

# Aloe Vera (Medicinal Plant) Research: A Scientometric Assessment of Global Publications Output during 2007-16

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## ABSTRACT

The paper examines 1988 global publications on Aloe Vera research, as covered in Scopus database during 2007-16. The Aloe Vera research registered 3.91% growth and averaged its citation impact to 9.57 citations per paper. The top 12 most productive countries individually contributed global share 5.36% to 52.17%. India accounted for the largest global publication share (32.55%), followed by USA (11.52%), Iran (8.15%), China (4.63%) etc. Together, the top 12 countries accounted for 79.18% global publications share and 84.94% global citation share during 2007-16. Seven of top 12 countries scored relative citation index above the world average i.e. 1.04: U.K. (1.82), Thailand and USA (1.63 each), Spain (1.23), Pakistan and China (1.15 each) and Italy (1.12) during 2007-16. The country share of international collaborative publications across top 12 most productive countries varied from 5.36% to 52.17%, in Aloe Vera research during 2007-16. Medicine, among other subjects, accounted for the highest publications share (40.90%), followed by pharmacology, toxicology and pharmaceuticals (35.16%), agricultural and biological sciences (23.09%), biochemistry, genetics and molecular biology (20.27%), chemistry (7.90%), immunology and microbiology (6.24%) and engineering (5.38) during 2007-16. The top 20 most productive research organizations and the authors collectively contributed 11.47% and 8.55% respectively global publication share and 12.87% and 13.82% respectively global citation share during 2007-16. The journals medium accounted for the largest 79.08% global share with top 15 journals accounting for just 16.01% of total output that was reported in journals during 2007-16. Only 18 papers in Aloe Vera research registered 100 plus citations between 104 to 242 citations per paper, and together these papers cumulated 2656 citations, averaging to 147.55 citations per paper. These 18 highly cited papers involved the participation of 66 authors and 41 organizations and were published in 15 journals.

**Key words:** Aloe vera, Medicinal plant, Global research output, Scientometrics, Bibliometrics.

## INTRODUCTION

Aloe Vera is a perennial, drought-resisting, succulent plant belonging to the *Asphodelaceae* family. The name, aloe, is derived from the Arabic “*alloe*” or Hebrew “*halal*” meaning bitter shiny substance. It has a vast traditional role in indigenous system of medicine like Ayurveda, Siddha, Unani and homoeopathy.<sup>1</sup> The Aloe Vera plant is a member of lily plant known as Aloe barbadensis, which is full of juice and closes like a cactus. Due to its cactus like feel, Aloe is often mistakenly called a “Desert Cacti”. Aloe Barbadensis miller or Aloe Vera, a semi tropical plant is one of the 250 species of Aloe. Most commonly used for its medicinal properties, Aloe Vera or the Sanskrit name “Ghee kunwar” is a member of Lilly family. The plant has lance-shaped, sharp pointed, and jagged and edged leaves.<sup>2</sup>

Aloe is native to North Africa and Spain, now the plant is also grown in the hot dry regions of Asia, Europe and America. Aloe Vera is found as the wild herb along the coast of south India. It is under cultivation in large areas in many parts of India viz; Tamil Nadu,

Gujarat, Maharashtra etc.<sup>3</sup> Aloes are often thought to only grow in hot and dry climates, but they actually grow in a variety of climates including desert, grassland, and coastal or even alpine locations.<sup>4</sup>

For centuries, it has been medicinally used for an array of ailments such as mild fever, wounds and burns, gastrointestinal disorders, diabetes, sexual vitality and fertility problems to cancer, immune modulation, AIDS and various skin diseases. In the pharmaceutical industry, it has been used for the manufacture of topical products such as ointments and gel preparations, as well as in the production of tablets and capsules. So, there is an urgent need to educate about the miraculous uses of Aloe Vera along with its cultivation methods for human race and popularize it for greater interest.<sup>5,6</sup>

There are more than 200 compounds found in Aloe barbadensis, about 75 of which have biological activity, Aloe Vera leaves contain a diverse array of compounds, including anthraquinones (e.g. alo-

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emodin), anthrones and their glycosides (e.g. 10-(1, 5' anhydroglucosyl)-aloeemodin- 9-anthrone, also known as aloin A and B), chromones, carbohydrates, proteins, glycoproteins, amino acids, organic acids, lipids, sugars, vitamins and minerals.<sup>5,6</sup>

