis paniculata* can be safely regarded as one of the modern catholicons. However, the investigated pharmacological activities of *Andrographis paniculata* need validation through the clinical studies. Though several clinical studies were successfully completed without adverse effects or fatalities on few infections for a variety of conditions. Verification of the efficacy of biological activities of *Andrographis paniculata* for other infections and diseases on human study subjects would bring a lot of benefits for the largest population of the globe.

Conclude that the analysis presented above throw interesting light on trends in research and therefore also help in identifying the existing gaps in research. R&D studies on *Andrographis paniculata* needs to be accelerated with increased R&D funding at the global level in different countries to fully exploit its potential in preventing and treating diseases as well as in discovering its strong potential therapeutic potential and for for developing new formulations.

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