

Published in Journals:

S.No.	Title of the Paper	Journal Name/Vol.(Issue)/ ISSN/ ISBN No. / Page Numbers	Impact Factor	Year
International Publication: 10				
1.	Analysis of Volleyball Serve- A Kinematic Study	International journal of Creative Research Thoughts/ Vol. 8(4)/ ISSN 2320-2882, 1813-1817	7.97	2020
2.	Kinematics Investigation on Different Types of Volleyball Serve	International Journal of Recent Scientific Research/ Vol. 10(9)/ISSN 0976-3031, 34628-34632, 2019	7.38	2019
3.	Spatio-Temporal Analysis of Volleyball Serve	International Journal of Engineering Development and Research/ Vol. 7(2)/ISSN 2321-9939, 805-810, 2019	4.61	2019
4.	Investigate the Manipulation of Kinematics on Tennis Serve performance	International Journal of Engineering Sciences & Research Technology/ Vol. 5(8)/ISSN 2277-9655, 988-995, 2016	4.12	2016
5.	Influence Of Spatio-Temporal Parameters On Gait Speed In School Children	International Journal of Advanced Research/ Vol. 4(4)/ISSN 2320-5407, 768-772, 2016		2016
6.	Analysis of Fitness Status of Urban and Rural Youth's of Maharashtra State	Academic Sports Scholars/ Vol. 4(8)/ ISSN 2277-3665, 1-6. 2015	2.11	2015
7.	Influence of Body Kinematics on Tennis Serve	EUROPEAN ACADEMIC RESEARCH/Vol. 3(1)/2286-4822/238-248	3.45	2015
8.	Kinematic Characteristics of Two Different Service at Three Varied Stages during the Match	International Journal for Research in Applied Science & Engineering Technology (IJRASET)/ Vol. 3(4)/2321-9653/388-404.	3.40	2015
9.	Construction Of Specific Physical Fitness Test For Bowlers	Academic Sports Scholar/Vol. 4(1)/2277-3665/1-8.	2.11	2015
10.	Three Dimensional Analysis of Drag-flick in The Field Hockey of University Players	Advances in Physics Theories and Applications/ Vol. 29/2225-0638/87-93	7.14	2014
11.	Variation between Successful and Unsuccessful Drag flick Techniques in Field Hockey	International Journal of Research Studies in Science, Engineering and Technology/Vol. 1(2)/2349-4751/74-78.	1.06	2014
12.	Three Dimensional Biomechanical Analysis of the Drag in Penalty Corner Drag Flick Performance	Journal of Education and Practice/Vol. 5(20)/2222-1735/91-96.	7.15	2014
13.	Three dimensional kinematic analysis of the drag flick for accuracy	Int. Journal of Applied Sciences and Engineering Research/ Vol.3(2)/2277 – 9442/431-435	---	2014
14.	Construction Of Specific Physical	Horizon Palaestra International	---	2014

Fitness Test For Batsman

Journal of Health Sports and
Physical Education/Vol. 3(1)/
2278 - 2982/31-36

National Publication: 01

1.	A Comparative Evaluation of Anxiety State Among Different Levels of Equestrian Players	Indian Journal of Physical Education and Yogic Sciences/ Vol 2(2)/2229-3191/26-29.	---	2012
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Published in Proceedings of Conferences/Seminars:

S.No.	Title of the Paper	Journal Name/ ISSN/ ISBN No. / Page Numbers	Year
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International: 04

1.	Kinematics Analysis of Jumping Sequences on Joker Jump	Sports, Health and Sports Economics/978-93-80748-86-3/594-599.	2015
2.	Mechanical Efficiency in Tennis Serve	Sports, Health and Sports Economics/978-93-80748-86-3/508-513.	2015
3.	Identification of Specific Physical Fitness Test Items For Cricket Batsmen and Bowlers	Sports, Health and Sports Economics/978-93-80748-86-3/721-727	2015
4.	Psycho-Socio-Biomechanical Perspective of Dancing Movement	Arts Oriented Journal/2395-0315/191-193.	2015

National: 03

1.	A Kinematic Study to Show-Jumping Event of Equestrian Sports	Fit and Healthy India/978-93-84869-24-3/62-64.	2015
2.	Biomechanical variation of Tennis Serve at Different Stages of the Match	Fit and Healthy India/978-93-84869-24-3/550-553.	2015
3.	Specific Physical Fitness Test for Crickets	Fit and Healthy India/978-93-84869-24-3/1-6	2015

6. Presentation of paper in Conferences and Seminars:

S.No.	Description	Year
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International: 04

1.	Presented research paper entitled “Biomechanical Investigation of the Changing Kinematics in Show Jumping Event” in International Congress on Sports Science and Yoga (ICSSY-2017) organized by Lakshmi Bai National Institute of Physical Education, Gwalior, M.P., on 02-04, February 2017, held at New Delhi.	2016
2.	Presented research paper entitled “Psycho-Socio-Biomechanical Perspective of Dancing Movement” in International Interdisciplinary Conference of Music, Recreation and Philosophy ‘Role of Recreational Activities and Musics for the Wellbeing of Society’, organized by Department of Physical Education, SantGadge Baba Amravati University, Amravati, Maharashtra, on 9-10, March, 2015	2015
3.	Presented research paper entitled “Kinematics Analysis of Jumping Sequences on Joker Jump” in the International Conference on SPORTS, HEALTH AND SPORTS ECONOMICS, organized by Department of Physical Education and Sports Technology, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab (INDIA) on March 03-04, 2015.	2015
4.	Presented research paper entitled “A Comparative Evaluation of Anxiety State	2015

among Different Levels of Equestrian Players” presented in International Conference on Physical Education and Sports Sciences (ICPESS-2012) organized by Department of Physical Health & Sports Education, Aligarh Muslim University, Aligarh, November, 16-18, 2012.

National: 07

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| 1. | Presented research paper entitled “ Biomechanical Variation of Tennis Serve at different Stages of the Match ” in National Seminar on Fit and Healthy India-Vision 2020 organized by LNIPE, North East Regional Centre, Guwahati, on 20-21, February, 2015 | 2015 |
| 2. | Presented research paper entitled “ A Kinematic Study to Show-Jumping Event of Equestrian Sports ” in National Seminar on Fit and Healthy India- Vision 2020 organized by LNIPE, North East Regional Centre, Guwahati, on 20-21, February, 2015 | 2015 |
| 3. | Presented research paper entitled “ Analysis of Show Jumping- A Biomechanical Study ” in National Conference on Youth Enrichment Through Sports and Physical Education (YES PE) organized by Amity School of Physical Education & Sports Sciences, Amity University Uttar Pradesh, NOIDA, on 21, January, 2014. | 2014 |
| 4. | Presented research paper entitled “ A Comparative Evaluation of Anxiety State among Different Levels of Equestrian Players ” presented in National Seminar on Scientific Approach in Sports organized by Department of Physical Health & Sports Education, A.M.U. Aligarh, November, 11-12, 2011. | 2011 |
| 5. | Presented research paper entitled “ Common Traditional Sports Played in Various Asian Countries and their Importance in Child Development ” presented in All India Seminar on Traditional Sports and School Curriculum organized by Degree College of Physical Education, HVPM, Amravati, on 19-20, February, 2011. | 2011 |
| 6. | Presented research paper entitled “ e-learning and Physical Education ” presented in All India Paper Presentation Contest on Physical Education & Sports Sciences organized by Degree College of Physical Education, HVPM, Amravati, on 27-28, January, 2011. | 2011 |
| 7. | Presented research paper entitled “ Components of Fitness ” presented in National Seminar on Physical Fitness & Holistic Life organized by Phulsing Naik Mahavidyalaya, Pusad, Maharashtra, on 22 January, 2011. | 2011 |

7. Participated in Conferences and Seminars: 15

S.No.	Discription	Year
International: 06		
1.	Participated in the International Interdisciplinary Conference of Music, Recreation and Philosophy ‘Role of Recreational Activities and Music for the Wellbeing of Society’ , organized by Department of Physical Education, Sant Gadge Baba Amravati University, Amravati, Maharashtra, on 9-10, March, 2015	2015
2.	Participated in the International Conference on SPORTS, HEALTH AND SPORTS ECONOMICS , organized by Department of Physical Education and Sports Technology, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab (INDIA) on March 03-04, 2015.	2015
3.	Participated in the International Conference on Physical Education and Sports Sciences (ICPESS-2012) organized by Department of Physical Health & Sports Education, Aligarh Muslim University, Aligarh, November, 16-18, 2012.	2015
4.	Participated in the International Conference of AIAER on “Learning	2011

	Community for Global Education Reform” organized by Institute of Professional Studies, Gwalior, (MP) INDIA during November, 18-20, 2011	
5.	Participated in the International Conference on educational Awareness for Social Sector Issues in India (EASSII-2011) organized by Toff Institute of Management & Engineering Studies held in Aligarh on 24, July, 2011.	2011
6.	Participated in the SPORTS MEDCON 2009 , organized by Indian Federation of Sports Medicine (IFSM) in New Delhi during November 06-08, 2009	2009
National: 08		
1.	Participated in the National Seminar on Fit and Healthy India- Vision 2020 organized by LNIPE, North East Regional Centre, Guwahati, on 20-21, February, 2015	2015
2.	Participated in the National Conference on Youth Enrichment Through Sports and Physical Education (YES PE) organized by Amity School of Physical Education & Sports Sciences, Amity University Uttar Pradesh, NOIDA, on 21, January, 2014.	2014
3.	Participated in the National Seminar on Scientific Approach in Sports organized by Department of Physical Health & Sports Education, A.M.U. Aligarh, November, 11-12, 2011.	2011
4.	Participated in the All India Seminar on Traditional Sports and School Curriculum organized by Degree College of Physical Education, HVPM, Amravati, on 19-20, February, 2011.	2011
5.	Participated in the National Seminar on Scientific Innovation in Sports organized by Department of Physical Health & Sports Education, A.M.U. Aligarh, February, 13-14, 2010.	2010
6.	Participated in the All India Paper Presentation Contest on Physical Education & Sports Sciences organized by Degree College of Physical Education, HVPM, Amravati, on 27-28, January, 2011.	2011
7.	Participated in the National Seminar on Physical Fitness & Holistic Life organized by Phulsing Naik Mahavidyalaya, Pusad, Maharashtra, on 22 January, 2011.	2011
State: 01		
1.	Participated in State level Seminar on Psychological Testing and Analysis in Physical Education & Sports Research organized by College of Physical Education, Wadala, Mumbai. On 10-11, March, 2011.	2011

8. Participated in Workshop: 08

S.No.	Description	Year
International: 02		
1.	Participated in International Workshop on Well-being Through YOGA organized by Department of Physical Education, Aligarh Muslim University, Aligarh, on 21, June, 2015	2015
2.	Participated in International Workshop on Sports Psychology organized by Department of Physical Education and Sports Technology, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab (INDIA) on March 03-04, 2015.	2015
National: 05		
1.	Participated in Digital Apps & Statistical Computation for Research Management organized by DRS-I, Department of Sociology, Aligarh Muslim University, Aligarh, on 29 February to 05 March, 2016	2016

2.	Participated in Skill Development in Digital Census/Excel Use for Social Research organized by DRS-I, Department of Sociology, Aligarh Muslim University, Aligarh, on 24 to 29 August, 201	2015
3.	Participated in National Workshop on Videographic Technique for Sports Motion Analysis organized by Department of Physical Education, Aligarh Muslim University, Aligarh, on 22 to 24, November, 2013	2013
4.	Participated in National Workshop on Bio-Feedback in Sports organized by Department of Physical Education, Aligarh Muslim University, Aligarh, on November 13, 2011	2011
5.	Participated in All India Workshop on Traditional Sports and School Curriculum organized by Degree College of Physical Education, HVPM, Amravati, on 19-20 Feb. 2011	2011

State: 01

1.	Participated in State level Workshop on Psychological Testing and Analysis in Physical Education & Sports Research organized by College of Physical Education, Wadala, Mumbai. On 10-11, March, 2011.	2011
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9. Program / Course Participation

S.No.	Description	Year
1.	Participated in Data Analysis/SPSS and MINITAB organized by Center for Academic Leadership and Education Management, UGC Human Resource Development Centre (HRDC), Aligarh Muslim University, Aligarh, on 29 December to 04 January, 2016	2016
2.	Participated in Personality Development organized by UGC Human Resource Development Centre (HRDC), Aligarh Muslim University, Aligarh, on 10 to 16, December, 2015	2015
3.	Participated in Induction Course organized by UGC Human Resource Development Centre (HRDC), Aligarh Muslim University, Aligarh, on 08 to 14, October, 2015	2015
4.	Participated in Data Analysis/SPSS and MINITAB organized by UGC Human Resource Development Centre (HRDC), Aligarh Muslim University, Aligarh, on 09 to September, 2015	2015



Prof. SHASHI BALA TRIVEDI
(Professor & Head of the Department)
Teacher Education Department (B.Ed.)
S. V. College, Aligarh

List of Publications

(i) Research Papers (Journals, etc.)

S0 N0	Title with Page No.	Journal National/ International	Year	ISSN/ISB N No.	National/ International/ Whether Peer reviewed Impact factor	Link of the recognitional in UGC CARE list
1.	Teacher Education & Environmental Ethics. [94-99]	The Gunjan Super Prakashan	Sept. 2014 Vol. 1, Issue 1	ISSN 2349-9273	International	RNI: APPLIED-78/JA/2014 Peer reviewed International Journal
2.	Effect of Convergent and Divergent Thinking on Problem Solving Performances During Individualistic and Cooperative Learning Settings. [129-133]	The Gunjan	Jan 2015 Vol. 1, Issue 2	ISSN 2349-9273	International	RNI: APPLIED-78/JA/2014 Peer reviewed International Journal
3.	परंपरागत भारतीय शिक्षा व्यवस्था, प्रबंधन, स्वरूप एवं उद्देश्य. (92-100)	Abhinav Gveshna	April, 2015 Vol. 1, Issue 1	ISSN 2394-4366	International	RNI: UPMUL00620/24/1/2014-TC Refereed International Journal
4.	भारतीय परिदृश्य में राष्ट्रीय एकता (159-164)	The Gunjan	April- July 2015 Vol. 1, Issue 3+4	ISSN 2349-9273	International	RNI: APPLIED-78/JA/2014 Peer reviewed International Journal
5.	A Review of National Policy: to Create Awareness on Information and Communication Technology (ICT) in School Education. (171-177)	Abhinav Gveshna	July-Oct, 2015 Vol 1, Issue 2+3	ISSN 2394-4366	International	RNI: UPMUL00620/24/1/2014-TC Refereed International Journal

6.	Role of Higher Education (University) in the Context of Indian Society Problems. (33-35) पर्यावरण चेतना तथा पोषणीय विकास ; जल एवं वायु के सन्दर्भ में. [40-44]	The Gunjan Abhinav Gveshna	Sep-Dec. 2015 Vol. 2, Issue 5 Jan.- Mar.,2016 Vol. 1, Issue 4	ISSN 2349-9273 ISSN 2394-4366	International International International	RNI: APPLIED-78/JA/2014 Peer reviewed International Journal RNI: UPMUL00620/24/1/2014-TC Refereed International Journal RNI: APPLIED-78/JA/2014 Peer reviewed International Journal
7.	निम्न स्तर के पारिवारिक तथा सामाजिक जीवन पर प्रौढ़ शिक्षा केंद्र द्वारा संचालित शिक्षा प्रसार कार्यक्रम के प्रभाव का अध्ययन. [53-56]	The Gunjan	April-June 2016 Vol. 2, Issue 7	ISSN 2349-9273	International	Peer reviewed International Journal
9.	Psycho-Physical Aspect of Women in Indian Liberalization Movements and Rights in the 21 st Century. [22-28]	Kavitanjali,	Feb. - Aug. 2018. Vol. 7, Issue 12	ISSN 2278-8344 Sr. N. 64337	UGC Approved Peer Reviewed	Sr. N. 64337 UGC Approved, Peer Reviewed
10.	Impact of Convergent and Divergent Learning on Literary Problem-Solving Performances During Cooperative Learning Settings.[221-232]	Akhil Geet Shodh Drishti	29 Dec. 2018 Vol. 8, Issue 11	ISSN: 2229-7308	UGC Referred, International Journal	प्रकाशक-विधि शैक्षिक एवं शोध संस्थान, आजमगढ़,(उ. प्र.) Sr. N. 41402 Link of the recognitional in UGC CARE list
11.	Item Analysis & Standardization of Achievement Test of English. [163-170]	Excellence International Journal of Education & Research (EIJER)	July 2019 Vol. 6, Issue 7	ISSN: 2349-8838	UGC Approved International Journal, Impact factor- 5.088	Publisher- Dr. Mujibul Hasan Siddiqui, Excellence International Publications Pvt Ltd, Aligarh, Sr. N. 41402R UGC Referred, International Journal www.ocwjournallonline.com
12.	“पंडित दीनदयाल उपाध्याय के ‘आत्म-अवधारणा’ और ‘शैक्षिक उपलब्धि उपागम’ का मजबूत पक्ष एवं प्रासंगिकता” [22-25]	Shodh- Rityu	July-Sep. 2021 Vol. 5, Issue 25	ISSN: 2454-6283	Peer Reviewed & Refereed International Journal Impact factor- IIJIF-7.312	UGC Approved International Journal, Impact factor- 5.088 Publisher- Sunil Gulab singh Jadhav
13	“Effects of Cooperative Teaching & Learning Techniques on Language Achievements in Small Groups” (103-109)	International Literary Quest	July- Dec.2021 Volume: 14 Issue: 01	ISSN: 2319-7137	An International Multidisciplinary Peer Reviewed Refereed Research Journal	Peer Reviewed Refereed International Research Journal Impact factor- IIJIF-7.312 Yugantar Prakashan
14	“Reflective Teaching: Effective Impact in Teacher Education Programme” (64-73)	World Translation	July- Dec., 2021 Vol.-14 Issue-01	ISSN: 2278-0408	An International Multidisciplinary Peer Reviewed Refereed Research Journal	An International Multidisciplinary Peer Reviewed Refereed Research Journal
15	Traditional Knowledge of Medicinal Plants and Its Use by Indian People (30-34)	International Literary Quest	July- Dec.2021 Volume: 14 Issue: 02	ISSN: 2319-7137	An International Multidisciplinary Peer Reviewed Refereed Research Journal	An International Multidisciplinary Peer Reviewed Refereed Research Journal Publisher- Yugantar Prakashan
16	The English Teacher: As A Future Maker & Nation Builder (45-53)	Excellence International Journal of Education & Research (EIJER)	January, 2022 Vol.-12, Issue-01	ISSN: 2349-8838	UGC Approved International Journal, Impact factor- 5.088 http://excellenceinternationaljournal.com	An International Multidisciplinary Peer Reviewed Refereed Research Journal Impact factor- 7.312
17	Status & Scope of English Language in the Global and Indian Context (58-60)	Shodh- Rityu	Jan-March, 2022 Vol. 6, Issue 27	ISSN: 2454-6283	Multy-Disciplinary Peer Reviewed & Refereed International Journal Impact factor- IIJIF-7.312	UGC Approved International Journal, Impact factor- 5.088 www.shodhritu.com Publisher- Sunil Gulab Singh Jadhav

18	रत्नकुमार सांभरिया जी का व्यक्तित्व एवं कृतित्व (पृष्ठ -75-80)	Shodh- Rityu	May 2022 e- visheshank	ISSN: 2454-6283	Peer Reviewed & Refereed International Journal Impact factor- IJIF-7.312 SJIF-6.586	Peer Reviewed Refereed International Research Journal Impact factor- IJIF-7.312 Publisher- Sunil Gulab Singh Jadhav
19.	“Women Leadership and Self-Reliance: Opportunities in Higher Education” (Part-II, Page: 46-56)	World Translation	July- Dec.2023 Vol.-18	ISSN: 2278-0408	An International Multidisciplinary Peer Reviewed Refereed Research Journal IIFS Impact factor-5.375	An International Multidisciplinary Peer Reviewed Refereed Research Journal IIFS Impact factor-5.375 website link- https://www.worldtranslation.in/ Akhand Publishing House
20	छात्रों के श्रवण कौशल विकास का अवलोकन: प्रक्रिया, रणनीतियाँ, बाधाएँ एवं सुझाव” (Page: 18-27)	शैक्षिक उन्मेष	July-Sep. 2023 Vol. 06, Issue 04	ISSN: 2581-687X	RNI NO. : UPHIN/2017/74904 Peer Reviewed & Refereed Research Journal शैक्षणिक पत्रिका, अध्यापक शिक्षा विभाग केन्द्रीय हिंदी संस्थान, आगरा	RNI NO. : UPHIN/2017/74904 Peer Reviewed & Refereed Research Journal शैक्षणिक पत्रिका, अध्यापक शिक्षा विभाग केन्द्रीय हिंदी संस्थान, आगरा website link- https://hindisansthan.in
21	एनईपी-2020: प्राथमिक और माध्यमिक शिक्षा के विशेष संदर्भ में अवसरों और चुनौतियों का विश्लेषण 100-110	शैक्षिक उन्मेष (संयुक्तार्क)	Oct.-Dec.,2023 & Jan.- March, 2024 Vol. 7, Issue 1, 2	ISSN: 2581-687X	शैक्षणिक पत्रिका अध्यापक शिक्षा विभाग केन्द्रीय हिंदी संस्थान, आगरा	RNI NO. : UPHIN/2017/74904 Peer Reviewed & Refereed Research Journal शैक्षणिक पत्रिका, अध्यापक शिक्षा विभाग केन्द्रीय हिंदी संस्थान, आगरा Regd No 2607/1-V 8522 Impact factor- 5.875 Publisher-History & Historical Writing Association, U.P. Varanasi shodh1984@gmail.com website link- https://Shodh.co.in/
22	“Fundamental Criteria for Critical Analysis of English Textbook in Modern Education System (278-289) (पृष्ठ-II-95-106)	Shodh	Vol. XXI/21 Issue No.1, Jan.-April. 2024,	ISSN: 0970-1745	A Triannual Bilingual Peer Reviewed Refereed Research Journal of Art & Humanities	Peer Reviewed & Refereed International Journal IISF-7.312 Impact factor- 9.0 website link- https://www.shodhritu.com
23	“Effect of Convergent & Divergent Thinking on Problem Solving Ability in Cooperative Learning Setting: Review of Related Literature” (Page: 72-75)	Shodh- Rityu	July-Sep. 2024 Vol. 6, Issue 37	ISSN: 2454-6283	Peer Reviewed & Refereed International Journal IISF-7.312 Impact factor- 9.0	Peer Reviewed & Refereed International Journal IISF-7.312 Impact factor- 9.0 website link- https://www.shodhritu.com
24	The Contemporary Relevance of Rabindranath Tagore’s Educational Philosophy and Discipline (Page- 80-84)	Abhinav Gveshna	July- Sept., 2024 Vol. 10, Issue 39	ISSN 2394-4366	Refereed / Peer Reviewed International Journal	RNI: UPMUL00620/24/1/2014-TC Refereed / Peer Reviewed International Journal
25	Life Skills: A Foundation for Holistic Human Development in Educational Settings	The Gunjan	July- Dec., 2024 Vol. 10+11, Issue 40+41	ISSN: 2349-9273	Multi Disiplinary Quarterly International Refreed/Peer Reviewed Research Journal	Super Prakashan
26	“व्यक्तित्व विकास द्वारा राष्ट्र निर्माण में शिक्षक की भूमिका एवं दायित्व” (Page- 11-13)	Shodh- Rityu	April-June 2025 Vol.2, Issue 40	ISSN: 2454-6283	Peer Reviewed & Refereed International Journal IISF-7.312 Impact factor- 9.0	Peer Reviewed & Refereed International Journal IISF-7.312 Impact factor- 9.0 Publisher- Navsahitykar Publication, Nanded
27	The Transformative Power of Breastfeeding: A Holistic Perspective on Maternal and Child Well-being (Page- 42-44)	Shodh- Rityu	July-September, 2025 (Issue- 41, Vol.- 2)	ISSN: 2454-6283	An International Multi- Disciplinary Research Journal & Open Transparent PEER Reviewed & Refereed JOURNAL IIFS Impact-10.25	Peer Reviewed & Refereed International Journal IISF-7.312 Impact factor- 9.0 Publisher- Navsahitykar Publication, Nanded

28	“समय प्रबंधन और प्रभावी अध्ययन तकनीकें: शैक्षणिक सफलता एवं व्यक्तित्व विकास” (Page- 124-127.)	IJASGE <i>International Journal of Advance Studies and Growth Evaluation (IJASGE Journal)</i>	Volume 04, Issue 08 31-August-2025	E-ISSN: 2583-6528	SJIF Impact-6.876	Manish Kumar (Publisher) IJASGE Journal Available online: www.alladvancenjournal.com Article URL Link: Published Article IJASGE-4-8-31, Journal website Link: http://alladvancenjournal.com/ Ref no: IJASGE-4-8-31.1
29.	“Impact of Thinking Styles on Problem-Solving: A Comparative Study of Cooperative and Individual Learning Approaches” (Page-48-62)	IRJHIS International Research Journal of Humanities and Interdisciplinary Studies (IRJHIS) is an open Access, Peer Reviewed International Journal.	Volume 06, Issue 09 September, 2025	ISSN: 2582-8568 Online (e-Journal)	Impact Factor- 8.031 (SJIF 2025)	DOI Link: https://doi-ds.org/doi/10.2025-66494759/IRJHIS2509005 DOI No. 03.2021-11278686 Article URL Link: http://irjhis.com/paper/IRJHIS2509005.pdf SHREYAS PUBLICATION (AURANGABAD) CHHA TRAPATI SAMBHAJINAGAR
30	Role of time management in balancing social media use and study habits	International Journal of Versatile Research and Analysis	Volume 4 Issue 3, March-2026 Co-Authors Mohini Sharma	ISSN: 2984-8903	An International Open Access, Peer Reviewed, Refereed Journal Impact Factor: 9.12 by Google Scholar	Paper ID-IJVRA26A3151 Registration ID-702984 IJVRA-International Journal of Versatile Research and Analysis International Scholarly, Open Access, Multi-disciplinary, Indexed Journal An Website: www.ijvra.org Email: editor@ijvra.org ESTD: 2023
31	Relationship between Study Habits and Social Media Engagement in Higher	JAAFR JOURNAL OF ADVANCE AND FUTURE RESEARCH	Volume 4 Issue 3, March-2026 Co-Authors Mohini Sharma	ISSN: 2984-889X	An International Open Access, Peer-reviewed, Refereed Journal Impact Factor: 9.87 by Google Scholar	Paper ID-JAAFR26A3092 Registration ID-506086
32	Predictive Analysis of Academic Performance Based on Social Media Usage Patterns	International Journal of Novel Trends and Innovation IJNTI.ORG	Volume 4 Issue 3. Apni-2026 Co-Authors Mohini Sharma	ISSN: 2984-908X	(An International Open Access, Peer-reviewed, Refereed Journal) An international Scholarly, Open Access, Multi-disciplinary, Indexed Journal Impact Factor: 9.57 by Google Scholar	Paper ID LJNTI2603152 IJNTI ISSN: 2984-908X Registration ID-231978 Website: www.ijnti.org Email: editor@ijnti.org ESTD: 2033 Manage By: IJPUBLICATION Website: www.ijnti.org Email ID: editor@ijnti.org

(ii) Conference Publications / Full Papers in Conference Proceedings:

Sr. No.	Title with page No.	Details of Conference Publication	National/ International	ISSN/ISBN No.	Editor & Publisher
1.	Achieving Gender Equality and Women Empowerment in India [sdgs-5]; Opportunities & Challenges. [220-232]	Multidisciplinary Higher Education, Research, Dynamics & Concepts; Opportunities & Challenges for Sustainable Development	National 17 th -18 th Feb. 2018 17/02/2018	ISBN- 978-93-87662-12-4	DR. Pankaj and Dr. Gunjan Agrawal... Swaranjali Publication
2.	Psychological Impact of ICT on Convergent & Divergent Thinking. [27-32]	Information Explosion and the 21 st Century Youth [prospects and challenges]	National 21 st Jan. 2019	ISBN: 978-81-936482-7-8	Dr. Shivani verma, Deepthi Bajpai, satyant kumar , Manyata Prakashan

(iii) Books published / Chapters published in Books & E-learning materials developed:

No. of books published and chapters in edited volumes-

Session	Title of the Book	Title of the Chapter volume and page numbers	Name of the Author/s	No. of co-authors	Name of the Publisher (National/International)	ISBN Number	Year of Publication
2020-2021	भारतीय शिक्षाशास्त्री शृंखला-1- 'स्वीन्द्रनाथ टैगोर', प्रथम संस्करण :2020 पेज 1-143	स्वीन्द्रनाथ टैगोर: शिक्षा दर्शन एवं अनुशासन, पेज- 79-90	Prof. Shashi Bala Trivedi	10	केन्द्रीय हिंदी संस्थान, आगरा (MHRD, Government of India) (National)	ISBN-978-93-88039-55-0 संपादक- प्रो० नन्द किशोर पाण्डेय	2020
2023-2024	Learning Technology (Page: 308)	-	Prof. Shashi Bala Trivedi	Single Authors	Pinakin Publishing, Harsh Vihar, Delhi URL-www.pinakinapp.com	ISBN-10:819675275X ISBN-13:978-8196752750	1 Jan 2024
2023-2024	Career and Counselling Education (Page: 298)	-	Prof. Shashi Bala Trivedi	Single Authors	Pinakin Publishing, Harsh Vihar, Delhi	ISBN-10:8196752725 ISBN-13:978-8196752729	1 Jan 2024
2024-2025	Thinking Modes in Individual and Cooperative Learning Contexts	-	Prof. Shashi Bala Trivedi	Single Authors	Swaranjali Publication No-1-B, Sector 10B, Vasundhara Sector 10, Delhi 201012, Behind Vanasthali Public School E-mail: swaranjalipublication@gmail.com	ISBN- 978-93-6559-069-2	September, 2025

(E) (Iii): Invited Lectures and Chairmanships at national or international conference/seminar etc.