Aloe Vera has number of uses and mainly they are used as a food preservative and medicine. Commercially, aloe can be found in pills, sprays, ointments, lotions, liquids, drinks, jellies, and creams. Numerous aloe species around the world are used for conditions ranging from dermatitis to cancer. Various studies have revealed that Aloe Vera leaf possesses many pharmaceutical activities, including antimicrobial, anticancer, antioxidant, anti-diabetic, anti-ulcer, hepato-protective, immune-modulatory and many more activities. Many of the health benefits associated with Aloe Vera have been attributed to the polysaccharides contained in the gel of the leaves.<sup>7,8,9,10,11,12,13,14</sup>

## Literature Review

Only few scientometric studies are available in the past, which quantitatively analyze global literature on individual medicinal plants, such as *Apocynum cannabinum*,<sup>15</sup> *Artemisia annua*,<sup>16</sup> *Glycyrrhiza glabra*,<sup>17</sup> *Phonix dactylifera*,<sup>18,19</sup> and *Podophyllotoxin*.<sup>20</sup>

## OBJECTIVES

The main objectives of this study are to study the performance of Aloe Vera research during 2007-16, based on publications output covered in Scopus database. In particular, the study focuses on the following objectives: (i) To study the growth of world research output in Aloe Vera research and its citation impact; (ii) To study the international collaboration share of top 10 most productive countries; (iii) To study the global research output by broad subject areas and the dynamics of its growth and decline; (iv) To study the trends by identifying significant keywords; (v) To study the publication productivity and citation impact of top 20 most productive organizations and authors; (vi) To study the modes of communication in research and (vii) to study the characteristics of top 18 highly cited papers.

## METHODOLOGY

The study retrieved and downloaded 10-year publication data of the world in Aloe Vera research from the Scopus database (<http://www.scopus.com>) covering the period 2007-16. Keywords, such as "Aloe Vera" was incorporated in the search string and qualified these keywords with "keyword tag", "Article Title tag", and in addition incorporated in this search string the period '2007-16' within "date range tag". Finally, this search string was applied for searching global publication data on Aloe Vera research. The search string was subsequently refined, using analytical functions and 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. For citation data, citations to publications were also collected from date of publication till 16 December 2016.

KEY ("aloe vera") AND PUBYEAR > 2006 AND PUBYEAR < 2017

## ANALYSIS

The total research output of the world in field of Aloe Vera research cumulated to 1988 publications in 10 years during 2007-16. The annual output of the world in Aloe Vera research increased from 135 in the year 2007 to 174 publications in the year 2016, registering 3.91% growth per annum. The cumulative world output in Aloe Vera research in 5 years 2007-11 increased from 837 to 1151 publications during succeeding 5-year period 2012-16, registering 37.51% quinquennial growth. Of

**Table 1: World Output in Aloe Vera Research, 2007-16.**

Publication Period	World		
	TP	TC	CPP
2007	135	3105	23.00
2008	146	3192	21.86
2009	156	2251	14.43
2010	186	2339	12.58
2011	214	2758	12.89
2012	241	1974	8.19
2013	243	1779	7.32
2014	243	1026	4.22
2015	250	527	2.11
2016	174	69	0.40
2007-11	837	13645	16.30
2012-16	1151	5375	4.67
2007-16	1988	19020	9.57

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

the total global publications output, 76.46% (1520) appeared as articles, 16.45% (327) as reviews, 2.26% (45) as conference papers, 1.21% (24) as letters, 1.06% (21) as articles in press, and the rest as notes, short surveys, editorials, book chapters and erratum. The citation impact of global publications on Aloe Vera research in 10 years averaged to 9.57 citations per publication (CPP) during 2007-16; five-yearly impact averaged to 16.30 CPP for the period 2007-11, which sharply declined to 4.67 CPP in the succeeding five-year 2012-16 Table 1.

