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**Bio-bibliometric Study of Prof. P Balaram contributions in the field of Bio-organic
Chemistry and Molecular Biophysics**

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Abstract

The present study uses Bio-Bibliometrics to examine the contributions made by Prof P Balaram renowned scientists in the field of Bio-organic chemistry and molecular biophysics from Indian Institute of Science (IISC) in India. It is important to study the contributions made by him to understand magnitudes and nature of contribution in a particular domain. The data was collected using Scopus database. Further the paper highlights on the contributions of P Balaram author productivity, Collaborations magnitude, Productivity of year wise distribution, collaboration coefficient, channels of communications, most used author keywords and high cited papers.

Keywords: *Scientometrics, Bibliometrics, Bio-bibliometric, P Balaram, Padmanabhan Balaram, Scopus, IISc, Indian Institute of Science.*

1. Introduction

Research plays an important role in the development of new knowledge in every domain. Research is a never-ending process, and it expands its horizons each day. Every country sets a benchmark to measure quality of its scientific, socio-economic and educational research output. There are numerous ways to evaluate the quality and quantity of research accomplishment of every country, its researchers and Institutions. In Library and Information domain, such measuring of the growing discipline is known as statistical bibliography or bibliometric analysis. Notably there are more ways to evaluate literature growth like Librarmetry, (S R Ranganthan 1948) Bibliometrics, (Alan Pritchard 1969) Informetrics, (Otto Nacke 1979) Scientometrics (T. Braunin 1977).

Bio-bibliometrics is term used in studying the quantitative and analytical methods used for discovering and organizing in functional way of relationships between bio-data and biblio-data elements (Sen and Gan, 1990). Renowned Biobibliometrician from India first used “Scientometric Portrait” to carry out Bio-bibliometrics study on Nobel laureates and scientists (Kademani et al., 1996). Bio-bibliometrics is a study carried out statistically to analyze the individual, department or subject of any domain. It is has been used to identify the trending research areas. In recent years Scientometrics or Bio-bibliometrics got new dimension which studies the profiles of eminent scientists, social scientists and Nobel Laureates. Such studies combine the life and legacy of the individual and also his or her contribution to the body of knowledge and to the welfare of mankind. The role of science and scientists is crucial in the development of the nation. Scientists try to find out how the laws of nature work using different scientific methods. This is not only important for the knowledge sake but also because we can build on this knowledge to create new technologies that improve people's life's better. In this context the Scientometric profile of scientists receives utmost importance.

This paper applies Bio-bibliometric methods and aims to study the scholarly publications of Prof. P. Balaram, a renowned scientist of Indian Institute of Science in the field of Bio-organic Chemistry and Molecular Biophysics.

2. Biographical Sketch of Prof. P Balaram

Padmanabhan Balaram popularly known as P. Balaram is an Indian biochemist and a former director of the Indian Institute of Science (IISc), Bengaluru. He is the recipient of the third highest Indian civilian award of 'Padma Bhushan'. He is also a recipient of The World Academy of Sciences (TWAS) prize.

P. Balaram was born on 19th February 1949. He obtained his BSc from Fergusson College, Poona University, in 1967 and MSc from Indian Institute Technology, Kanpur in the year 1969. Balaram got his Ph. D from Carnegie-Mellon University, USA in the year 1972. He worked as a Research Associate at the Harvard University (1972-73) with Professor RB Woodward of the Department of Chemistry. He returned to India and joined Indian Institute of Science (IISc), Bengaluru as lecturer in 1973 and continued till 1977. He was Assistant professor during 1977 - 1982, Associate professor during 1982 - 1985, and finally he became professor in 1986. Balaram was the chairman of Molecular Biophysics Unit from 1995-2000 and an Astra professor at Biological Sciences during 1997-2000. P. Balaram was the Director of IISc, Bengaluru from 2005 to 2013.

In his prolonged career he had honored number of awards; few of them are listed below-

- INSA Medal for Young Scientists (1977),
- UGC Career Award (1979),
- Shanti Swarup Bhatnagar Prize of CSIR (1986),
- Alumni Award for Excellence in Research by IISc (1991),
- GD Birla Award (1994),
- TWAS Award in Chemistry (1994),
- Jawaharlal Nehru Birth Centenary Lecture (1995),
- Jawaharlal Nehru Birth Centenary Visiting Fellowship (1996),
- Alumnus Award of IIT Kanpur (2000),
- Padma Shri by the Government of India (2002),
- The Jagadis Chandra Bose Medal (2004),
- Pamda Bhushan by Government of India (2004)

