

A bibliometric assessment of apocynin (*Apocynum cannabinum*) research

Shri Ram

Deputy Librarian

Jaypee University of Information Technology
Waknaghat, Solan – 173234 (Himachal Pradesh), India
Email: shriram2576@gmail.com

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Apocynin, also known as acetovanillone, is a naturally occurring organic compound isolated from the root of *Apocynum cannabinum* (Canadian hemp) and variety of plant sources. Apocynin is being studied for its variety of pharmacological properties and used for the treatment of different diseases such as diabetes, arthritis, asthma, bowel disease, heart related diseases, and atherosclerosis to mention few. This bibliometric analysis reflects the key activities of apocynin research being carried out throughout the globe. The data for this study was obtained from Scopus database and it has been found that 1,424 papers were published during 1908-2011. These 1,424 documents received a total of 39,780 citations with an average 28.50 citations per paper. USA (35.88%) is the most productive country undertaking research in the area of apocynin. India's rank is 16th in overall publication output on apocynin. *Free Radical Biology* and *American Journal of Physiology- Heart and Circulatory Physiology* are the most productive journals publishing apocynin research.

Keywords: Apocynin, *Apocynum cannabinum*, NADPH-oxidase, Bibliometric study

Introduction

Apocynin (4-hydroxy-3-methoxyacetophenone, trivial names: apocynin, acetovanillone) was first described by Schmiedeberg in 1883 and was isolated from the roots of *Apocynum cannabinum* (Canadian hemp). This plant is known to be effective against edema and heart troubles¹. In 1971, apocynin was identified during activity-guided isolation of immunomodulatory constituents from the root of *Picrorhiza kurroa* (*Scrophulariaceae*, a native plant grown in the mountains of India, Nepal, Tibet, and Pakistan). *P. kurroa* is well known medicinal plant mentioned in traditional Indian medicine (Ayurveda). In 1990, Simons *et al.* isolated apocynin to a pharmacologically useful level by using an actively guided isolation procedure. Apocynin is observed to have anti-inflammatory capabilities, and have ability to prevent the formation of free radicals, oxygen ions, and peroxides in the body. Apocynin is an acetophenone with a molecular weight of 166.17 and forms needles upon crystallization from water². Apocynin has since been extensively studied to determine its disease-fighting capabilities and applications. Anti-arthritic activity³, human rheumatoid arthritis⁴, ulcer and tuberculosis⁵, anti-inflammatory response in asthma⁶, cure of ailments related to heart attack^{7,8} and insulin

resistance through suppressing inflammation⁹ are some of the potential medicinal benefits obtained from apocynin application. Because of these beneficial characteristics of the plant, it has attracted the global scientists to harness its medicinal value.

There are diverse bibliometric studies conducted on various medicinal plants to elucidate the character of publishing pattern and justify the utilities in life saving drugs and medicine. As far as this researcher knows, neither a comprehensive bibliography nor a bibliometric study of literature on apocynin has thus far been reported in the sources consulted. Many other bibliometric studies focus on a defined body of literature in a variety of disciplines that share a common methodology. Some of these writings that are important for methodological reasons are mentioned here. Adenaike analyzed some characteristics of the citations taken from two bibliographies on cowpea (*Vigna unguiculata*) covering the period from 1888 to 1973. It was found that the literature doubled every 20 years, English language accounted for 87% of the literature and journal was the most popular medium of publishing¹⁰. Subbaiah who studied Indian grape research literature covering 1901-1981, reported the clustering of research in this specific area, increase in collaborative research, and journals as the main source of

information¹¹. Meera studied the characteristics of 4,840 citations on ecological literature published during 1994-1995 in terms of their subject, language, geographic dispersion and author ranking¹².

There are three studies that touch on themes closer to the present research. Haiqi did a bibliometric analysis of 3,006 citations published between 1974 and 1992 on Chinese traditional medicine retrieved from the Medline database focusing on geographic and language dispersion of the literature and ranking of journals that published it¹³. Dhiman & Sinha studied the nature and growth of literature on ethno-botany published during 1989-1999¹⁴. The bibliometric studies on medicinal plants were also carried out on plants such as *Podophyllum hexandrum* (Podophyllotoxin)¹⁵, *Artemisia annua* (Artemisinin)¹⁶, *Phoenix Dactylifera* (Date Palm)^{17,18}, *Nigella sativa* (Black Pepper)¹⁹ to elucidate the growing importance of medicinal plants. Such studies elucidated the different pattern of publications related to medicinal plants. Fan analyzed 10,185 citations dealing with 'neoplasm' covering the period from 1984 to 1998 retrieved from the TCMLARS database (Traditional Chinese Medical Literature Analysis and Retrieval System). The author presented results related to the neoplasm type, year of publication, author's organizational affiliation, type of literature, and the research grant²⁰.