## Top 10 Most Productive Countries in Aloe Vera research

The global research output in the field of Aloe Vera research had originated from as many as 92 countries in the world during 2007-16. Of the 92 countries, 60 published 1-10 papers in 10 years, 23 countries 11-50 papers, 6 countries 51-100 papers and 3 countries 162 to 647 papers. The top 12 most productive countries in Aloe Vera research contributed 45 to 647 publications each during 2007-16 Table 2. The top 12 most productive countries in Aloe Vera research accounted for 79.18% global publication share and 84.94% citation share during 2007-16. Their five-yearly output accounted for 76.11% global publication share during 2007-11 which increased to 81.41% during succeeding 5-year period 2012-16. Country-wise, the global publication shares of top 12 countries varied widely 2.26% to 32.55% during 2007-16, with India accounting for the highest publication share (32.55%), followed by USA (11.52% share), Iran (8.15%), and China (4.63% share). The other 8 countries contributed their global publication share between 2.26% and 3.92% in 10 years during 2007-16. The global publication share registered an increase by 8.09% in Iran in five years period (2007-11 and 2012-16), followed by 6.27% in India, 1.31% in Pakistan, 1.22% in Italy, 0.99% in Thailand, 0.81% in Spain and 0.59% in Brazil. In other top 12 countries, like the USA, UK, Nigeria, China, and South Korea, their quinquennial global share registered decline between 0.11% and 8.17% during 2007-11 to 2012-16. Seven of top 12 countries scored relative citation index above the world average of 1: U.K. (1.82), Thailand and USA (1.63 each), Spain (1.23), Pakistan and China (1.15 each) and Italy (1.12) during 2007-16. India has though emerged as the world leader in Aloe Vera research, its performance in terms of relative citation index has below the world average (0.85).

**Table 2: Global Publication Share of Top 12 Most Productive Countries in Aloe Vera Research during 2007-16.**

S.No	Name of the Country	Number of Papers			Share of Papers			TC	CPP	HI	ICP	%ICP	RCI
		2007-11	2012-16	2007-16	2007-11	2012-16	2007-16						
1	India	242	405	647	28.91	35.19	32.55	5282	8.16	31	56	8.66	0.85
2	USA	136	93	229	16.25	8.08	11.52	3567	15.58	31	66	28.82	1.63
3	Iran	29	133	162	3.46	11.56	8.15	1184	7.31	19	13	8.02	0.76
4	China	41	51	92	4.90	4.43	4.63	1010	10.98	18	20	21.74	1.15
5	Brazil	30	48	78	3.58	4.17	3.92	625	8.01	11	12	15.38	0.84
6	U.K.	43	26	69	5.14	2.26	3.47	1201	17.41	21	36	52.17	1.82
7	Nigeria	35	21	56	4.18	1.82	2.82	554	9.89	12	3	5.36	1.03
8	Italy	16	36	52	1.91	3.13	2.62	558	10.73	13	14	26.92	1.12
9	South Korea	22	29	51	2.63	2.52	2.57	406	7.96	12	9	17.65	0.83
10	Thailand	15	32	47	1.79	2.78	2.36	733	15.60	14	11	23.40	1.63
11	Pakistan	13	33	46	1.55	2.87	2.31	506	11.00	11	11	23.91	1.15
12	Spain	15	30	45	1.79	2.61	2.26	530	11.78	16	11	24.44	1.23
	Total	637	937	1574	76.11	81.41	79.18	16156	10.26	17.42	262	16.65	1.07
	World	837	1151	1988	100.00	100.00	100.00	19020	9.57				
	Share of 12 Countries in World Total	76.11	81.41	79.18				84.94					

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

## International Collaboration

The international collaborative output of top 12 most productive countries in Aloe Vera research as a national share in the country-wise output varied widely from 5.36% to 52.17%, with highest share coming from U.K. (52.17%), followed by USA (28.82%), Italy (26.92%), Spain (24.44%), Pakistan (23.91%), Thailand (23.40%), China (21.74%), South Korea (17.65%), Brazil (15.38%), India (8.66%), Iran (8.02%) and Nigeria (5.36%) during 2007-16. Most surprisingly, India's international collaborative share in its national output in Aloe Vera research has been marginal, 8.66%. This trend could be attributed to its global leadership in Aloe Vera research. Being recognized a global research hub in the field, India's need for reliance on international collaboration in research has not been significant as it is by other top 12 most productive countries in Aloe Vera research.