P. Balaram was in the editorial board many journals, notable among them are -

- Journal of Peptide Research 1997
- Indian Journal of Chemistry Section B. 1985-1991
- Indian Journal of Biochemistry and Biophysics 1989-1991
- Current Science, Editorial Committee 1991-1994
- Proceedings, Indian National Science Academy, Section B. 1985-1990
- Proceedings of the Indian Academy of Sciences, Chemical Sciences 1980-1983
- Associate Editor, Indian Journal of Chemical Education 1977-1982

Presently P. Balaram in the Editorial board of *Current Science* (Editor), *Chem Biochem: A European Journal of Chemical Biology* (Editorial Advisory Board), *Biopolymers* (Peptide Science), *Protein Engineering* (Design and Selection)

Balaram's core areas of research are - Peptide Design and Conformational Analysis, Peptide Natural Products: Conus Peptides and Fungal peptides, Mass Spectrometry of Proteins and Peptides, Triosphosphate Isomerase (TIM) from *Plasmodium falciparum* and Computational Analysis on Protein Structures.

3. Objectives of the Study

- To determine and differentiate his research contribution.
- To examine the authorship pattern of his research output.
- To investigate the extent of collaborative research he made with other core authors.
- To analyze the year-wise distribution of his research output through his career research life.
- To analyze author appearance in each paper and years.
- To analyze different communication channel used for publications
- To analyze top authors keywords.
- To analyze the top cited papers.

4. Review of Literature

In recent years, Bio-Bibliometric study has become a trend in Library and Information Science to gauge the research output of individual authors. There are innumerable of articles

that have been published on Bio-Bibliometric, Scientometrics studies, and Scientometrics Portrait. Few of the closest papers have been reviewed for this study has follows

- Scientometrics study by **(Kalyane & Sen, 1996)** analysis the research of output of French Physicist and Nobel Laureate Pierre-Gilles de Gennes from the year 1956-1995. The study throws light on collaborative ratio and Scattering of publications in different fields.
- A scientometric study conducted by **(Sangam et al., 2006)** on Prof. Peter John Wyllie. The study reveals the collaboration coefficient is 0.64. More often used collaborate with 2 authored (154) papers. Huang P J was the core author and highest collaborator.
- Study by **(Kalaiappan et al., 2010)** revealed the works of Prof. G N Ramachandran on the subject of Biophysics and Crystallography. The study was solely dedicated to comparing the collaborative authorship pattern of Prof. G. Ramachandran.
- **(Manjunath & Ramesha, 2015)** studied the bio-bibliometrics of C V Raman has reflected in google scholar. Results reveled his single authored papers were highest (339), collaborated with cross domain authors, used only 21 communication channel to publish his work and top cited paper cited (1327 times)
- **(Kalaiappan & Yesudoss, 2018)** conducted scientometrics analysis of Prof G N Ramachandran and Prof C N Rao's research output. In this study, compared the contributions made by these two eminent scientists. Their study revealed that in terms of publications and citations, Prof. CNR made an upper hand than Prof. G.N. Ramachandran.
- Study **(Sab et al., 2018)** of Bio-Biblometric on Prof B S Biradhar contributions in the field of Library and Information Science. The study reveals the publications output of BSB his majorly contributed 162 research papers from 1990 to 2016 most co-authored (16) papers with B T Sampath Kumar and highly cited paper was “use of ICT in College libraries in Karnataka India: A Survey” in 2010 and got 45 Citations

5. Methodology

To study the Bio-biblometrics of Prof. P.Balaram data was collected using Scopus citation and abstract database which is the product of Elsevier using author search. Balaram P has a keyword term, further the analyses carried out by concentrating only on the core articles of P Balaram using by limiting the search by using following search terms AU-ID ("Balaram, Padmanabhan" 7103401390) AND (EXCLUDE (PUBYEAR , 2020)) AND (LIMIT-TO (DOCTYPE , "ar")) and the search indexed into resulted of 442 articles and recorded in csv format for the study. All the data was tabulated using Microsoft excel and biblioshiny.

6. Data Analysis and Interpretation

6.1 Contributions

Table 1- Contributions made by Prof P Balaram

SI No	DOCUMENT TYPE	No of Items	Percent
1	Article	442	66%
2	Editorial	191	29%
3	Review	12	2%
4	Erratum	6	1%
5	Letter	6	1%
6	Conference Paper	4	1%
7	Book Chapter	3	0%
8	Note	1	0%
	Total	665	100%

The contributions made by P Balaram throughout his professional and research career have been tabulated in (Table 1) of 665 publications. Major contribution of 66 percent (442) on Journal articles, followed by Editorial material 29 percent (191), Reviews 2 percent (12), Erratum 1 percent (6), Letter 1 percent (6), Conference Paper 1 percent (04), Book Chapter (3), and Note (1).