Sr. No.	Title of Lecture / Academic Session	Title of Conference / Seminar, etc.	Date(s) of the event	Organized by	Invited Lectures and Chairmanships	Whether International / National
1.	“Effective Teaching and Learning Through ICT in New Indian Education System”	NEP 2020:A Revolutionary step towards digital India under the aegis of “ Azadi ka Amrit-Mahotsav”	5 th & 6 th November 2022	ICSSR, Shri Tika Ram Kanya Mahavidyalaya, Aligarh	Chairmanships	National
2.	Tension & Stress: Causes and Coping Skills	“Health promotion focusing mental health & life skills among youth of 35 degree colleges of Uttar Pradesh”	20 th Jan. 2023	SIFPSA, Uttar Pradesh	Given Training in Workshop	National Health Mission
3.	“Women Self-Reliance and Leadership: Opportunities in Teacher Education”	Women Self-Reliance: Opportunities, obstacles.....in Indian modern scenario.	4 th & 5 th March 2023	Higher Education, U.P.& Shri Tika Ram Kanya Mahavidyalaya, Aligarh	Chairmanships	National
4	सड़क सुरक्षा विषय पर जिला / मंडल स्तर पर आयोजित पोस्टर, स्लोगन एवं क्विज प्रतियोगिता	सड़क सुरक्षा	13 TH DEC., 2023	उत्तर प्रदेश सरकार	निर्णायक	जिला / मंडल स्तर
5.	Digital Transformation in Indian Higher Education: Opportunities and Challenges (भारतीय उच्च शिक्षा में डिजिटल परिवर्तन: अवसर एवं चुनौतियाँ)	International One Month Samvardhan Summit 2025	8 th JULY, 2025	Organised by Saksham Society Rajasthan (A World Record Holder NGO)	KEYNOTE SPEAKER	INTERNATIONAL
6.	Psychological benefits of breastfeeding for both mother and baby	International Conclave on Breastfeeding Week	6 th AUGUST, 2025	Organised by Saksham Society Rajasthan (A World Record Holder NGO) in collaboration with Charutar Vidya Mandal's S M Patel College of Home Science and Alankar Mahila PG Mahavidyalaya, Jaipur, Rajasthan	KEYNOTE SPEAKER	INTERNATIONAL
7.	TRANSFORMING HIGHER EDUCATION IN INDIA THROUGH SKILL DEVELOPMENT: PROSPECTS AND CHALLENGES	One Day National Seminar	24 March, 2026	Organized by Department of Education, RMPSU, ALIGARH (U.P.)	Chairmanships Or Chair Person	National

Details of Conferences / Seminars / Workshops

(i) Details of Conferences / Seminars:

Sr. No.	Title of the paper presented	Title of Conference / Seminar, etc.	Date(s) & Year of the event	Organized by	Whether National / International
1.	परम्परागत भारतीय शिक्षा व्यवस्था एवं प्रबंधन का स्वरूप व उद्देश्य की वर्तमान सन्दर्भ में प्रासंगिकता	परम्परागत भारतीय शिक्षा व्यवस्था एवं प्रबंधन	13 th , 14 th & 15 th Feb. 2009	भारतीय शिक्षा शोध संस्थान, सरस्वती कुंज, निराला नगर, लखनऊ	National
2.	Teacher Education and Environmental Ethics	Education In the New Millennium; Challenges & Issues	28 th Feb. 2009 to 1 st March .2009	Deptt. of Education, AMU, Aligarh	National
3.	चरित्र निर्माण एवं व्यक्तित्व के समग्र विकास की शिक्षा	चरित्र निर्माण एवं व्यक्तित्व के समग्र विकास की शिक्षा	23 rd Aug. 2009	शिक्षा बचाओ आन्दोलन समिति	Regional
4.	Competent Teacher Education: Need for Quality Enrichment in Higher Education.	Quality Improvement in Teacher Education	07 th Nov. 2009 07/11/2009	Dev Education & Dev College, Agra	National
5.	कैशविक विवाद : पहचान व निवारण	Role of Value Education in Global Peace	22 nd Nov. 2009	Department of Teacher Education, S.V. College, Aligarh	National
6.	भारतीय नारीवाद : दशा एवं दिशा	भारतीय नारीवाद : दशा एवं दिशा	16 th Feb. & 17 th Feb. 2011	आदर्श कृष्ण स्नातकोत्तर महाविद्यालय, शिकोहाबाद (फिरोजाबाद), उ. प्र.	National
7.	The Role and Contribution of School Education in Women's Development in the Context of Changing Indian Society.	Postmodernism; Dimensions and Challenges	4 th , 5 th & 6 th March, 2011	S.V. College, Aligarh (U. P.)	International
8.	Role of Pragmatic Approach & Strategies Towards Value Education in Modern India	Postmodernism; Dimensions and Challenges	1 st , 2 nd & 3 rd March 2012	S.V. College, Aligarh	International
9.	शिक्षा में स्वायत्तता: भारतीय शिक्षा की मूलभूत आवश्यकता	शिक्षा में स्वायत्तता: भारतीय शिक्षा की मूलभूत आवश्यकता	17 th Sep. 2013	शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली	National [Participation]
10.	National Integration	National Seminar on National Integration	15 th Dec. 2013	UGC, ASC,AMU, Aligarh and National Foundation for Communal Harmony	National [Participation]
11.	प्रभावशाली सम्प्रेषण : शिक्षक के लिए एक अनिवार्यता	All Edu. Topic	15/12/2013	Kalidas Academy New Delhi, by Abhinav Gveshna	National
12.	Role of Teacher Education in Conflict Prevention and Peace Building	Globalization and Human Security: Issues & Challenges	21 st & 22 nd Nov. 2015	ICSSR, S.V. College, Aligarh	International
13.	ICT As a Changing Agent of Teaching and Learning Process	The ICT and Education	22 nd Oct. & 23 rd Oct. 2016	KRIT Coll. & All India Association of Teacher Educators, New Delhi	National

	Financial Awareness	Financial Awareness	9 th Feb. 2017	S. V. Coll. and SEBI	College Level [Participation]
14.	Financial Awareness	Financial Awareness	9 th Feb. 2017	S. V. Coll. and SEBI	College Level [Participation]
15.	Psycho-Physical Aspect of Women Liberalization Movement and Rights in the 21 st Century.	Women's Rights & Liberties: Continuing Gender Gap	6 th march, 2017	D.S. Coll., Aligarh	National
16.	Value Education – Problem & Solution	Indian Education- Problem & Solution	1 st Feb, 2018	Shyamal Saraswati Mahavidyalaya	National
17.	Achieving Gender Equality and Women Empowerment in India [sdgs-5]; Opportunity & Challenges	Multidisciplinary Higher Education, Research, Dynamics & Concepts: Opportunities and Challenges for Sustainable Development	17 th -18 th Feb. 2018	S.V. Coll., Aligarh in Collaboration with NGO- Ahsas	National
18.	Analytical Insight & Thoughts of Dr. B. R. Ambedkar Towards Women Empowerment in India.	Vartman Parivesh Me Dr. B.R. Ambedkar Ke Chintan Ki Prasangita.	18 th -19 th Feb. 2018	V.V. Coll., Shamli & ICSSR, New Delhi	National
19.	Psychological Impact of ICT on Convergent and Divergent Thinking	Information Explosion and 21 st Century Youth; Prospects and Challenges	21 st Jan. 2019	Km. Mayawati Gov. Girls P. G. College, Badalpur, Gautambudh Nagar, UP.	National
20.	Globalization & its Impact on Divergent Thinking of Secondary Level Students in India.	Globalization & its Impact on Indian Education & Society	19 th & 20 th Feb. 2019	Shree Balaji Academy, Sambhal Road, Moradabad, UP.	National
21.	Classroom Competencies & Challenges of Secondary Education in India	Pedagogic Skills & Professional Development	31 st Aug. & 1 st Sep. 2019	Institute of Education, Bundelkhand University, Jhansi	National
22.	The Impact of Education Policy in Country's Economic Development: A Theoretical Perspective	Managerial & Entrepreneurial Interventions for Sustainable Development in India	20 th & 21 st Nov. 2019	Veerangana Avantibai Government Degree College, Atrauli (Aligarh), UP.	National
23.	“National Education Policy-1019: A Need for Excellence in Teacher Education”	National Education Policy-1019	1 st & 2 nd March, 2020	Shyamal saraswati mahavidyalaya, Bulandshahr, C.C.S. University, Meerut	National
24.	“Curriculum Reform for Facing Terrorism & Demographic Challenges”	Emerging Threats of Terrorism and Demographic Challenges in North East India's Region	7 th & 8 th March, 2020	Department of Defence & Strategic Studies, Seth Phool Chand Bagla (P.G.) College, Hathras, U.P.	National
25.	“Reflective Teaching and Holistic Development of Teacher Education Programme”.	“Global Scenario of Education and Holistic Development: With Reference to New Education Policy 2020”	13 TH March 2021	Km. Mayawati Gov. Girls Post Graduate College, Badalpur, Gautambudh Nagar, U.P.	National
26.	“Effective Teaching and Learning Through ICT in New Indian Education System”	NEP 2020:A Revolutionary step towards digital India under the aegis of “ Azadi ka Amrit- Mahotsav”	5 th & 6 th November 2022	ICSSR, Shri Tika Ram Kanya Mahavidyalaya, Aligarh	National

27.	“Impact of Technological Education on National Consciousness”	Swaraj National Consciousness and Resistance in Indian Freedom Struggle	12 th & 13 th November 2022	ICHR, Department of History, S. V. College, Aligarh	National
28.	“Women Self-Reliance and Leadership: Opportunities in Teacher Education”	Women Self-Reliance: Opportunities, obstacles.....in Indian modern scenario.	4 th & 5 th March 2023	Higher Education, U.P.& Shri Tika Ram Kanya Mahavidyalaya, Aligarh	National
29.	Indo-China Relations: Suitable Opportunities & Challenges	Indo-China Relations: Issues and Emerging Trends”	18 th & 19 th March, 2023	Department of Defense & strategic studies, S. V. College, Aligarh	National
30.	“Implementation & Impact of A. I. Tools in Teaching & Learning of Languages”	Impact of Artificial Intelligence on Ethics and Governance in Education within NEP - 2020	16 th & 17 th August 2024	Sponsored by ICSSR, Shri Tika Ram Kanya Mahavidyalaya, Aligarh	National
31.	वैश्विक शिक्षा मुद्दों के प्रति भारत का दृष्टिकोण	भू-राजनीतिक गतिशीलता और भारत की विदेश नीति: उभरती चुनौतियाँ और अवसर (Geo- Political Dynamics and India's Foreign Policy: Emerging Challenges and Opportunities)	9 th & 10 th Nov. 2024	Sponsored by ICWA, New Delhi (भारतीय वैश्विक परिषद्) Department of Defense & strategic studies, S. V. College, Aligarh	National

(ii) Details of Orientation Programmes/ Refresher Courses/ Workshops:

Sr. No.	Programme	Duration	Organized by	Title	Grade
1.	Orientation Programme	28 th July 2004 to 24 th Aug.2004	UGC Academic Staff College, AMU, Aligarh]ASC [AMU, Aligarh]	FOR ALL	Obtained Grade “A”
2.	Refresher Course	5 th -25 th July,2006	ASC [AMU, Aligarh]	Education	Obtained Grade “A”
3.	Refresher Course	26 th Nov.2008 to 18 th Dec.2008	ASC [AMU, Aligarh]	Education	Obtained Grade “A”
4.	Refresher Course	20 th Jan. 2010 to 10 th Feb. 2010	ASC [AMU, Aligarh]	Women's Study	Obtained Grade “A”
5.	Refresher Course	29 th Sep. to 16 th Oct. 2015	UGC, ASC, AMU, Aligarh	Research Methodology in Social Sciences	Obtained Grade “A”
6.	Workshop	31 st March 2009 to 04 th April 2009	Deptt. of Linguistic [AMU, Aligarh]	Testing and Evaluation	
7.	Workshop	30 th Jan. 2011	Math Deptt., S.V. College, Aligarh [save education movement]	Vadik Math	
8.	Workshop	16 th April 2012 to 21 st April 2012	ASC [AMU, Aligarh]	Academic Writing Skills	

9.	Workshop	9 th Dec. 2013 to 15 th Dec. 2013	UGC, ASC, AMU, Aligarh	Personality Development	
10.	Workshop	10 th Dec. 2015 to 16 th Dec. 2015	UGC, ASC, AMU, Aligarh	Personality Development	
11.	Workshop	5 th Sep. 2016 to 11 th Sep. 2016	IQAC Cell [S.V. Coll.], Deptt. of Medical Health and Family Welfare, Aligarh.	Public Health Awareness...	
12.	Workshop	8 th Aug. 2017 to 14 th Aug. 2017	MHRD, PMMMNMTT, UGC, ASC, AMU, Aligarh	Training Programme on Academic Leadership	
13.	Workshop	4 th Dec. 2019 to 10 th Dec. 2019	MHRD, PMMMNMTT, UGC, ASC, AMU, Aligarh	Short Term Course on 'Gender Studies'	
14.	Workshop	1 st July, 2020 to 7 th July, 2020	Pandit Deendayal Shodh Peeth, CCS University, Meerut, MJPR University, Bareilly & Prajna Pravas Pashchimi Uttar Pradesh Kshetra.	Online workshop on 'शोध की भारतीय व समकालीन दृष्टि'	
15.	NATIONAL FACULTY DEVELOPMENT PROGRAM	19 th Feb. to 27 th Feb., 2024	UGC-MMTTC/GAD-MMTTC, SGTB KAHALSA College, DU in collaboration with T.R. College, Aligarh, U.P.	OFDP 173: Designing and Implementing Internal Quality Assessment and Quality Assurance in Higher Education Institutions	Obtained Grade "A"

Certain inequalities for fractional (p, q) -calculus

Pankaj Jain¹ and Rohit Manglik²

^{1,2}Department of Mathematics, South Asian University, Akbar Bhawan, Chanakya Puri, New Delhi-110021, India
E-mail: pankaj.jain@sau.ac.in¹, pankajkrjain@hotmail.com¹, rohitmanglik1234@gmail.com², rohitmanglik@students.sau.ac.in²

Communicating editor - Managing editors' group

Abstract

In this paper, we derive Hölder's inequality (weighted standard as well as reverse), Minkowski's inequality, Grüss-integral inequality and Hermite-Hadamard inequalities for fractional (p, q) -calculus.

2010 Mathematics Subject Classification. **26D10.** 26D15, 34A08.

Keywords. fractional (p, q) -integral inequalities, Hölder's inequality, Minkowski's inequality, Hermite-Hadamard's inequality, Grüss-integral inequality, convex function.

1 Introduction

The theory of quantum calculus or q -calculus (also known as calculus without limits) has been in use for quite some time although it was initiated much earlier by Jackson [12]. The q -derivative of a function f at $x \neq 0$ is given by

$$D_q f(x) = \frac{f(x) - f(qx)}{(1-q)x}$$

and the q -integral on an interval $[0, b]$ (also known as Jackson integral) is defined by

$$\int_0^b f(x) d_q x = (1-q)b \sum_{j=0}^{\infty} q^j f(q^j b),$$

provided the series on the right converges. For several notions and applications of q -calculus one may refer to the books [9, 16].

People have generalized q -calculus in several ways, namely, (p, q) -calculus [25, 26], power calculus [23], symmetric calculus [8, 10, 13, 17, 18, 19, 20, 24]. Very recently in [27], the (p, q) -calculus has been generalized to fractional (p, q) -calculus.

The aim in the present paper is to further focus on fractional (p, q) -calculus and obtain several inequalities in this framework, namely, Hölder's inequality (weighted standard as well as reverse version), Minkowski's inequality, Grüss inequality and Hermite-Hadamard type inequalities for convex functions. These inequalities in q -calculus have been discussed in [28, 30, 31]. It is worth mentioning that in [7, 14, 22], the famous Hardy inequality has been derived in the framework of q -calculus.

2 Preliminaries

In this section, we collect certain preliminaries connected with (p, q) -calculus and fractional (p, q) -calculus which is required throughout the paper. For more details on these notions, one may refer to [25, 26, 27].

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Classical inequalities for (p, q) -calculus on finite intervals

Pankaj Jain¹ · Rohit Manglik¹

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Abstract

In this paper, certain classical inequalities, namely, trapezoidal inequality (first as well as second order), generalized weighted Hölder's inequality, Minkowski's inequality and Grüss type inequalities have been investigated in the framework of (p, q) -calculus. These inequalities extend the corresponding known inequalities in q -calculus. Moreover, in the case of trapezoidal inequality, we improve upon the constant as well. To prove (p, q) -Grüss inequalities, we first derive (p, q) -Andrieief's identity which, in particular, contains (p, q) -Korkine identity.

Keywords (p, q) -integral inequalities · Hölder's inequality · Minkowski's inequality · Grüss-integral inequality · Andrieief's identity · Korkine identity

Mathematics Subject Classification 26D10 · 26D15 · 34A08

1 Introduction

The notion of quantum calculus or q -calculus, although a couple of centuries old, has picked up much attention during the last three decades, in particular, in mathematical sciences. This is also sometimes known as limitless calculus, where the q -derivative of a function f at $x \neq 0$ is given by

✉ Pankaj Jain
pankaj.jain@sau.ac.in; pankajkrjain@hotmail.com

Rohit Manglik
rohitmanglik1234@gmail.com

¹ Department of Mathematics, South Asian University, Akbar Bhawan, Chanakya Puri, New Delhi 110021, India

CLASSICAL INEQUALITIES FOR FRACTIONAL SYMMETRIC q -CALCULUS

ROHIT MANGLIK

ABSTRACT. In this paper, we define the notions of fractional q -symmetric integrals and derivatives of Riemann-Liouville as well as Caputo type on finite intervals. Under this framework, we derive Hölder's inequality (weighted standard as well as reverse), Minkowski's inequality and Grüss-integral inequality.

(Received: February 22, 2024, Accepted: September 25, 2024)

1. INTRODUCTION

The theory of quantum calculus or q -calculus, initiated by Jackson [4], gained momentum during the last two decades when people realized much of its applications. q -calculus is an important area both from a mathematical point of view and for several applications, see [3, 10], [15], [21] and the references therein. This theory has been applied in many areas of mathematical sciences as well as engineering. The notion of q -calculus has been generalized to the so called (p, q) -calculus and also to symmetric calculus. It is difficult to put on record all the literature that has been published in this direction, however, we refer to [1, 2, 5–8, 10, 11, 14, 16–20] which influenced our own investigation. Let us also point out that (p, q) -calculus and q -calculus are different and similarly symmetric calculus can not be obtained from (p, q) -calculus, see [5, 6].

In q -calculus and its various generalizations, the case of finite intervals requires special attention. In fact, it is very likely that if $x \in [a, b]$ and $0 < q < 1$, then the product qx may not belong to $[a, b]$ which is usually the requirement in q -calculus. Here, we refer to [19] for q -calculus on finite intervals and to [22] for (p, q) -calculus on finite intervals. Very recently, in [13], the author has

2020 *Mathematics Subject Classification.* Primary 26D10; Secondary 26D15,

Key words and phrases: Fractional Riemann-Liouville type q -symmetric integral; Caputo-type derivative, Hölder's inequality; Minkowski's inequality; Grüss-integral inequality.

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Professor Vikas Yadav, Department of Zoology, Shri Varshney College

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Dr. Seema Anand (Associate Professor), Department of Botany, Shri Varshney College, Aligarh.

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Title of paper	Name of the author/s	Name of Journal	Year of Publication	ISBN/ISSN Number
Correlation between Idealism and Tragedy: A Study of Tragic	Sanjeev Kumar Bansal & Prof. Sharmila Saxena	International Literary Quest (An International Multidisciplinary Peer Reviewed	July-December 2020 Vol- 12, Issue-1	2319-7137

Patterns in the Select Novels of John Galsworthy		Refereed Research Journal)		
Human Quest for Idealism: A Saga of Incessant Sufferings in the Select Novels of Munshi Premchand	Sanjeev Kumar Bansal & Prof. Sharmila Saxena	Deptt of Education, Aligarh Muslim University, Aligarh, U.P., EIJR, Monthly, Excellence International Journal of Education and Research: A Multilingual Journal for All Subjects	April, 2021, Vol 10, Issue:4 Impact Factor: 6.435	2349-8838
Quest of National Identity in 'The Silver Box' through Readers' Point of View	Sanjeev Kumar Bansal & Pramod Kumar Singh	Shodh Triannual Bilingual Peer Reviewed Refereed Journal of Arts & Humanities	Vol. XVIII, Jan- Dec- 2021 (Issue No 1, 2, & 3 Combined)	0970- 1745
Enhancement of Vocabulary through Puzzles & Quizzes	Sanjeev Kumar Bansal	Educreator Research Journal	Vol IX, Issue:III May- June, 2022 SJIF Impact Factor 7.717	2455-0515 (P) 2394- 8450 (E)
The Problems of Being Creative	Dr Sanjeev Kumar Bansal & Prof Sharmila Saxena	Shodh, Triannual Bilingual Peer Reviewed Refereed Journal of Arts & Humanities	Vol. XIX, Issue 1,2 & 3 Combined 2022 (January-December)	0970-1745
उत्तर प्रदेशीय राष्ट्रीय आय एवं योग्यता आधारित छात्रवृत्ति परीक्षा: एक समीक्षा	Santosh Kumar Khare & Dr SK Bansal	International Literary Quest (An International Multi-disciplinary Peer Reviewed Refereed Research Journal)	Vol. 16, July- Dec, 2022	2319-7137

Safia Elhillo's 'Alien Suite': A Saga of Nostalgia, Love and Oppression due to Apartheid	Dr Sanjeev Kumar Bansal & Mr Himanshu Sharma	World Translation, (An International Multi-disciplinary Peer Reviewed Refereed Research Journal)	Vol. 17, January- June, 2023	2278- 0408
Augmentation of English Language Teaching and Learning Through Digital Technology	Mr Himanshu Sharma *& Dr Sanjeev Kumar (Bansal)**	SHODH	Vol. XXI Issue No. I, Jan.–April. 2024,	ISSN: 0970-1745 Impact Factor 5.875 Regd. No. 2607/1- V8522

List of Publications

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2. Decomposition Theorems for Periodic Near Rings, Rad. Math., Vol. 12 (2003), 5 – 11.
3. On Lie Ideals with (θ, ϕ) -Derivations as Homomorphisms and Anti-Homomorphisms, International symposium of Trends in Theory of Rings and modules, 2005.
4. On Generalized Derivations of Prime Rings, Southeast Asian Bull. Math., Vol. 29 (2005), 669 – 675.
5. On Lie Ideals and Generalized Derivations of Prime Rings, East-West J. Math., Vol. 7, No. 1 (2005), 93 – 98.
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9. Some Remarks on Homomorphisms of Lie Ideals in Prime Rings with Involution, Inter. J. Multi. Research & Advcs. in Engg. Vol. 8 No.II(2016), 1-6.
10. On Left α -Centralizer of Prime Rings with Involutions, Inter. J. Math. Sci. & Engg. Apples. Vol. 11 No. 1 (2017), 177-183.
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14. Commutativity of 3-Prime Near Rings with Jordan Ideals, Science Phenomenon, Vol. 25(2020), 63-69.
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Harendra Kumar Gaur

1. Research Publications:

- Assessment of Behavioural Changes in Wild Drosophila Fed on Normal and High Caloric Diet under Stress of Beta-Cyfluthrin
- Environmental Change Enhancing Combined Approach of Organic and Conventional Farming for Sustainable Productivity
- The Effect of Geo-Political Mobility on Climate Control Regulations with Special Perspective of Sustainable Development Goals (SDGs)
- Evaluation of Trade Related Intellectual Property Rights (TRIPR, s) and Convention on Biodiversity (CBD) in India.
- Biopiracy and IPR: Post Effects of Convention on Biological Diversity (CBD)
- Effect of Beta-Cyfluthrin on Total Cholesterol Level in Wild Drosophila Fed on Normal and High Caloric Diet
- Biochemical responses of developing stages of Wild Drosophila melanogaster after Beta-Cyfluthrin Intoxication

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2. Effect of Gender and Residential Area upon Cyber Crime Awareness / IJIP, Volume 2, Issue 3 / July-Sept. 2023 / 23485396 / DOI- 10.25215/1103.452

3. The Effect of Type of Marriage and Duration of Marriage on Marital Adjustment / Printing Area, Issue 37, Vol.1 (UGC 43053 Impact Factor 4.002) / Jan 2018 / 23945303 /

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4. Impact of the academic Stream on attitude towards modernization & Social Maturity of the female Post Graduate Students of Kumaun Region / VMR, Vol. 3, UGC 48402 / Oct-Dec 2017 / 23950390

5. Study of the attitude towards modernization of female post graduate Students of Kumaun Region in relation to their Self Confidence / Research Highlights, Vol. 4 / Jan-March 2017/ 23500611

S.No.	Title of Paper	Name of Journal	Year	ISSN No.
1	Floral Biology of <i>Mitrgyana parvifolia</i> (Rubiaceae)	Plant Cell Incomptability News Letter-2000	2000	
2	Insect Visitors of <i>Mitrgyana parvifolia</i>	Journal of Non-Timber Forest Products	2007	
3	Impact of Zinc In Alluvial Soil For Rabi Crop	Scholarly Research journal for Interdisciplinary Studies	2017	2278-88088
4	Energy ,Security Planning and Process Under Sustainable Development	Multidiciplinary Higher Education, Research,Dynamics and Concepts	2018	978-93-87662-12-4
5	Antimicrobial Potential of algae	Scholarly Research journal for Interdisciplinary Studies	2018	2278-88088
6	The Effect of algae on plant growth and productivity	Scholarly Research journal for Interdisciplinary Studies	2018	2278-88088
7	Biodiversity and its conservation	Parishodh journal	2019	2347-6648
8	Energy Resources:An Analytic Study	Journal of Interdisciplinary cycle Research	2020	0022-1945
9	Phenology, floral Morphology and Floral Development of <i>Mitrgyana parvifolia</i> (Roxb.) Korth (Rubiaceae)	Journal of Interdisciplinary cycle Research	2021	0022-1945
10	The Biochemical Studies of Reproductive Structure of <i>Mitrgyana parvifolia</i> (Rubiaceae) (Roxb.) Korth	The International Journal of Analytical and Experimental Modal Analysis	2022	0886-9367
11	EFFECT OF VARIOUS LEVELS OF CU AND CU+ZN AMENDMENT IN SOIL ON GROWTH REPRODUCTIVE YIELDS AND BIOCHEMECAL RESPONSES OF MUSTURED (BRASSICA CAMPESTRIS L.)PLANTS.	Scholarly Research journal for Interdisciplinary Studies	2022	2278-88088
12	TRIGONELLA FONEUM-GRAECUML AND FUNGAL DISEAS	Scholarly Research journal for Interdisciplinary Studies	2024	2278-88088
13	Energy Congervation and Climate Change:Aligning Indian Foreign Policy with Global Sustainability Goals	Bhu-Rajnatik Gatisheelta aur Bhart ki Vedesh Niti:	2025	978-81-981916-6-2

1 43922 Journal of Interdisciplinary Cycle Research 022-1945 E-COMMERCE:
OPPORTUNITIES AND CHALLENGES IN DEVELOPING INDIA XII 614-620

2 July-Dec 2022 SHODHASAMHITA 2277-7067 VARIOUS INVESTMENT
ALTERNATIVES AVAILABLE FOR INDIVIDUAL INVESTORS IN INDIA IX
204-212

3 Jan- March 2023 Sodh Prabha 0974-8946 INVESTMENT IN MUTUAL
FUND: OPPORTUNITIES AND CHALLENGES IN INDIA 48 204-212

4 45047 Madhya Pradesh Journal of Social Sciences A biannually Journal of M. P.
Institute of Social Science Research, Ujjain 0973-855X EXAMINING THE
INVESTMENT BEHAVIOUR OF INDIVIDUAL INVESTORS IN STOCK MARKET
AND MUTUAL FUNDS: A COMPARATIVE STUDY IN INDIA WITH SPECIAL
REFERENCE TO ALIGARH DIVISION 28 189-203

5 45413 International Journal of Research and Analytical Reviews (IJRAR). E-
ISSN 2348-1269, P- ISSN 2349-5138 Microfinance: A Catalyst for Women's
Economic Empowerment 11 266-269

6 Sep-Dec 2025 Sodh [A Triannual Bilingual Peer Reviewed Refereed Research
Journal of
Arts & Humanities] 0970-1745 Mutual Fund Performance Evaluation in India Using
Risk-Adjusted Measures XXII 65-73

S. NO.	MONTH/YEAR	JOURNAL NAME	ISSN NO.	Total of the paper
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1	Apr-20	journal of interdisciplinary cycle research	0022-1945	PLANNING AND DEVELOPMENT OF MARKETING MANAGEMENT IN INDIA (A Postreform period of socio- economic since 2016)
2	Sep-20	SHODH SARITA	2348-2397	A study of liquidity and profitability trend analysis with A SPECIAL REFERENCE TO STEEL AUTHORITY OF INDIA LIMITED (SAIL)
3	Jun-24	INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & MANAGEMENT TECHNOLOGY	2348-4039	A STUDY OF Decentralized finance(DIFI) The correlation between multiple financial variable and the DIFI PROTOCOL VALUATION:ISSU &CHALLENGE
4	Dec-24	corrosion management	1355-5243	Transforming profusion of capable human capital in knowledge based economy through skill development initiative in india
5	Jan-25	I. J.R.A.R	2349-5138	A Study on performance of corporate social responsibility (CSR) With special refrence to steel authority of india limited, SAIL)
6	Dec-25	COMMERCE TODAY	0975-7775	A comparative study on credit risk management of D- SIB (Domestic systemically important bank) in india(A Special refrence with SBI,HDFCAND ICICI

Research Article - Rakesh Kumar.docx

Published Paper "Analysis of Kinematic & Anthropometric Variables of the Spike
Execution Technique of Volleyball" in International Journal for Research in Applied
Science & Biotechnology Volume 7, Issue 4 July 2020.

<https://doi.org/10.31033/ijrasb.7.4.15>

□ Published Paper "Biomechanical Analysis of Take off in Spike in Technique of
Volleyball Based on Anthropometric & Kinematic Variables" in International Journal
for

Research in Applied Science & Biotechnology Volume 7, Issue 4 July 2020.