## Subject-Wise Distribution of Research Output

The global Aloe Vera research output published during 2007-16 is distributed across seven sub-fields (as identified in Scopus database classification), with medicine accounting for the highest publications share (40.90%), followed by pharmacology, toxicology and pharmaceuticals (35.16%), agricultural and biological sciences (23.09%), biochemistry, genetics and molecular biology (20.27%), chemistry (7.90%), immunology and microbiology (6.24%) and engineering (5.38) during 2007-16. Its activity index, which computes change in research activity in the discipline over time 2007-11 to 2012-16 (world average activity index of a given subject is taken as 100), witnessed increase in biochemistry, genetics and molecular biology (from 93.12 to 105.0), chemistry (from 95.31 to 103.41) and engineering (from 62.15 to 127.52), as against decline of research activity in medicine (from 106.34 to 95.39), pharmacology, toxicology and pharmaceuticals (from 100.58 to 99.58), agricultural and biological sciences (from 108.15 to 94.07) and immunology and microbiology (from 113.01 to 90.54) from 2007-11 to 2012-16. Chemistry, among various subjects registered the highest citations impact per paper of 13.99 CPP, followed by medicine (11.79), biochemistry, genetics and

molecular biology (11.33), immunology and microbiology (8.40), pharmacology, toxicology and pharmaceuticals (8.29), agricultural and biological sciences (7.69) and engineering (6.48) during 2007-16 Table 3.

## Profile of Top 16 Most Productive Global Organizations

The productivity of top 16 most productive global organizations in Aloe Vera Research varied from 10 to 33 publications and together they contributed 11.47% (228) publication share and 12.87% (2448) citation share during 2007-16. The scientometric profile of these top 16 organizations is presented in Table 4. **Four of these organizations** registered publications output greater than the group average of 14.25: Tehran University of Medical Sciences, Iran (33 papers), Islamic Azad University, Isfahan, Iran (25 papers), Indian Institute of Technology, Kharagpur, India (21 papers) and Chula long University, Thailand (18 papers) during 2007-16. **Nine organizations** registered impact above the group average of 10.74 citations per publication during 2007-16: Universidad de La Serena, Chile (26.67), Amity University, Noida, India (21.10), Shahrekord University of Medical Sciences, Iran (15.82), Tehran University of Medical Sciences, Iran (14.09), Chula long University, Thailand (13.72), Mazandaran University of Medical Science, Iran (12.80), Univera Inc., Seoul, South Korea (12.31), Morinaga Milk Industry Co Ltd., Japan (11.82) and National University of Singapore (11.73) during 2007-16. **Six organizations** registered h-index above the group average of 5.87: Universidad de La Serena, Chile (12), Tehran University of Medical Sciences, Iran (11), Chula long University, Thailand (9), National University of Singapore (7), Univera Inc., Seoul, South Korea and Morinaga Milk Industry Co Ltd., Japan (6 each) during 2007-16. **Seven organizations** contributed international collaborative publications share above the group average of 17.54%: National University of Singapore (81.82%), Universidad de La Serena, Chile (50.0%), University of Tehran, Iran and UNESP-Universidade Estadual Paulista, Brazil (40.0% each), Indian Institute of Technology, Kharagpur, India (19.05%), North West University, South Africa and Mashhad University of Medical Science, Iran (18.18% each) during 2007-16. **Nine organizations** registered the

**Table 3: Subject-Wise Breakup of Global Publications in Aloe Vera Research during 2007-16.**

S.No	Subject*	Number of Papers (TP)			Activity Index		TC	CPP	%TP
		2007-11	2012-16	2007-16	2007-11	2012-16	2007-16	2007-16	2007-16
1	Medicine	364	449	813	106.34	95.39	9588	11.79	40.90
2	Pharmacology, Toxicology and Pharmaceutics	296	403	699	100.58	99.58	5797	8.29	35.16
3	Agricultural and Biological Sciences	209	250	459	108.15	94.07	3531	7.69	23.09
4	Biochemistry, Genetics and Molecular Biology	158	245	403	93.12	105.00	4567	11.33	20.27
5	Chemistry	63	94	157	95.31	103.41	2196	13.99	7.90
6	Immunology and Microbiology	59	65	124	113.01	90.54	1041	8.40	6.24
7	Engineering	28	79	107	62.15	127.52	693	6.48	5.38
	World Output	837	1151	1988	100.00	100.00			