In light of these reviews, it is found that the literature on apocynin has not been subjected to bibliometric analysis so far. It is important that the literature must be studied in detail in order to understand scholarly interests and activity on *Apocynum cannabinum*. So it is decided to undertake a bibliometric study on apocynin.

Objectives of the Study

- To examine the core journals publishing apocynin research globally;
- To list the major organizations working in the area of apocynin;
- To trace the most productive authors in the area of apocynin research;
- To analyse the country trends in research in the area of apocynin; and
- To analyze the subject coverage of apocynin research.

Methodology

The data for this study has been collected from Scopus database. It covers nearly 18,000 titles from

over 5,000 international publishers, including coverage of 16,500 peer-reviewed journals in the scientific, technical, medical, and social sciences (including arts and humanities)²¹. The MeSH keyword for apocynin "Acetophenones", "apocynin", "apocynine", "4-hydroxy-3-methoxyacetophenone" has been used for retrieving data from Scopus. The following string was used for retrieving data on apocynin: (TITLE-ABS-KEY("Apocynin") OR TITLE-ABS-KEY ("apocynine") OR TITLE-ABS-KEY ("acetophenones") OR TITLE-ABS-KEY ("4-hydroxy-3-methoxyacetophenone")) AND PUBYEAR < 2012

Papers on apocynin published during 1908 to 2011 has been used for this study. The citation count for the study has been taken as the number of citations received by the articles since it has been published.

Results

Document types and languages

There are ten document types that were found among the total 1,424 publications related to apocynin. The most frequent document type was peer-reviewed journal articles (1,182), which accounted for 83.01% of the total publications. Others included reviews (133, 9.34%), conference proceeding papers (52, 3.65%), note items (14), article in press (12), case studies (8), editorial materials (6), letters (10) along with uncategorized items (6) and erratum (1).

As for as publishing language is concerned, 1,396(98.03%) of the 1,424 articles were written in English. This observation was consistent with the fact that English is the prevalent academic language. Other publication languages included Chinese (21), German (2), and one each for Japanese, Korean, Portuguese, Russian and Spanish.

Publication output

Research output descriptors suggested a solid development in apocynin research in terms of both increasing scientific production and citation impact. Table 1 indicates the availability of apocynin literature in different years and the citations received by the papers during the period 1996-2011 (Citation data in Scopus is only available for 1996 onwards). It is found that out of 1,424 articles published on apocynin, 1,368 documents have obtained citations, i.e. 96.07% papers have been cited by other documents. A total of 39,780 citations have been received by 1,424 documents on an average of 28.50 citations per paper.

Table 1—World publication output and citation status on apocynin

Publication year	Total papers	Cited papers	Total citations (1996-2011)	ACPP (1996-2011)
1908	2	2	3	1.50
1930	1	0	0	0.00
1973	1	1	7	7.00
1974	1	0	0	0.00
1975	1	0	0	0.00
1976	1	1	28	28.00
1978	1	1	2	2.00
1980	2	2	36	18.00
1984	1	1	6	6.00
1985	1	1	1	1.00
1988	1	1	13	13.00
1990	2	2	50	25.00
1991	4	4	249	62.25
1992	7	5	165	23.57
1993	1	1	14	14.00
1994	8	8	801	100.13
1995	5	5	115	23.00
1996	9	9	215	23.89
1997	3	1	28	9.33
1998	9	9	549	61.00
1999	15	14	890	59.33
2000	19	19	676	35.58
2001	22	22	1264	57.45
2002	19	19	1275	67.11
2003	42	41	3363	80.07
2004	77	76	3601	46.77
2005	111	109	5163	46.51
2006	128	126	4441	34.70
2007	160	156	4773	29.83
2008	176	169	4826	27.42
2009	191	189	3402	17.81
2010	188	180	2234	11.88
2011	215	194	1590	7.40
Total	1424	1368	39780	28.50

There was a significant increase in apocynin research since 2001 and it is found that the literature has grown exponentially after 2005 (Figure 1).

Along with the common explanations such as medicinal values, treatment of diseases through plant products and social awareness of use of

plants for treatment of various diseases since ancient time and its commercial values, it is conjectured that there is an increasing number of publications on medicinal plants including *Apocynum*. It is seen that there is a significant leap in the number of published articles in the area of apocynin after 2005. From 1908 to 1998, there has been a slow growth in the publications. During this period, the publication on apocynin comprises of only 61 (4.28%) documents of total publication (n=1424). From 1998 to 2002, the next four year period, there has been a linear growth and yielded 75 documents which is 5.27% of total publication (n=1424).