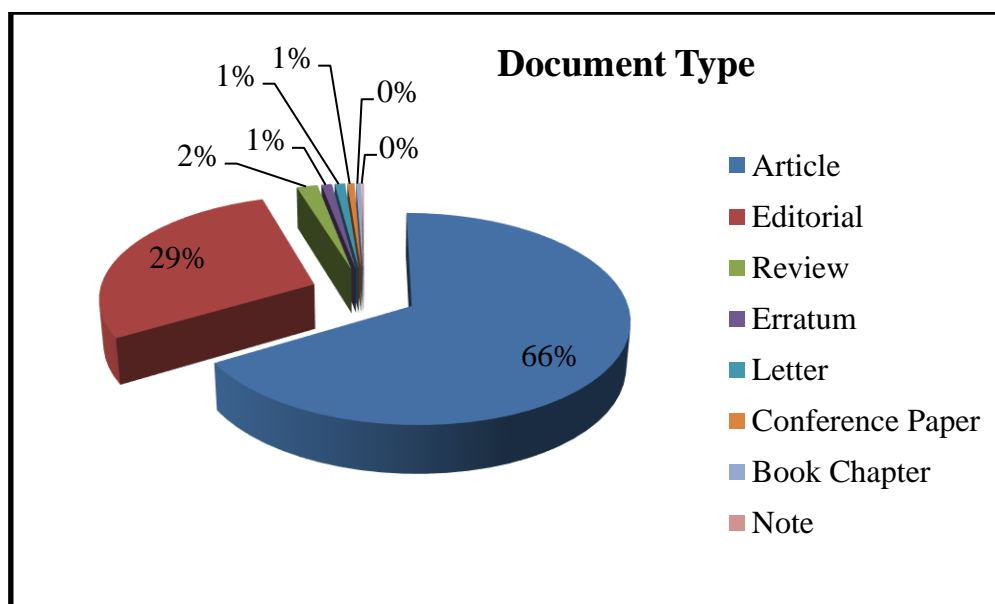


Figure-1

6.2 Author Productivity

P. Balam published 442 research articles during his productive year from 1973 to 2019. Where the Table 2 shows he has only credited 12 research papers as single author in the years 1981-1982, 1984-1985, 1997 and 1999 respectively. Further data interpreted in Table 2 shows as multiple authored paper appearance of P. Balam has 1st author 4 (0.90%), has 2nd author 84 (19%) has 3rd author 102 (23.08%), has 4th author 109 (24.66%), has 5th author 61 (13.80%), has 6th author 39 (8.78%), has 7th author 19 (4.28%), has 8th author 7 (1.58%), has 9th author 1 (0.23%), has 10th author 3 (0.68%) and has 11th author 1 paper (0.23%). P Balam as main author (MA) has 16 (3.62%) papers and has co-authored papers (CA) 426 (96.38%). His highest research came in the year 1981 of 28 papers, where his chronological age was 31 and this productive age was 9 and in 1982, 1996-1997, 2002 and 2009 on an average he has been publishing around 15-20 papers and his degree of collaboration (Subramanyam, 1983) is 0.036. Comparatively Balam is collaborative in nature with co-authored papers when compare to his individual contributions.