<https://doi.org/10.31033/ijrasb.7.4.11>

□ Published Paper “Relationship of Selected Biomechanical Variables with the Performance of Cover Drive Shot in Cricket” in International Journal of Scientific Development and Research (IJS DR), Volume 7 Issue 8, August 2022. ISSN 2455-2631

□ <https://ijsdr.org/papers/IJS DR2208101>

List of some selected papers (out of more than 100) with DoI

- [1.] Effect of the Growth Rate on the Optical and Terahertz Characteristics of Temperature Gradient Solvent Method-Grown ZnTe Single Crystals. (2025). *Physica Status Solidi - Rapid Research Letters*. doi: 10.1002/pssr.202500141
- [2.] Computational investigation of X₃BiN (X = Mg, Ca, Sr) anti-perovskites: Highly efficient thermo-electric materials in focus. (2025). *Computational Condensed Matter*, 45. doi: 10.1016/j.cocom.2025.e01144
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- [5.] Dielectric, magnetic and structural properties of Co doped CeO₂ powders. (2024). *Journal of Physics and Chemistry of Solids*, 184. doi: 10.1016/j.jpms.2023.111721
- [6.] Crack formation and optical properties in 175 MeV Au¹³⁺ ion beam irradiated CeO₂ thin films. (2023). *Radiation Effects and Defects in Solids*, 178(11-12), 1372-1383. doi: 10.1080/10420150.2023.2253482
- [7.] Some Physical Features of Glasses Synthesized from Some Environmental Wastes. (2018). *Silicon*, 10(2), 431-438. doi: 10.1007/s12633-016-9470-4
- [8.] First-Principle Calculations of Structural, Elastic, and Electronic Properties of Intermetallic Rare Earth R₂Ni₂Pb (R = Ho, Lu, and Sm) Compounds. (2018). *Journal of Superconductivity and Novel Magnetism*, 31(2), 395-403. doi: 10.1007/s10948-017-4234-y
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Dr. Maheep Kumar

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(REVIEW ARTICLE)



Quercetin loaded zinc nanoparticles: Recent applications and developments

Yaduvir Singh ¹, Dinesh Kumar Sharma ¹ and Maheep Kumar ^{2,*}

¹ Institute of Applied Sciences, Faculty of Sciences, Mangalayatan University, Aligarh, Uttar Pradesh, India.

² Department of Chemistry, Shri Varshney College, Raja Mahendra Pratap Singh State University, Aligarh, Uttar Pradesh, India.

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Abstract

A member of the flavonoid class, Quercetin, can be found universally in vegetables, fruits and other plant sources. Quercetin is the focus of interest due to its diverse biological activities viz. antioxidant, anti-inflammatory, anticancer and antimicrobial properties. But Quercetin faces limitations, including poor water solubility, low bioavailability and rapid metabolism and demands novel delivery systems development. Delivery and efficacy of Quercetin can be improved by means of nanotechnology. Zinc has such unique properties as biocompatibility, biodegradability and the potential for synergistic effects with Quercetin that make it an attractive material for the formulation of nanoparticles. In the current study, recent applications and developments of Quercetin loaded zinc nanoparticles are reviewed, including their synthesis techniques, characterization techniques, and diverse applications in drug delivery, wound healing, food preservation, cancer therapy and antimicrobial action. We also outline possible future direction in this emerging area, with a reflection of the current literature to fill the gaps.

Keywords- Quercetin; Nanotechnology; Zinc; Nanoparticles; Applications

1. Introduction

Quercetin, a member of the flavonoid class, is universally distributed in a variety of vegetables, fruits, and other plant sources [1,2,3]. Due to its diverse and potential biological activities, Quercetin has been the subject of interest. Its inherent antioxidant, anti-inflammatory and antimicrobial properties constitute a multifaceted therapeutic potential, thereby making it an important subject of research and development for use in various biomedical applications [2,4,5]. However, Quercetin possesses limitations, including poor water solubility, low bioavailability and rapid metabolism and these limitations restrict it from being therapeutically effective in its native form [4,5,6]. As a result, it requires the development of novel delivery systems to overcome these challenges and unlock its full therapeutic potential.

These limitations are being overcome using nanotechnology, as a promising means. Delivery and efficacy of Quercetin can be improved by means of nanotechnology. Recent advances have focused on improving confines of Quercetin through innovative nanoparticle formulations as Quercetin can be encapsulated in nanocarriers, namely nanoparticles, nanoliposomes or nanomicelles, which increase its solubility, stability and bioavailability. These nanocarriers enhance the Quercetin absorption by protecting it from degradation while its passage through the gastrointestinal tract, and thus promote delivery of the compound to the target tissues. Additionally, Quercetin nanocarriers can give targeted delivery of Quercetin to distinct places inside the body, boosting treatment effectiveness whilst lowering negative effects. One of the additional ways that Quercetin can be used therapeutically is its controlled release from nanocarriers, that will prolong its therapeutic effects and maximize the impact while minimizing the frequency of administration [2,3].

* Corresponding author: Maheep Kumar

Zinc has unique properties, such as biocompatibility, biodegradability that renders it functionally biodegradable within biological and medical frameworks and potential synergistic effects with Quercetin. These properties make it an attractive material for nanoparticle formulation. The solubility of Quercetin is increased by zinc nanoparticles which otherwise is low in aqueous environments. It is important for its bioavailability in biological systems [7]. Incorporating zinc nanoparticles into formulations show ability to shield Quercetin from degradation [4].

The objective and scope of the review is to provide a comprehensive understanding of the advancements in Quercetin-loaded zinc nanoparticles, their applications, and the future perspectives necessary for their effective therapeutic use. In the current study, recent applications and developments of Quercetin loaded zinc nanoparticles are reviewed, including their synthesis techniques, characterization techniques, and diverse applications in drug delivery, antioxidant and anti-inflammatory properties, food preservation, cancer therapy and antimicrobial action. We will also have a look of the current literature to identify the gaps and future directions in this emerging area of research.

2. Methodology

To find every study that examined Quercetin-loaded zinc-based nanomaterials, their applications, and advancements during the previous ten years, a search technique was developed. Using a variety of search terms, we searched the Scopus, ScienceDirect, Pub-Med, and Google Scholar databases to find and gather the pertinent study literature. The search was carried out using several different strings like “quercetin and zinc nanoparticles”, “applications of quercetin-zinc nanomaterials”, “quercetin and zinc nanoparticles as antimicrobial”, “quercetin based zinc nanomaterial use”, “zinc with quercetin nanoparticles synthesis methods”, “zinc and quercetin in nanotechnology”, “quercetin zinc nanomaterial recent technology”, “zinc and quercetin in cancer therapy”, “quercetin and zinc for food industry”, “quercetin and zinc nanoparticles in drug delivery” etc. The searched papers were further studied to select specific studies connected to “applications of quercetin loaded zinc nanoparticles” and other non-relevant studies were removed. The final selected papers were those for which the full text was available and which fitted the objectives of the review. Fig 1 shows screening process of methodology.

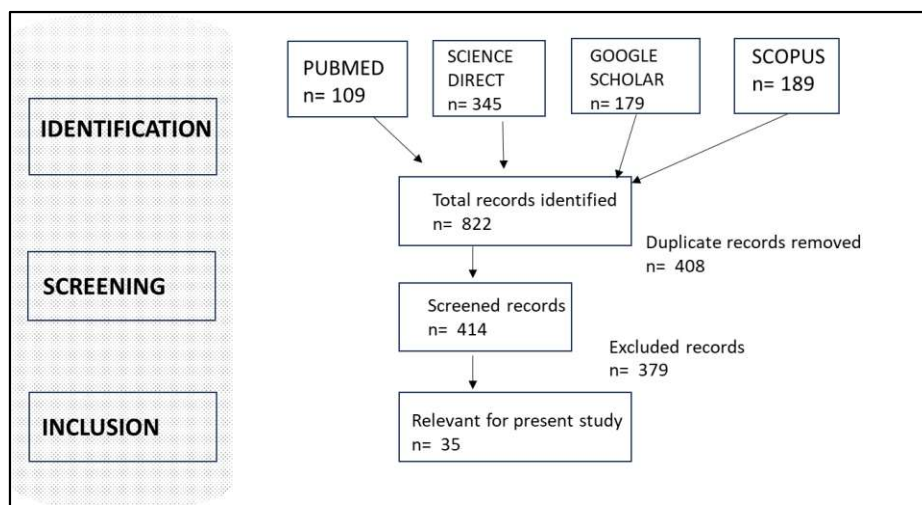


Figure 1 Screening process of methodology

3. Synthesis Methods of Quercetin-Loaded Zinc Nanoparticles

Quercetin loaded zinc nanoparticles have been synthesized by several methods. The most common method is the homogenous precipitation method in which the Quercetin is added at the time of formation of ZnO nanoparticles. The method is to allow controlled precipitation of zinc ions with Quercetin resulting in the entrapment of Quercetin in the ZnO nanoparticle matrix. There are various specific conditions (pH, temperature, reactant concentrations) that govern the size, morphology and the Quercetin loading efficacy of the resulting nanoparticles [8].

Another method is the chemical synthesis of ZnO@Quercetin nanoparticles (quercetin functionalized wurtzite type zinc oxide nanoparticles) confirmed by DRS UV-vis spectroscopy. The ZnO@Quercetin nanoparticles were hexagonal, monocrystalline with an average size of 20–25 nm as confirmed by XRD and Raman spectroscopic analysis [9].

The Quercetin drug delivery matrix was developed by one study which used sonochemical methods to synthesize Zn/SBA-15 (silica based mesoporous material functionalized with zinc nanoparticles). The precursor for SBA-15 preparation was rice husk ash, a readily available and inexpensively source of silica. This, with a relatively simple and scalable sonochemical approach, enabled the controlled nanoparticle synthesis with precise size and morphology [10]. In another study by Trendafilova et al., the incipient wetness impregnation method was used to synthesise similar Zn-modified SBA-15. The pores of Zn modified SBA-15 were loaded with Quercetin. This method efficiently exploited the benefits of Zn modification and the high loading capacity of Quercetin, thus making the resulting delivery system a promising dermal application [11].

Quercetin functionalized bimetallic nanoparticles, in particular, iron and zinc oxide (zinc ferrite) nanoparticles were prepared using another synthesis method involving co precipitation. This method offers a convenient route for the production of bimetallic nanoparticles with predetermined properties, albeit with the need for careful optimization of reaction parameters to achieve consistent results [12].

A notable progress is reported in the synthesis of zeolitic imidazolate framework-8 (ZIF-8) nanoparticles using zinc ions. In this method, Quercetin is encapsulated using the properties of a metal organic framework, ZIF-8, to undergo controlled drug release [13].

In another approach, a cellulose nanofiber–Quercetin complex was made incorporating zinc ions, forming a Quercetin loaded cellulose nanofiber composite (CNF–Zn–QT) with improved properties and high loading capacity for use in various applications [14]. Additionally, a study made use of a novel complex of metal ions (including zinc) with quercetin which increased its antioxidant properties. Then, polycaprolactone based nanoparticles were synthesised, vitamin E was loaded onto them and an enhanced antioxidant profile was achieved [15].

ZnO nanoparticle synthesis was explored using green synthesis techniques using plant extracts. These methods provide an environmentally friendly route for the preparation of nanoparticles with improved biocompatibility and stability, as compared to the conventional chemical methods. However, the yield and control over nanoparticle characteristics may differ with plant extract as well as with specific synthesis conditions [16, 17]. The various approaches show versatility of zinc in forming Quercetin-loaded nanoparticles with varying and customized properties. Table 1 summarizes the comparison, advantages and disadvantages of different synthesis methods of Quercetin loaded zinc nanoparticles.

Table 1 Comparison of different synthesis methods for Quercetin-loaded zinc nanoparticles

Technique	Process	Advantage	Disadvantage	Quercetin Loading	Reference
Homogeneous Precipitation	This method involves the gradual development of ZnNPs in a uniform solution by managing factors like pH, temperature, and the concentration of precursors.	It yields consistent nanoparticles with precise morphological control.	It necessitates exact conditions to prevent issues related to agglomeration and precipitation.	Quercetin can be added during or after the precipitation process, influencing its dispersion and bioavailability.	[8]
Chemical Synthesis	This approach employs chemical precursors (such as zinc salts) that are reduced by agents like sodium borohydride to create ZnNPs.	It is simple, scalable, and capable of producing small nanoparticles.	It involves the use of hazardous reducing agents and stabilizers, raising potential environmental concerns.	Frequently involves post-synthesis functionalization through ligand exchange or direct integration during the synthesis phase.	[9]
Sonochemical Method	This technique utilizes ultrasonic waves to create cavitation, leading to localized high temperatures and	The process is quick, energy-efficient, and results in well-dispersed nanoparticles.	It requires specialized equipment and may produce inconsistent particle sizes.	Quercetin can either be co-synthesized with ZnNPs or added after synthesis.	[10,11]

	pressures that facilitate nanoparticle generation.				
Co-precipitation	This involves the simultaneous precipitation of ZnNPs and quercetin in a carefully controlled environment (considering pH and ionic strength).	It is simple, cost-effective, and permits greater encapsulation of quercetin.	There is a risk of particle aggregation and variations between batches.	Direct incorporation during the synthesis improves the efficiency of drug loading.	[12]
Green Synthesis	This method employs plant extracts, bacteria, or fungi as reducing and stabilizing agents to create ZnNPs in an environmentally friendly way.	It is biocompatible, avoids toxic substances, and enhances bioactivity.	Controlling particle size and morphology can be more challenging	Quercetin can be integrated into biosynthesized ZnNPs using plant-derived polyphenols, boosting antioxidant properties.	[16,17]

3.1. Characterization Techniques for Quercetin- Loaded Zinc nanoparticles

Physicochemical properties of Quercetin loaded zinc nanoparticles are studied using various characterization techniques.

The presence and concentration of zinc nanoparticles within the matrix is confirmed using X-ray fluorescence (XRF) and X-ray diffraction (XRD). XRF and XRD are used to assess the purity and crystalline structure of the ZnO-NPs. The results of a study [18] indicated that high-purity ZnO-NPs were successfully fabricated. The results show that the crystalline structure is essential for determining the stability and reactivity of the nanoparticles, which can impact their performance in biomedical applications.

Detailed information on nanoparticle size, morphology and distribution is obtained using transmission electron microscopy (TEM) [10,18]. In the study conducted by Azizah et al. [10], it was observed that zinc nanoparticles ranging from 4-14 nm and were located on the surface of the mesoporous channels of SBA-15. In another study [18], the average size of the ZnO-NPs was determined to be 45.924 ± 27.910 nm, with hexagonal and rod-like shapes observed. The results show that the size and distribution of nanoparticles are crucial for their effectiveness in drug delivery. Smaller nanoparticles can enhance the surface area and improve interaction with the drug, which is essential for achieving higher encapsulation efficiency. Smaller particles also enhance bioavailability and improve the solubility of compounds like diosgenin [18].

Scanning electron microscopy (SEM) provides understanding of surface morphology and particle aggregation [12]. It corroborates the findings from TEM, confirming the nanoscale dimensions and shapes of the particles. The surface characteristics observed through SEM can influence the interaction of ZnO-NPs with biological systems, affecting their efficacy as drug delivery vehicles.

Various techniques such as ultraviolet visible spectroscopy (UV-Vis), Fourier transform infrared spectroscopy (FTIR), and dynamic light scattering (DLS) are known to be used to ascertain zeta potential, particle size, and surface functionality [1,6,19]. These characterization methods are essential for ensuring the consistency and quality control of synthesized nanoparticles and for the understanding of their response to Quercetin. The measurement of the zeta potential, for example, reveals information on the colloidal stability of the nanoparticles, which is key for the long-term storage and effective delivery [10].

UV-Vis Spectroscopy technique measures the concentration of released Quercetin at specific time intervals. The percentage of drug release over time provides insights into the release kinetics, which is essential for evaluating the

effectiveness of the drug delivery system. A slower release rate can indicate better control over drug delivery, which is beneficial for therapeutic applications [10].

The FTIR analysis allows to identify the presence of the functional groups inside and their interactions between the nanoparticles; thereby, it gives information about the encapsulation and drug release mechanism. Understanding the interactions between Quercetin and Zn is vital for assessing how well the drug can be loaded and released from the carrier. The chelation suggests a strong bond between the drug and the carrier, which can influence the drug's release profile [6].

Therefore, the synthesized nanoparticles and their properties require multiple characterization techniques to make a complete understanding. Predicting their behaviour under biological systems and perhaps optimising their therapeutic efficacy require these techniques.

3.2. Applications of Quercetin-Loaded Zinc Nanoparticles

The exceptional blend of the bioactivity of Quercetin and delivery capability of zinc nanoparticles has unlocked a myriad of applications (Fig 2).

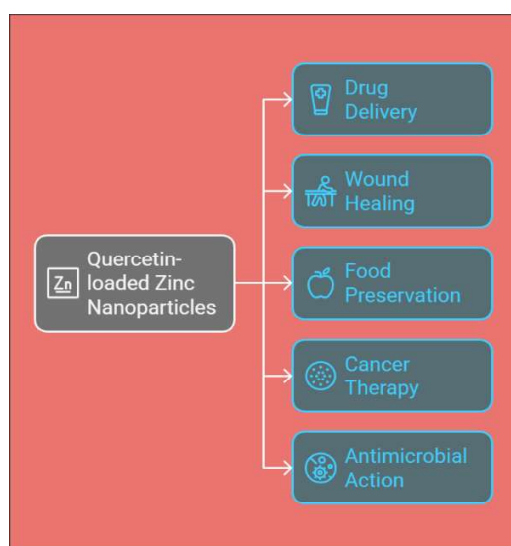


Figure 2 Applications of Quercetin-Loaded Zinc Nanoparticles

3.3. Drug Delivery

Enhanced drug delivery is the primary application. Quercetin is a low bioavailable compound which requires development of efficient delivery systems [4,5]. This problem is solved by zinc nanoparticles, which can enhance solubility and targeted delivery [10,13]. To illustrate, Azizah et al. showed Zn/SBA-15 to be a potential Quercetin delivery matrix, where Quercetin loading was 28.30mg/g and release was 33.64%, after 240 minutes. It was shown that Zn/SBA-15 was capable of sustaining Quercetin's therapeutic effect over an extended period with an improved efficacy. In this study, sonochemical route was used to synthesize SBA-15 using rice husk ash as a sustainable silica precursor and a well-ordered mesoporous material was obtained. Post-synthesis impregnation was used to incorporate zinc into the SBA—15 framework and XRD and FTIR analyses confirmed there was change in physicochemical characteristics of the material as affected by varying metal loadings. In addition to that, FTIR spectroscopy showed that quercetin and ZnSBA-15 interact via chelation of the carbonyl (C=O) and hydroxyl (C–OH) groups, suggesting strong host–guest interactions. It was shown that the diffusion rate of quercetin could be slowed by reducing pore diameters and by potential ZnO formation on SBA-15. The controlled release profile generated by ZnSBA-15 supports its ability to be used as an effective drug delivery platform for sustained topical delivery of quercetin with long photoprotective effect [10]. Additionally, in a separate study, ZIF-8 nanoparticles were also used in pH-responsive release of Quercetin to protect chondrocyte, both from inflammation and apoptosis in osteoarthritis and to enhance cartilage structural integrity [13].

In another study, a co-biopolymer hydrogel containing zinc oxide nanoparticles improved Quercetin delivery to brain cancer cells by increasing penetration through the blood-brain barrier [20].

Sathishkumar et al. conducted a study by developing an advanced drug delivery system using zinc oxide-Quercetin (ZnO-Quercetin) nanocomposite. The ZnO nanoparticle successfully loaded a large amount of Quercetin (210 µg/mg) and release of Quercetin from ZnO nanoparticles is faster in acidic conditions like those found in cancer environments. Here, specific molecular interactions between Quercetin and its receptor were identified. Interactions at 5-OH in the A ring, 3-OH in the C ring of Quercetin were most important. Based on these results, this study provides a promising design concept for the development of smart drug delivery systems based on metal oxides and hydrophobic natural drugs for cancer therapy [21].

Another study concerned the manufacture of a new hydrogel formulation consisting of Quercetin extracted from onion peel waste via embedding green synthesized ZnO nanoparticles into a chitosan matrix. Electrostatic and hydrophobic interactions between QE and ZnO NPs increased the hydrogel's swelling and increased efficiency of drug loading and loading. Results showed that ratios of QE/chitosan and ZnO/chitosan, but not DAC/chitosan, had significant impact to loading efficiency. The drug release was Fickian diffusion showing that the drug release was diffusion controlled. Moreover, the hydrogel showed high biocompatibility to normal cells and selective cytotoxicity on cancer cells with potential use of topical therapies in infections and cancer. The research succeeded in demonstrating the ability of this green nanohybrid hydrogel formulation made from ZnO NPs and onion peel waste in controlled drug release, antimicrobial and anticancer applications. This formulation could be a promising alternative in biomedical field especially for topical applications [22]. These studies demonstrate the usefulness of zinc nanoparticles to deliver Quercetin to specific target sites and thereby, enable enhanced therapeutic effect and suppress its limitations.

3.4. Wound Healing

Quercetin has been proposed as a promising agent for wound healing due to its antioxidant and anti-inflammatory properties [2, 12]. Promising results for incorporating Quercetin loaded zinc nanoparticles into the wound dressings have been demonstrated [12]. In a rat model, Yadav et al., showed that Quercetin functionalized bimetallic (zinc ferrite) nanoparticles promoted wound healing. Molecular docking studies indicated strong binding affinity of quercetin with numerous wound healing protein targets, thus suggesting a molecular mechanism for its therapeutic effect. This synergy of the bioactivity of Quercetin with the nano delivery of zinc nanoparticles combines to offer a unique approach to enhancing wound healing when the tried-and-true treatments fail [12].

Further advancement of this application is the development of injectable hydrogels that comprise Quercetin modified zeolitic imidazolate framework-8 (ZIF-8@QCT) which enhances tissue regeneration and remediate challenges in alveolar bone restoration in periodontitis [23].

In mice, quercetin offered a means of mitigating testicular toxicity caused by zinc oxide nanoparticles. It lowered inflammation and oxidative stress markers, restored normal testosterone levels, suggesting its protection from nanoparticle induced reproductive toxicity [24]. Zinc ion containing cellulose nanofiber composite had superior antioxidant activity and sustained quercetin release. In addition, the composite demonstrated improved antibacterial properties, which would support its use in long term antioxidant and antimicrobial applications [14].

In a separate study, zinc oxide nanoparticles loaded with Quercetin (Quercetin@ZnO NPs) were created to deliver photoprotective effects from UVA induced damage to HaCaT cells. The research demonstrated that these nanoparticles played a dual role in the delivery of Quercetin and in reducing the toxic effects of free iron in skin cells. The findings suggest that Quercetin@ZnO NPs can markedly lower expression of inflammatory markers associated with photoaging and possibly make a potent therapeutic agent in skincare products. An approach of enhancing skin protection and tackling oxidative stress resulting from UV exposure was presented by the study [8]. While all of this show much promise for Quercetin-loaded zinc nanoparticles, a number of challenges about cytotoxicity and oxidative stress inherent with nanoparticles need to be overcome. Further research and development in nanotechnology is necessary in order to optimise these formulations for use in safe and efficient therapeutic applications [2].

3.5. Food Preservation and Packaging

Quercetin has antioxidant capacity that can be used for food preservation. Quercetin-loaded zinc nanoparticles increase the antioxidant activity of polyvinyl chloride (PVC) films and can be used to prolong the shelf life of fatty foods [25]. Braga et al. have shown that PVC films containing zinc nanoparticles loaded with quercetin have enhanced structural, morphological, optical, and thermal properties, which are desired for food packaging applications. By this approach, a new strategy in food preservation is offered for active food packaging materials that prevent the food from undergoing oxidative processes, preserve the food quality, and mitigate food processing waste. With this application, quercetin loaded zinc nanoparticles are shown to have potential to be used as a shelf-life extension agent of food products, to reduce spoilage as well as to enhance food safety [25]. A further study was successful in developing a versatile packaging

material formed from methylcellulose (MC) and chitosan nanofibers (CNFs) combined with the addition of zinc oxide nanoparticles (ZNPs), quercetin (Qu), and natamycin (NAT). The purpose of this material is to be multifunctional, showing antibacterial, anti-fungal and antioxidant properties, which are essential for food preservation and safety. These green multifunctional packaging films are suitable as a promising alternative to traditional plastic packaging [26].

3.6. Cancer Therapy

The anticancer properties of quercetin and the targeted delivery potential of zinc nanoparticles provide the scope for novel cancer therapies [2,5]. Zinc oxide nanoparticles (ZnONPs) were incorporated into a hydrogel nanocomposite, which resulted in increased quercetin loading and improved controlled release, with cytotoxic effects on breast cancer cells. Targeted drug release was mediated due to the pH sensitivity of formulation. This facilitated an increase in number of apoptotic cancer cells [27]. Sadhukhan et al. studied phenylboronic acid (PBA) conjugated Zinc oxide nanoparticles (PBA-ZnO) with quercetin (PBA-ZnO-Q) for treating cancer. PBA-ZnO-Q significantly increased quercetin bioavailability and improved anticancer properties. Better tumor inhibition was seen using this formulation than PBA-ZnO or free quercetin alone. Targeted delivery to cancer cells inducing the apoptotic cell death via oxidative stress was achieved with the help of the PBA moieties. PBA-ZnO-Q acted selectively cytotoxic to cancer cells but was not cytotoxic to vital organs by impeding redox homeostasis. The chemotherapeutic potential with reduced tumor associated toxicity was significant for this nanoformulation and thus represents a promising candidate for clinical development [28]. In another study, wurtzite type zinc oxide (ZnO) nanoparticles were synthesized and functionalized with quercetin (ZnO@Quercetin) for ovarian cancer treatment. Excellent efficacy was demonstrated by ZnO@Quercetin nanoparticles for inducing intracellular oxidative stress and depolarizing mitochondrial membrane potential in human ovarian cancer cells. Dual staining assay further showed that the apoptosis triggered in PA-1 cells by ZnO@Quercetin was mediated by the intrinsic apoptosis signaling pathway. Overall, the results suggest that ZnO@Quercetin nanoparticles may represent a viable therapeutic for human metastatic ovarian cancer [9]. Majority of the studies explore quercetin nanoformulations for cancer treatment [1,2,5,29], whereas literature related to the quercetin loaded zinc nanoparticles in this context is still lacking. Nevertheless, the promising biocompatibility of such systems in drug delivery and the success of alternative zinc-based nanoparticle systems indicate a strong potential for future development [13,20].

3.7. Antimicrobial Therapy

Study done by Choi et al., successfully bio-conjugated zinc oxide nanoparticles (ZnO NPs) with quercetin (Q), to enhance its antibacterial efficacy. Formations of ZnO@Q nanocomposites were confirmed using advanced techniques. Overall, the resulting ZnO@Q NCs had greatly enhanced antibacterial activity against *Staphylococcus* species when compared to the Q and ZnO NPs alone. Bacterial membranes were disrupted and biofilm formation was also prevented by the nanocomposite. It showed that ZnO@Q NCs can act as an effective antibacterial agent in association with antibiotics with a low level of cytotoxicity, suggesting a strategy for combating antimicrobial resistant strains while improving bactericidal efficacy [30]. In another study, the researchers synthesized ZnO NPs using pure Quercetin extracted from *Ipomoea batatas* to study the organic dye reduction as well as antimicrobial and antioxidant evaluation [31].

Liu et al. developed a hydrogel (QPQH) made of quercetin (QT), quaternary ammonium salt chitosan (QCS) and polydopamine coated zinc oxide nanoparticles (PDA@ZnO NP) in a matrix of Polyacrylamide-Poly(2-acrylamido 2 methyl 1 propanesulfonic acid (PAM-co-AMPS), which showed exceptional adhesion and mechanical properties, adhering thoroughly to lesions. It induced high efficiency sterilization of bacteria, *Staphylococcus aureus* and *Escherichia coli*, using its photothermal properties and Zn²⁺ release, combined with QCS. Antioxidant properties reducing oxidative stress and inflammation were also provided by Quercetin. This hydrogel was compatible with blood and cells, and therefore assisted in wound repair, angiogenesis and collagen deposition, making it a good candidate for treating bacteria infected wounds in clinical use [32].

Another developing area is antiviral potential of Quercetin loaded nanoparticles. Most research in this area relates to other types of nanoparticles [33], however the inherent antioxidant and anti-inflammatory properties of Quercetin, in conjunction with the enhanced delivery provided by zinc nanoparticles, make a strong case for antiviral applications [34]. Mechanisms of action and efficacy of Quercetin loaded zinc nanoparticles against different viruses need to be further investigated.

Additionally, a recent study investigated the combined therapeutic effects of a quercetin-zinc (Q/Zn) complex and mesenchymal stem cells (MSCs) in a diabetic rat model with pulmonary dysfunction. The findings revealed that this combination therapy significantly improved glycemic control, enhanced antioxidant defenses, and reduced oxidative stress and genotoxicity. Notably, the treatment also ameliorated structural alterations in pancreatic and lung tissues, suggesting potential benefits for diabetic patients with respiratory complications, including those associated with COVID-19 [35].

Future Directions and Limitations

Promising applications of this combination, however, are met with several research questions, limitations and challenges that warrant further investigation. Synthesis method and formulation parameters (such as Zn ion concentration, pH, nanoparticle mass, surfactant concentration) play an important role in encapsulation efficiency and kinetics of drug release from Quercetin loaded zinc nanoparticles [10,13]. Knowledge of these factors is essential for optimal nanoparticle design and the consistency of therapeutic outcome. Understanding how quercetin and zinc oxide molecules interact, will optimize their combined protective effects. A thorough evaluation of the lasting toxic effects on cells, along with environmental assessments of these nanoparticles, must be conducted to maintain their safety and sustainable nature.

In addition, some formulations require improved long-term stability [36]. The need is to carefully evaluate the potential toxicity of zinc nanoparticles especially under high concentrations or prolonged exposure [2, 37].

Rigorous toxicity studies of these nanoparticles are crucial to demonstrate that they are safe and biocompatible for clinical uses. In future research, synthesis methods should be optimized to improve efficiency of encapsulation and control release of the drug, to develop more stable formulations, and to provide comprehensive toxicity studies. Additionally, the synergistic effects when combining quercetin loaded zinc nanoparticles with other therapeutic agents should enhance the therapeutic efficacy [34].

The mechanisms of action of quercetin loaded zinc nanoparticles in various biological systems need to be investigated specifically to understand their therapeutic potential and to guide the formulation of more effective ones. Finally, more research is also needed to decode promising findings of these in vitro, and preclinical data into clinical trials, to assess whether these nanoparticles are effective and safe in humans. Although ZnO NPs hold promise for the enhancement of Quercetin's bioavailability and stability, long term safety issues concerning nanoparticles in biological systems, as well as the possible cytotoxicity of nanoparticles, deserves further study. Efficacy and safety, in balance, remains a major issue throughout the development of nanoparticle drug delivery systems.