• There is overlapping of literature covered under various subjects

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

**Table 4: Scientometric Profile of Top 20 Most Productive Global Organizations in Aloe Vera Research during 2007-16.**

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	%ICP	RCI
1	Tehran University of Medical Sciences, Iran	33	465	14.09	11	2	6.06	1.47
2	Islamic Azad University, Isfahan, Iran	25	132	5.28	5	3	12.00	0.55
3	Indian Institute of Technology, Kharagpur, India	21	124	5.90	4	4	19.05	0.62
4	Chulalong University, Thailand	18	247	13.72	9	3	16.67	1.43
5	Univera Inc., Seoul, South Korea	13	160	12.31	6	1	7.69	1.29
6	Universidad de LaSerena, Chile	12	320	26.67	12	6	50.00	2.79
7	Mashhad University of Medical Science, Iran	11	44	4.00	4	2	18.18	0.42
8	Morinaga Milk Industry Co Ltd., Japan	11	130	11.82	6	0	0.00	1.23
9	National University of Singapore	11	129	11.73	7	9	81.82	1.23
10	Shahrekord University of Medical Sciences, Iran	11	174	15.82	4	0	0.00	1.65
11	North West University, South Africa	11	65	5.91	5	2	18.18	0.62
12	University of Rajasthan, Jaipur, India	11	53	4.82	5	0	0.00	0.50
13	UNESP-Universidade Estadual Paulista, Brazil	10	29	2.90	3	4	40.00	0.30
14	Mazandaran University of Medical Science, Iran	10	128	12.80	5	0	0.00	1.34
15	University of Tehran, Iran	10	37	3.70	3	4	40.00	0.39
16	Amity University, Noida, India	10	211	21.10	5	0	0.00	2.20
	Total of 16 organizations	228	2448	10.74	5.87	40	17.54	1.12
	Total of World	1988	19020	9.57				
	Share of top 16 organizations in World total output	11.47	12.87					

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

relative citation index above the group average (1.12) of all organizations: Universidad de La Serena, Chile (2.79), Amity University, Noida, India (2.20), Shahrekord University of Medical Sciences, Iran (1.65), Tehran University of Medical Sciences, Iran (1.47), Chula long University, Thailand (1.43), Mazandaran University of Medical Science, Iran (1.34), Univera Inc., Seoul, South Korea (1.29), Morinaga Milk Industry Co Ltd., Japan and National University of Singapore (1.23 each) during 2007-16.

### Profile of Top 20 Most Productive Authors

The research productivity in the field of Aloe Vera research of top 20 most productive authors varied from 7 to 12 publications. Together they contributed 8.55% (170) global publication share and 13.82% (2628) citation share during 2007-16. The scientometric profile of these 20 authors is presented in Table 5. **Nine authors** registered publications output above the group average of 8.5: A. Vega-Galvez (12 papers), M.Tanaka (11 papers), M.Miranda (10 papers), M.Abdollahi, D.Martinez-

Romero, S.Ramakrishna, M.Serrano, P.Thunyakitpisal and D.Valero (9 papers each) during 2007-16. **Four authors** registered impact above the group average of 15.46 citations per publication: J.Hamman (44.0), M.Miranda (28.10), A. Vega-Galvez (26.67) and M.Abdollahi (19.22) during 2007-16. Ten authors registered h-index above the group average of 5.9 of all authors: A. Vega-Galvez (12), M.Abdollahi and D.Martinez-Romero (9 each), M.Miranda and F.Gullen (8 each), S.Ramakrishna (7), J.Hamman, M.Serrano, D.Valero and M.Tanaka (6 each) during 2007-16. **Four authors** contributed international collaborative publications share above the group average of 12.35% of all authors: S.Ramakrishna (88.89%), A. Vega-Galvez (50.0%), J.Hamman (42.86%) and M.Miranda (30.0%) during 2007-16. **Eight authors** registered the relative citation index above the group average (1.62) of all authors: J.Hamman (4.60), M.Miranda (2.94), A. Vega-Galvez (2.79), M.Abdollahi (2.01), F.Gullen, S.Castillo and P.J.Zapata (1.63 each) and C.K.Lee (1.63) during 2007-16.