Table 2 Year Wise and Age-wise publication productivity of P. Balaram

Appearance of Author by-line wise position

Year	Single Auth	As 1 st Auth	As 2 nd Auth	As 3 rd Auth	As 4 th Auth	As 5 th Auth	As 6 th Auth	As 7 th Auth	As 8 th Auth	As 9 th Auth	As 10 th Auth	As 11 th Auth	MAP	CA	TP	CT	DC	CA	PPA
1973	-	1	-	-	-	-	-	-	-	-	-	-	1	0	1	1	0.002	23	1
1975	-	-	1	-	-	-	-	-	-	-	-	-	0	1	1	2	0.000	25	3
1976	-	-	4	-	-	-	-	-	-	-	-	-	0	4	4	6	0.000	26	4
1977	-	-	1	3	-	-	-	-	-	-	-	-	0	4	4	10	0.000	27	5
1978	-	-	3	2	-	-	-	-	-	-	-	-	0	5	5	15	0.000	28	6
1979	-	-	1	2	4	1	-	-	-	-	-	-	0	8	8	23	0.000	29	7
1980	-	-	5	5	3	-	-	-	-	-	-	-	0	13	13	36	0.000	30	8
1981	1	2	15	5	1	2	-	2	-	-	-	-	3	25	28	64	0.007	31	9
1982	2	-	5	7	-	1	1	-	-	-	-	-	2	14	16	80	0.005	32	10
1983	-	-	8	7	-	1	-	1	-	-	-	-	0	17	17	97	0.000	33	11
1984	2	-	7	4	1	-	-	-	-	-	-	-	2	12	14	111	0.005	34	12
1985	1	-	3	5	-	-	1	-	-	-	-	-	1	9	10	121	0.002	35	13
1986	-	-	4	4	-	1	2	-	-	-	-	-	0	11	11	132	0.000	36	14
1987	-	-	2	4	1	2	-	-	-	-	-	-	0	9	9	141	0.000	37	15
1988	-	-	-	3	7	-	2	-	-	-	-	-	0	12	12	153	0.000	38	16
1989	-	-	1	1	5	1	1	-	-	-	1	-	0	10	10	163	0.000	39	17
1990	-	-	1	2	6	2	-	-	-	-	-	-	0	11	11	174	0.000	40	18
1991	-	-	-	-	1	1	-	1	1	-	-	-	0	4	4	178	0.000	41	19
1992	-	1	-	1	4	2	-	1	-	1	-	-	1	9	10	188	0.002	42	20
1993	-	-	1	2	4	-	-	-	-	-	-	-	0	7	7	195	0.000	43	21
1994	-	-	3	-	4	5	1	-	-	-	-	-	0	13	13	208	0.000	44	22
1995	-	-	2	5	2	-	1	-	-	-	-	-	0	10	10	218	0.000	45	23
1996	-	-	1	4	7	4	1	-	-	-	2	-	0	19	19	237	0.000	46	24
1997	1	-	4	3	5	3	2	-	-	-	-	-	1	17	18	255	0.002	47	25

1998	-	-	-	2	3	2	1	-	-	-	-	-	0	8	8	263	0.000	48	26
1999	1	-	2	2	4	2	2	1	-	-	-	-	1	13	14	277	0.002	49	27
2000	-	-	1	2	3	2	1	-	-	-	-	-	0	9	9	286	0.000	50	28
2001	-	-	1	5	4	-	1	-	-	-	-	-	0	11	11	297	0.000	51	29
2002	-	-	-	6	5	2	1	1	-	-	-	-	0	15	15	312	0.000	52	30
2003	-	-	-	2	5	1	1	1	1	-	-	1	0	12	12	324	0.000	53	31
2004	-	-	-	2	2	1	-	1	1	-	-	-	0	7	7	331	0.000	54	32
2005	-	-	-	1	3	2	3	-	1	-	-	-	0	10	10	341	0.000	55	33
2006	-	-	1	4	-	3	1	1	1	-	-	-	0	11	11	352	0.000	56	34
2007	-	-	2	1	1	2	4	3	-	-	-	-	0	13	13	365	0.000	57	35
2008	-	-	2	1	2	4	1	1	1	-	-	-	0	12	12	377	0.000	58	36
2009	3	-	1	2	2	2	4	1	-	-	-	-	3	12	15	392	0.007	59	37
2010	1	-	-	1	1	3	-	-	-	-	-	-	1	5	6	398	0.002	60	38
2011	-	-	-	-	4	2	1	-	-	-	-	-	0	7	7	405	0.000	61	39
2012	-	-	-	-	6	4	-	1	1	-	-	-	0	12	12	417	0.000	62	40
2013	-	-	-	-	3	1	2	2	-	-	-	-	0	8	8	425	0.000	63	41
2014	-	-	-	1	1	-	2	-	-	-	-	-	0	4	4	429	0.000	64	42
2015	-	-	-	-	-	-	1	1	-	-	-	-	0	2	2	431	0.000	65	43
2016	-	-	-	-	2	1	1	-	-	-	-	-	0	4	4	435	0.000	66	44
2017	-	-	-	-	3	-	-	-	-	-	-	-	0	3	3	438	0.000	67	45
2018	-	-	1	1	-	-	-	-	-	-	-	-	0	2	2	440	0.000	68	46
2019	-	-	1	-	-	1	-	-	-	-	-	-	0	2	2	442	0.000	69	47
Total	12	4	84	102	109	61	39	19	7	1	3	1	16	426	442		0.036		
%	2.71	0.90	19.00	23.08	24.66	13.80	8.82	4.30	1.58	0.23	0.68	0.23	3.62	96.38					
CP	2.71	3.62	22.62	45.70	70.36	84.16	92.99	97.29	98.87	99.10	99.77	100.00							

Auth = Author; **MAP** = Multiple Authorship Papers; **CA**=Co Author; **TP** = Total number of Papers or Publications; **CT** = Cumulative Total;
DC = Degree of Collaboration- MAP/TP; **CA** = Chronological Age; **PPA** = Publication Productivity Age.