From the year 2003 onwards there has been an exponential growth in the publications related to apocynin. There has been a significant upward trend which reached its highest point in 2011. During this period there has been a growth of publications on an average of 143.11 publications per year. During the period 2003 to 2005 there were 230 publications which comprises of 16.15% of total publications, while next three years i.e. period ranging from 2006-2008, There were 464 documents which is 32.58% of total publications. Finally, the last three year period i.e. 2009-2011 have yielded 594 publications which is 41.71% of total apocynin publication. The moving average line (period 3) began with a straight line up to 1999 and thereafter it increased by a small margin and maintained the level up to 2003. After 2003, the line takes a steep curve (reflective of an exponential growth). It can be concluded that the most productive period is 2003 to 2011. The trend-line ($y=0.3146^{0.192x}$; $R^2=0.8871$) revealed an uptrend in the research output of apocynin and this trend could continue in future also.

Core journals publishing apocynin research

Scholarly journals are the main channel used for the publication of apocynin literatures. A total number of 484 journals produced 1,424 publications during the period of study. Bradford law of scattering²² states that the journal used in a given subject tends to be concentrated in a relatively small core of highly productive journals. Journals are ranked based on their productivity (number of articles contributed) to enable them be divided into three equal zones with each zone containing journals in the ratio of 1:n:n². Table 2 illustrates the status of articles published by core journals.

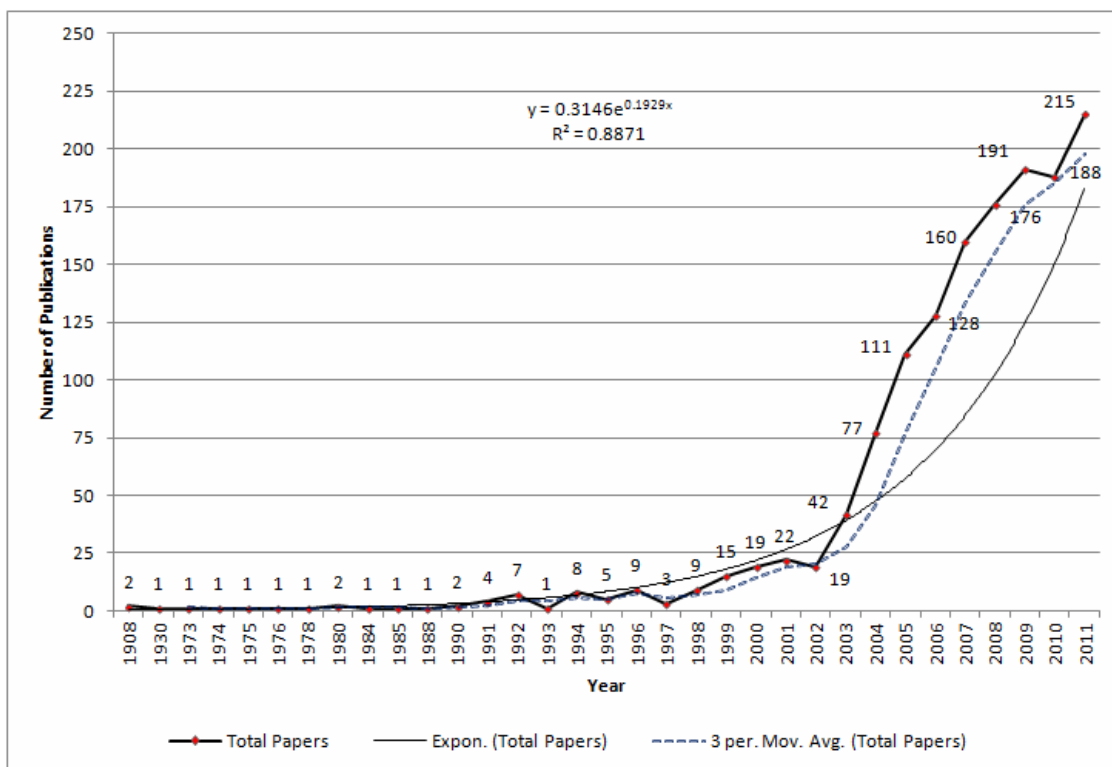


Fig. 1—Publication trend of apocynin research

Table 2—Journals and articles

No. of journals (N=484)	No. of articles published by each journal	Total no of articles (N=1424)	Cumulative no. of journals	Cumulative journals percentage	Cumulative no. of articles
1	63	63	1	0.21	63
1	62	62	2	0.41	125
1	46	46	3	0.62	171
1	26	26	4	0.83	197
3	25	75	7	1.45	272
2	24	48	9	1.86	320
1	21	21	10	2.07	341
1	20	20	11	2.27	361
1	18	18	12	2.48	379
2	17	34	14	2.89	413
2	16	32	16	3.31	445
3	14	42	19	3.93	487
1	13	13	20	4.13	500
2	12	24	22	4.55	524
3	11	33	25	5.17	557
3	10	30	28	5.79	587
4	9	36	32	6.61	623
6	8	48	38	7.85	671
8	7	56	46	9.50	727
9	6	54	55	11.36	781
6	5	30	61	12.60	811
12	4	48	73	15.08	859
34	3	102	107	22.11	961
86	2	172	193	39.88	1133
291	1	291	484	100.00	1424