4. Conclusion

Zinc nanoparticles loaded with Quercetin represent a major breakthrough achievement in nanomedicine and a potential solution for improving the bioavailability and therapeutic efficacy of Quercetin. The versatile applications in drug delivery, wound healing, food preservation, cancer therapy and antimicrobial therapy adds to the diversity of potential uses of this approach. Nevertheless, future work needs to be devoted to issues such as encapsulation efficiency, release kinetics, long term stability and toxicity. Future investigation of these mechanisms of action and development of suitable formulations will prepare this novel technology for broader clinical uses and the translation into effective therapeutics. Exciting future advancements in several fields derive from the synergy between Quercetin's bioactivity and zinc nanoparticles' delivery capabilities. To realize the full therapeutic potential of these innovative nanoparticles, complex new synthesis techniques need to be explored, more sophisticated characterization tools need to be developed, and the rigorous toxicity and efficacy studies need to be conducted.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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A minireview on vermicompost and vermiwash as green pesticide for sustainable crop production: Approaches, applications, and advancements

Tanvi Singh¹  | Rachna Kapila¹  | Maheep Kumar² 

¹Department of Zoology, Institute of Home Economics, University of Delhi, Delhi, India

²Department of Chemistry, Shri Varshney College, Raja Mahendra Pratap Singh State University, Aligarh, India

Correspondence

Maheep Kumar, Department of Chemistry, Shri Varshney College, Raja Mahendra Pratap Singh State University, Aligarh 202001, India.
Email: maheepchem.svc@gmail.com

Abstract

Indiscriminate use of chemicals is the main cause of reduction in crop yield as well as certain serious diseases. There is an increased demand of organic substitutes which can be met by production of technology that involves the use of organic and environment friendly fertilizers. Vermicompost and vermiwash are suitable substitute for chemical fertilizer. In vermicomposting, organic matter is exposed to bacteria and enzymes of earthworm gut that alter the nutritive constituents and provide the unique consistency and property to vermicompost, also the derived leachate is vermiwash. Chemically, they consist of mucous, proteins, hormones, enzymes, macronutrients, micronutrients, and several microorganisms. Vermicompost and vermiwash hold immense potential for sustainable crop production by the application as fertilizer, biopesticide and disease control, food security, enhancing salinity tolerance as well as in allied fields. This technology is also undergoing advancements with the progression of science and technology. This review focusses on the approaches for preparing vermicompost and vermiwash, applications in the field of sustainable crop production and others as well as advancements in this technology.

KEYWORDS

biopesticide, environment friendly, fertilizer, organic, technology

INTRODUCTION

Excessive use of insecticides, pesticides, and chemical fertilizers are the main cause of reduction in crop yield as well as certain serious diseases. Moreover, the public, now is becoming aware of the harmful effects of these inorganic substances. This has led to an increase in demand of the organic substitutes by the buyers. Therefore, the main objective of all agriculture-based researches should be the production of technology that involves the use of organic and environment friendly fertilizers.¹

Organic agriculture has the aim of benefitting mankind by promoting human health and deriving a technology for sustainable use of natural resources and ecological conservation.² This can bring about the improvement in product quality, elimination of harmful effects of chemical products and could stop the devastation of environment.

Organic agriculture involves no usage of chemicals at any step, thereby improving soil health and providing organic food.³ The organic fertilizer, vermicompost, is extensively used in organic sustainable agriculture. It is a suitable substitute for chemical fertilizer.¹ Vermicomposting is the bio-oxidative process that involves alteration of decomposable organic matter by the aid of earthworms and their interaction with microorganisms.⁴ This technique produces worm excreta rich in plant nutrients. Vermicompost is a non-toxic, energy efficient, eco-friendly recycled biological product. A brownish-red colored liquid produced during vermicomposting, from the body of earthworm, is known as vermiwash. Vermiwash is known to control diseases and pests of plants thereby reducing the usage of insecticides and pesticides on crops, rendering them healthy for consumption and valuable in the market.⁵ Vermicomposting has proved to be an efficient technology

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for waste management, all over the world. Moreover, agricultural by-products and waste material can be used as the substrate on which earthworms feed.⁶ This can help in proper waste management, as the poor management of animal waste is a concern to public health because of release of untreated material to agricultural fields, also contaminating the groundwater.⁷ The purpose of this study is to focus on the advancements done in the preparation and applications of vermicompost and vermiwash as potential candidates for sustainable agricultural development. Since vermicompost and vermiwash hold immense potential in improving and sustaining the agricultural practices, we have reviewed the approaches for preparing vermicompost and vermiwash, applications in the field of sustainable crop production and others as well as advancements in the technology.

METHODOLOGY

An attentive literature search was executed to find publications reporting the studies on vermicompost and vermiwash for sustainable crop production. The relevant articles of well repute were collected through Google Scholar database, Scopus, ScienceDirect, Pub-Med using various search threads like ‘Vermiwash and Vermicompost in pest control,’ ‘Vermiwash and Vermicompost in Plant diseases,’ ‘Vermicompost in pest management,’ ‘role of vermicompost and vermiwash on growth of plants,’ ‘effect of vermicompost and vermiwash on plants.’ All the searched articles were read carefully. The irrelevant data and study were removed while the significant concepts of data were extracted, constructed, reworked and updated meaningfully and substantially.

VERMICOMPOST AND VERMIWASH: APPROACHES

Vermicompost is a compost or the product of the decomposition of organic matter, specifically wastes, using earthworms. Vermicomposting is the transformation of organic residues into simple, less complex, appropriate and harmless decomposed product where earthworm alter biological and domestic wastes into superior quality compost.⁸ This process is a biotechnological extension of composting involving participation of diverse species of earthworms along with the natural microbial decomposition. In vermicomposting, organic matter is exposed to bacteria and enzymes of earthworm gut that alter the nutritive constituents and provide the unique consistency and property to vermicompost.^{9,10}

The leachate derived from vermicomposting units is called vermiwash.¹¹ It is brown colored, natural product and holds great quantities of nutrients for plants and hence can be used as liquid fertilizer. Also, its humic acid composition contributes to plant development.¹²

Chemistry and preparation of vermicompost and vermiwash

Vermicompost and vermiwash are essentially same in composition if prepared using same organic content. Their quality and chemistry

vary with the variations in organic matter used in their preparation. These constitute mucous, proteins, hormones, enzymes—amylase, lipase, cellulase and chitinase, macronutrients—nitrogen (2%–3%), phosphorous (1.55%–2.25%), potassium (1.85%–2.25%) calcium and magnesium (22.68–47.68 mg/100 g), and micronutrients—iron, copper, molybdenum, zinc, sulfur and great number of beneficial microorganisms such as phosphate solubilizers, N₂ fixers, enzyme-producing, plant growth-promoting bacteria, *Actinomyces* and mycorrhizal fungi. The constitution of microorganisms differentiates vermicompost and vermiwash.¹³ Vermicompost and vermiwash when applied annually to the soil, lead to increased activity of soil enzyme like urease, phosphodiesterase, phosphomonoesterase and arylsulfatase, increased electrical conductivity and neutral pH of soil. Vermicompost exhibit aeration, drainage, high porosity, water holding capacity.¹⁴ Tissues of deceased earthworm release nitrogen in the form of nitrates (25%), ammonia (45%), organic soluble compound 3% and uncalculated material 27% which advances the nutrient superiority of vermiwash. The nitrogen exists as mucous, enzymes, plant growth hormones and nitrogenous excretory matter of earthworms.¹⁵ Table 1 describes the composition and role of each constituent in vermicompost and vermiwash.

The basic method of preparation involves using vermibins designed to collect vermiwash. Several studies have described the design and dimensions of vermibins.^{14,16–18} In general, different layers are prepared inside pots used as vermibins. The bottommost layer is fitted with brick pieces or pebbles or coconut shell to absorb the excess water, the second layer from bottom is filled with sandy soil, both coarse and fine, to avoid accumulation of superfluous water and drain it for maintenance of moderate level of moisture. The third layer has earthworms along with organic soil and old compost. After this, the top layer is made using decomposed organic substances like cow dung, straw, leaf litter which is covered with an additional layer of raw materials like coconut fronds to prevent direct sunlight exposure. This is followed by springling of water periodically to prevent dryness and to ease the decomposition of organic matter. Nearly after 1 month of decomposition, vermicompost and vermiwash can be collected. Figure 1 demonstrates the preparation of vermicompost and vermiwash. Preparation of vermicompost and vermiwash can be done at smaller or larger scales by batch mode or continuous mode. In batch mode, earthworms are inoculated periodically while in continuous mode, earthworms are inoculated once whereas the raw materials are supplied continuously and products of decomposition are continuously produced.¹⁷

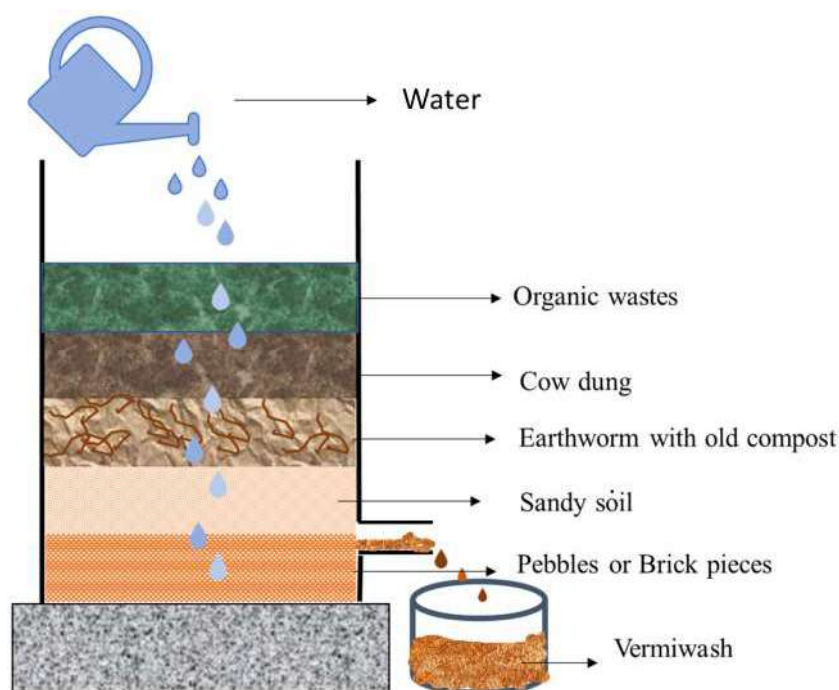
APPLICATIONS OF VERMICOMPOST AND VERMIWASH FOR SUSTAINABLE CROP PRODUCTION

As fertilizer

Study conducted on *Trigonella foenum* (fenugreek) plant showed an increase in growth rate of crop, pod length and width, grain yield, chlorophyll a and b, percentage and yield of essential oil percentage.

TABLE 1 Vermicompost and vermivash- Composition and role of each constituent.

Composition	Role	References
Humic acids	<ul style="list-style-type: none"> Supportive milieu for chemical reactions and microbial populations Soil organic matter dynamics Bio-effectors on physiological processes, biochemical activities, and plant-microbial interactions 	27,44
Macro and micronutrients (N, K, P, Ca, S, Fe, Mg, Mn, Cu, Zn, B)	<ul style="list-style-type: none"> Enhance plant metabolic functions Enhance root growth and development Nitrogen promotes leaf and stem growth. Gives dark color to plants and recovers foliage quality. Phosphorous enhances plant growth, plant maturity, and flower development Potassium increases disease resistance and vigor of plant, water usage efficiency, improves the quality of fruit and seed. 	14,27
Microorganisms (Phosphate solubilizing bacteria, N ₂ fixers, Enzyme-producing bacteria, Plant growth-promoting bacteria, fungi and actinomycetes)	<ul style="list-style-type: none"> Biochemical decomposition of organic matter Improve overall plant growth 	45
Mucous	<ul style="list-style-type: none"> Mineralization and humification of organics. Increases of microbial activity Mechanism of defense Insecticidal, pesticidal, and antifungal bioactive compound 	13,16,46
Proteins	<ul style="list-style-type: none"> Pathogen and pest suppression 	17
Hormones (gibberellins, auxins, and cytokinin) and enzymes	<ul style="list-style-type: none"> Improve growth and yield of plants Improve soil health by promoting the activity of beneficial microbes 	47,48
Vitamins (B and D)	<ul style="list-style-type: none"> Improve growth and development of plants 	49

**FIGURE 1** Preparation of vermicompost and vermivash.

The results revealed that the application of vermicompost and vermivash as biofertilizer had a positive reaction to the fenukgreek.¹ Similar studies on two varieties of *Linum usitatissimum* L. (Linseed),¹⁹

Coriandrum sativum (coriander),⁵ *Arachis hypogea* (groundnut),²⁰ and tomato (*Lycopersicon esculentum* Mill.)²¹ in the greenhouse reported enhanced growth and yield in the presence of vermicompost and

vermiwash. Gupta et al.²² reported in their study that the use of vermiwash and vermicompost formed from rice bran waste and cow manure had positive impact on the physiological growth of *Abelmoschus esculentus* L. (okra).

In another study conducted on lettuce plant in Nubaria region of Egypt, the application of vermicompost as fertilizer in combination to foliar spray of vermiwash showed improvement in vegetative growth like height of plant, leaf number area, fresh and dry weight of leaves, total yield and chemical composition of lettuce plants. The study recommended the safe use of vermicompost and vermiwash to improve vegetative growth, produce, and nutrition status of lettuce plants.²³ Similar results were obtained for *Fragaria* sp. (strawberry) by Zuo et al.²⁴ and *Tagetes erectus* (Marigold) by Shafique et al.²⁵

The nutritional profiling of the plants was also enhanced by the use of vermicompost as organic fertilizer. In a study conducted by Ganapathi and Dharmatti,²⁶ the total sugar, reducing sugars, non-reducing sugars, and starch content were reported to be enhanced in banana by the application of vermicompost. High nitrogen and phosphorous content in soil are related to high protease and acid phosphatase activity in vermicompost. In addition, hormones like auxins and cytokines, enzymes like amylases, proteases, urease and phosphatases as well as macronutrients like different amino acids, vitamins possessed by vermicompost and vermiwash contribute to increase in soil fertility. Deepthi et al.¹⁴ have reported an increase in growth indices of *Amaranthus viridis* L. using different concentration of vermiwash prepared from cow dung, aquarium water, and tap water. Also, an increase in protein and carbohydrate concentration in plant was reported by authors.

Al Jaouni et al.²⁷ reported the use of vermicompost as environment safe and nutrition as well as medicinal value enhancing component for *Phoenix dactylifera* L. var. Ajwa, Hulwa, Ruthana, Sefri, and Luban (Saudi date palm). Application of vermicompost increased vitamin, mineral content, primary metabolites as well as the medicinal potential of the date palm fruits.

As biopesticide and disease control

Vermicompost and vermiwash, besides acting as biofertilizer to increase crop productivity, play an important role in pest control and suppression of diseases because of the presence of crucial antipest and antimicrobial properties. Studies report the synergistic effect in minimizing pest infestation by the application of vermicompost and vermiwash with other pest controlling methods. Control of red spider mite (*Tetranychus urticae*) was observed by the use of vermiwash as it could inhibit growth of eggs of mite. This could prove to be an efficient method of mite control in agricultural fields.²⁸ Vermiwash contains mucus which is the coelomic fluid secreted through the dorsal pores of earthworm, as defense mechanism when it is irritated. This mucus is reported to contain fungicidal, insecticidal, and pesticidal activities.¹³ In earthworms, through various evolutionary processes, amino acid chains synthesize various bioactive compounds

to fight and defend against pathogens.¹⁷ Akinnuoye-Adelabu et al.²⁹ reported the inhibitory effect of vermiwash along with *Eisenia fetida* mucus on growth of pathogenic fungus *Fusarium graminearum*, thereby enhancing the quality and productivity of wheat plant (*Triticum aestivum* L.).

Food security

Vermicompost and vermiwash can contribute to providing food security of the ever-growing population of humans as well as to animals. In arid and semi-arid regions, drought is one of the major threats to food security, and in order to address the water scarcity, agricultural production systems are required to be changed significantly. *Opuntia ficus-indica* (Prickly pear) holds importance as food and feed source. This plant though a drought tolerant species, shows restricted growth in dry conditions. Lahbouki et al.³⁰ studied the effect of vermiwash in combination with arbuscular mycorrhizal fungi on Prickly pear plant and reported an improvement in physiological and biochemical properties of plant under field drought conditions.³⁰ In another study conducted by Jaikishun et al.,¹² vermiwash and vermicompost formed from *Azadirachta indica*, and *Citrus aurantifolia* using *Eisenia fetida* showed suitable amount of nutrients for plant growth. And hence can be used as an efficient hydroponic solution for increasing the food production for rising population of the world in soil-free medium, thereby dropping the dependence on land.

Salinity tolerance

Crop productivity is influenced greatly by the salt content of soil. Salinity of soil decreases the efficiency of crops. Humic substances present in vermicompost and vermiwash interact with soil and plant roots and effect the tolerance to salinity. Ruiz-Lau et al.³¹ showed the decrease in symptoms of stress when vermicompost is added to soil as well as an increase in tolerance to salinity. This increase in tolerance is attributed to improved activity of antioxidant enzyme, reduced leakage of electrolyte, reduced oxidative stress and Na accumulation in plant tissues. Therefore, the application of vermicompost and vermiwash alleviated the damage occurred due to salinity.³¹

Other applications

Cosmetic and pharmaceutical industry

Vermicomposting has been enhancing not only to plant growth and disease suppression but has been providing an important contribution to cosmetic and pharmaceutical industry. Damsak rose (*Rosa damascena* Mill.) is an important and valuable raw material to perfume, cosmetic, and pharmaceutical industry for its volatile oil from flower petals. In a recent study conducted by Hamedi et al.,³² vermicompost

and animal manure have found to improve quality and quantity of damask rose volatile oil.

Waste management

Biomedical wastes being infectious and containing a collection of pathogenic microorganisms, should be sterilized and then disposed in the environment. This requires utilization of safe, easy and inexpensive methods. Vermicomposting plays an important role in safe management of such wastes and their bioconversion to valuable compost. Vermicomposting is an important tool for recycling of organic wastes. The body of earthworm acts as biofilter and thus helps in reducing the pathogens like *Salmonella* and fecal coliform from biomedical wastes. Also, the process of mechanical grinding and presence of digestive enzymes during vermicomposting helps in reducing population of pathogens.³³ Similar conclusion was reported by Molavi et al.³⁴ in their study that at the end of vermicomposting, there was substantial decrease in fecal coliforms and parasite eggs.

Vermicomposting is a boon not only to the management of biomedical wastes but also for the management of municipal solid waste. The organic fraction of solid waste is effectively managed by vermicomposting. Vermicomposting could also reduce the cost of collection, transport, and disposal of wastes in urban areas thereby benefitting the country's economy. Srivastava et al.,³⁵ in their study, have concluded the efficacy of vermicomposting in waste management plan of Varanasi and designing of similar successful plan to be used throughout the country.

ADVANCEMENTS IN TECHNOLOGY

With the increase in applications of vermicomposting technology, there occurs the need to establish the technology in commercial and business sectors. Production of natural fertilizers by the reuse of civic and agriculture wastes for supporting organic agriculture could be used as a way for supportable and sustainable rural development. New tools, bio-waste mixes, economically viable technologies could pave a way for improving vermicomposting process for family-based agricultural practices.³⁶

Process of pyrolysis produces biochar which is indicated to increase soil organism's biomass and stimulate enzymatic activity. Becagli et al.³⁷ in their study proved that biochar and vermiwash stimulated the rhizospheric activity and increased the soil fertility of tomato crop. In near future, urban farming is going to be technologically advanced. Schröder et al.³⁸ have reported the use of vermicomposting as a dependable technology for increasing the fertility of soils for cultivating lettuce.

Further, mathematical models and sensors are being developed through novel researches with an aim to optimizing vermicomposting parameters using artificial intelligence. Response Surface Methodology (RSM) and Artificial Neural Networks (ANNs) are statistical and machine learning models, respectively, that are utilized for testing,

optimization of data, and verification.³⁹ Both, RSM- and ANNs-based models have found to be accurate for measuring vermicomposting parameters. However, ANNs simulated models achieved greater validity and reliability.⁴⁰ Cost-effective technologies play an important role in facilitating ways for farmers with poor socioeconomic conditions. Choudhary and Suri⁴¹ have developed an affordable technology for utilizing obnoxious weed-flora as vermicompost for plants as nutritive material for vegetable crops, cash crops, and horticulture crops.

Presently, scientists are focusing on nanoparticles and therefore nanotechnology has gained quick emergence as an important application in environment sector. Nanoparticles have been synthesized using vermicomposting leachate and this has contributed towards green chemistry-based nanotechnology. Arslan et al.⁴² have developed an easy and less expensive method of FeO-NPs fabrication by using vermicompost leachate which showed decent biological properties, can be used in production and formulation of new drugs and in biomedical applications. Nanovermicompost can amend the damaging effects caused by drought stress by upregulating the crucial tolerance mechanisms.

Ahanger et al.⁴³ examined the role of nanovermicompost on tomato crop under drought stress. Reactive oxygen species accumulation was reduced significantly and reduced mineral uptake and reduced growth were benefitted by application of nanovermicompost. Protease, lipoxygenase activity, and lipid peroxidation were reduced significantly whereas there was significant increase in osmolyte accumulation.⁴³

CONCLUSION

Vermicompost and vermiwash hold great potential as green pesticide for sustainable agriculture as well as environment improvement. This is a safe and effective way to meet the growing need of food due to increase in population. This technology requires promotion and training to the farmers so that efficient use of locally available material can be done in order to produce vermicompost.

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CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ORCID

Tanvi Singh  <https://orcid.org/0000-0001-5686-4156>

Rachna Kapila  <https://orcid.org/0000-0002-1580-0305>

Maheep Kumar  <https://orcid.org/0000-0002-7094-0941>

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Chemopreventive Action of Compounds from *Parmelia Perlata*

Authors

- Sonal Dobhal
- Maheep Kumar
- Ashok Kumar
- Yogesh Chandra Joshi

Keywords:

Cancer, *Parmelia Perlata*, Ethanolic Extract, LPO, SOD

Abstract

Cancer prevention may be accomplished by phytochemicals obtained from vegetables fruits spices teas herbs and medicinal plants The investigations on the species of *Parmelia* proved to be source of unique chemical agents that have already been proved to be effective against various types of cancer Present study focus on chemopreventive activity against random-bred male Swiss albino mice through oral administration of dried ethanolic extract of traditional medicinal lichen *Parmelia perlata* Further ethanolic extract of entitled lichen afforded three novel compounds

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By Sonal Dobhal, Maheep Kumar, Yogesh Chandra Joshi, Ashok Kumar

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Keywords: Cancer, *Parmelia Perlata*, Ethanolic Extract, LPO, SOD

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Chemopreventive Action of Compounds from *Parmelia Perlata*

Sonal Dobhal ^α, Maheep Kumar ^σ, Yogesh Chandra Joshi ^ρ & Ashok Kumar ^ω

Abstract- Cancer prevention may be accomplished by phytochemicals obtained from vegetables, fruits, spices, teas, herbs and medicinal plants. The investigations on the species of *Parmelia* proved to be source of unique chemical agents that have already been proved to be effective against various types of cancer. Present study focus on chemopreventive activity against random-bred male *Swiss albino* mice through oral administration of dried ethanolic extract of traditional medicinal lichen *Parmelia perlata*. Further ethanolic extract of entitled lichen afforded three novel compounds.

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I. INTRODUCTION

Cancer is classes of disease in which cells do not follow the defined programmed growth pattern rather divided in random uncontrolled manner to invade surrounding tissues and metastasize. Some of the major known reasons behind cancer are spreadness of western diets, increasing tobacco consumption, relentless industrialization, chemicals, radiation, infectious organisms and internal factors like inherited mutations, hormones and immune status. All reasons lead to serious derangement of the ecosystem such that cancer has emerged as a deadly disease across the globe. However, it is now clear that the cause of cancer is not due to one single event, but a multifactorial phenomenon. These risk factors either together or in sequence can initiate or promote carcinogenesis [1].

There is an urgent need to develop mechanism-based approaches for the management of cancer i.e. to develop strategies, which can eliminate only the damaged or malignant cells without harming the normal ones. Basically cancer chemoprevention mechanism uses natural, synthetic or biochemical agents to inhibit the development of invasive cancer by either blocking the DNA damage or by arresting or reversing the progression of premalignant cells [2]. In recent years,

Author α: (Ph.D.), Radiation and Cancer Biology Laboratory, Department of Zoology, University of Rajasthan, Jaipur-302004, India. e-mail: dobhalsonal10@gmail.com

Author σ: (Ph.D.) (Corresponding Author), Department of Chemistry, Sri Varshney PG College, Aligarh-202001. e-mail: maheepchem.svc@gmail.com

Author ρ: (Ph.D.), Lab no. 207, Department of Chemistry, University of Rajasthan, Jaipur- 302019. e-mail: drycj_16@yahoo.com

Author ω: Former Vice Chancellor, DDU University Gorakhpur India and Presently President, Nirwan University, Jhar, Jaipur, India. e-mail: mamsjpr@gmail.com

natural products have been emerged as one of major route of cancer chemotherapy because of its diverse pharmacological properties [3]. However, the prompt pace of gene identification and the new technologies of combinatorial chemistry, high-throughput screening, should provide access to a wide range of totally newly synthetic drugs. Natural products are likely to provide several lead structures and used as templates for the construction of novel compounds with enhanced biological properties.

Parmelia perlata (Lichen) belonging to family Parmeliaceae is one of the potent anticancerous agent. It is commonly known as “Charila” in India and mostly found in hilly region. It is a lichen composed mainly of fungal mycelia that forms a network where algal cells or gonidia are enclosed. It grows in rosettes or spread irregularly over the substratum and resembles a flower in its appearance. Three lichen acids- namely, (+)-usnic acid, vulpinic acid and atranorin were isolated from *Parmelia tinctorum* showed *in vitro* antioxidant effects on mice-liver mitochondrial [4]. Extracts of *Parmelia caperata* demonstrated interesting activities particularly on human cancer cell lines [5]. Gyrophoric, usnic, and diffractaic acid have been shown antiproliferative and cytotoxic activity on human keratinocyte growth [6].

The objective of our study was to explore lichen, *Parmelia perlata* as a chemopreventive agent. Its efficacy has been examined against 7, 12-Dimethylbenzene (α) anthracene (DMBA) and croton oil induced skin papillomas. In our study, mouse skin model of two stage carcinogenesis has been taken as the experimental protocol for various reasons. One of the merit is the latent period which is relatively short in the case of tumours, and therefore, expanse of time for observation is not too long. Animals are not sacrificed for the tumours, as they are externally visible and hence can be scored easily. Also, they are non lethal and efficacy of compound as a potential chemopreventive agent can be concluded by having a look at the number of tumors on the skin of the animal.

II. RESULTS

In group I (control) all the animals were treated with Dimethylbenzene (α) anthracene (DMBA) that was applied once topically and later on after two weeks promoter (croton oil) was applied. Skin papillomas were visible on almost all the animals (100 ± 0.00 percent).

Animals treated orally in the group II, group III, group IV and group V with the extract of *Parmelia perlata* showed significant reduction (66.66 ± 3.33 , 76.66 ± 3.33 , 73.33 ± 3.33 and 56.66 ± 3.33 respectively) ($p < 0.001$) in the tumor incidence i.e. percent as compared to control group which is calculated to be 100 ± 0.00 percent [Table 1 and Graph 1]. The average number of tumors per tumor bearing mouse (Tumor burden) was (3.11 ± 0.34 , 3.22 ± 0.13 , 2.63 ± 0.31 , 1.73 ± 0.17 respectively) that was significantly less comparison to control group (4.63 ± 0.08) [Table 2 and Graph 2]. Increase in average latent period was observed i.e. 11 ± 0.57 , 13.66 ± 0.33 , 12 ± 0.00 , 14 ± 0.00 respectively as compared to control group (11.66 ± 0.66) [Table 3 and Graph 3].

a) Biochemical studies

The Glutathione (GSH) value of animals of control group was 2.31 ± 0.12 , but the animals that were treated with ethanolic extract at pre initiational stage reported 3.05 ± 0.06 ($p < 0.01$) value, for peri initiational stage it was 3.06 ± 0.06 ($p < 0.01$), 3.71 ± 0.06 ($p < 0.01$) was calculated for animals in post initiational stage and mice treated in throughout initiational stage showed i.e. 3.64 ± 0.07 ($p < 0.001$), GSH values that are significantly high as compared to

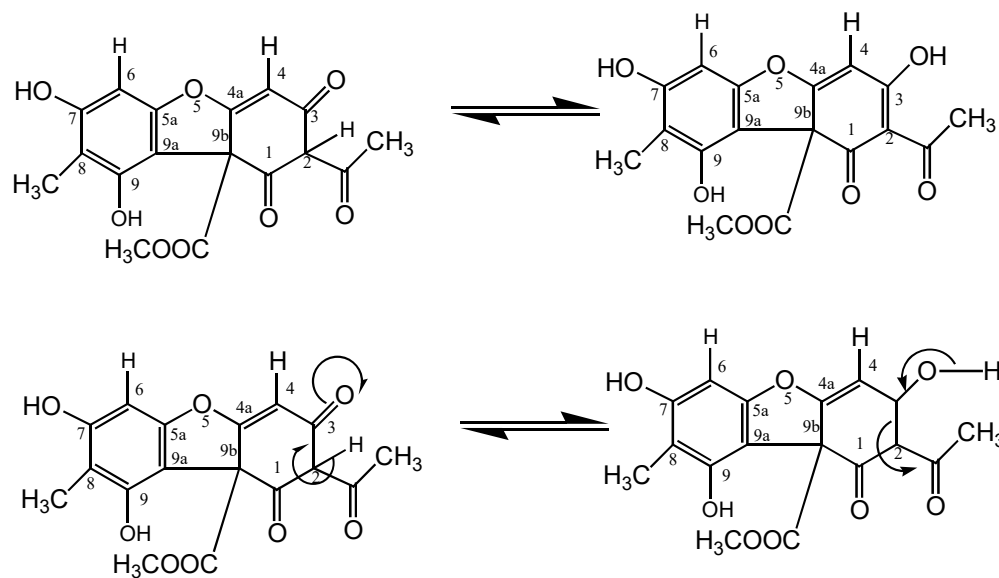
control group. All animals in control group showed high value for Lipid peroxidation (LPO) i.e. 9.00 ± 0.24 , whereas animals of pre group showed low values ($p < 0.001$) for LPO i.e. 6.09 ± 0.20 , same with peri group mice with significantly low ($p < 0.05$) LPO values (6.12 ± 0.59), significant decrease ($p < 0.001$) in post initiational stage mice i.e. 6.04 ± 0.22 , and 6.24 ± 0.44 ($p < 0.01$) was observed for animals that were treated at throughout initiational stage [Table 4 and Graph 4].

b) Compound obtained from ethanolic extract

When the column was eluted with different solvents in order of increasing polarity following compounds were obtained.

i. Isolation of compound 'A' as (+)-6-deacetyl-9b-carbmethoxy-9b-demethylusnic acid

Compound 'A' was obtained when column was eluted with petroleum ether. After solvent removal, a yellow solid mass was obtained which on crystallization with ethyl acetate yielded shining yellow crystals. It showed single spot on TLC examination ($R_f = 0.35$) in petroleum ether: chloroform (3: 1). The melting point of this compound was found to be 131°C . Compound 'A' in solution exists in two tautomeric forms i.e., ketonic and enolic [7-14].