**Table 5: Scientometric Profile of Top 20 Most Productive Authors in Aloe Vera Research during 2007-16.**

S. No	Name of the Author	Affiliation of the Author	TP	TC	CPP	HI	ICP	%ICP	RCI
1	A. Vega-Galvez	Universidad de LaSerena, Chile	12	320	26.67	12	6	50.00	2.79
2	M.Tanaka	Morinaga Milk Industry Co Ltd., Japan	11	125	11.36	6	0	0.00	1.19
3	M.Miranda	Universidad de LaSerena, Chile	10	281	28.10	8	3	30.00	2.94
4	M.Abdollahi	Tehran University of Medical Sciences, Iran	9	173	19.22	9	0	0.00	2.01
5	D.Martinez-Romero	University of Miguel-Harnandez, Spain	9	135	15.00	9	0	0.00	1.57
6	S.Ramakrishna	National University of Singapore	9	122	13.56	7	8	88.89	1.42
7	M.Serrano	University of Miguel-Harnandez, Spain	9	135	15.00	6	0	0.00	1.57
8	P.Thunyakitpibal	Chulalong University, Thailand	9	93	10.33	4	0	0.00	1.08
9	D.Valero	University of Miguel-Harnandez, Spain	9	135	15.00	6	0	0.00	1.57
10	S.Castillo	University of Miguel-Harnandez, Spain	8	126	15.75	5	0	0.00	1.65
11	S.G.Do	Univera Inc., Seoul, South Korea	8	42	5.25	3	0	0.00	0.55
12	F.Gullen	University of Miguel-Harnandez, Spain	8	126	15.75	8	0	0.00	1.65
13	E.Misawa	Morinaga Milk Industry Co Ltd., Japan	8	110	13.75	5	0	0.00	1.44
14	P.S.Rao	Indian Institute of Technology, Kharagpur, India	8	13	1.63	3	0	0.00	0.17
15	P.J.Zapata	University of Miguel-Harnandez, Spain	8	126	15.75	5	0	0.00	1.65
16	K.S.Anantharaju	East West Institute of Technology, Bangladesh	7	38	5.43	4	0	0.00	0.57
17	M.D.Boundreau	US Food and Drug Administration, MD, USA	7	73	10.43	5	1	14.29	1.09
18	J.Hamman	Tshwane University of Technology, South Africa	7	308	44.00	6	3	42.86	4.60
19	C.K.Lee	Chunbuk National University, South Korea	7	109	15.57	3	0	0.00	1.63
20	H.Nagabhushana	Tumkar University, Tumkar, India	7	38	5.43	4	0	0.00	0.57
		Total of 20 authors	170	2628	15.46	11.7	21	12.35	1.62
		Total of World	1988	19020	9.57				
		Share of top 20 authors in World total output	8.55	13.82					

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 in Aloe Vera Research during 2007-16.**

S.No	Name of the Journal	Number of Papers		
		2007-11	2012-16	2007-16
1	Journal of Ethno-pharmacology	19	39	58
2	International Journal of Pharmacy and Pharmaceutical Science	6	32	38
3	International Journal of Pharmaceutical Science Review and Research	10	19	29
4	International Journal of Pharma and Bio Sciences	4	20	24
5	Research Journal of Pharmaceutical Biological and Chemical Sciences	1	20	21
6	Phototherapy Research	8	10	18
7	International Journal of Pharma Technology Research	10	6	16
8	Industrial Crops and Products	3	12	15
9	BMC Complementary and Alternative Medicine	7	7	14
10	Carbohydrate Polymers	3	11	14
11	Journal of Food Science and Technology	5	9	14
12	Pharmacologyonline	10	4	14
13	Asian Pacific Journal of Tropical Biomedicine	1	11	12
14	African Journal of Biotechnology	11	0	11
15	Evidence based Complementary and Alternate Medicine	3	8	11
	Total of 15 journals	101	208	309
	Total global journal output	646	1206	1930
	Share of top 15 journals in global journal output	15.6	17.25	16.01