Table 3—Scattering of journals and distribution of publication over Bradford zone

Zones	No. of journals	Percent	No. of articles	Percent	Multiplier
1	19	3.93	487	34.10	-
2	88	18.18	474	33.28	4.63
3	377	77.89	463	32.51	4.28
All Zones	484	100.00	1424	100.00	(mean)4.46

For the purpose of testing Bradford formulation, the total publication on apocynin is divided into three zones and it is found that about 487 documents are published in about 19 journals. There are 88 journals which have produced 474 articles and 377 journals have produced about 463 articles (Table 3).

According to Bradford's, Law the zones framed in this way, will follow the geometric series in the form $1:n:n^2$. Thus, the number of journals in these three zones is in the proportion of 19:88:377. Here, 19 represent the number of journals in the nucleus and $n=4.46$ is multiplier.

Therefore, $19 : 19 \times 4.46 : 19 \times 4.46^2 :: 1 : n : n^2$
 $19 : 84.74 : 377.94 \gg 481.68$

The percentage error = $\frac{481.68 - 484}{484} = -0.05$

Since the percentage error is negligible, it confirms the Bradford's Law of Scattering which states that the journals productivity in a given subject tends to be concentrated to a relatively small number of highly productive journals.

Highly productive journals

On the whole, the percentages of total articles produced in three zones do not differ from each other. This shows that the most productive zone constitute 35.42% of the total amount (Rounding to 33%). Table 4 shows the highly productive journals in zone one producing more than ten articles. It can be noticed that there are two journals namely *Free Radical Biology* and *American Journal of Physiology – Heart and Circulatory Physiology* are the most productive journals on apocynin research. Both the journals have produced 61 articles which are about 4.45% of total apocynin publication.

Apocynin is observed to have anti-inflammatory capabilities and proved to have the ability to prevent the formation of free radicals, oxygen ions, and peroxides in the body. It can be observed from Table 4 that there are journals which are focused in this area and publishing articles on these subjects. These journals cover the research areas of

apocynin which is used for the treatment of various diseases, related to skin, inflammation, heart disease, diabetes, etc.

Country wise distribution

The 1,424 publication of apocynin are spread over 49 countries. Out of these, USA has highest contribution (511 documents), followed by Japan (107 documents), and China (82 documents). Table 5 presents the status of most productive countries and their citation impact. It is found that USA ranked first with highest number of papers as well as citations count

Author productivity

The authorship pattern of apocynin research shows collaborative research trend, as it happens in any scientific and medical field. A total of 7,963 authors produced the 1,424 papers. Only 50 documents have been produced by single authors and rest of the articles have been authored by two or more than two authors (Figure 2). This shows the collaborative nature of research in the field of apocynin research.

Figure 2 shows that highest numbers of documents (218, 15.13%) were written by five authors in joint collaboration. There are also instances where more than fifteen authors collaborated to produce papers in apocynin research. It is found that 'Jamie Y. Jeremy' (*h*-index: 30) and 'Nilima Shukla' (*h*-index: 23) from University of Bristol, Bristol Heart Institute, United Kingdom are the two most productive authors and each has published 16 papers, where as 'Michael S. Wolin' (*h*-index: 42) from New York Medical College, Departments of Medicine, Pharmacology, and Physiology, United States has contributed 15 papers on apocynin.

Leading organizations working in the area of apocynin

Table 6 presents the status of most productive institutions where the study and research in the area of apocynin is most frequently being carried out and the authors of the paper belongs to these