6.3 Author Appearance

Table-3 has been tabulated on the basis of author appearance of P. Balaram in by-line position in each paper. Has 1st position he appeared only in 4 papers, has 2nd position appeared in 86 papers. His second highest has 3rd position in 102 papers and his first highest appearance came has 4th position in 109 papers. Followed by 61 papers in 5th position, 39 papers in 6th position, 17 papers in 7th position, whereas his lowest appearance came has 11th position in 1 paper. Therefore Table 3 shows that P. Balaram is more collaborative with appearance between 2nd to 7th author positions in his papers.

Table 3- Appearance of P. Balaram by-line Position

Authorship Pattern	1 st P	2 nd P	3 rd P	4 th P	5 th P	6 th P	7 th P	8 th P	9 th P	10 th P	11 th P	Total
Single-Authored	12	-	-	-	-	-	-	-	-	-	-	12
2-Authored	2	70	-	-	-	-	-	-	-	-	-	72
3-Authored	1	9	90	-	-	-	-	-	-	-	-	100
4-Authored	-	3	11	103	-	-	-	-	-	-	-	117
5-Authored	1	4	-	5	54	-	-	-	-	-	-	64
6-Authored	-	-	-	1	6	35	-	-	-	-	-	42
7-Authored	-	-	1	-	-	3	14	-	-	-	-	18
8-Authored	-	-	-	-	-	-	2	6	-	-	-	8
9-Authored	-	-	-	-	-	-	-	1	1	-	-	2
10-Authored	-	-	-	-	-	-	1	-	-	3	-	4
11-Authored	-	-	-	-	1	1	-	-	-	-	1	3
Total-	4	86	102	109	61	39	17	7	1	3	1	442