(+)-6-Deacetyl-9b-carbmethoxy-9b-demethylusnic acid

Structure 1

c) Spectral data

IR (KBr, cm^{-1}): 3410 (O-H stretching), 1780 ($>\text{C}=\text{O}$, str.), 1555 ($>\text{C}=\text{C}$ str.), 1055 (C-O, str.) etc.; ^1H NMR (δ ppm, CDCl_3): 2.53 (s, 3H, C-2, $-\text{COCH}_3$), 5.13 (s, 1H, C-4, -H), 6.47 (s, 1H, C-6, -H), 13.32 (s, 1H, C-7, -OH), 2.18 (s, 3H, C-8, $-\text{CH}_3$), 11.98 (s, 1H, C-

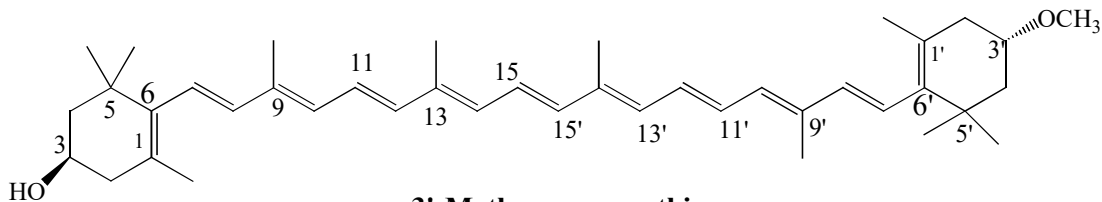
9, -OH), 4.04 (s, 3H, C-9b, $-\text{COOCH}_3$); ^{13}C NMR (δ ppm, CDCl_3): 197.19 (C-1), 108.49 (C-2), 200.38 ($\text{C}=\text{O}$ at C-2), 31.69 ($-\text{COCH}_3$ at C-2), 166.65 (C-3), 101.58 (C-4), 178.11 (C-4a), 140.16 (C-5a), 99.13 (C-6), 165.11 (C-7), 108.49 (C-8), 7.69 ($-\text{CH}_3$ at C-8), 158.02 (C-9), 105.18 (C-9a), 59.87 (C-9b), 172.02 ($-\text{COOCH}_3$ at C-9b), 52.31 (-

COOCH₃ at C-9b); MS (m/z): 346(M⁺), 347 (M⁺ +H), 259, 232, 165 etc; Molecular formula: C₁₇H₁₄O₈ (Calculated).

i. Isolation of compound 'B' as 3'-Methoxy-zeaxanthin

It was isolated as intense orange-red crystalline compound when we eluted column with mixture of

petroleum ether with chloroform (1:1) and it showed single spot on TLC examination. Melting point of compound was found to be 163 °C [15].



3'-Methoxy-zeaxanthin

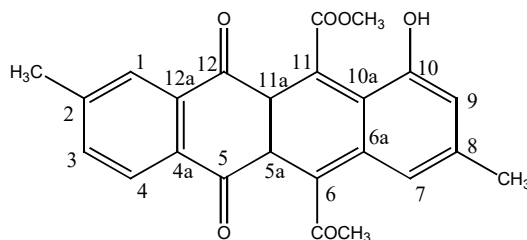
Structure 2

d) Spectral data

IR (KBr, cm⁻¹): 3410 (O-H stretching), 1440, 1370 (-CHMe₂ gem bend.) 1625(>C=C< str.), 1105 (C-O, str.) etc. ¹H NMR (δ ppm, CDCl₃): 2.61 (s, 3H, C-3', -OCH₃), 5.13-6.00 (m, 1H, for 14 conjugated protons), 4.11 (s, 1H, C-3, -OH), 1.45-1.91 (m, 3H, for remaining 38 protons). ¹³C NMR (δ ppm, CDCl₃): 28.03 (C-5), 29.43 (C-1'), 45.31 (C-2), 49.24 (C-4), 50.68 (C-2'), 65.89(C-3), 75.38(C-3'), 42.01(C-4'), 140.90-143.07 (C-1, C-6, C-5' and C-6'), 132.01-134.01(Complicated pattern for conjugated carbon); MS (m/z): 580(M⁺), 581(M⁺ +H), 565, 550, 535, 400, 364, 277, 212 etc.; Molecular formula(Calculated): C₄₁H₅₆O₂.

i. Isolation of compound 'C' as 6-acetyl-11-carbomethoxy-10-hydroxy-2,8-dimethylnaphthacene-5,12-quinone (New)

Compound 'C' was obtained when column was eluted with petroleum ether. After removal of solvent, it was redissolving in acetone. Acetone soluble part was crystallized into yellow shining crystals. It showed single spot on TLC examination in petroleum ether: chloroform (4:1) mixture. The melting point of this compound was found to be 141°C.



6-Acetyl-11-carbomethoxy-10-hydroxy-2,8-dimethylnaphthacene-5,12-quinone

Structure 3

e) Spectral data

IR (KBr, cm⁻¹): 3310 (O-H stretching) 1733, 1762 (>C=O, str.), 1625(>C=C< str.), 1053 (C-O, str.) etc. ¹H NMR (δ ppm, CDCl₃): 2.52 (s, 3H, C-2, -CH₃), 6.47 (s, 1H, C-9), 2.77 (s, 3H, C-6, -COCH₃), 2.11 (s, 3H, C-8, -CH₃), 12.41 (s, 1H, C-10, -OH), 4.00 (s, 3H, C-11, -COOCH₃), 6.13(d, 1H, C-3), 6.29 (s, 1H, C-7), 6.22 (s, 1H, C-1), 6.17 (d, 1H, C-4). ¹³C NMR (δ ppm, CDCl₃): 162.09 (C-1), 109.21 (C-2), 10.25 (C-2, -CH₃), 110.49 (C-3), 161.09 (C-4), 115.75 (C-4a), 181.35 (C-5), 141.21(C-6), 194.10 (-COCH₃ at C-6), 24.10(-COCH₃ at C-6), 108.21 (C-6a), 163.23 (C-7), 137.21 (C-8), 28.21 (CH₃ at C-8), 118.14 (C-10), 128.51 (C-11), 178.25(-COOCH₃ at C-11), 51.79 (-COOCH₃ at C-11), 187.23 (C-

12), 153.44 (C-11a); MS (m/z): 402(M⁺), 403 (M⁺ +H), 401, 385 etc; Molecular formula(Calculated): C₂₄H₁₈O₆,

III. DISCUSSION

The study conducted on *Parmelia perlata* signifies that the oral administration of the vacuum dried ethanolic extract of *Parmelia perlata* at pre, peri, post and throughout initiational phases showed a significant reduction in tumor incidence, tumor burden, and a significant increase in average latent period and displayed a significant increase in GSH whereas a significant decrease was observed for LPO. The chemopreventive effects of the natural dietary compounds includes antioxidative, anti-inflammatory

activity, induction of phase I and phase II enzymes, apoptosis and cell cycle arrest. Recently, attention has been focused on intracellular-signalling cascades as common molecular targets for various chemopreventive natural dietary compounds [16]. Data obtained after epidemiological and experimental studies provided the information that antioxidants also includes a vast variety of nutritional factors in inhibiting or reducing the risk of cancer. Such antioxidants include vitamin A, C and E, beta carotene, and micronutrients [17].

Lichens have been found to contain a variety of secondary lichen substances and have attracted the attention of investigators for over 100 years. The most known lichen substances are usnic acid, phenolic compounds, anthraquinones, dibenzofurans, depsides, depsidones, depsones, triterpenes, gamma lactones and pulvinic acid derivatives and exhibit multiple biological activities such as antiviral, antibiotic, antitumor, allergenic, plant growth inhibitory and enzyme inhibitory [18]. Usnic and atranorin acids like secondary metabolites were found out to be effective in the suppression of viability and cell proliferation at equitoxic doses and also demonstrated increased number of floating cells or a higher apoptotic index [19].

Therefore, because of the presence of secondary metabolites in the lichens, they have immune-modulating properties, potent antibiotic, antitumor, antiviral as well as antioxidant properties [20]. Further, the ethanolic extract was observed for its reduced glutathione level. GSH act as an antioxidant, as by reacting with singlet oxygen, hydroxyl radicals and superoxide it can function as a free radical scavenger. Also, by removing acyl peroxides formed as a result of lipid peroxidation, GSH may stabilize membrane structure [21]. Moreover, study reported GSH acts as a reducing agent by recycling ascorbic acid (vitamin C) from its oxidized form to its reduced form by dehydroascorbate reductase enzyme [22]. The enhanced levels of Glutathione prevents the oxidation of cellular proteins and detoxifies reactive oxygen species directly. Oxygen free radicals play an important role in stimulating cancer development at all three stages of carcinogenesis i.e. initiation, promotion and progression [23]. The increased reduced glutathione level plays a significant role in the reduction of oxidized glutathione to reduced glutathione at the expenses of NADPH and regulates GSH-GSSG cycle in the cell [24]. Hence, glutathione is often considered as the first line of defense against oxidative stress. Also, the elevated levels of GSH protects proteins in the cells against oxidation through redox cycle and detoxifies reactive oxygen species directly and/or neutralizes reactive intermediate species generated from exposure to xenobiotics including chemical carcinogens [25]. Membranes where the unsaturated fatty acids content is relatively high, lipid peroxidation occurs. Free radicals are fundamentals to any biochemical processes and

represent an essential part of aerobic life and metabolism. It may be defined as any species, that is capable of independent existence and contains one or more unpaired electrons. Free radicals are atoms or groups of atoms with at least one unpaired electron and because of this they are highly reactive. They are highly toxic in nature and if accumulated they can destroy macromolecules like lipids, proteins, mitochondrial and nuclear DNA molecules of the cells and causes oxidative stress [26]. To safeguard against the fatal effects of free radicals and their derivatives all cells and tissues of our body are equipped with antioxidative enzymes like superoxide dismutase (SOD), glutathione peroxidase (GPx), glutathione reductase (GR) and substances like glutathione (GSH), they dispose the free radicals as and when they are generated thereby protecting the cells and tissues from the oxidative attack. About 1-4% of oxygen taken up in the body is converted as free radicals.

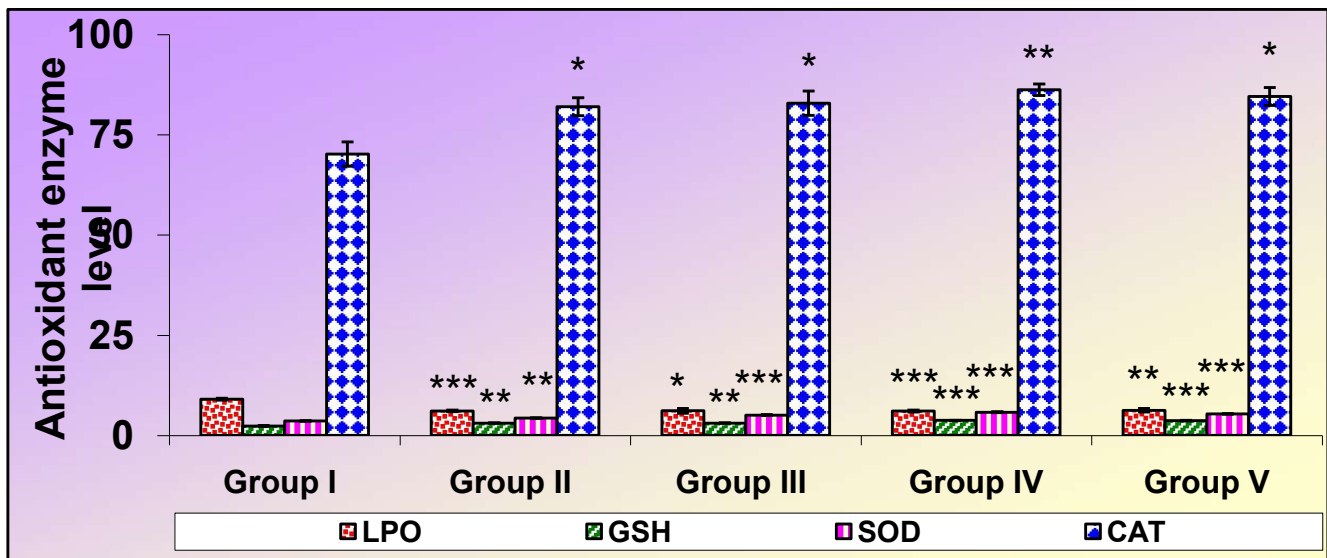
Increase in the activity of Chloramphenicol acetyltransferase (CAT) enhances the free radical scavenging activity of SOD. At the present time, it is suspected that lichens do act as potent antioxidants, therefore, in search for new natural antioxidant sources, attention has been focused on lichens [27]. Lichens produce secondary metabolites like depsides, depsidones, dibenzofurans and phenolic compounds, and they possess biological activities like antimicrobial, antipyretic, antiproliferative, cytotoxic, antitumor, analgesic and antioxidant [28]. In the laboratory it was revealed that lichens behaves as antioxidant because of presence of particular types of compounds [29]. The investigations on the species of *Parmelia* proved to be source of unique chemical agents that have already been proved to be effective against various cancers. Among these few reported compounds some showed activity against few human cancers [6].

Usnic acid and atranorin are effective anticancer compounds, they both have the capability to induce a massive loss in the mitochondrial membrane potential, along with activation of Caspase3 (only in HT-29 cells) and phosphatidylserine externalization in both tested cell lines. It was observed that both usnic acid and atranorin are activators of programmed cell death in A2780 and HT-29 through mitochondrial pathway [30]. Usnic acid may be considered for non-genotoxic anticancer drugs, as it without causing any DNA damage to DNA can decrease the proliferation of human breast cancer cells and human lung cancer cells [31].

IV. MATERIALS AND METHODS

Animal: Random-bred male Swiss albino mice (7-8 weeks age old) were maintained in the animal house at temperature of $24^{\circ} \pm 3^{\circ}\text{C}$ and at light of 14:10 hours of light and dark. The animals housed in polypropylene

		Croton oil (100 µg of 1% conc. + <i>Parmelia perlata</i> (800 mg/kg body wt./day)						peri, peri, post initiational stages of papillomage nesis
Group IV	9	DMBA (100 µg/50 µl acetone + Croton oil (100 µg of 1% conc. + <i>Parmelia perlata</i> (800 mg/kg body wt./day)	14 weeks	6.04±0.22***	3.71±0.06***	5.76±0.10***	86.19±1.46**	<i>Parmelia perlata</i> (800 mg/kg body wt./day) at post initiational stages of papillomage nesis
Group V	9	DMBA (100 µg/50 µl acetone + Croton oil (100 µg of 1% conc. + <i>Parmelia perlata</i> (800 mg/kg body wt./day)	14 weeks	6.24±0.44**	3.64±0.07***	5.34±0.06***	84.50±2.23*	<i>Parmelia perlata</i> (800 mg/kg body wt./day) at peri, peri, post initiational stages of papillomage nesis



Group I: CONTOL- 16 weeks duration
 Group II: Pre-initiation stage (800mg/kg body wt./day)
 Group III: Peri-initiation stage (800mg/kg body wt./day)
 Group IV: Post-initiation stage (800mg/kg body wt./day)
 Group V: Throughout-initiation stage (800mg/kg body wt./day)

Graph 4: The modulatory effect of 800 mg/kg b.wt/day of *Parmelia perlata* extract on the GSH, LPO, SOD and CAT levels in the tissue of Swiss albino mice after initiation of DMBA, followed 2 weeks later by croton oil treatment (three times in a week) for 14 weeks with or without treatment for *Parmelia perlata*

i. Preparation of Homogenate for Biochemical Studies

Animals were killed by cervical dislocation and its dorsal skin was taken off, it was then trimmed into pieces and weighed. For reduced glutathione assay it was homogenized in ice-cold Tris KCl buffer (pH 7.4) to yield a 10% (w/v) homogenate. 0.5ml aliquot of this was used for examining reduced glutathione. For assaying lipid peroxidation the tissue was homogenized in ice-cold 1.15% KCl to yield 10% (w/v) homogenate. For lipid peroxidation assay 0.8 ml aliquot was used.

Reduced glutathione (GSH): GSH is total non-protein sulphhydryl group which is estimated by the method [32]. Absorbance was read against blank at 412 nm wavelength using UV-VIS Systronics spectrophotometer [33]. Absorbance was taken at 532 nm wavelength using UV-VIS Systronics spectrophotometer.

d) Statistical Analysis

i. Study parameters

Statistical significance of difference between control and experimental groups were determined by Student's t- test and Analysis of variance (ANNOVA) test.

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Plate - I



Fig. 1: Normal unclipped male Swiss albino mice



Fig. 2: Male Swiss albino mice with papillomas developed on the dorsal side after topical application of 7, 12-dimethylbenz(a) anthracene (DMBA) and croton oil



Fig. 3: Reduced number of papillomas were displayed by the mice treated orally with *Parmelia perlata* extract at a dose level of (800 mg/kg body wt./day)



Phytochemical and Pharmacological Profile of *Terminalia chebula*

Kumar M^{1*}, Sharma N² and Singh Ranjan A³

¹Department of Chemistry, Sri Varshney PG College, India

²Department of Chemistry, University of Rajasthan, India

³Department of Zoology, University of Rajasthan, India

*Corresponding author: Maheep Kumar, Department of Chemistry, Sri Varshney PG College, India, Tel: +91-6396096995; Email: maheepchem.svc@gmail.com

Review Article

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Abstract

Plant secondary metabolites have been of interest to man for a long time due to their pharmacological relevance. In this search *Terminalia chebula* is widely used to enhance the natural resistance to various diseases. It is called the “king of medicines” and always listed first in the Ayurvedic materia medica because of its extraordinary powers of healing. Traditionally it has been used as a popular folk medicine for homeostatic, antitussive, laxative, diuretic and cardio tonic treatments. Recent studies showed that it has also been used as antidiabetic, antiviral, cardioprotective, anticancer, antioxidant, free radical scavenging and hypolipidemic agent. The present review is an attempt to highlight the various ethnopharmacological and traditional uses as well as phytochemical and pharmacological aspect of *Terminalia chebula*.

Keywords: *Terminalia Chebula*; Pharmacological Effect; Gastrointestinal Activity; Anticariogenic Effect; Antidiabetic Effects; Cardiotonic Activity; Phytochemical Constituents

Abbreviations: ITM: Iranian Traditional Medicine; STZ: Streptozotocin; IFHP: Isolated Frog Heart Perfusion Technique; LDL: Low Density Lipoprotein; VLDL: Very Low Density Lipoprotein; HDL: High Density Lipoprotein; MIC: Minimum Inhibitory Concentration; HSV: Herpes Simplex Virus; CA: Chromosomal Aberration; MN: Micronucleus; HETC: Hydroalcoholic Fruit Extract of *Terminalia Chebula*; MES: Maximal-Electroshock; EPM: Elevated Plus Maze; PI: Phagocytic Index; AI: Avidity Index, NBT: Nitro Blue Tetrazolium; MT: Mother Tincture.

Introduction

Terminalia chebula is a native to various parts of Southern Asia including India, Nepal, China (Yunnan), Sri Lanka, Malaysia and Vietnam [1]. It is found all over India from eastern to western region and is commonly known as “black ‘Myroblans’” in English and ‘Harad’ in Hindi. It is known as the “king” of Mongolian and Tibetan medicines, a drug for a wide range of diseases [2]. This tree is known in Iranian traditional

medicine (ITM) as halileh or halilaj and the fruit is used to develop treatments [3]. In Ayurveda *Terminalia chebula* is considered to destroy all diseases and eliminate all waste from the body. At the same time, it is known to promote tissue growth and health. It is most powerful Ayurvedic herb used in the treatment of any kind of gastric infection in any part of the body. It is found to be an effective product for infections caused by *E. coli* and other parasites of the digestive system. Recent studies have demonstrated that *T. chebula* exhibits a wide range of biological activities including cardioprotective [4], antispasmodic [5], antioxidant [6], free radical scavenging [7] and hypolipidemic [8]. Its antimicrobial [9], antiviral [10,11], anticancer [12], antianaphylaxis [13] and antidiabetic [14] activities.

Habitat

Terminalia chebula is a deciduous tree growing upto 30 mts. tall with a trunk up to 1 mt. diameter. The leaves are alternate to sub opposite in arrangement, oval, 7-18 cm

long and 4.5-10 cm broad with a 1-3 cm petiole. The fruit is drupe-like, 2-4.5 cm long, 1.2-2.5 cm broad and blackish with

five longitudinal ridges [15] (Figures 1 & 2).



Figure 1: Leaves of *T. chebula*.

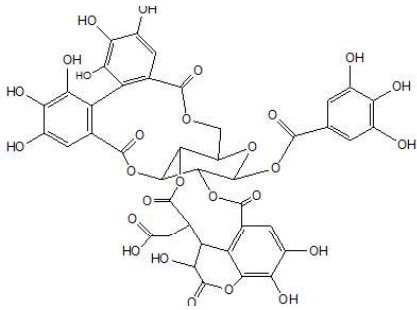

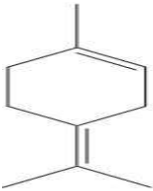


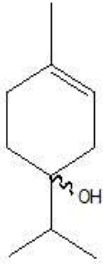
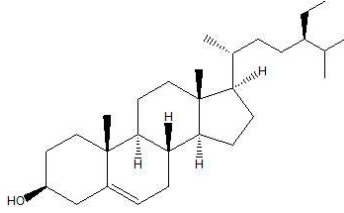
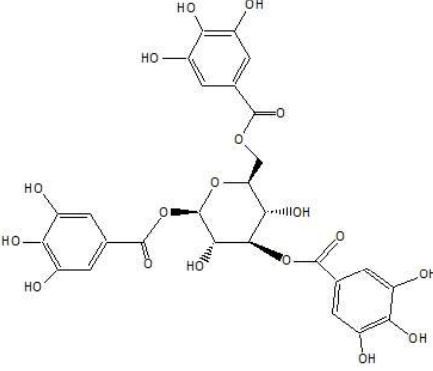
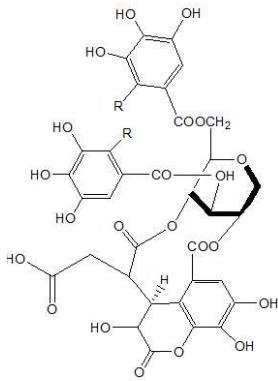
Figure 2: Fruits of *T. chebula*.

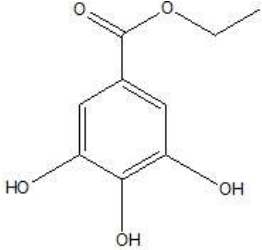
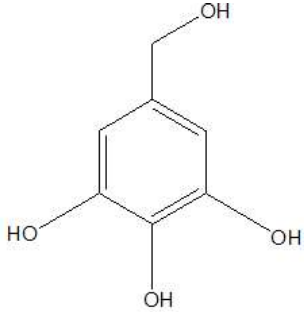

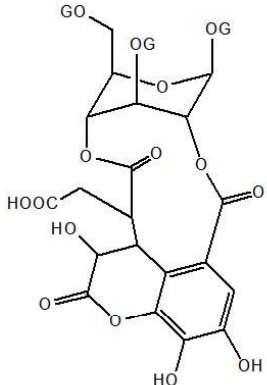
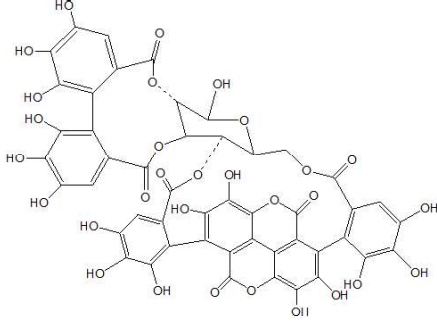
Taxonomical Classification

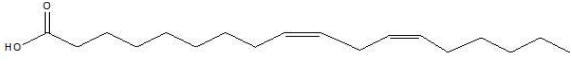
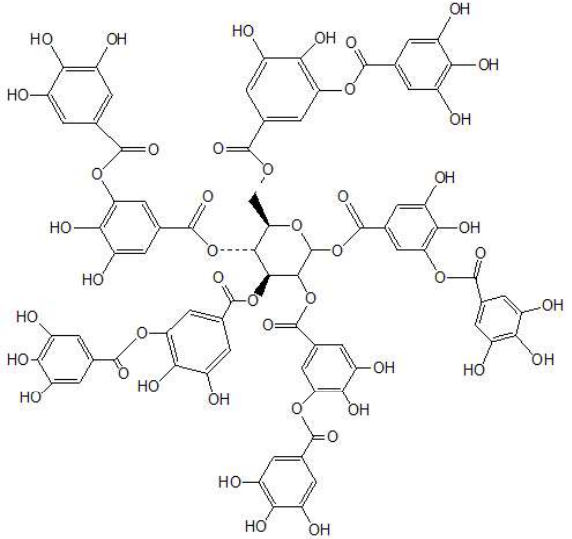
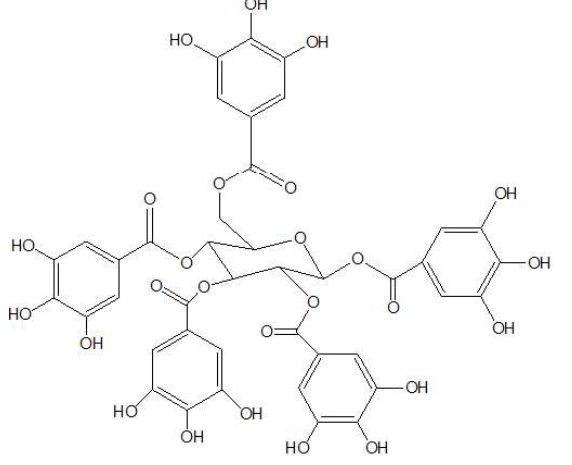
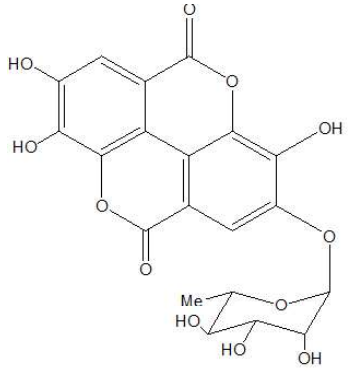
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Division: Magnoliophyta
Class: Magnoliopsida

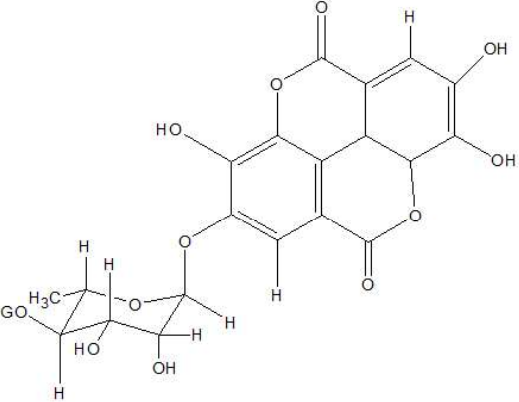
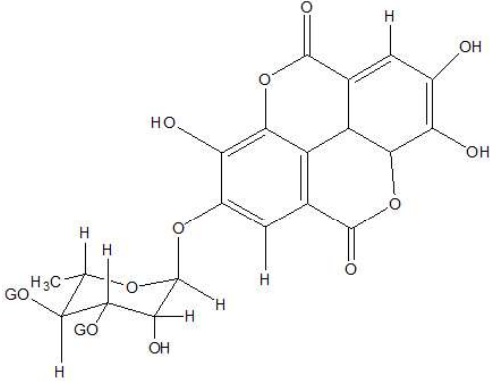
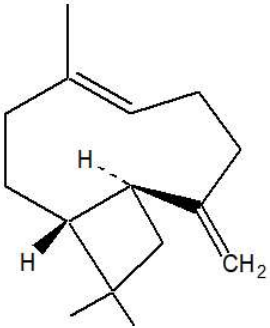
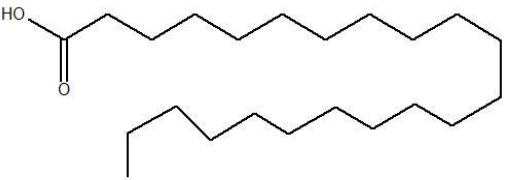
Order: Myrtales
Family: Combretaceae
Genus: *Terminalia*
Species : *Terminalia chebula*

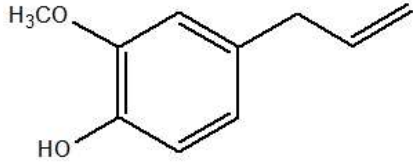
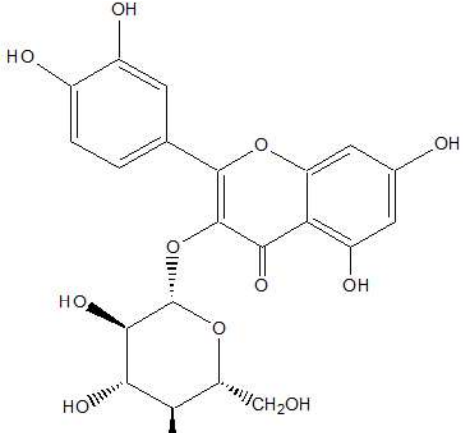
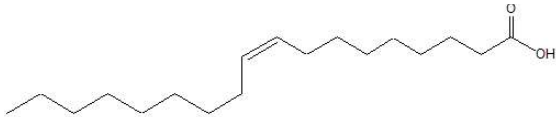
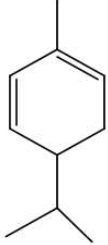
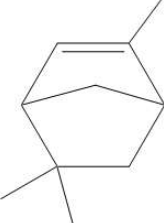
S. No.	Chemical constituent	Plant part	Pharmacological activity	References
1.	 Chebulagic Acid	Fruit	Immuno- suppressive effects	[20] [39,40,41] [46,47]
2.	 Triacontanoic Acid			[10]
3.	 Terpinolene			[10]