Table 4—Highly productive journals publishing apocynin literature

Sl. no.	Journal	IF (2012)	No. of articles	Percentage
1	<i>Free Radical Biology and Medicine</i>	5.271	61	4.45%
2	<i>American Journal of Physiology- Heart and Circulatory Physiology</i>	3.708	61	4.45%
3	<i>Hypertension</i>	6.207	46	3.35%
4	<i>Circulation Research</i>	9.489	25	1.82%
5	<i>Cardiovascular Research</i>	5.940	25	1.82%
6	<i>American Journal of Physiology Renal Physiology</i>	3.612	25	1.82%
7	<i>British Journal of Pharmacology</i>	5.067	25	1.82%
8	<i>European Journal of Pharmacology</i>	2.592	24	1.75%
9	<i>Arteriosclerosis Thrombosis and Vascular Biology</i>	6.368	23	1.68%
10	<i>Journal of Hypertension</i>	4.021	21	1.53%
11	<i>American Journal of Physiology Regulatory Integrative and Comparative Physiology</i>	3.284	20	1.46%
12	<i>Circulation</i>	14.816	18	1.31%
13	<i>Biochemical and Biophysical Research Communications</i>	2.406	17	1.24%
14	<i>Journal of Biological Chemistry</i>	4.773	17	1.24%
15	<i>Journal of Pharmacology and Experimental Therapeutics</i>	3.828	16	1.17%
16	<i>American Journal of Physiology Lung Cellular and Molecular Physiology</i>	3.523	16	1.17%
17	<i>Antioxidants and Redox Signaling</i>	8.456	14	1.02%
18	<i>Free Radical Research</i>	2.878	14	1.02%
19	<i>Journal of Molecular and Cellular Cardiology</i>	5.166	14	1.02%
20	<i>Journal of Applied Physiology</i>	3.753	13	0.95%
21	<i>Toxicology and Applied Pharmacology</i>	4.447	11	0.80%
22	<i>Life Sciences</i>	2.527	11	0.80%
23	<i>Diabetes</i>	8.286	11	0.80%
24	<i>Atherosclerosis</i>	3.794	11	0.80%
25	<i>Journal of Cardiovascular Pharmacology</i>	2.287	11	0.80%
26	<i>Kidney International</i>	6.606	10	0.73%
27	<i>Journal of Neurochemistry</i>	4.061	10	0.73%

Table 5—Country - wise distribution of apocynin papers

Sl. no.	Country	Total publications	Percent	Total citations	ACPP
1	United States	575	40.38	15186	26.41
2	Japan	137	9.62	2040	14.89
3	China	113	7.94	1264	11.19
4	Germany	90	6.32	2353	26.14
5	United Kingdom	76	5.34	2345	30.86
6	Canada	62	4.35	1610	25.97
7	Italy	57	4.00	851	14.93
8	France	54	3.79	1152	21.33
9	Spain	53	3.72	1037	19.57
10	South Korea	52	3.65	983	18.90
11	Taiwan	44	3.09	503	11.43
12	Australia	40	2.81	827	20.68
13	Netherlands	38	2.67	907	23.87
14	Brazil	28	1.97	323	11.54
15	Poland	26	1.83	396	15.23
16	India	19	1.33	157	8.26