**Table 7: List of Significant Keywords in Literature on Global Aloe Vera Research during 2007-16.**

S.No	Keyword	Frequency	S.No	Keyword	Frequency	S.No	Keyword	Frequency
1	Abdominal Discomfort	15	47	Drug Screening	59	93	Macrophage	15
2	Abdominal Pain	35	48	Dry Skin	22	94	Magnoliphyta	11
3	Aloe Vera Gel	9	49	Eating Disorders	7	95	Malaria	26
4	Aloe Vera	1559	50	Echinacea	29	96	Malignant Neoplastic Disease	16
5	Aloe Vera Extract	719	51	Ecliptic Prostrata	18	97	Medicinal Plant	381
6	Aloe	501	52	Edema	18	98	Nanofibres	12
7	Alternate Medicine	109	53	Erythema	53	99	Nanoparticles	35
8	Anti-Diabetic Activity	51	54	Ethno pharmacy	51	100	Nausea	50
9	Anti-Diabetic Agent	51	55	Fbaceae	21	101	Non-Insulin Dependent Diabetes	64
10	Anti-Fungal Activity	51	56	Fat	649	102	Obesity	34
11	Anti-Inflammatory Activity	131	57	Fennel	30	103	Paclitaxel	17
12	Anti-Microbial Activity	100	58	Fenugreek	51	104	Pain	52
13	Anti-neoplastic Activity	70	59	Fever	49	105	Pruritus	15
14	Anti-Oxidant Activity	166	60	Flavonoids	60	106	Periodontitis	9
15	Anti-Viral Activity	26	61	Gastrointestinal Disease	32	107	Pain	53
16	Ageing	14	62	Genital Herpes	9	108	Psoriasis	34
17	Aphthous Stomatitis	9	63	Gingivitis	14	109	Radiation Dermatitis	26
18	Arthritis	27	64	Hair Loss	17	110	Rheumatic Disease	24
19	Asthma	41	65	Head and Neck Cancer	13	111	Radiation Injury	18
20	Atopic Dermatitis	23	66	Headache	44	112	Rash	30
21	Burn	88	67	Healing	16	113	Traditional Medicine	138
22	Blood Pressure	11	68	Heart Arrhythmia	13	114	Tooth Paste	17
23	Burning Mouth Syndrome	7	69	Heart Disease	21	115	Skin	61
24	Burning Sensation	24	70	Heart Infarction	10	116	Skin Disease	62
25	Constipation	65	71	Human Immunodeficiency Virus Infection	20	117	Skin Allergy	16
26	Complementary Therapy	50	72	Hypertension	52	118	Skin Injury	29
27	Crohn Disease	10	73	Insomnia	12	119	Taste Disorder	9
28	Contact Dermatitis	27	74	In-Vitro Study	449	120	Ubidecarenone	23
29	Cosmetics	52	75	Inflammation	71	121	Ulcerative Colitis	30
30	Cosmetic Industry	12	76	Inflammatory Bowel Disease	15	122	Ulcer	30
31	Cold Injury	14	77	Immune System	20	123	Urinary Tract Infection	15
32	Coughing	19	78	Immunomodulation	47	124	Vomiting	46
33	Dandruff	16	79	Immuno-stimulation	16	125	Urogenital Track Disease	7
34	Dandelion	16	80	Immuno-suppressive Agents	10	126	Weight Gain	21
35	Debridement	15	81	Jaundice	26	127	Weight Reduction	30
36	Dependent Diabetic Mellitus	64	82	Keratinocyte	13	128	Wound	48
37	Dermatitis	31	83	Kidney Disease	17	129	Wound Healing	166
38	Dental Care	11	84	Klebsiella Pneumonia	12	130	Weakness	15
39	Dentistry	10	85	Laxative	38	131	Xerosis	6
40	Diabetic Mellitus	153	86	Lichen Planus	21	132	Xerostomia	13
41	Diarrhea	99	87	Liver	36	133	Xanthorrhoeacea	8
42	Diet Supplement	84	88	Liver Injury	17			
43	Drug Activity	61	89	Liver Disease	27			
44	Drug Formulation	88	90	Lactate Dehydrogenase	17			
45	Drug Mechanism	126	91	Lactobacillus	12			
46	Drug Safety	103	92	Lamiaceae	29			

## Medium of Research Communication

Of the total world output on Aloe Vera research, 79.08% (1930) appeared in journals, 16.38% (5673) in journals, 1.01% (20) in book series, 0.91% (18) in conference proceedings, 0.65% (13) as trade publications and 0.35% (7) as books, etc. during 2007-16. The top 15 most productive journals reported 11 to 58 papers each on Aloe Vera research; together they accounted for 16.01% (309 papers) of total Aloe Vera output published in journals during 2007-16. Aloe Vera research being reported increasingly in journals is gradually becoming a trend; for example, the top 15 most productive journals in five years has shown rise in their Aloe Vera output from 15.60% to 17.25% share between 2007-11 and 2012-16. The top ranking journal is *Journal of Ethno-pharmacology* (with 58 papers), followed by *International Journal of Pharmacy and Pharmaceutical Science* (38 papers), *International Journal of Pharmaceutical Science Review and Research* (29 papers), *International Journal of Pharma and Bio Sciences* (24 papers), etc. during 2007-16 Table 6.

## Significant Keywords

Around 133 significant keywords having potential to identify comparative research trends in Aloe Vera research studies including pharmacological properties and medicinal uses were discovered from the global literature on science and medicine. These keywords are listed in Table 7 in the decreasing order of the frequency of their occurrence in the literature during 2007-16.