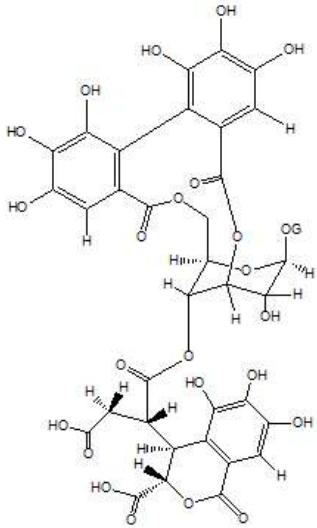
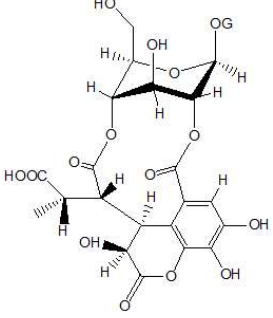
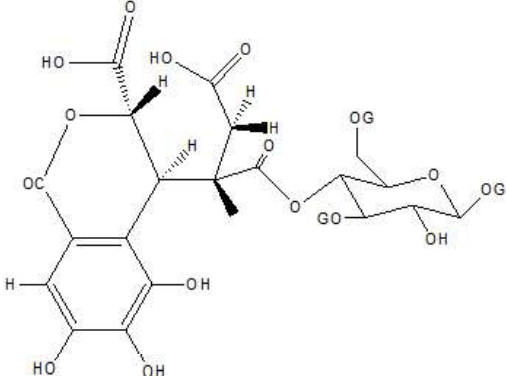
4.	 <p>Terpinen-4-ol</p>			[10]
5.	 <p>β Sitosterol</p>	Fruit		
6.	 <p>Corilagin</p>			[47]
7.	 <p>Chebulic Acid</p>	Fruit	Hepatoprotective	[45] [47]

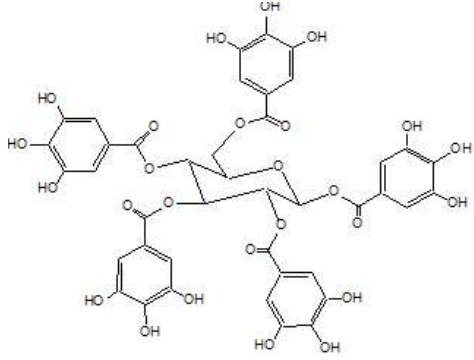

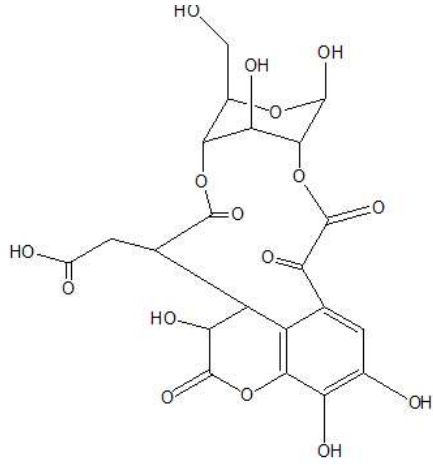
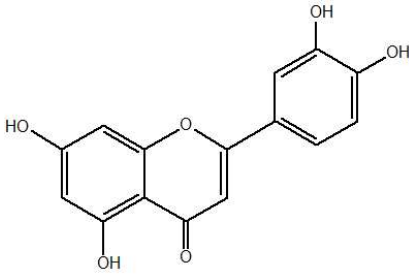
8.	 <p>Ethyl Gallate</p>	Fruit	Anticancer	[49]
9.	 <p>Gallic Acid</p>	Fruit	Anticancer	[47] [49]
10.	 <p>Stearic Acid</p>			[46]
11.	 <p>(G = Galloyl) Chebulinic acid</p>	Fruit	Anticancer	[40] [46][47] [49]
12.	 <p>Punicalagin</p>			[47]

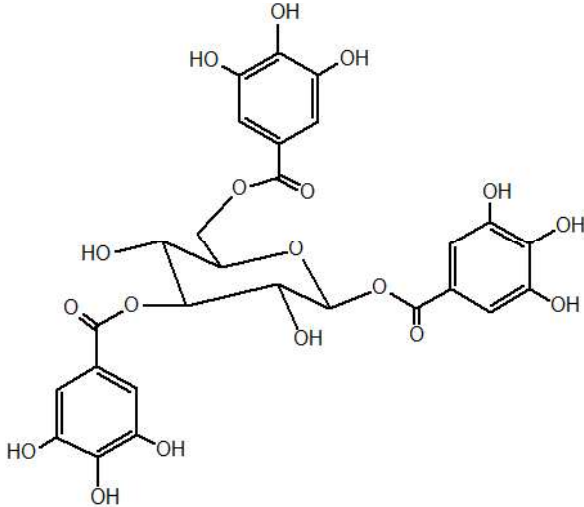
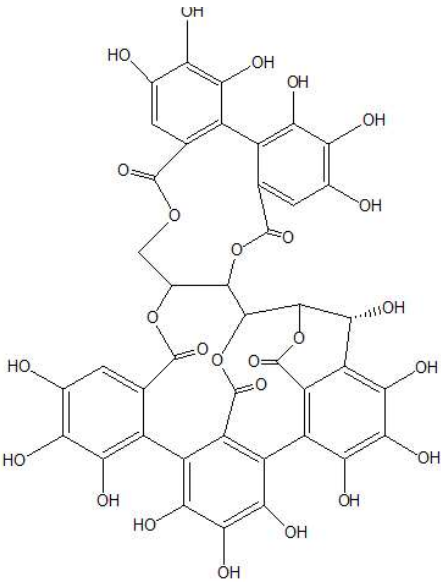
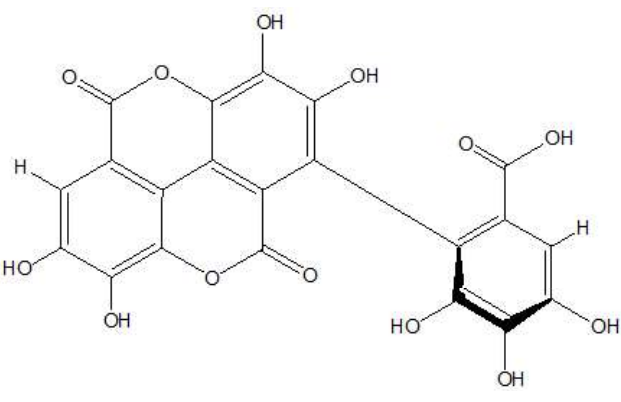
13.	 <p style="text-align: center;">Linoleic Acid</p>	Fruit		[48]
14.	 <p style="text-align: center;">Tannic Acid</p>	Fruit	Anticancer, Antioxidant	[37] [49]
15.	 <p style="text-align: center;">Galloyl Glucose</p>		Anti HIV	[9]
16.	 <p style="text-align: center;">Ellagic Acid</p>	Fruit	Anticancer, Anti HIV	[9,10] [47,49]

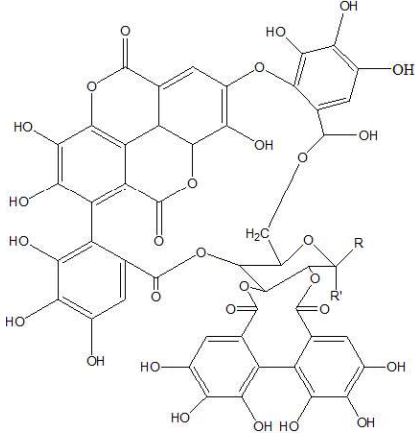
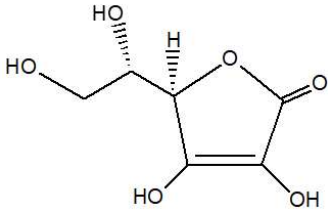
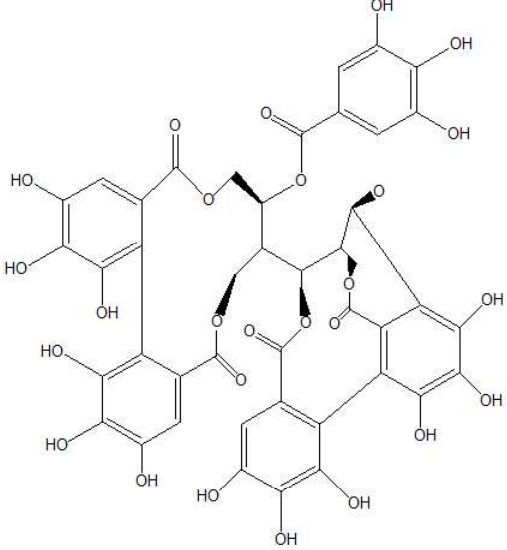
17.	 <p>(G = Galloyl) 4-O-(4''-O-galloyl-α-l-rhamnopyranosyl)ellagic acid</p>			[40]
18.	 <p>(G = Galloyl) 4-O-(3'',4''-di-O-galloyl-α-l-rhamnopyranosyl)ellagic acid</p>			[40]
19.	 <p>β Caryophyllene</p>			[10]
20.	 <p>Behenic acid</p>			[10]

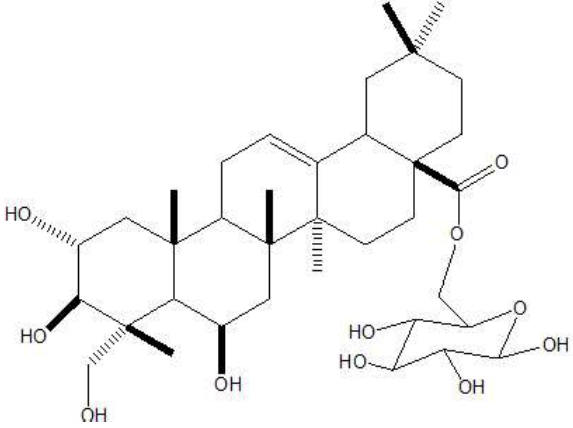
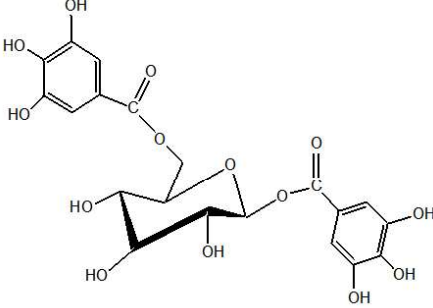
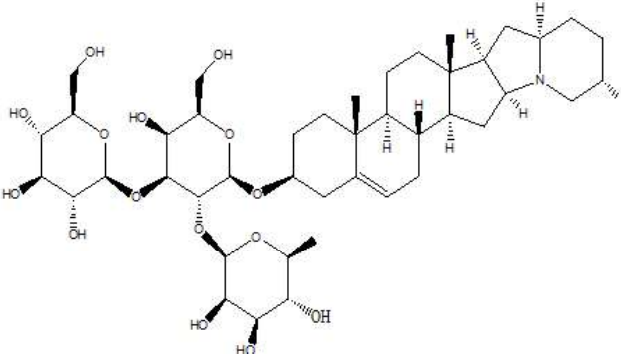
21.	 <p style="text-align: center;">Eugenol</p>			[10]
22.	 <p style="text-align: center;">Isoquercetin</p>			[10]
23.	 <p style="text-align: center;">Oleic acid</p>	Fruit		[10] [48]
24.	 <p style="text-align: center;">[Ca]²⁺ Ca-phellandrene</p>			[10]
25.	 <p style="text-align: center;">Alpha terpine</p>			[10]

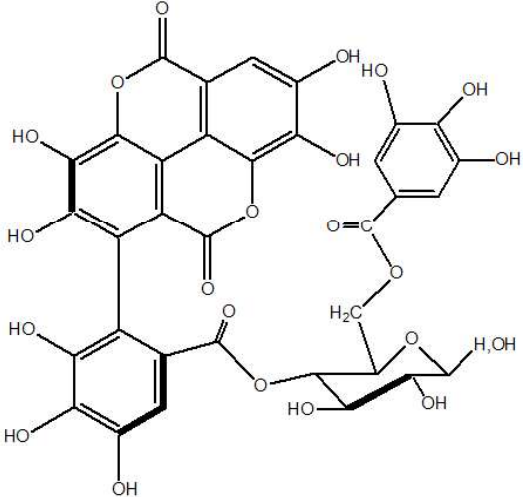
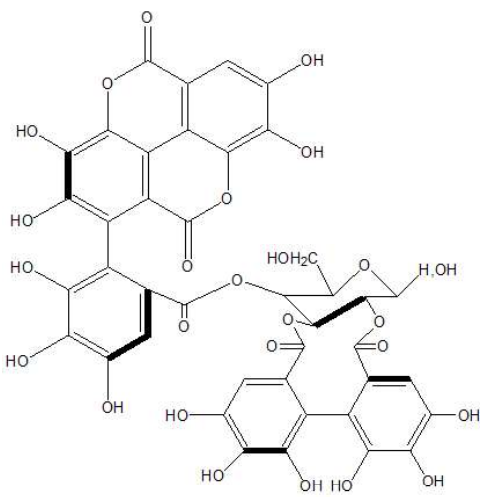
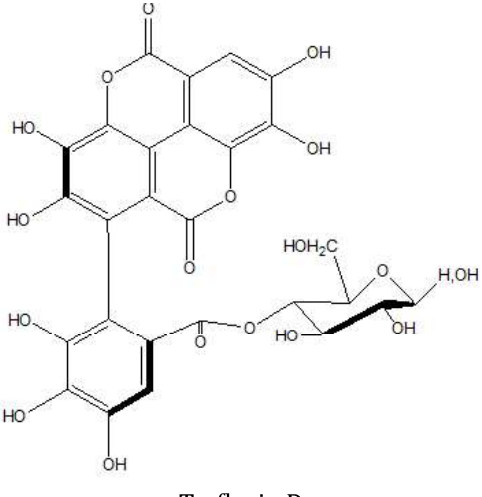
26.	 <p>(G = Galloyl) Neochebolic acid</p>		Hepatoprotective	[45]
27.	 <p>(G = Galloyl) Chebulanin</p>	Fruit		[47]
28.	 <p>Neochebolic acid</p>			[47]

29.	 <p>1,2,3,4,6-penta-O-galloyl-beta-D-glucose</p>	Fruit		[47]
30.	 <p>Palmitic acid</p>	Fruit		[48]
31.	 <p>2,4-Chebulyl-beta-D-glucopyranose</p>	Fruit	Anticancer	[49]
32.	 <p>Luteolin</p>		Anticancer	[49]

33.	 <p>1,3, 6-Tri-O-galloyl-β-D-glucose</p>			[51] [55]
34.	 <p>Castalagin</p>			[52]
35.	 <p>Flavogallonic acid</p>			[52]

36.	 <p>(α- R=H, R'=OH) (β- R=OH,R'=H) Terchebulin</p>			[52]
37.	 <p>Ascorbic acid</p>	Fruit		[37]
38.	 <p>Casuarinin</p>	Fruit		[53]

39.	 <p>Chebuloside II</p>	Fruit		[54]
40.	 <p>1,6-di-O-galloyl-β-D-glucose</p>	Fruit		[53]
41.	 <p>Saponin</p>	Fruit		[55]

42.	 <p>Terflavin B</p>	Leaves		[56]
43.	 <p>Terflavin C</p>	Leaves		[56]
44	 <p>Terflavin D</p>	Leaves		[56]

Chemical Constituents Table.

Table 1: Phytochemical Constituents Isolated from *Terminalia* and Their Pharmacological Activity.

Ethnic Uses

Plants of the genus *Terminalia* are amongst the most widely used plants for traditional medicinal purposes worldwide [16]. Plant-derived medicines have been a part of our traditional health care system and the antimicrobial properties of plant-derived compounds are well documented. It is one of the main ingredients of the Triphla (*Terminalia chebula*, *Terminalia belerica*, and *Emblica officinalis*). Triphla is an Ayurvedic preparation that is used for correcting the digestive ailments. It is also useful in asthma, mouth ulcers, stomach infections, gastritis, hepatitis, skin diseases, piles and cough. It is used as gargle against inflammation of mucous membrane of mouth. Its paste with water is found to be anti-inflammatory, analgesic and having purifying and healing capacity for wounds. Its decoction as a lotion is used in surgical dressing for healing the wound earlier. The dried ripe fruit of herb has traditionally been used as a popular folk medicine for homeostatic, antitussive, laxative, diuretic and cardiotoxic treatments [16,17].

Study of Pharmacological Effects

In recent years, there is an upsurge in the clinical usage of indigenous drugs, because of their efficacy and being free from serious toxic effects. Moreover constant increase in the antibiotics resistant strains and various side effects caused by the synthetic drugs has prompted scientists to look for herbal immunomodulators to treat various infections [18]. Herbal drugs are believed to enhance the natural resistance of the body against infection and their immunomodulatory activities have been reported in numerous plants [19]. Herbs are selected and combined for their ability to inhibit microbial overgrowth in various parts of the body and support those organ systems responsible for immune functions [20].

Anticariogenic Effect

The aqueous extract of *T. chebula* is used as a mouth rinse seems to be a potential anticariogenic mouthwash. A mouth rinse of 10% concentration was prepared by diluting the concentrated aqueous extract of the fruit of *T. chebula* in sterile distilled water. The efficacy of the mouth rinse was assessed by testing on 50 salivary samples. Salivary samples were collected from subjects assessed to be at high risk for caries. Salivary pH, buffering capacity and microbial activity were assessed before rinsing, immediately after, and 10 min, 30 min and 1 h after rinsing. There was an increase in the pH and buffering capacity and decrease in microbial count [21].

The total phenol content of aqueous extract was found to be 21.33 ± 1.633 (mean \pm SD) and total flavonoids as found to be 23.17 ± 2.317 (mean \pm SD). There was a gradual increase in pH till 45 minutes post-rinse when compared to pre-rinse was observed. Antimicrobial effect of *Terminalia*

chebula against microbes showed that there was a significant reduction between the pre-rinse and post-rinse samples [22].

Activity Against Anaphylactic Shock

The water soluble fraction of methanol extract of *T. chebula* fruit was tested in an anaphylactic shock model *in vivo*, by the death of Spague-Dawley rats (200-300 g) and ICR mice (20-30 g). Doses of 0.01-1.0 g/kg of the extract, administered 1 h before the experiment inhibited the anaphylactic shock with 100 %. Administration 5-10 mins after decreased the mortality dose dependently. Oral application reduced the cutaneous anaphylaxis with 63.5 +/- 7.8 %. From the rat mast cells the release of histamine was hindered in a dose dependent manner [13].

Gastrointestinal Activity

Terminalia chebula is a commonly advocated agent in Ayurveda for improving gastrointestinal motility. Charles Foster rats (150-200 grams of either sex) were divided into four groups as follows - Group 1 (n = 15) normal animals; Group II (n = 6) rats administered metoclopramide (1.35 mg/kg); Group III (n = 8) rats given atropine (0.45 mg/kg). These agents were injected intramuscularly, 30 mins before the experiment. Rats from Group IV (n = 8) were administered *Terminalia chebula* (100 mg/kg/day for 15 days orally). All rats were then given a test meal of methyl cellulose (1.5%) mixed with phenol red (50 mg/100 ml) orally and gastric emptying was measured 20 mins later. Gastric emptying of normal rats (Group I) was found to be 51.6 +/- 7.79%. Metoclopramide significantly increased the gastric emptying (76.33 +/- 12.37%; p < 0.01) and atropine inhibited the motility (% gastric emptying being 7.26 +/- 19.76%; p < 0.01). *Terminalia chebula* was found to increase the percent gastric emptying (86.57 +/- 6.65%; p < 0.01). Thus from this study it appears that *Terminalia chebula* can serve as a useful alternative to prokinetic drugs available today [23].

The antimicrobial action of *Terminalia chebula* especially on gastrointestinal tract is considered in supplementation of soothing to mucosal lining. Ellagic acid present in *T. chebula* has a potent inhibitory action on microorganisms like *C. perfringens* and *E. coli*. It is commonly advocated for increasing the gastrointestinal motility thus relieving the symptoms of gastroparesis for better bioavailability and fast absorption of the micronutrient. The presence of anthraquinone and sennoside are responsible for the purgative action. Studies have also shown the additional antibacterial activity of *T. chebula* on *Helicobacter pylori*. Reports have shown the extract of *T. chebula* to be effective against a broad spectrum of pathogens comprising of both gram positive as well as gram negative microorganisms [24].

Immunosuppressive Effects

Gallic acid and chebulagic acid, isolated from fruits of *T. chebula* inhibited the killing activity of CD8 and CTL clones at IC₅₀ values of 30 and 50 μ M, respectively. Granule exocytose in response to anti-CD3 stimulation was also blocked by both substances at the equivalent concentrations [25]. Chebulagic acid from immature seeds of *T. chebula* was found as a potent suppressor of the T cell activity. In DBA/1J mice arthritis was induced by subcutaneous immunization with bovine type II collagen on days 0 and 21. Chebulagic acid was administered intraperitoneally for 3 weeks, either as prophylaxis (10 or 20 mg/kg) before disease onset or as a therapy (20 mg/kg) after disease onset. In both the prophylactic and either in the therapeutic model, all clinical scores, like serum levels of total and anticollagen IgG and levels of interleukin-10 and interleukin-6 were reduced. The serum levels of the transforming growth factor beta were markedly elevated. The number of the granulocytes was reduced, but the proportion of CD4+, CD25+ T cells was greater in the knee joints of the chebulagic acid-treated mice. It concludes that chebulagic acid significantly suppressed the onset and progression the disease in mice [26].

The biologically active compounds such as chebulagic acid, gallic acid and ellagic acid make *T. chebula* highly potent antioxidant, which may be responsible for its immunomodulatory activity [17,27,28]. Its extract neutralizes reactive oxygen species (ROS) and scavenges free radicals. The free radicals are responsible for causing inflammation by stimulating release of cytokines such as IL-1, TNF- α and IFN- β , which stimulate additional neutrophils and macrophages at site of inflammation [29]. Thus, different antioxidants of the extract exhibit immunosuppressive properties, which help in neutralizing these important inflammatory mediators [30].

Antidiabetic Effects

The chloroform extract of *T. chebula* seed powder, produced significant antidiabetic effects with various doses in Streptozotocin-induced diabetic rats using short term and long term study protocols. In short term studies, *T. Chebula* extract produced a maximum reduction of blood glucose of 20.85% ($p < 0.01$), 28.45% ($p < 0.001$) and 42.20% ($p < 0.001$) at 4 h with doses of 100, 200 and 300 mg/kg respectively, whereas glibenclamide (0.04 mg/kg) produced a maximum reduction of 50.44% (4 h, $p < 0.001$) compared to control group. While the long term administration of *T. chebula* (300 mg/kg) for four weeks produced significant reduction in blood glucose. The reduction was significant after treatment for one week in both the extract and glibenclamide treated groups and continued to increase up to four weeks. At the end of 4th week, *T. chebula* extract produced significant blood glucose reduction of 53.09% ($p < 0.01$). On the other hand,

glibenclamide produced significant blood glucose reduction of 60.10% ($p < 0.01$). The hepatic and skeletal muscle glycogen content decreased to 75 % and 62.2 % in the diabetic controls. In the *in vitro* investigation the pancreatic islets showed that the insulin release was nearly two times more than that in untreated diabetic animals. The treatment did not bring any unfavourable effects on the other blood parameters of the liver and the kidney function tests. The LD₅₀ value was above 3 g/kg. There were no deaths of animals even at this dose [31].

Oral administration of ethanolic extract of the fruits (200 mg/kg body weight/rat/day) for 30 days significantly reduced the levels of blood glucose and glycosylated hemoglobin in streptozotocin (STZ)-induced experimental diabetes in rats. Electron microscopic studies showed significant morphological changes in the mitochondria and endoplasmic reticulum of pancreatic β cells of STZ- induced diabetic rats. Also, a decrease in the number of secretory granules of β -cells was observed and these pathological abnormalities were normalized after treatment with *T. chebula* extract. The present study shows that the ethanolic extract of *T. chebula* fruit has potential hypoglycemic action in STZ-induced diabetic rats and the effect was found to be more effective than glibenclamide [32].

Study was conducted to evaluate the anti-diabetic effects of ethanolic extract of *Terminalia chebula* Retz. Fruits by using alloxan-monohydrate induced diabetic control by using Wistar Albino rats for 30 days. The effect of this extract (200 mg kg⁻¹ b.wt.) was compared with the glibenclamide (600 mg kg⁻¹ b.wt.). This extract showed nil toxicity up to 500 mg kg⁻¹ b.wt. After the completion of the study, collected samples were performed under parameters like biochemical and anti-oxidant enzymes related to diabetes. The histopathological changes caused after induction of alloxan showed the granular cytoplasm, dilatation, shrunken nuclei and inflammation, which were reduced after treatment of the ethanolic extract (200 mg kg⁻¹ b.wt.). Excess proliferation of epithelium in the pancreas was observed in diabetic rats, which was reduced. From the evaluation of the present study has been confirmed that having the pharmacological action against the diabetic condition, even though the mechanism of the action is unknown [33]. The 80%-ethanolic extract of *Terminalia chebula* Retz. Has also significant hypoglycemic effect on alloxan induced diabetic rats and it been comparable with standard drug, metformin. The effective dose was 200 to 400 mg/kg [34].

The aqueous extract of the fruits of *Terminalia chebula* Retz. Has been evaluated for its antidiabetic activity in streptozotocin (STZ) induced mild diabetic rats and compared with a known drug, tolbutamide. Oral administration of 200 mg / kg body weight of aqueous extract of *T. chebula* daily

once for two months reduced the elevated blood glucose by 43.2% ($p < 0.01$) and significantly reduced the increase in HbA1c ($p < 0.01$). Hepatic and skeletal muscle glycogen content decreased by 75% and 62.9% respectively in diabetic controls, these alterations were partly prevented (34.9% and 21.17%) in aqueous extract treated group when compared to the healthy controls. The *in vitro* studies with pancreatic islets showed that the insulin release was nearly two times more than that in untreated diabetic animals. The treatment did not have any unfavorable effect on other blood parameters of liver and kidney function tests [35].

Chebularic acid, isolated from *T. chebula* proved to be a reversible and non-competitive inhibitor of maltase with a KI value of 6.6 μM . The inhibitory influence of chebularic acid on the maltase-glucoamylase complex was more potent than on the sucrase-isomaltase complex. The magnitude of the inhibition is greatly affected by its origin [36].

Cardiotonic Activity

The different extracts of fruits of *T. chebula* exhibited cardiotonic activity when tested on isolated frog hearts. The benzene and chloroform extracts showed a moderate cardiotonic activity, though at high doses because they were not completely soluble in the experimental Ringer solution. Ethylacetate, butanone, butanol and aqueous extracts exerted fairly potent cardiotonic activities. These all gave easily dispersible solutions, produced dose-dependent positive isotropic effects and an increase in the cardiac output. There was no appreciable change in the heart rate. The extracts being tested here stimulated the isolated perfused frog heart without inducing depression [37].

Cardiotonic effect of aqueous extract of stem bark of *Terminalia chebula* was studied by using isolated frog heart perfusion technique (IFHP). This was studied on both normal and hypodynamic hearts. Calcium free Ringer solution was used as vehicle for administration of aqueous extract of *Terminalia chebula* as a test extract and digoxin as a standard. A significant increase in height of force of contraction (positive inotropic effect) with increase in dose, no change in heart rate was observed with test extract as compared to dose of a standard digoxin. The test extract produced cardiac arrest at 3 mg/ml, a higher concentration, as compared to standard, digoxin (15 $\mu\text{g}/\text{ml}$). Compared to digoxin, a drug with narrow therapeutic window, *Terminalia chebula* showed wide therapeutic window [38].

An ethanolic extract of *T. chebula* fruits (500 mg/kg) was tested in rats with isoprotenerol (200 mg/kg) induced myocardial damage. In them the level of lipid peroxidase increased significantly in the serum and the heart. The activity of the myocardial marker enzymes decreased with

a concomitant increase in the activity of the serum. The myocardial necrosis was confirmed by histopathological examination. Pre-treatment with the extract ameliorated the effect of isoprotenerol on the lipid peroxide formation and retained the activities of the diagnostic marker enzymes [39].

The fruits of *T. chebula* are claimed to be useful against heart diseases. Besides the known effects of extracts on isolated frog hearts in this investigation, extracts are applied on (Na^+ , K^+ and Mg^{2+}) ATP ases of a whole homogenate prepared from ventricular portion of frog heart. The extracts exerted the following inhibition: Butanolic extract 13.5 % and 57.4 % with doses of 0.5 and 1.0 mg respectively. Aqueous extract 31.22 %, 40.68 %, and 49.18 % with doses of 0.1, 0.5, and 1.0 mg. The inhibition of the ATPase system with the dose of 1 mg is enormous. It is higher than that caused by ouabain, which is a specific inhibitor of this ATPase [4].

Wound Healing

The alcoholic extract of leaves from *T. chebula* was topically administered on dermal wounds of rats. The treated wounds healed much faster, indicated by improved rates of contraction and a decreased period of epithelisation. The granulation tissue increased in total protein DNA and collagen content. The levels of hexosamine and uronic acid in these tissues also increased up to 8 days post-wounding. In addition, the extract was active against *Staphylococcus aureus* and *Klebsiella*. These results document the beneficial effects of *T. chebula* extract for the healing process [40].

The hydroalcoholic extract of *T. Chebula* fruit was evaluated for its wound healing activity in alloxan induced diabetic rats using excision and dead space wound models. Extract treated animals exhibited 82% reduction in the wound area when compared to controls which was 40%. The extract treated wounds were found to epithelize faster as compare to controls. The wet and dry granulation tissue weight content was increased significantly when compared to controls. This extract promotes significant wound healing in diabetic rats and further evaluation of this activity in humans is suggested [41].

Different concentrations of various organic and aqueous extracts (solvent-free) of *T. chebula* were tested on fibroblast (L929) and keratinocytes cells to evaluate its biocompatible concentration by using MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide] and live-dead viability/cytotoxic assay. These extracts were found to be effective in decreasing the ammonia accumulation in the media, thereby reducing its toxic effect on cells. The cytoskeletal structure and extracellular matrix secretion of the cells treated with extracts showed higher cellular activity in comparison to control. In conclusion, we have demonstrated the effect of

these extracts of *T. chebula* on both types of skin cells and optimized concentration in which it could be used as a bioactive component for wound healing applications by increasing cell proliferation and decreasing free-radical production without affecting the normal cellular matrix [42].

Hypolipedemic Effect

Hypercholesteremia is one of the risk factors for coronary artery disease. The present study highlights the efficacy of Ayurvedic herbal formulation Triphala on total cholesterol, low density lipoprotein (LDL), very low density lipoprotein (VLDL), high density lipoprotein (HDL) and free fatty acid in experimentally induced hypercholesteremic rats. Four groups of rats were employed namely control, Triphala treated, hypercholesterolemia rats (4% Cholesterol + 1% cholic acid + egg yolk) and Triphala pre-treatment in hypercholesteremic rats. Results showed significant increase in the total cholesterol, LDL, VLDL, and free fatty acid in hypercholesteremic rats were significantly reduced in Triphala treated hypercholesteremic rats [43].