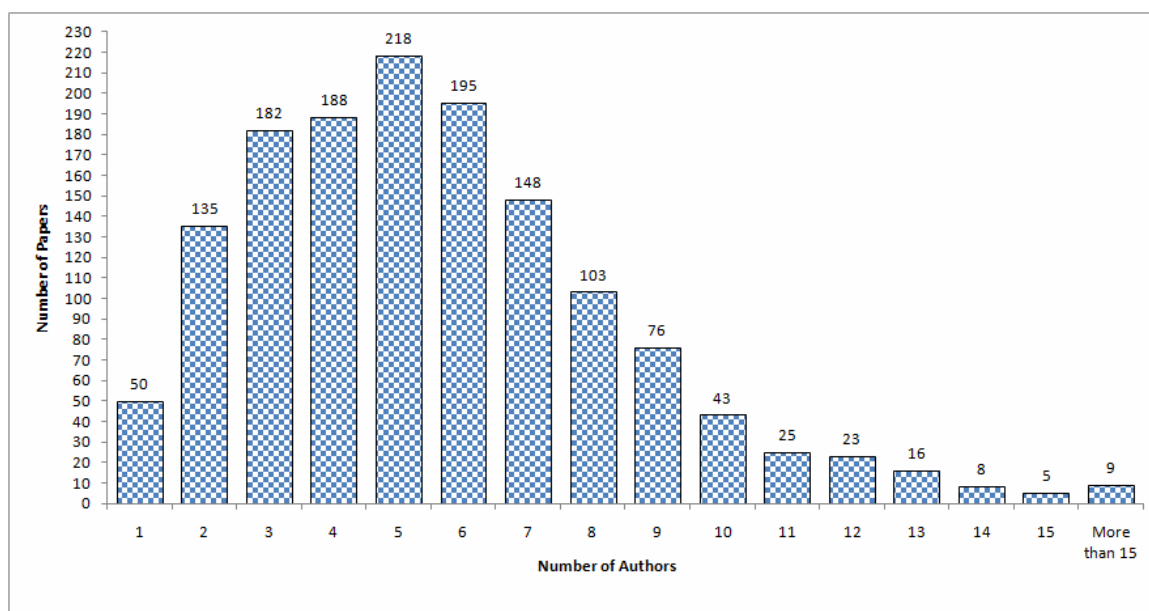


Fig.2—Authorship pattern of apocynin research

Table 6—Most productive institutions working in the area of apocynin research

Sl. no.	Institute	Country	No. of papers	Percent
1	Veteran Affairs Medical Center	USA	40	2.81
2	New York Medical College	USA	32	2.25
3	Medical College of Georgia	USA	27	1.90
4	Medical College of Wisconsin	USA	26	1.83
5	Monash University	Australia	18	1.26
6	Inserm, France	France	17	1.19
7	University of Missouri-Columbia	USA	16	1.12
8	University of Nebraska Medical Center	USA	16	1.12
9	Universidade de Sao Paulo	Brazil	15	1.05
10	The University of North Carolina at Chapel Hill	USA	15	1.05
11	University of Melbourne	Australia	15	1.05
12	Michigan State University	USA	14	0.98
13	Heinrich Heine Universität	Germany	14	0.98
14	University of Bristol	United Kingdom	14	0.98
15	Chang Gung University	Taiwan	13	0.91
16	University of California, San Francisco	USA	13	0.91
17	Universidad Complutense de Madrid	Spain	13	0.91
18	Yeungnam University	South Korea	12	0.84
19	Universite de Montreal	Canada	12	0.84
20	Emory University	USA	11	0.77
21	University of Mississippi Medical Center	USA	11	0.77
22	Henry Ford Hospital	USA	11	0.77
23	Stanford University School of Medicine	USA	11	0.77
24	Medical University of Lublin	Poland	11	0.77
25	Semmelweis Egyetem, Hungary	Hungary	10	0.70
26	University of Iowa Caver College of Medicine	USA	10	0.70
27	Nagoya University School of Medicine	Japan	10	0.70
28	Georgetown University	USA	10	0.70
29	Emory University School of Medicine	USA	10	0.70
30	Johannes Gutenberg Universität Mainz	Germany	10	0.70
31	National Yang-Ming University Taiwan	Taiwan	10	0.70

institutions. It is found that Veteran Affairs Medical Centre, USA has contributed most number of papers. This centre has produced forty papers during the period of study which constitutes about 2.81% of total publications.

Subject coverage of apocynin research

Apocynin research spanned over 23 broad subject categories. The apocynin literatures which have been retrieved from Scopus show a multidisciplinary research area, but the primary focus of research is medicine (Table 7).

More than 52.247% of the research has been carried out in the area of medicine as the plant and its product are having medicinal values. About 50.315% of publications are related to biochemistry, genetics and molecular biology field. 21.208% publications reflect the area of research related to pharmacy and pharmaceuticals. These aspects of apocynin research highlight the medicinal value of the plant.

Highly cited articles

Out of 1424 papers, 1368 papers got at least one citation. These papers in all received 39,780 citations on an average citation of 25.50 citations per paper. Based on the citation count it is found that there were 58 papers which have one citation, 40 papers with two citations, 122 papers with 3-5 citations, 229 papers with 6-10 citations, and 334 papers with 11-20 citations. There were 351 paper whose citation count ranges between 20-50 citations, 158 articles whose citation ranges between 51-100 and 57 articles have citation range between 101-200. There were 14 articles that have received 200 or more citations is given in Table 8.

Conclusion

Since ages, natural products have been used as therapeutics by the majority of under-privileged people in developing and underdeveloped country. The potential use of medicinal plants have attracted the attention scientist to harness its medicinal value

Table 7—Subject coverage of apocynin research

Subject coverage	No. of records	Percent
Medicine	744	52.247
Biochemistry, Genetics and Molecular Biology	717	50.351
Pharmacology, Toxicology and Pharmaceutics	302	21.208
Neuroscience	122	8.5674
Chemistry	79	5.5478
Immunology and Microbiology	60	4.2135
Agricultural and Biological Sciences	52	3.6517
Environmental Science	27	1.8961
Chemical Engineering	14	0.9831
Nursing	10	0.7022
Social Sciences	8	0.5618
Health Professions	5	0.3511
Physics and Astronomy	5	0.3511
Earth and Planetary Sciences	4	0.2809
Materials Science	4	0.2809
Engineering	4	0.2809
Computer Science	3	0.2107
Veterinary	3	0.2107
Multidisciplinary	2	0.1404
Psychology	2	0.1404
Mathematics	1	0.0702
Undefined	1	0.0702
Arts and Humanities	1	0.0702