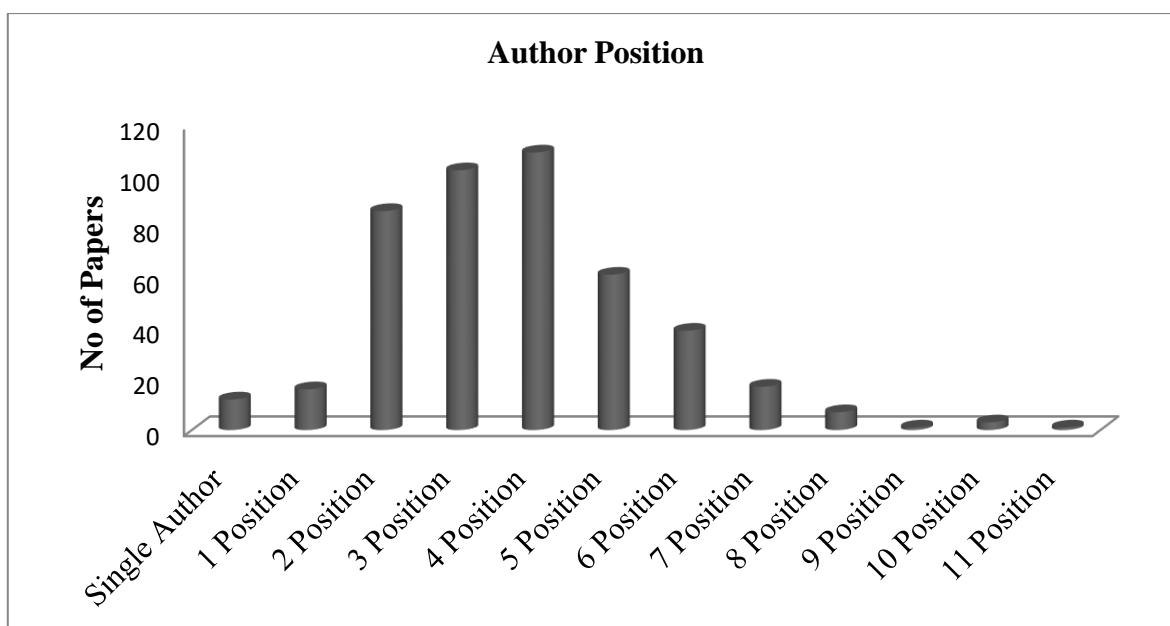


Figure: 2 Author Appearance

6.5 Block years

Table 5 examines the contribution Prof. P. Balaram in Block years where his productive year started from 23 from 1973. In this table contribution was divided for 5 block years starting from 1973-1978 contributed 15 papers (3.39%) his PA was 1-6 and CA was 23-28. His highest authorship pattern came in 1979-1983 contributed 82 papers (18.55%) PA was 7-11 and CA was 29-33, 68 (15.38%) papers from 1994-1998 his PA was 22-26, 61(13.80%) papers from 1999-2003 his PA was 27-31.

Table-5 Authorship pattern in Block years of P. Balaram

Block Years	Chronological age	Productive age	No. of Papers	Productivity in Single Block Years	%
1973-1978	23-28	1-6	15	3	3.39
1979-1983	29-33	7-11	82	16.4	18.55
1984-1988	34-38	12-16	56	11.2	12.67
1989-1993	39-43	17-21	42	8.4	9.50
1994-1998	44-48	22-26	68	13.6	15.38
1999-2003	49-53	27-31	61	12.2	13.80
2004-2008	54-58	32-36	53	10.6	11.99
2009-2013	59-63	37-41	48	9.6	10.86
2014-2019	64-69	42-47	17	3.4	3.85
			442		100.00

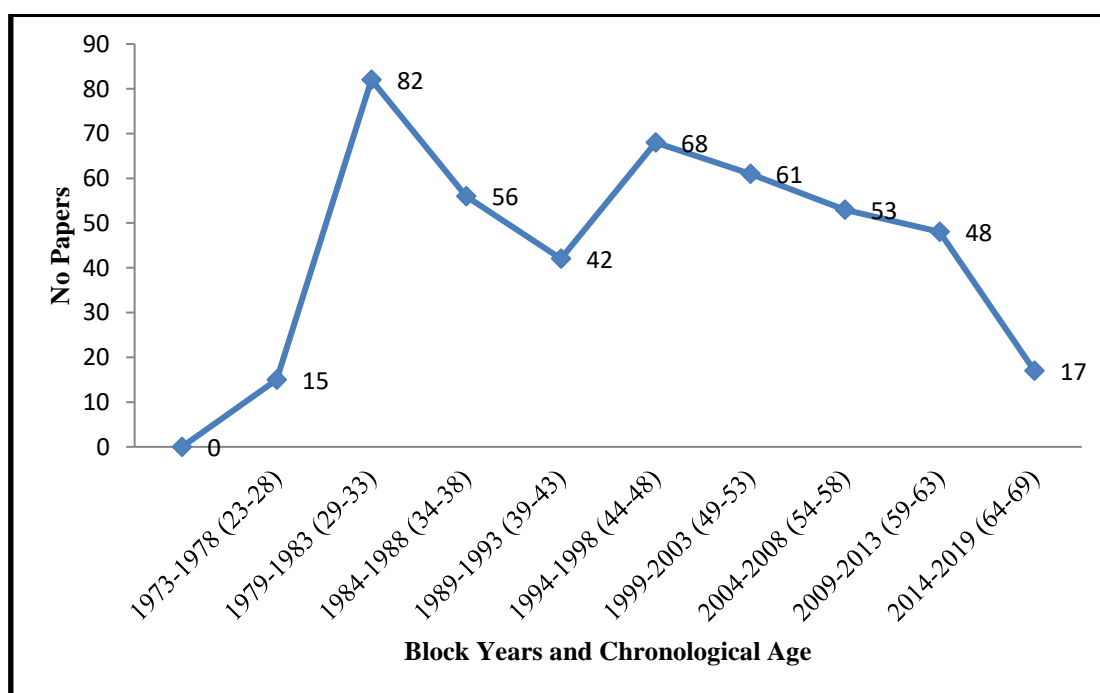


Figure 3

6.6 Authorship pattern

Has main author P. Balaram has credited 12 papers alone in his research career of 48 years and collaborated with other co-author of 432 papers. Has tabulated in Table-4 with 2 authors produced 70 papers, with 3 authors produced 100 papers, with 4 authors produced 117 papers and also his highest collaborative authorships, further with 5 authors produced 64 papers, with 6 authors produced 42 papers, with 7 authors produced 18 papers. His smallest collaboration was from 8-11 authors, on an average of 8,2,4,3,2 papers collaborated respectively and only 2 papers with 21 authored papers.