In atherogenic diet induced hyperlipidemic model, the rats receiving treatment with Haritaki (*Terminalia chebula*) showed significant reduction in total cholesterol, triglycerides, total protein and elevation of high density lipoprotein cholesterol. The results also suggest that Haritaki at 1.05 and 2.10 mg/kg b.wt. concentrations is an excellent lipid-lowering agent. It can be utilized for providing dietary management in the prevention of atherosclerosis in hyperlipidemic patients [44]. Treatment with *Terminalia chebula* ameliorated the biochemical parameters, histological and histochemical results [45].

Antibacterial

The ethanolic extract of *T. chebula* fruit was tested for its activity against methicillin-resistant and methicillin-sensitive *Staphylococcus aureus* strains from clinical isolates. The extract showed a broad spectrum of antibacterial activity with an inhibition zone size of 11 to 27 mm, against all the test bacteria. There was a synergistic interaction of the crude extract with tetracycline, too. TLC analysis indicated phenols and flavonoids as major active compounds [46]. In a similar investigation gallic acid and its ethyl ester could be verified on the basis of spectroscopic evidence [47].

Ether, alcohol and water extracts of *T. chebula* and black myrobalan (*Terminalia chebula* Retz) were tested against *Helicobacter pylori* in an agar diffusion test. The water extract had a MIC value of 125 mg/L and a MBC of 150 mg/L. Plant powder, incorporated in agar gave higher MIC and MBC values (150 and 175 mg/l). The extract was active

after autoclaving for 30 min at 121°C. The water extract at a concentration of 1-2.5 mg/L inhibited the activity of urease [9]. The aqueous extract of *T. chebula* strongly inhibited the growth, the sucrose induced adherence and the glucan-induced aggregation of *Streptococcus mutans*. Mouth rinsing with a 10 % solution of the extract significantly reduced the total bacterial counts and the total streptococcal counts in the saliva samples. It successfully inhibited glycolysis of salivary bacteria for up to 90 min after rinsing [9,21].

An ethanol extract of *Terminalia chebula* fruit was studied for its antibacterial activity against clinically important standard reference bacterial strains. The antimicrobial susceptibility was screened using the disc diffusion method and the minimum inhibitory concentration (MIC) was determined using the broth micro dilution method. The results showed that it was active against both gram-positive and gram-negative bacteria. The *T. chebula* fruit extract was highly effective against *Salmonella typhi* SSFP 4S, *Staphylococcus epidermidis* MTCC 3615, *Staphylococcus aureus* ATCC 25923, *Bacillus subtilis* MTCC 441 and *Pseudomonas aeruginosa* ATCC 27853. The MIC was determined as 1 mg/ml for *S. typhi*. These results indicate that the *T. chebula* dry fruit possesses a potential broad spectrum of antimicrobial activity [48]. This extract demonstrated a strong antimicrobial activity against all the test isolates and found to be most effective over others. Phytochemical analysis revealed the presence of high concentration of phenolics and low concentration of flavonoids and terpenoids. In acute oral toxicity study, no gross behavioral changes were observed in mice at recommended dosage level and 24 h LD₅₀ was found to be >4 g/kg, p.o. in mice. The results provide that *Terminalia chebula* fruit could be useful for the development of alternative/complementary medicine for multidrug-resistant uropathogens [49].

Antiviral

HSV-1 (Herpes simplex virus) is a common human pathogen that causes lifelong latent infection of sensory neurons. Non-nucleoside inhibitors that can limit HSV-1 recurrence are particularly useful in treating immunocompromised individuals or cases of emerging acyclovir-resistant strains of herpes virus. The extract of *T. chebula* showed a strong anti-HSV-1 activity in combination with acyclovir. With doses, corresponding to the human use it limited the development of skin lesions and prolonged the mean survival times of infected mice compared with both acyclovir and with the mice treated alone with the herbal extract (p<0.01 and p<0.05). It reduced virus yields in the skin and brain stronger than acyclovir alone. It exhibited a stronger anti-HSV-1 activity in the brains than in the skin, in contrast to acyclovir treatment alone. The combination

was not toxic to mice [50]. Chebulagic acid and punicalagin inhibit HSV-1 entry at noncytotoxic doses in A549 human lung cells. Experiments revealed that both tannins targeted and inactivated HSV-1 viral particles and could prevent binding, penetration, and cell-to-cell spread, as well as secondary infection. Results indicated that both blocked interactions between cell surface glycosaminoglycans and HSV-1 glycoproteins [51,52].

Chebulagic and chebulinic acids have higher direct antiviral activity against HSV-2 and efficacy to inhibit virus attachment and penetration to the host cells as compared to acyclovir. Hence, it may be a useful candidate for developing alternative therapy for prevention of sexually transmitted HSV-2 infection [53].

Chebulinic acid and chebulagic acid can effectively inhibit IAV (The influenza A virus) replication. These compounds act as neuraminidase inhibitors and show antiviral potency to both wild-type and oseltamivir-resistant IAV strains [54]. Chebulagic acid and/or its hydrolysis fragments as new chemical leads to restores growth of M2(S31N)-expressing yeast and inhibits *in vitro* influenza A replication regardless of M2 sequence [55].

Hot water extracts of *T. chebula* were examined for ant cytomegalovirus activity *in vitro* and *in vivo*. *In vitro* they inhibited the replication of human cytomegalovirus. *In vivo* they were tested in an infection model on immune suppressed mice. The herbal extract was orally administered to the mice treated with 50 mg/kg cyclosporine for one day before the intraperitoneal infection. The efficacy was evaluated by the reduction of the virus yield in the lung. The *T. chebula* extract significantly suppressed the virus yields in the lungs of the treated mice compared with the water treated animals [10].

Antioxidant and Cytoprotective Effects

Treatment and pretreatment of the hepatocytes with the *T. chebula* extract significantly reversed the *t*-BHP-induced cell cytotoxicity and lactate dehydrogenase leakage. In addition, extract exhibited *in vitro* ferric-reducing antioxidant activity and 2,2-diphenyl-1-picrylhydrazyl free radical-scavenging activities. The *in vivo* study showed that pretreatment with extract (500 or 1000 mg/kg) by gavage for 5 days before a single dose of *t*-BHP (0.1 mmol/kg) significantly lowered the serum levels of the hepatic enzyme markers aspartate aminotransferase, alanine aminotransferase and reduced the indicators of oxidative stress in the liver, such as the glutathione disulfide content and lipid peroxidation, in a dose dependent manner. Histopathologic examination of the rat livers showed that extract reduced the incidence of liver lesions, including hepatocyte swelling and neutrophilic

infiltration, and repaired necrosis induced by *t*-BHP [17]. Triphala extracts inhibit 50 % of lipid peroxidation, induced with Fe²⁺ ascorbate were 85.5, 27, 74, and 69 µg/mL *in vitro*. The concentrations needed for inhibition of the hydroxyl radical scavenging were 165, 71, 155.5, and 12.5 µg/mL. A continued daily administration sustained the effect [14].

The water extract of *T. chebula* fruits was tested for its radio protective ability. The free radical neutralizing ability was comparable to that of ascorbate (100 µM) 93.5 % and gallic acid (100 µM) 91.5 %, respectively. It protected the plasmid DNA pBR322 from the radiation-induced strand breaks. The administration of 80 mg/kg prior to whole body irradiation of mice (4 Gray) reduced the peroxidation of membrane lipids in the mice liver from radiation-induced DNA damages. Human lymphocytes also were protected from DNA damages exposed *in vitro* by 2 Gray [56]. It inhibits xanthine oxidase activity. It is an excellent scavenger of DPPH radicals. A HPLC analysis showed the presence of ascorbate, gallic acid and ellagic acid. The extract seems to be able to protect cell organelles from radioinduced damages [57].

The percentage inhibition of CaOx nucleation was found 95.84% at 25µg/mL of *Terminalia chebula* aqueous extract which remained almost constant with the increasing concentration of the plant extract; however, plant extract inhibited CaOx crystal growth in a dose dependent pattern. When MDCK and NRK-52E cells were injured by exposure to oxalate for 48 hours, the aqueous extract prevented the injury in a dose-dependent manner. On treatment with the different concentrations of the plant extract, the cell viability increased and lactate dehydrogenase release decreased in a concentration dependent manner. This study indicates that *T. chebula* is a potential candidate for phytotherapy against urolithiasis as it not only has a potential to inhibit nucleation and the growth of the CaOx crystals but also has a cytoprotective role [58].

The polyphenolic extract of *T. chebula* fruits was evaluated for antioxidant activity by determining the reducing power, total antioxidant capacity, DPPH radical concentration (IC₅₀ 14 µg/mL), nitric oxide radical concentration (IC₅₀ 30.51 µg/mL) and hydrogen peroxide scavenging activity (IC₅₀ 265.53 µg/mL) under *in vitro* conditions. Moreover, the phytochemical characterization of the extract was also measured by determining the total phenolic, flavonoid, tannin and ascorbic acid contents. It also scavenges hydrogen peroxide-induced radicals. The activity of the extract may be due to the total polyphenolic content. The antioxidant activity of the extract is significantly higher than the standard ascorbic acid, and its activity is concentration-dependent. It is concluded that a polyphenolic-rich fraction of *T. chebula* fruits is a potential source of natural antioxidants

[59].

Antimutagenic

Tannin fractions and gallic acid from the dried pulp of *T. chebula* were evaluated for their antimutagenic potential. They all were highly significant active against S9-dependent mutagen 2AF. The effect corresponds with the nature of the fractions; the monomeric gallic acid was the least effective [60]. The water extract of dried *T. chebula* fruits inhibited the direct acting mutagens sodium azide and 4-nitro-o-phenyldiamine in the strains TA100, TA1535, TA97a, TA98 of *Salmonella typhi* murium and S9-dependent mutagen 2-aminofluoren in TA97, TA98 and TA100 strains. Autoclaving the water extract reduced the effect not significantly [61]. In the VITOTOX Test for detection of DNA damages in prokaryotic and eucaryotic cells extracts from *T. chebula* were not genotoxic. This result is consistent with another Ames Test. But in the COMET assay the extracts increased DNA damages with content above 500 ppm [62].

Study showed that ethyl acetate portion of of *Embllica officinalis*, *Terminalia chebula* and *T. bellirica* extracts contain two major compounds, gallic acid and ellagic acid which might be responsible for potent antimutagenic activity induced by different genotoxic compounds in a dose dependent manner [63].

To obtain experimental evidence on the therapeutic efficacy of the *Terminalia chebula* fruit extract, we examined its effect on chromosomal aberration (CA) and micronucleus (MN) formation in C57BL hybrid mice, to assess the anti-mutagenic activity. In MN formation test, single application of *Terminalia chebula* methanolic fruit extract at different doses of 50, 100 and 150 mg/kg dry weight 24 hours prior to administration of cyclophosphamide (CP) at the dose of 50 mg/kg significantly reduced the frequency of MNCPE and at the same time significantly increased PCE/NCE ratio compared to CP alone. Concerning CA test, fruit extract at all different doses significantly reduced the % CA and at the same time increased the % degree of protection in dose dependent manner in bone marrow cells of mice as compared to CP alone treated group. However *Terminalia chebula* fruit extract alone did not show any chromosomal aberration and/or micronucleus formation. The anti-mutagenic activity observed in this study can be attributed to the presence of flavonoids and polyphenols. Thus it could be a better choice to treat cancer without inducing mutations in healthy body cells [64].

Protective Drugs against Stress

The IC₅₀ value of hydroalcoholic fruit extract of *Terminalia chebula* (HETC) in *in vitro* antioxidant assays

i.e. ABTS, DPPH and NO radical scavenging assay was found to be 2.27µg/ml, 6.04µg/ml and 4.37µg/ml respectively. In experimental study, PTZ (pentylenetetrazole) and MES (maximal-electroshock) treated groups exhibited 100% seizures with increased oxidative stress ($p < 0.001$) and cognitive deficits ($p < 0.01$) as compared to control group. HETC at highest dose (1000mg/kg) showed 83.33% (5/6) protection in MES induced seizures while 66.66% (4/6) protection in PTZ induced seizures. However, HETC (1000mg/kg) and co-administration of sub-therapeutic dose of HETC with valproate and phenytoin showed complete protection. In addition, it also attenuated the seizure induced oxidative stress and cognitive impairment as indicated by significant ($p < 0.01$) improvement in the transfer latencies in elevated plus maze (EPM) and passive avoidance test (PA) as compared to PTZ and MES treated group. The findings suggest that HETC exhibited significant anticonvulsant activity and also potentiated the subtherapeutic dose of phenytoin and valproate indicate its usefulness as an adjuvant to antiepileptic drugs with an advantage of preventing cognitive impairment and oxidative stress [65].

Pretreatment with an ethanol extract of *T. chebula* is found to retain near normal activities of lysosomal enzymes in rats compared with isoproterenol alone. Isoproterenol administration produced significant cardiac damage (as seen by the triphenyltetrazolium chloride assay) and significantly altered lysosomal enzyme activities. Results showed that *T. chebula* extract stabilizes the lysosomal membrane and prevents myocardial damage [66].

Immune Activation

In recent years, much attention is being focused on the immunological changes occur during stress. The immunomodulatory activities of Triphala were assessed by testing the various neutrophil functions like adherence, phagocytosis [phagocytic index (P.I) and avidity index (A.I)] and nitro blue tetrazolium (NBT) reduction in albino rats. Noise (100 dB) stress for 4 h/d for 15 d, was employed to alter the neutrophil functions. The neutrophil function tests and corticosterone levels were carried out in eight different groups of animals, namely control, Triphala, noise-stress, Triphala noise-stress, and corresponding immunized groups were used. Sheep red blood cells (SRBC 5 x 10⁹ cells per ml) were used for immunizing the animals that belongs to immunized groups. In Triphala administration (1g/kg/d for 48 d), A.I was found to be significantly enhanced in the Triphala group, while the remaining neutrophil functions and steroid levels were not altered significantly. However the neutrophil functions were significantly enhanced in the Triphala immunized group with a significant decrease in corticosterone level was observed. Upon exposure to the noise stress, the neutrophil functions were significantly

suppressed and followed by a significant increase in the corticosterone levels were observed in both the noise-stress and the noise-stress immunized groups. These noise-stress induced changes were significantly prevented by Triphala administration in both the Triphala noise-stress and the Triphala noise-stress immunized groups. Hence study has divulged that oral administration of Triphala appears to stimulate the neutrophil functions in the immunized rats and stress induced suppression in the neutrophil functions [67].

Study reports the effect of dry fruit extract of *T. chebula* (TCE) on Th1/Th2-mediated immune responses in mice. TCE was administered orally for 10 consecutive days, after which mice were immunized with goat RBC (gRBC) or ovalbumin. TCE enhanced the expression of Th1 cytokine, interferon γ , decreased interleukin 4, and increased the number of plaque-forming cells in gRBC-immunized mice. The percentage of CD4+ cells and delayed-type hypersensitivity response also increased in these mice. Treatment is reported to increase lymphocyte proliferation and macrophage phagocyte response, but decrease nitrite production. The bone marrow cellularity and WBC count also increased in the treated mice. None of the group showed any sign of toxicity. The data indicate that TCE elicits a significant dose-dependent Th1 response [68].

Immunomodulatory activity of ripe *T. chebula* fruits evidenced by increase in the concentration of antioxidant enzymes, GSH, T and B cells, the proliferation of which play important roles in immunity. This phenomenon also enhances the concentration of melatonin in pineal gland as well as the levels of cytokines, such as IL-2, IL-10 and TNF- α , which play important roles in immunity [69].

A-Glucosidase Inhibitor

Mammalian α -glucosidase inhibitory activity by *Terminalia chebula* Retz. fruits was investigated. The aqueous methanolic extract was found to have potent rat intestinal maltase inhibitory activity, whereas neither intestinal sucrase nor isomaltase activity was inhibited by this extract. Using bioassay-guided separation, three active ellagitannins were identified as chebulanin (1), chebulagic acid (2) and chebulinic acid (3) and were shown to possess potent intestinal maltase inhibitory activity, with the IC_{50} values of 690 μ M, 97 μ M and 36 μ M, respectively. The intestinal maltase inhibitory activities of 2 and 3 were even higher than that of 1,2,3,4,6-penta-*O*-galloyl- β -D-glucose (PGG) (4, IC_{50} =140 μ M), which is a known potent α -glucosidase inhibitor. Comparison of the activities of 1–4, 1,2,3-*O*-trigalloyl- β -D-glucose (5), neochebulagic acid (6) and corilagin (7) suggested that the positions of chebulloyl and galloyl groups mostly affected the potency. Kinetic studies

revealed that 2, 3, and 4 inhibited maltose-hydrolyzing activity of intestinal α -glucosidase, noncompetitively. This is the first report on mammalian α -glucosidase inhibition by 1, 2 and 3 isolated from *T. chebula* fruits. These results suggest a use of the extract of *T. chebula* fruits for managing Type 2 diabetes [70].

Chebulagic acid, isolated from *Terminalia Chebula* proved to be a reversible and non-competitive inhibitor of maltase with a K_i value of 6.6 μ M. The inhibitory influence of chebulagic acid on the maltase glucoamylase complex was more potent than on the sucrase-isomaltase complex. The magnitude of α -glucosidase inhibition by chebulagic acid was greatly affected by its origin. These results show a use for chebulagic acid in managing type-2 diabetes [36]. Compounds, 23-*O*-galloylarjunolic acid (IC_{50} 21.7 μ M) and 23-*O*-galloylarjunolic acid 28-*O*- β -D-glucopyranosyl ester (IC_{50} 64.2 μ M) from *Terminalia chebula* also showed potent inhibitory activities against Baker's yeast α -glucosidase compared to the positive control, acarbose (IC_{50} 174.0 μ M) [71].

Anticancer Activity

Homeopathic preparations of *Terminalia chebula* known as Mother tincture (*MT*) decreased the viability of breast cancer (MDAMB231 and MCF7) and non-cancerous (HEK293) cells. However, other homeopathic preparations of *Terminalia chebula* (*3X*, *6C* and *30C*) decreased the viability of only breast cancer cells without affecting the viability of the non-cancerous cells. All the potencies, *MT*, *3X*, *6C* and *30C*, reduced growth kinetics of breast cancer cells, more specifically at 1:10 dilution at 24, 48 and 72 h. Under SEM, *MT* appeared as a mesh-like structure whereas under TEM, it showed presence of nanoclusters. On the other hand, *6C* potency contained 20 nm sized nanoparticles. The current study reports the anticancer activity of homeopathic preparations of *Terminalia chebula* against breast cancer and reveals their nano particulate nature. These preliminary results warrant further mechanistic studies at both *in vitro* and *in vivo* levels to evaluate the potential as nanomedicine in breast cancer [72].

In several human malignant cell lines a 70 % methanolic extract of *T. chebula* fruits decreased the cell viability, inhibited the cell proliferation and induced the cell death in a dose dependent manner. In lower concentrations some apoptosis was induced, but at higher concentrations necrosis was the major mechanism of the cell death. The following IC_{50} values could be revealed: Chebulinic acid: 53.2+/-0.16 μ M, tannic acid 59.0+/-0.19 μ M, ellagic acid 78.5+/-0.24 μ M, respectively [14].

Potent Suppressor of T- Cell Activity

In both the prophylactic and therapeutic Chebulagic acid (CHE) dosing models, all clinical scores, serum levels of total and anticollagen IgG, and levels of interleukin-10 (IL-10) and IL-6 were reduced, while serum levels of transforming growth factor (TGF) were markedly elevated. The number of granulocytes was reduced, but the proportion of CD4+, CD25+ T cells was greater in the knee joints of CHE-treated collagen-induced arthritis (CIA) mice. Expression of Foxp3 and TGF β messenger RNA was also augmented significantly in the knee joints of CHE-treated CIA mice in the therapeutic dosing model. It concludes that CHE significantly suppressed the onset and progression of CIA in mice. Immune suppression via the induction of TGF β and CD4+, CD25+ T cells may represent a new strategy in the development of therapies for managing rheumatoid arthritis and other inflammatory diseases [26].

Study assessed *T. chebula* extract-dependent protein expression changes in Jurkat cells. Matrix-assisted laser desorption/ionization–time-of-flight mass spectrometry and Ingenuity Pathways Analysis (IPA) were performed to assess protein expression and networks, respectively. A comparative proteomic profile was determined in *T. chebula* extract (50 μ g/mL)-treated and control cells; the expressions of β -tubulin, ring finger and CHY zinc finger domain containing 1, and insulin-like growth factor 1 receptor kinase were significantly down-regulated in *T. chebula* extract-treated Jurkat cells. Treatment with the *T. chebula* extract significantly inhibited nuclear factor- κ B activity and affected the proteomic profile of Jurkat cells [73-89].

Conclusion

Terminalia chebula have extensive medicinal potential to explore. It is called the “king of medicines” and always listed first in the Ayurvedic materia medica because of its extraordinary powers of healing. This review describes the key bioactive phytochemicals isolate from it and their role in various system of traditional medicine to cure various diseases. Phytochemical constituents of this plant show anticariogenic effect, gastrointestinal activity, immunosuppressive effects, antidiabetic effects, hypolipidemic effect, antimutagenic, α -glucosidase inhibitor, potent suppressor of T- Cell Activity etc. The present review summarizes the ethnic use, pharmacological activities of extracts and phytochemicals of *Terminalia Chebula* for last 40 years.

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Reversible Antifertility Effect of Withaferin

Authors

- Dr. Ashish Ranjan Singh
- Dr. Maheep Kumar

Keywords:

Withania somnifera, Withaferin-A, Contraceptive, Antifertility, Sperm Motility

Abstract

Background: Currently world population crosses the 7.30 billion and increasing continuously day by day. There is a great need to support an individuals in family-planning since increasing growth rate of world's population caused negative impact on sustainable, economic growth and increased poverty especially in developing countries. However, there is still no method available in the field of male contraception that satisfies the essential criteria of safety, efficacy, economy and complete reversibility. Clearly, there is a need for development of reversible contraceptive from natural resources. Therefore, we have performed the present study to examine the effect of Withaferin-A on the sexual hormone levels and to consider the effect of alkaloid of *Withania somnifera* on changes of glucose, cholesterol and triglyceride serum levels in male rats and can prevent the fertility of male albino rat by evaluating some andrological parameters such as sperm motility, sperm counts, rate of fertility and morphology which are some of the indices that determine the ability of a male to produce viable spermatozoa. Method: The Withaferin-A was separated by column chromatography; compound was finally purified by crystallization and identified with the help of NMR and administered orally at different dose levels. Animals were

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University of Rajasthan

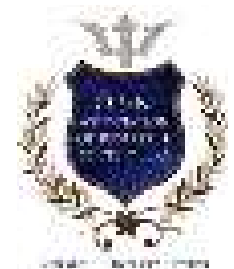
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Reversible Antifertility Effect of Withaferin-A from *Withania somnifera* in Male Albino Rats

Dr. Ashish Ranjan Singh ^α & Dr. Maheep Kumar ^σ

Abstract- Background: Currently world population crosses the 7.30 billion and increasing continuously day by day. There is a great need to support an individuals in family-planning since increasing growth rate of world's population caused negative impact on sustainable, economic growth and increased poverty especially in developing countries. However, there is still no method available in the field of male contraception that satisfies the essential criteria of safety, efficacy, economy and complete reversibility. Clearly, there is a need for development of reversible contraceptive from natural resources. Therefore, we have performed the present study to examine the effect of Withaferin-A on the sexual hormone levels and to consider the effect of alkaloid of *Withania somnifera* on changes of glucose, cholesterol and triglyceride serum levels in male rats and can prevent the fertility of male albino rat by evaluating some andrological parameters such as sperm motility, sperm counts, rate of fertility and morphology which are some of the indices that determine the ability of a male to produce viable spermatozoa.

Method: The Withaferin-A was separated by column chromatography; compound was finally purified by crystallization and identified with the help of NMR and administered orally at different dose levels. Animals were distributed equally into five treatment groups containing ten animals in each. Animals were administrated orally with Withaferin-A at the dose of 10, 20 and 40 mg/kg. body wt./day to male albino rats daily for 60 days. A marked dose-dependent decrease in the count and motility of sperms of treated rats was observed as compared with controls in a randomized controlled study and followed by 30 days recovery period.

Results and discussion: This plant-based contraceptive inhibited male fertility, after administration of Withaferin-A from *Withania somnifera*. A marked reduction in counts and motility of caudaepididymal sperm in a dose-dependent manner was observed in treatment group but after 30 days withdrawal of treatment all these changes were reversibly observed in recovery group.

Conclusion: The oral administration of Withaferin-A (*Withania somnifera*) in male albino rats produced a reversible antifertility effect.

Keywords: *Withania somnifera*, Withaferin-A, Contraceptive, Antifertility, Sperm Motility.

Author α: Reproductive Biomedicine and Natural Products Lab, Department of Zoology, University of Rajasthan, Jaipur Rajasthan (India) – 302004. e-mail: singhdrashishranjan@gmail.com

Author σ: Department of Chemistry, Shri Varshney PG College, Aligarh, Uttar Pradesh (India) – 202001. e-mail: maheepchem.svc@gmail.com

I. INTRODUCTION

Currently population explosion is one of the biggest problems facing by world. It's inevitable consequences are employment, education, housing, health care, economy and environment. At the present growth rates, the population of economically developed countries would double in 120 years. Overpopulation led to serious social and environmental problems such as poverty, overcrowded slums, crime, pollution of air & water and depletion of the protective ozone layer (Vogelsong, 2005) and all around human development especially in developing countries like India (Akbarsha *et al*, 2001,). India is also only the second country to achieve a population of 1.32 billion. Our future well-being depends on increased access to family planning and reproductive health services in developing countries and decreased consumption by people in wealthy countries (Speidel, 2000).

India is first among the countries which adopted an official family planning programmed, as early as 1950. However, fifty years later this has not prevented the population touching the one billion mark (Qian *et al*, 1995). It is obvious that despite good intentions and concerted efforts we have failed in controlling our population. Since the major responsibilities of pregnancy, birth, and child rearing fell on women, they found methods for controlling fertility and aborting unwanted children, and they have passed down this knowledge as an oral tradition that survives worldwide. It is obvious now that there cannot be an ideal contraceptive (Moudgal and Rao, 1984; Joshi *et al*, 1977) suitable for everybody.

About 90% of the world's contraceptive users are women. This gender-based usage has occurred due to the emphasis of family planning programs and contraception research (Hazarika and Sarma, 2007). The only male-specific contraceptive methods currently available are withdrawal, condoms, and vasectomy. As concerns regarding side effects and convenience of these existing methods prevent (Beckman *et al*, 1996; Moore, *et al*, 1996) their universal acceptance. There is an urgent need for development of male contraceptives drug to prevent unintended pregnancy, of which 80–90 million occur annually (Amory, 2016). The development of additional male methods of fertility control can provide tremendous social and public health benefits. Because methods that require infrequent administration

have the lowest typical (user) failure rates (Potter, 1996), considerable research has focused on development of a herbal male contraceptive.

Fertility regulation comprising contraception and management of infertility forms an important (Pankajakshy and Madambath, 2009) component of reproductive health. Though considerable progress has been made in the development of highly effective, acceptable and reversible methods of contraception (Njaret *et al*, 1995) among females. Progress and possibilities on male are still slow and limited, with recent progress towards a better understanding of male reproductive physiology; there is a need to develop new contraceptive modalities for male. Several potential approaches for induction of infertility have been investigated over a long period including hormonal, chemical, and immunological, approaches. However, no suitable method has emerged that is effective and free from side effects (Montanari *et al*, 1998).

Clearly, there is a need for development of reversible contraceptive from natural resources. The chemical compounds affecting testicular function include steroidal and non-steroidal but application of these compounds has serious reversible antifertility effect (Kulshreshtha and Mathur, 1990; Jensen, 2002). The present study was undertaken therefore, to determine and examined whether plant might have any effect on male reproductive organs, spermatogenesis, and serum hormone levels in rats. Although contraceptives containing estrogen and progesterone are effective and popular, the risks associated to the drugs have triggered the need to develop newer molecules from medicinal plants (Swerdloff *et al*, 1998). Hence, there is a need for searching suitable product from indigenous medicinal plants that could be effectively used in the place of pills. More over the phytochemical even today are important resources for medicine (Sundaram and Kumar, 2000).

Plant drugs have been used since time immemorial for their effects upon sex hormones particularly for suppressing fertility, regularizing menstrual cycle, relieving dysmenorrhea, treating enlarged prostate, menopausal symptoms, breast pain and during and after childhood (Williamson *et al*, 1996). Specific biological effects under the division of fertility regulating category are non- specific contraceptive or antifertility effects, abortifacient, uterine stimulant and uterine relaxants, labour induction and labour inhibition oxytocic and anti- oxytocic, oestrogenic and anti-oestrogenic, progesterogenic and anti-progesterogenic, ovulatory and anti- ovulatory, androgenic and anti-androgenic, spermicidal and anti- spermatogenic effects (Soejarto, *et al*, 1978). The flavonoids, phytosterol, and terpenoid present in the alcoholic extracts of *Piper betle* may be responsible for significant antifertility activity (62.2%) (Shah andJhade, 2018).

Antifertility agents may therefore exert their effort at this level either by disrupting (Bullock *et al*, 1995, WHO, 1990) hormonal function of the hypothalamus or the pituitary, or by interrupting the neural pathway to the hypothalamus that control the liberation of gonadotropins releasing hormones.

The investigation of plant constituents with antifertility properties represents a potential alternative approach to birth control from the existing available methods. If an estrogen from a local source could be shown to be active in humans, it would be of great value as a fertility-regulating agent (United Nations, 1998).The development of new fertility regulating drug from medicinal plants is an attractive proposition, because from times immemorial humans have relied on plants and their products as sources of drugs and therapeutic agents, although in recent times, synthetic drugs are used extensively(Tuxhorn, 2002) in modern medicine. However many modern medicines are developed through the clues obtained from phytochemical.

In view of the importance of plants in the traditional Indian system as a positive health promoter, it was decided to carry out work on the chemical profiling of *W. somnifera* on the basis of Withaferin-A (Roja *et al*, 2006, Ganzera *et al*, 2003, Sengupta *et al*, 2018).