Table 8—Highly cited papers of apocynin research

Sl. No.	Title of the paper	Journal	No. of citations
1	The vascular NAD(P)H oxidases as therapeutic targets in cardiovascular diseases. <i>Cai H, Griendling K K, Harrison D G</i>	<i>Trends in Pharmacological Sciences</i> , 24 (9) (2003) 471-478	429
2	Characteristics of the inhibition of NADPH oxidase activation in neutrophils by apocynin, a methoxy-substituted catechol. <i>Stolk J, Hiltermann T J, Dijkman J H, Verhoeven A J</i>	<i>American journal of respiratory cell and molecular biology</i> , 11 (1) (1994) 95-102	373
3	Expression of a functionally active gp91phox-containing neutrophil-type NAD(P)H oxidase in smooth muscle cells from human resistance arteries: Regulation by angiotensin II <i>Touyz R M, Chen X, Tabet F, Yao G, He G, Quinn M T, Pagano P J, Schiffrin E L</i>	<i>Circulation Research</i> , 90 (11) (2002) 1205-1213	361
4	Apocynin is not an inhibitor of vascular NADPH oxidases but an antioxidant <i>Heumuller S, Wind S, Barbosa-Sicard E, Schmidt H H H W, Busse R, Schroder K, Brandes R P</i>	<i>Hypertension</i> , 51 (2) (2008) 211-217	281
5	Generation of superoxide in cardiomyocytes during ischemia before reperfusion <i>Becker L B, Vanden Hoek T L, Shao Z H, Li C Q, Schumacker P T</i>	<i>American Journal of Physiology - Heart and Circulatory Physiology</i> , 277 (6-46-6) (1999) H2240-H2246	276
6	Antioxidants inhibit monocyte adhesion by suppressing nuclear factor-B mobilization and induction of vascular cell adhesion molecule-1 in endothelial cells stimulated to generate radicals <i>Weber C, Erl W, Pietsch A, Strobel M, Ziegler-Heitbrock H W L, Weber P C</i>	<i>Arteriosclerosis and Thrombosis</i> , 14 (10) (1994) 1665-1673	272
7	Angiotensin II induces monocyte chemoattractant protein-1 gene expression in rat vascular smooth muscle cells <i>Chen X L, Tummala P E, Olbrych M T, Alexander R W, Medford R M</i>	<i>Circulation Research</i> , 83 (9) (1998) 952-959	271
8	Superoxide excess in hypertension and aging a common cause of endothelial dysfunction <i>Hamilton C A, Brosnan M J, McIntyre M, Graham D, Dominiczak A F</i>	<i>Hypertension</i> , 37 (2-II) (2001) 529-534	260
9	Drug antioxidant effects: A basis for drug selection? <i>Halliwell B</i>	<i>Drugs</i> , 42 (4) (1991) 569-605	241
10	Reactive oxygen species-regulated signalling pathways in diabetic nephropathy <i>Lee H B, Yu M R, Yang Y, Jiang Z, Ha H</i>	<i>Journal of the American Society of Nephrology</i> , 14 (SUPPL. 3) (2003) S241-S245	220
11	NADH/NADPH oxidase and enhanced superoxide production in the mineralocorticoid hypertensive rat <i>Beswick R A, Dorrance A M, Leite R, Webb R C</i>	<i>Hypertension</i> , 38 (5) (2001) 1107-1111	216
12	Lignin-derived compounds as efficient laccase mediators for decolorization of different types of recalcitrant dyes <i>Camarero S, Ibarra D, Martinez M J, Martinez A T</i>	<i>Applied and Environmental Microbiology</i> , 71 (4) (2005) 1775-1784	215
13	Role of xanthine oxidoreductase and NAD(P)H oxidase in endothelial superoxide production in response to oscillatory shear stress <i>McNally J S, Davis M E, Giddens D P, Saha A, Hwang J, Dikalov S, Jo H, Harrison D G</i>	<i>American Journal of Physiology - Heart and Circulatory Physiology</i> , 285 (6-54-6) (2003) H2290-H2297	213
14	Oxidative stress and gene expression in sepsis <i>Macdonald J, Galley H F, Webster N R</i>	<i>British Journal of Anaesthesia</i> , 90 (2) (2003) 221-232	206

and use them for the benefit of people by developing drugs to combat human diseases as well as being used in crude form by poor in treatment of diseases. Apocynin is a medicinal product derived from root of *Apocynum cannabinum* and being used as treatment of many diseases. Through this study, it is found that the apocynin research is being conducted in forty nine countries of the world. USA is the most productive country, while India's contribution is far behind in comparison to other countries. Most of the papers have been published in joint authorship, which reflects the collaborative nature of research. In the list of most productive institutions, none of the Indian institute makes their appearance. Medicine, biochemistry, pharmaceuticals and pharmacology are the major subject area of research in apocynin along with the eighteen other subjects. Like other subjects, Apocynin research follows some of the standard Bibliometric laws given by Bradford and Lotka.