## Highly Cited Papers

A total of 18 highly cited papers were identified each cumulating at least 100+ citations in 10 years during 2007-16. Together these 18 papers cumulated a total of 2656 citation, averaging 147.55 citations per paper, and individually cumulating 104 to 242 citations per paper in 10 years. Of the 18 highly cited papers, 9 resulted from the participation of research organizations in their role as stand-alone (non-collaborating) institutional authors and remaining 9 from two or more research organizations working in their role as collaborating partners per paper (all national collaborative). Among highly cited papers, the largest participation was seen from India (7 papers), followed by the USA and Brazil (2 papers each), Italy, Nigeria, Pakistan, South Africa and U.K. (1 paper each). These 18 highly cited papers involved the participation of 66 personal authors and 41 research organizations in total across globe. Of the 18 highly cited papers, 6 were published as articles and 12 as review papers. These 18 highly cited papers were published in 15 journals; *Journal of Ethnopharmacology* (4 papers) and 1 paper each in 14 other journals, namely *Acta Oncology*, *Annals of Oncology*, *Asian Pacific Journal of Tropical Biomedicine*, *Burns*, *Corrosion Science*, *Cochrane Database of Systematic Reviews*, *Endocrine Metabolic and Immune Disorders*, *Food Chemistry*, *Free Radical Biology and Medicine*, *Indian Journal of Dermatology*, *Journal of Clinical Biochemistry and Nutrition*, *Journal of American Academy of Dermatology*, *Molecules* and *The Scientific World Journal*.

## CONCLUSION

Research publications data sourced from the Scopus database was analysed in this study to provide a quantitative and qualitative description of global Aloe Vera research covering 10 years period, 2007-16. The study showed that global Aloe Vera research registered 3.91% growth and averaged its global citation impact to 9.57 citations per paper in 10 years.

Nearly 1/3<sup>rd</sup> of global Aloe Vera research was mainly from India alone (32.55% global share) whereas other 11 top ranking countries accounted for global share between 2.26% and 11.52%. The top 12 most productive countries in Aloe Vera research together accounted for a high of 79.18% global share during 2007-16. Top ranking Asian countries in Aloe Vera research dominate in quantity of research whereas western countries in

the ranking list dominate more in quality of research. For example, India, Iran, China, South Korea, Thailand, and Pakistan from Asia together accounted for 52.57% global share and comparatively the USA, the U.K., Brazil, Italy and Spain for 23.79% during 2007-16. In terms of quality of research, the USA, the U.K., Brazil, Italy and Spain performed better on citation impact (averaging 13.7 citations per paper) than that of India, Iran, China, South Korea, Thailand, and Pakistan (averaging 5.79 citations per paper). National share of western countries accounting for international collaborative publications in Aloe Vera research was greater (15.58% to 52.17% national share) compared to that of Asian countries (8.02% to 23.91% national share).

Medicine was the most sought after subject area of Aloe Vera research, accounting for (40.90%) the highest publications share, followed by pharmacology, toxicology and pharmaceuticals (35.16%), agricultural and biological sciences (23.09%), biochemistry, genetics and molecular biology (20.27%), chemistry (7.90%), immunology and microbiology (6.24%) and engineering (5.38) during 2007-16. The top 20 most productive research organizations and the authors on Aloe Vera research collectively contributed 11.47% and 8.55% global publication share and 12.87% and 13.82% global citation share respectively during 2007-16.

The journals medium accounted for 79.08% global share in Aloe Vera research with top 15 most productive journals accounting for 16.01% of total publications output in journals during 2007-16. These journals are *Journal of Ethno-pharmacology* (58), followed by *International Journal of Pharmacy and Pharmaceutical Science* (38 papers), *International Journal of Pharmaceutical Science Review and Research* (29 papers), *International Journal of Pharma and Bio Sciences* (24 papers), etc. during 2007-16. Of the total global Aloe Vera research output (1988), only 18 papers registered high citations, between 104 to 242 citations per paper. These 18 highly cited papers collectively cumulated a total of 2656 citation (averaging to 147.55 citations per paper), and involved the participation of 26 authors and 27 organizations in their publication.

Conclusively, this research study reveals that Asian countries (India, Iran, China, South Korea, Thailand and Pakistan) dominate in Aloe Vera research more in terms of quantity of research, whereas western countries (the USA, the UK, Italy, Brazil and Spain) dominate instead more in terms of quality of research. For enabling Asian countries to perform better in terms of quality of research, it is desirable that the stakeholders from Asian countries may give priority to Aloe Vera research, and encourage leading academic and research organizations from the Asia for international collaboration with counterparts from western countries.

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