Table 6 Authorship pattern of B. Balaram

Non-Collaborative Authorship	Single	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	21A	Total
	12	-	-	-	-	-	-	-	-	-	-	-	12
Collaborative	-	70	100	117	64	42	18	8	2	4	3	2	430

6.7 Life Span

Table 5 show the Life Span of time and years of authorship pattern lights the collaborations of authors. The peak collaborations came in with four authored papers of (117) from 1979 to 2017 and within time of 43 years. In three authored papers of (100) from 1984-2018 in 34 years, with two authored papers (70) from 1977-2019

Table 7- Life-Span of time and years of Authorship pattern

No. of Author	Single	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven	Twenty one
No of Papers	12	70	100	117	66	42	18	8	2	4	3	2
Life Span	1981-2010	1977-2019	1984-2018	1979-2017	1979-2020	1982-2016	1986-2015	1983-2012	1992-2006	1986-2012	2003-2013	1981-1981
No. of Years	24	42	34	43	41	34	29	29	14	26	10	1

6.8 Communication Channels

P. Balaram as eminent author published numerous papers and used different communication channels to publish his research output. In Table 8 explores his publication. (*Biopolymers*) was highest channel where he published 55 papers from (1979-2017), followed by (*International Journal of Peptide*) and (*Protein Research*) 34 papers (1977-1996), (*Journal of the American Chemical Society*) published 32 papers (1979-2010), followed by (*Biochemical and Biophysical Research Communications*) published 24 papers (1976-2004), and further in (*Biochemistry*) published 20 papers (1973-2012). In (*FEBS Letters*) published 19 papers (1975-2003), (*Proceedings of the National Academy of Sciences*

of the United States of America) (1986-2014) 13 papers, (*Journal of Peptide Research*) and (*Chemistry - A European Journal*) (2001-2014) published 10 papers each.

Table 8 Communication channels used by P. Balaram

Rank	Title-	Papers	CT	FYP	PYP
1	<i>Biopolymers</i>	55	55	1979	2017
2	<i>International Journal of Peptide and Protein Research</i>	34	89	1977	1996
3	<i>Journal of the American Chemical Society</i>	32	121	1979	2010
4	<i>Biochemical and Biophysical Research Communications</i>	24	145	1976	2004
5	<i>Biochemistry</i>	20	165	1973	2012
6	<i>FEBS Letters</i>	19	184	1975	2003
7	<i>Proceedings of the National Academy of Sciences of the United States of America</i>	13	197	1986	2004
8	<i>Journal of Peptide Research</i>	10	207	1997	2005
8	<i>Chemistry - A European Journal</i>	10	217	2001	2014
9	3 Periodical with 7 papers	20	237	1992	2020
10	4 Periodical with 6 papers	23	260	1981	2012
11	4 Periodical with 5 papers	20	280	1994	2012
12	9 Periodical with 4 papers	36	316	1978	2011
13	10 Periodical with 3 papers	30	346	1982	2018
14	21 Periodical with 2 papers	44	390	1978	2019
15	52 Periodical with 1 papers	52	442	1976	2019
	Grand Total	442			

6.9 Author Keywords

Table 9 highlights the frequency of keywords used by P Balaram in his research papers. Peptide Conformation (34 times) tops highest in the table. Followed by Peptide (21 times), mass spectrometry (13 times), turns (13 times), Hydrogen Bonds (12 times), amino acids, circular dichroism and X-ray diffraction each (11 times) and other than 59 keywords used for 240 times in this papers.

Table- 9 Author Keywords

Keywords	Frequency
peptide conformation	34
peptides	21
mass spectrometry	13
turns	13
hydrogen bonds	12
amino acids	11
circular dichroism	11
x-ray diffraction	11

triosephosphate isomerase	10
crystal structure	9
fluorescence	9
nuclear overhauser effects	9
crystal structures	8
nmr	8
aminoisobutyryl peptides	7

hairpin	7
helical structures	6
plasmodium falciparum	6
protein folding	6
structure elucidation	6
alamethicin	5
conformation analysis	5
conformational analysis	5
conotoxins	5
helix termination	5
hybrid peptides	5
peptide crystal structure	5
bilirubin	4
dimer stability	4
n m r	4
nuclear magnetic resonance	4
protein conformation	4
thymidylate synthase	4
xray diffraction	4
helix	3
310 helix	3
aromatic interactions	3
cone snails	3
fluorescence resonance energy transfer	3
glutathionylation	3
helices	3
hexafluoroacetone	3

hydrogen bonding	3
melittin	3
oxidative stress	3
peptide aggregation	3
peptide design	3
peptide disulfide	3
plasmodium falciparum triosephosphate isomerase	3
polymorphs	3
protein data analysis	3
stereochemistry	3
subunit interface	3
tryptophan peptides	3
aminoisobutyric acid	2
hairpin peptide	2
turn	2
turn conformation	2
aib residues	2
amadori rearrangement	2
aromatic cluster	2
beta turns	2
bile salt	2
c-ho hydrogen bond	2
c-ho hydrogen bonds	2
cd	2
channel forming ionophores	2