References

- 1 Luchtefeld R, Luo R, Stine K, *et al.*, Dose formulation and analysis of diapocynin, *Journal of Agricultural and Food Chemistry*, 56(2) (2008) 301–306.
- 2 Hougee S, Hartog A, Sanders A, *et al.*, Oral administration of the NADPH-oxidase inhibitor apocynin partially restores diminished cartilage proteoglycan synthesis and reduces inflammation in mice, *European Journal of Pharmacology*, 531(1–3) (2006) 264–269.
- 3 Hart B A, Simons J M, Knaan-Shanzer S, *et al.*, Antiarthritic activity of the newly developed neutrophil oxidative burst antagonist apocynin, *Free Radical Biology and Medicine*, 9(2) (1990) 127- 131.
- 4 Trentham D E, Collagen arthritis as a relevant model for rheumatoid arthritis: Evidence pro and con, *Arthritis and Rheumatism*, 25(8) (1982) 911-916.
- 5 Hart B A, Elferink T J G R, and Nibbering P H, Effect of Apocynin on the induction of ulcerative lesions in Rat skin injected with tubercle bacteria, *International Journal of Immunopharmacology*, 14(6) (1992) 953-961.
- 6 Houser K R, Johnson D K, and Ishmael F T, Anti-inflammatory effects of methoxyphenolic compounds on human airway cells, *Journal of Inflammation*, 9(6) (2012).
- 7 Cabassi A, Halpern S, Barouhiel E, *et al.*, Chronic Apocynin treatment improves noradrenergic presynaptic reuptake, inhibits sympathetic-mediated lipolysis and fat loss in a aging rat model of heart failure, *Journal of Hypertension*, 28 (e-supplement) (2010).
- 8 Yu J, Weiwer M, Linhardt R J, and Dordick J S, The Role of the Methoxyphenol Apocynin, a Vascular NADPH Oxidase Inhibitor, as a Chemopreventative Agent in the Potential Treatment of Cardiovascular Diseases, *Current Vascular Pharmacology*, 6 (3) (2008) 204-217.
- 9 Meng R, Zhu D, Bi Y, Yang D and Wang Y, Apocynin Improves Insulin Resistance through Suppressing Inflammation in High-Fat Diet-Induced Obese Mice, *Mediators of Inflammation*, 2010 (2010).
- 10 Adenaike B O, Bibliometric studies on a protein-rich crop: The cowpea, *Journal of Information Science*, 4(2-3) (1982) 117-121.
- 11 Subbaiah R, Eighty years of grape research in India (1901-1981): A bibliometric study, *Annals of Library Science and Documentation*, 31(1-2) (1984) 18-26.
- 12 Meera, Plant ecology literature: A bibliometric study, *International Information Communication and Education*, 17(1) (1998) 41-59.
- 13 Haiqi Z, A bibliometric study on medicine Chinese traditional [sic] in Medline database, *Scientometrics*, 31(3) (1994) 241-250.
- 14 Dhiman A K, and Sinha S C, Impact of research collaboration on growth of literature in ethnobotany: A bibliometric study, *SRELS – Journal of Information Management*, 38(1) (2001) 53-62.
- 15 Ram S, Research Practices in Herbal Medicinal Plant: A Case Study of Podophyllotoxin, *Annals of Library and Information Studies*, 57(1) (2010) 65-71.
- 16 Ram S, Research output on Artemisia (*Artemisia annua*): a bibliometric study, *Annals of Library and Information Studies*, 58(3) (2011) 237-248.
- 17 Anwar M A, Phoenix Dactylifera L: A Bibliometric Study of the Literature on Date Palm, *Malaysian Journal of Library & Information Science*, 11(2) (2006) 41-60.
- 18 Alhaider I, Ahmed M K K and Gupta B M, Global Research output on date palm (Phoenix dactylifera): a 12 years scientometric perspective, *Scientometrics*, 94(3) (March 2013).
- 19 Anwar M A, Nigella Sativa: A Bibliometric Study of the Literature on Habbat Al-Barakah, *Malaysian Journal of Library & Information Science*, 10(1) (2005) 1-18.
- 20 Fan W, The Traditional Chinese Medical Literature analysis and Retrieval system (TCMLARS) and its application, *Inspel*, 35(3) (2001) 147-156.
- 21 About Scopus. Available online at <http://www.info.sciverse.com/scopus/about> (Accessed on 20 Jun 2013).
- 22 Bradford S C, Sources of information on specific subjects 1934 (reprint), *Journal of Information Science*, 10(4) (1985) 173–180.