6.10 Top Citations

List of high cited papers in Table-10 shows highest cited paper came in the year 1990 by Karle Isabella L and Padmanabhan Balaram. On the title of "Structural characteristics of. Alpha.-helical peptide molecules containing Aib residues." Which has cited 883 times and published in Journal of "Biochemistry"

Table-10: List of Top 10 cited papers

Sl. No	Citations	No. of Times Cited
1	Karle, Isabella L., and Padmanabhan Balaram. "Structural characteristics of. alpha.-helical peptide molecules containing Aib residues." <i>Biochemistry</i> 29.29 (1990): 6747-6756.	883
2	Venkataram Prasad, B. V., P. C. R. C. Balaram, and Ettore Benedetti. "The Stereochemistry of Peptides Containing α -Aminoisobutyric Aci." <i>Critical Reviews in Biochemistry</i> 16.4 (1984): 307-348.	370

3	Vasudev, Prema G., Sunanda Chatterjee, Narayanaswamy Shamala, and Padmanabhan Balaram. "Structural chemistry of peptides containing backbone expanded amino acid residues: conformational features of β , γ , and hybrid peptides." <i>Chemical reviews</i> 111, no. 2 (2011): 657-687..	243
4	Woodward, R. B., E. Logusch, K. P. Nambiar, K. Sakan, D. E. Ward, B. W. Au-Yeung, P. Balaram, L. J. Browne, P. J. Card, and C. H. Chen. "Asymmetric total synthesis of erythromcin. 1. Synthesis of an erythronolide A secoacid derivative via asymmetric induction." <i>Journal of the American Chemical Society</i> 103, no. 11 (1981): 3210-3213.	222
5	Nagaraj, Ramakrishnan, and Padmanabhan Balaram. "Alamethicin, a transmembrane channel." <i>Accounts of Chemical Research</i> 14, no. 11 (1981): 356-362.	215
6	Balaram, Padmanabhan. "Non-standard amino acids in peptide design and protein engineering." <i>Current Opinion in Structural Biology</i> 2, no. 6 (1992): 845-851.	188
7	Srinivasan, N., R. Sowdhamini, C. Ramakrishnan, and P. Balaram. "Conformations of disulfide bridges in proteins." <i>International journal of peptide and protein research</i> 36, no. 2 (1990): 147-155.	188
8	Rajan, Rahul, and P. Balaram. "A model for the interaction of trifluoroethanol with peptides and proteins." <i>International journal of peptide and protein research</i> 48, no. 4 (1996): 328-336.	169
9	Kaul, Ramesh, and P. Balaram. "Stereochemical control of peptide folding." <i>Bioorganic & medicinal chemistry</i> 7, no. 1 (1999): 105-117.	167
10	Gunasekaran, K., C. Ramakrishnan, and P. Balaram. "Beta-hairpins in proteins revisited: lessons for de novo design." <i>Protein engineering</i> 10, no. 10 (1997): 1131-1141.	162

7. Conclusion

Prof P Balaram is a genius in this domain subject and contributed excellent work and collaborated with number of foreign and Indian authors and his citations conferred on him are numerous to be listed. Guided many students in his professional career. He has been recognized and honored with top awards national and international acclaimed prestige's institutions. In Indian he has recipient with Padma Bhushan the third highest Indian civilian honored award for this contributions towards science. P Balaram held numerous positions in his career but one of the top position which he held as a Director, of Indian Institute of Science from 2005-2013. He also writes much of editorial materials on current science. He is more collaborative in nature compare to individual output and this degree of collaboration is 0.036. His highest author appearance came has 4th position in (109 papers) and his core author collaboration with Shamla N (64 papers), Karle I L (59 papers) and also collaborated with C N R Rao (6 papers). His most collaborative papers with 4 authored papers (117 papers), where his productive years from 1979-2017. Biopolymer was the most used communications channels (55 papers) and highly cited paper came from same Periodical (883 times). The top author keywords are peptide conformation used (34 times).

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