Nonstandardized herbal preparation have not found acceptance in the global market; therefore, there is a need to be chemically standardized on the basis of isolated constituents, preferably bioactive ones. Presently, formulations standardized on the basis of a maximum possible number of biomarkers are accepted readily in the global market. Thus, as part of a long-term evaluation of potential antifertility plant, we have conducted these studies on the effects of *Withania somnifera* extractand their alkaloids (Withaferin-A) on the fertility of rats.The present investigation elucidated the association of biological activities with specific secondary metabolites known as Withaferin-A present in the *Withania somnifera*. The aim of present study was to evaluate safety and reversible contraceptive efficacy of alkaloids from this plant to search for an inexpensive, orally effective and reversible male contraceptive. The present study will help in the development of reversible male oral contraceptive from natural resources and to determine whether plant drugs (phytochemical and phytosomes) might have any effect on male reproductive organs, spermatogenesis and serum hormone levels in rats. The availability and use of acceptable male contraceptive methods could reduce the burden traditionally placed almost exclusively on the female partner.

Table 1: Changes in the body weight and various organ weights of male rats after 60 days treatment of Withaferin-A (WS3)

Treatment	Initial B. wt. (gm.)	Final B. wt. (gm.)	Testes (mg/100 gm b. wt.)	Epididymides (mg/100gm B. wt.)	Vas-defere ns (mg/10 0gm B. wt.)	Seminal vesicle (mg/100g m B. wt.)	Ventral Prostate (mg/100 gm B. wt.)	Kidney (mg/100 gm B. wt.)	Heart (mg/100 gm B. wt.)	Liver (mg/100 gm B. wt.)	Adrenal (mg/100g m B. wt.)
Group A Control Intact	106.50 ± 1.50	157.0 ± 2.00	1155.12 ± 14.71	507.48 ± 16.24	163.89 ± 2.11	425.00 ± 14.27	96.51 ± 1.84	580.72 ± 12.84	274.67 ± 4.84	2454.68 ± 33.91	20.48 ± 0.54
Group B 10mg/kg. b. wt.	105.00 ± 1.67 ^{ns}	155.0 ± 2.24 ^{ns}	1144.30 ± 13.53 ^{ns}	503.21 ± 10.09 ^{ns}	162.37 ± 3.21 ^{ns}	423.66 ± 14.17 ^{ns}	96.49 ± 2.13 ^{ns}	612.73 ± 15.82 ^{ns}	271.13 ± 4.78 ^{ns}	2449.18 ± 24.74 ^{ns}	20.23 ± 0.41 ^{ns}
Group C 20mg/kg. b. wt.	102.00 ± 1.33 ^{ns}	159.0 ± 1.94 ^{ns}	1137.57 ± 20.20 ^{ns}	492.99 ± 10.90 ^{ns}	158.54 ± 2.64 ^{ns}	421.55 ± 14.30 ^{ns}	95.75 ± 2.12 ^{ns}	551.76 ± 7.86 ^{ns}	268.31 ± 7.76 ^{ns}	2415.94 ± 35.64 ^{ns}	19.74 ± 0.34 ^{ns}
Group D 40mg/kg. b. wt.	102.00 ± 1.33 ^{ns}	155.0 ± 1.67 ^{ns}	1105.35 ± 17.87*	464.77 ± 10.62*	153.41 ± 3.33*	399.05 ± 15.77 ^{ns}	94.32 ± 2.06 ^{ns}	551.74 ± 12.83 ^{ns}	240.63 ± 14.71 ^{ns}	2412.85 ± 27.45 ^{ns}	19.68 ± 0.43 ^{ns}
Group E Recovery 20mg/kg. b. wt.	104.00 ± 1.63 ^{ns}	156.0 ± 1.94 ^{ns}	1142.34 ± 13.27 ^{ns}	498.87 ± 10.84 ^{ns}	159.98 ± 3.41 ^{ns}	423.63 ± 13.99 ^{ns}	95.86 ± 2.22 ^{ns}	573.26 ± 11.76 ^{ns}	270.58 ± 4.58 ^{ns}	2446.01 ± 32.72 ^{ns}	19.84 ± 0.44 ^{ns}

Data are expressed as mean ±S.E, and analyzed for statistical significance by using Student's t test for 10 animals. Groups B, C, D and E were compared with Group A. ns = non-Significant, * Significant (P≤0.05).

Table 2: Effect on the sperm motility, Density and Fertility after 60 days treatment of Withaferin-A (WS3) in male rats

Treatment	Sperm motility (Cauda) (%)	Sperm density		Fertility (%)	Number of pups delivered
		Cauda (million/mm ³)	Testes (million/mm ³)		
Group A Control Intact	74.57 ± 0.97	15.15 ± 0.19	3.42 ± 0.17	100 % (+ve)	70
Group B 10mg/kg. b. wt	73.89 ± 0.75 ^{ns}	14.90 ± 0.11 ^{ns}	3.11 ± 0.10 ^{ns}	64% (-36%)	45
Group C 20mg/kg. b. wt	73.17 ± 1.02 ^{ns}	14.88 ± 0.22 ^{ns}	2.98 ± 0.05*	51% (-49%)	36
Group D 40mg/kg. b. wt.	68.14 ± 0.87**	14.10 ± 0.14**	1.97 ± 0.08*	35% (-65%)	24
Group E Recovery 20mg/kg. b. wt.	73.31 ± 0.71 ^{ns}	14.90 ± 0.11 ^{ns}	3.08 ± 1.98 ^{ns}	72% (-28%)	50

Data are expressed as mean ±S.E, and analyzed for statistical significance by using Student's t test for 10 animals. Groups B, C, D and E were compared with Group A. ns = non-Significant, * Significant ($P \leq 0.05$), ** Highly Significant ($P \leq 0.01$).

Table 3: Tissue biochemical changes after 60 days treatment of Withaferin-A (WS3) in male rats

Treatment	Cholesterol (mg/gm)				Glycogen (mg/gm)				Ascorbic acid (mg/gm)		Fructose (mg/gm)	
	Testis	Liver	Heart	Adrenal	Testis	Liver	Heart	Adrenal	Adrenal	Seminal Vesicle		
Group A Control Intact	12.62 ± 0.40	14.11 ± 0.62	14.80 ± 0.83	9.40 ± 0.42	3.62 ± 0.17	4.55 ± 0.17	4.16 ± 0.15	3.05 ± 0.25	7.56 ± 0.41			
Group B 10mg/kg. b.wt.	11.56 ± 1.19 ^{ns}	14.08 ± 0.50 ^{ns}	14.49 ± 0.74 ^{ns}	8.82 ± 0.48 ^{ns}	3.38 ± 0.10 ^{ns}	4.20 ± 0.13 ^{ns}	3.93 ± 0.22 ^{ns}	2.84 ± 0.20 ^{ns}	7.49 ± 0.34 ^{ns}			
Group C 20mg/kg. b.wt.	11.44 ± 0.42 [*]	13.75 ± 0.68 ^{ns}	13.88 ± 0.67 ^{ns}	8.31 ± 0.53 ^{ns}	3.25 ± 0.19 ^{ns}	4.22 ± 0.14 ^{ns}	3.85 ± 0.07 ^{ns}	2.66 ± 0.21 ^{ns}	6.11 ± 0.44 [*]			
Group D 40mg/kg. b.wt.	10.81 ± 0.85 [*]	13.58 ± 0.57 ^{ns}	13.81 ± 0.72 ^{ns}	8.25 ± 0.36 [*]	2.74 ± 0.12 [*]	4.07 ± 0.40 ^{ns}	3.57 ± 0.35 ^{ns}	2.38 ± 0.13 [*]	5.96 ± 0.39 [*]			
Group E Recovery 20mg/kg. b.wt.	11.00 ± 1.13 ^{ns}	13.94 ± 0.54 ^{ns}	14.50 ± 0.74 ^{ns}	8.56 ± 0.44 ^{ns}	3.28 ± 0.10 ^{ns}	4.12 ± 0.12 ^{ns}	3.71 ± 0.05 ^{ns}	2.73 ± 0.19 ^{ns}	7.45 ± 0.36 ^{ns}			

Data are expressed as mean ±S.E, and analyzed for statistical significance by using Student's t test for 10 animals. Groups B, C, D and E were compared with Group A. ns = non-Significant, * Significant (P≤0.05).

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Triterpenoids of Nerium oleander shows Antifertility effect in Male Albino Rats

Maheep Kumar

Department of Chemistry, Sri Varshney PG College, Aligarh-202001, U.P., India.

<http://orcid.org/0000-0002-7094-0941>

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ABSTRACT

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Research Article

Triterpenoids of *Nerium oleander* shows Antifertility effect in Male Albino Rats

Maheep Kumar*

Department of Chemistry, Sri Varshney PG College, Aligarh-202001, U.P., India.

Abstract: Antifertility activity of methanolic extract of the stem of *Nerium oleander* was carried out on male albino rats. After the careful experiments, the results revealed that oral administration of methanolic extract of the stem of *Nerium oleander* affected male fertility by two means, antispermatogenic and antiandrogenic action. It might be due to the presence of some triterpenoids compounds. So it could be a scope of developing an ideal male contraceptive, due to its antispermatogenic effects.

Keywords: *Nerium oleander*, Methanolic extract, Triterpenoids, Antifertility.

1. Introduction

Over a long period, several approaches for the induction of infertility have been investigated. However, no suitable method has emerged that is effective and free from side-effect [1,2]. Although contraceptives containing estrogen and progesterone are effective and popular. The risks associated with these drugs have paved the way to develop newer compounds from medicinal plants. Hence, there is a need for searching suitable products from indigenous medicinal plants that could be effectively used in the place of contraceptive pills. Compounds isolated from *Nerium oleander* have been reported for antimicrobial activity [3], anti-inflammatory activity [4], anticancer activity [5,6], CNS-depressant activity [7] and neuroprotective effects [8]. Effect of the sap of *Nerium oleander* on male fertility and spermatogenesis in tobacco budworm (*Helicoverpa assulta*) [9] motivate toward the antifertility activities. So, this study is preliminarily concerned with antifertility activity of dry methanol extract of the stem of *Nerium oleander* on male albino rats.

2. Material and Methods

2.1 Animal model

For this study, colony bred, healthy, fertility proven adult Wistar rats (*Rattus norvegicus*) of 60 days aged were selected. Before using the animals for experiments, their initial body weights were recorded and blood samples were examined. Supervision of qualified veterinarian was available throughout the

study. The animals were kept in plastic cages and well-ventilated room under controlled conditions (12 hrs light: 12 hrs dark) [10]. The rats were maintained on pellet standard rat feed supplemented with soaked gram, wheat and water were provided. Two experiments were conducted during the course of study with dry methanol extract of the stem of *Nerium oleander*. A suspension was prepared daily (100 and 200mg/ml) before administration. The required drug was administered orally for a period of 60 days.

2.2 Plant material

Plant material of *Nerium oleander* was collected from the roadside lining, Jaipur (India). It is abundantly available in this part of the country.

2.3 Isolation of marker

Nerium oleander stem was collected from the roadside lining, Jaipur (India). Herbarium, Department of Botany, University of Rajasthan, Jaipur, India had authenticated and identified this Plant material. 1.0 kg Plant material was crushed then, shocked in methanol overnight, boiled exhaustively for 24 hours and finally filtered. The filtrate was concentrated under the reduced pressure and obtained (65gm) methanol extract of this plant for the experiment. A part of this extract (solvent-free) was fed to rats at 100 and 200mg/kg body weight per day [11].

2.4 Tests for the presence of triterpenes

On treatment with Liebermann-Burchard and Noller's reagents fraction [petroleum ether: benzene (1:1)] gave a positive test showing its triterpenoid

nature. It also gave a positive test with TNM, which confirms that the given fraction is unsaturated triterpenoids.

2.5 Treatment protocol for antifertility activity study

Methanolic extract were orally fed to know about its hormonal nature and antifertility effect. Animals were distributed into two treatment groups, each consisting of 6 animals.

Group-A: Only sterile distilled water were given orally for 60 days to animals of this group. This group served as a control-treated vehicle.

Group-B: Animals of this group were orally fed with methanol extract at the dose of 100mg/kg body weight per day, for 60 days. Doses were freshly prepared and administered orally during the study.

Group-C: Animals of this group were orally fed with extract at the dose of 200mg/kg body weight per day for 60 days.

A suspension of the triterpenoids was made every day in DMSO and the required drug was administered orally with a glass syringe fitted with a feeding needle.

2.6 Study parameters

2.6.1 Sperm motility and density

For determining sperm motility and sperm density, 100mg of cauda epididymis was minced in 1ml of physiological saline within a scarification period of 5 minutes. The motility percentage was determined by counting motile and immotile spermatozoa per unit area [12]. Next cauda epididymis sperm density was determined by routine procedure and expressed as million/mm³ of suspension [12].

2.6.2 Fertility test

Successful mating was carried out in all animals (male-female ratio 1: 2). The mated females were allowed to complete the gestation period. Five days prior to sacrifice period, numbers of pups were recorded. After this litter size and percent of fertility were calculated [11].

2.6.3 Body and organ weights

The initial and final body weight of the animals were recorded. Then the testes, epididymis, seminal vesicle and ventral prostate were dissected out and weighed accurately up to milligram level.

2.6.4 Serum biochemistry

Serum was isolated and stored for the detection of protein content [13], total cholesterol [14], phospholipids [15], alkaline phosphatase [16] and LDH [17] by respective calculations.

2.6.5 Hormone assay

Blood samples were collected for estimation of serum testosterone, FSH and LH by using radioimmunoassay. Serum samples were separated by standard procedures and stored at -20°C for subsequent analysis. Serum levels of testosterone, FSH and LH were assayed in duplicate by using radioimmunoassay kit [18].

2.6.6 Hematology

The blood samples from the heart were also collected and analyzed for blood urea [19], blood sugar [20] RBC, WBC and hematocrit levels [21].

2.6.7 Histological Study

Contralateral side of the testis, epididymis, seminal vesicle, kidney and liver were fixed in Bouin's fluid, dehydrated in graded ethanol, cleared in xylene and embedded in paraffin wax. Sections were cut at 6 μ was stained with Harris's hematoxylin and eosin to observe under a light microscope. The same sections were used for percentage of normal tubules. Similarly, seminiferous tubules and intertubular areas were observed, finally expressed of seminiferous tubules, intertubular area and sertoli cell nuclear area [22] was also determined.

2.6.8 Statistical Analysis

Data are expressed as mean \pm S.E. and analyze for statistical significance by using student's "t" test. The data are considered as significant at $p \leq 0.01$ and non-significant at $p \leq 0.001$ [23].

3. Results

3.1 Body and organ weight

The weight of testes, epididymis, vas deferens and seminal vesicle of rats treated with methanol extract of the stem of *Nerium oleander* at the dose level of 100mg/kg body weight (Group-B) ($p \leq ns$) was non-significantly changed while treatment at the dose level of 200mg/kg body weight (Group-C) weight of testes significantly reduced ($p \leq 0.001$) as compared to control intact rats (Group-A) (Table 1). The weight of ventral prostate, kidney, heart, liver and adrenal gland did not alter at any significant level in rats following methanol extract of the stem of *Nerium oleander* treatment (Group-B and C) as compared with control rats (Group-A) (Table 1).

3.2 Sperm motility and density

The sperm motility of cauda epididymis and sperm density in cauda as well as testes of rats after treatment of methanol extract of the stem of *Nerium oleander* for 60 days at the dose level of 100mg/kg body weight (Group-B) were changed non-significantly ($p \leq ns$) while treatment at the dose of 200mg/kg body weight (Group-C) sperm motility and density were decreased

significantly as compared to control (Group-A) (Table 2).

3.3 Fertility

It was observed that the fertility was significantly ($p \leq 0.001$) reduced in methanol extract of the stem of *Nerium oleander* treated rats at the dose level of 100mg/kg body weight and 200mg/kg body weight (Group-B and C) respectively by 77.77% & 46.66% (Table 2).

3.4 Hematological observations

The hematological parameters, i.e. hemoglobin, W.B.C., R.B.C, hematocrit, MCHC, blood sugar and blood urea were observed within normal range ($p \leq ns$) in rats after 60 days treatment with methanol extract of the stem of *Nerium oleander* in all groups (Group-B and C) as compared to control rats (Group-A) (Table 3).

3.5 Serum biochemistry

Changes in protein, cholesterol, triglycerides and phospholipids level in serum of all treated rats at dose levels (100 and 200mg/kg body weight), were non-significant ($p \leq ns$). Observation in all the hematological indices and serum biochemistry parameters are free from side effects (Table 4).

3.6 Hormone levels

The levels of luteinizing hormone, follicle-stimulating hormone and testosterone hormones were significantly decreased ($p \leq 0.001$) at the dose of 200mg/kg body weight of methanol extract of the stem of *Nerium oleander* (Group-C) as compared to control rats (Group-A), while LH level in other groups (Group-B) were non-significantly changed after treatment ($p \leq ns$) (Table 4).

3.7 Tissue biochemical analysis

The protein level of testis, cauda, seminal vesicle in rats at the dose level of 100mg/kg body weight (Group-B) was non-significantly ($p \leq ns$) change while protein level in rats treated at the dose levels of 200mg/kg body weight (Group-C) was significantly decreased ($p \leq 0.001$) as compared to protein level of control intact rats. The protein level of ventral prostate was non-significantly ($p \leq ns$) change in all treated groups as compared to protein level of control intact rats (Table 5).

It was observed that cholesterol level in adrenal was significantly decreased ($p \leq 0.001$) at the dose level of 100 and 200mg/kg body weight (Group-B and C) in dose-dependent manner as compared to cholesterol level in testis of control intact rats (Group-A). Cholesterol levels of testes, liver and heart were non-significantly ($p \leq ns$) change in all treated groups as compared to cholesterol level of control intact rats (Table 5).

The glycogen content of rats in testis was decreased significantly at the dose level of 200mg/kg body weight (Group-C) while glycogen contents were non-significantly reduced ($p \leq ns$) at the dose level of 100mg/kg body weight (Group-B) as compare to glycogen level of control intact rats. The glycogen levels of liver and heart were non-significantly ($p \leq ns$) change in all treated groups as compared to cholesterol level of control intact rats (Table 5).

The fructose level of seminal vesicle in rats treated at the dose level of 100 and 200mg/kg body weight (Group-B and C) was decreased non-significantly ($p \leq ns$) as compared to control intact rats (Group-A) (Table 5).

Table 1: Changes in the body and various organ weight of rat after 60 days of treatment of dry methanolic extract of Kaner (*Nerium oleander*).

Treatment	Initial b. wt. (gm.)	Final b. wt. (gm.)	Testes mg/100gm b. wt.	Epididymides mg/100gm b. wt.	Vas Deferens mg/100gm b. wt.	Seminal vesicle mg/100gm b. wt.	Ventral prostate mg/100gm b. wt.	Kidney mg/100gm b. wt.	Heart mg/100gm b. wt.	Liver mg/100gm b. wt.	Adrenal mg/100gm b. wt.
Group-A											
Control	103.33±2.10	165.00±1.82	1091.39±23.18	473.62±11.05	153.31±2.33	400.53±23.25	95.84±2.57	567.66±16.49	272.84±12.76	2355.29±38.72	19.39±0.56
Group-B											
100mg/kg b. wt.	103.33±2.11	166.67±2.11	1065.11±17.55 ^{ns}	455.57±10.13 ^{ns}	146.18±1.80 ^{ns}	359.80±9.09 ^{ns}	84.87±3.25 ^{ns}	559.90±17.66 ^{ns}	265.10±11.15 ^{ns}	2325.69±44.51 ^{ns}	17.71±0.35 ^{ns}
Group-C											
200mg/kg b. wt.	105±2.23	173.33±1.66	971.87±27.00*	421.43±11.87*	136.68±4.14*	315.38±13.50*	83.96±3.48 ^{ns}	536.97±18.75 ^{ns}	258.70±12.76 ^{ns}	2237.36±38.95 ^{ns}	17.50±0.32 ^{ns}

Data exposed as Mean ± S.E, ns = non-significant, * Significant ($p \leq 0.01$), ** Highly Significant ($p \leq 0.001$).

Table 2: Effect on sperm motility, density and fertility after treatment of dry methanolic extract of Kaner (*Nerium oleander*) in male rats.

Treatment	Sperm motility %	Sperm density		No. of Pups delivered	Fertility %
		Cauda (million/mm ³)	Testes (million/mm ³)		
Group-A Control	72.32±0.62	14.72±0.18	2.97±0.06	45	100 %
Group-B 100mg/kg b. wt	69.96±0.78 ^{ns}	14.11±0.20 ^{ns}	2.68±0.11 ^{ns}	35	77.77 %
Group-C 200mg/kg b. wt	62.14±0.58*	13.97±0.07*	2.35±0.12*	21	46.66 %

Data exposed as Mean ± S.E, ns = non-significant, * Significant ($p \leq 0.01$), ** Highly Significant ($p \leq 0.001$).

Table 3: Blood biochemical changes in control and dry methanolic extract of Kaner (*Nerium oleander*) treated male rats.

Treatment	HB %	WBC th/mm ³	RBC mill/cu.mm	Hematocrit %	MCHC gm/dl	Blood Sugar mg/gl	Blood urea mg/dl
Group-A Control	12.96±0.57	11.07±0.28	5.54±0.10	38.59±2.58	34.50±3.09	96.66±2.70	26.67±1.67
Group-B 100mg/kg b. wt.	13.00±0.36 ^{ns}	11.36±0.29 ^{ns}	5.58±0.07 ^{ns}	39.68±1.71 ^{ns}	33.01±1.42 ^{ns}	98.56±2.52 ^{ns}	29.33±1.68 ^{ns}
Group-C 200mg/kg b. wt.	12.96±0.56 ^{ns}	11.86±0.38 ^{ns}	5.46±0.19 ^{ns}	38.58±2.57 ^{ns}	34.49±3.09 ^{ns}	96.66±2.70 ^{ns}	26.66±1.68 ^{ns}

Data Exposed as Mean ± S.E, ns = non-significant, * Significant ($p \leq 0.01$), ** Highly Significant ($p \leq 0.001$).

Table 4: Serum biochemical changes in control and dry methanolic extract of Kaner (*Nerium oleander*) treated male rats.

Treatment	Protein gm %	Cholesterol mg/dl	Triglycerides mg/dl	phospholipids mg%	Testosterone ng/ml	LH mIU/ml	FSH mIU/ml
Group-A Control	10.86±0.58	125.00±7.21	133.28±0.48	123.81±5.35	2.09±0.08	3.38±1.90	4.80±0.16
Group-B 100mg/kg b. wt.	10.76±0.40 ^{ns}	131.25±5.35 ^{ns}	133.28±0.47 ^{ns}	124.99±2.60 ^{ns}	1.82±0.06 ^{ns}	2.83±0.10 ^{ns}	4.33±0.15 ^{ns}
Group-C 200mg/kg b. wt.	10.84±0.58 ^{ns}	125±7.21 ^{ns}	133.28±0.47 ^{ns}	123.80±5.35 ^{ns}	1.61±0.07*	2.35±0.14*	3.55±0.16*

Data exposed as Mean ± S.E, ns = non-significant, * Significant ($p \leq 0.01$), ** Highly Significant ($p \leq 0.001$).

Table 5: Tissue biochemical analysis after the treatment of dry methanolic extract of Kaner (*Nerium oleander*), in male albino Rats.

Treatment	Protein mg/gm				Cholesterol mg/gm				Glycogen mg/gm			Fructose mg/gm
	Testes	Cauda	Seminal Vesicle	Ventral prostate	Testes	Liver	Heart	Adrenal	Testes	Liver	Heart	Seminal vesicle
Group-A Control	380.70±7.75	343.67±13.51	329.60±13.10	231.83±27.72	12.60±0.46	15.20±0.67	15.41±0.41	8.85±0.69	3.11±0.16	4.98±0.34	3.88±0.04	7.77±0.97
Group-B 100mg/kg	334.78±14.81 ^{ns}	292.56±17.68 ^{ns}	274.04±15.25 ^{ns}	199.98±22.68 ^{ns}	11.04±0.34 ^{ns}	16.14±0.46 ^{ns}	16.14±0.37 ^{ns}	6.14±0.37*	2.46±0.17 ^{ns}	4.77±0.25 ^{ns}	3.96±0.05 ^{ns}	4.57±0.73 ^{ns}
Group-C 200mg/kg	324.41±14.28*	278.49±9.57*	282.19±6.56*	151.09±5.50 ^{ns}	9.47±0.91 ^{ns}	16.25±1.71 ^{ns}	16.25±1.59 ^{ns}	6.35±0.10*	2.11±0.24*	4.38±0.19 ^{ns}	3.59±0.17 ^{ns}	4.51±0.55 ^{ns}

Data exposed as Mean ± S.E, ns = non-significant, * Significant ($p \leq 0.01$), ** Highly Significant ($p \leq 0.001$).

3.8 Histological observations

Photomicrograph of control rats (Group-A) testes showing well-developed structure of highly convoluted seminiferous tubules lined by a stratified germinal epithelium, which contained all spermatogenic cells (spermatogonia, primary spermatocytes, secondary spermatocytes, spermatid and mature spermatozoa) and sertoli cell with their distinctive nuclei present in the basal lamina. The spermatogonia can see close to the basal lamina. The seminiferous tubules are well developed and supported by loose connective tissue containing leydig cells, blood vessels and nerves. Photomicrograph of testis of rats treated at the dose

level of 100mg/kg body weight of methanol extract of the stem of *Nerium oleander* show testicular lesions and degenerative changes in germinal epithelium of seminiferous tubules, number of spermatids and spermatozoa was reduced and lumen is devoid of mature sperms. At the dose level of 200mg/kg body weight of methanol extract of the stem of *Nerium oleander* treatment, spermatogenesis was completely arrested and atrophied in treated rats. Cellular debris appears in the lumen is normal, seminiferous tubules were reduced and intertubular in between seminiferous tubules space increase (Group-B and C) (PLATE-1).



PLATE 1: Testis. Fig. 1: Photomicrograph shows normal histoarchitecture of testis, seminiferous tubules contain all the stages of spermatogenesis from spermatogonia to spermatozoa. Spermatozoa were clearly visible in the lumen. Sertoli cell in tubules in interstitial tissue and Leydig cell also seen (200 X HE).

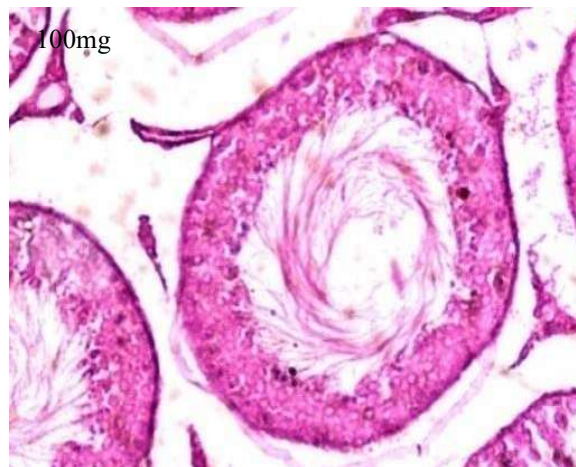


PLATE 1: Testis. Fig. 2: Photomicrograph of testis of rats treated with *Nerium oleander* stem at 100mg/kg body weight for 60 days shows degenerative changes in spermatogenesis, inhibition of primary spermatocyte stage and spermatozoa (200 X HE).

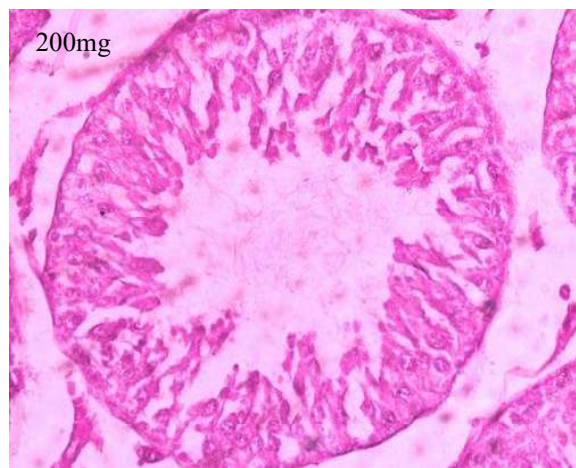


PLATE 1: Testis. Fig. 3: Photomicrograph of testis of rats treated with *Nerium oleander* stem at 200mg/kg body weight for 60 days shows reduced number of spermatids and spermatozoa, clearly visible cellular debris in lumen and lumen was devoid of sperm (200 X HE).

4. Discussion

This study was conducted to elucidate the effect of the association of biological activities with triterpenoids from *Nerium oleander* on male reproductive system. The result of this investigation demonstrated that the triterpenoids interfere with the structure and function of major elements of male fertility as reflected by a marked decrease in the rate of fertility. The plant-based contraceptive, inhibit male fertility after administration of (200mg/kg body weight) methanolic extract of *Nerium oleander* exhibited a marked reduction in counts and motility of cauda epididymal sperms in dose-dependent manner. The reduction of sperm density is confirmed by histological and hormonal investigation of testis and serum of the animals. The testes of the treated animals revealed the arrest of spermatogenesis. Size of seminiferous tubules appeared to be reduced. Vacuolization was observed in the sertoli cells, spermatogonia and spermatocytes. The significant decrease in sperm motility, density, weight of testis, epididymis and seminal vesicle may occur due to significant reduction of testosterone, luteinizing, and follicle-stimulating hormone. After treatment of methanolic extract of *Nerium oleander*, there is no significant change was observed in serum biochemistry and hematological parameters of treated group of animal which showed triterpenoids are free from side effects. However, the treatment resulted in the reduction of fertility and number of pups, indicating the fertilization might be due to stored epididymal sperms. It is histologically evident that the treatment arrested spermatogenesis.

5. Conclusion

The oral administration of triterpenoids from *Nerium oleander* at 100 and 200mg/kg body weight in male albino rats did produce antifertility effects. The results revealed that oral administration of methanol extract of the stem of *Nerium oleander* affected male fertility in two ways, antispermatogenic and antiandrogenic action. From the foregoing account, it can be conjectured that methanol extract of the stem of *Nerium oleander* could be a scope of developing an ideal male contraceptive, due to its antispermatogenic effects and no untoward side effect on the general health of the animal.

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PESTICIDE RESIDUE IN FOOD
PRODUCTS: ANALYTICAL
TECHNIQUES AND CASE STUDIES

Research project submitted
for the degree of
Master of Science,
in Chemistry
2024

Submission date
1/05/2024 *(MK)*

Session - 2023-24 *(MK)*

Submitted to- *(MK)*

Dr. Maheep Kumar

Assistant professor

Department of Chemistry,

Shri Varshney College

Submitted By

Mansi Varshney (2322020571013)

Bhumika Varshney (2322020571002)

Bhoopendra Singh (2322020571001)

Gunjan Sharma (2322020571003)

Verified
llh
31/5/24

Head
Department of Chemistry
Shri Varshney College, Aligarh



SHRI VARSHNEY COLLEGE

Affiliated to



Raja Mahendra Pratap Singh State University, Aligarh

**M.Sc. II Semester
Project Submission on
Analysis and effect of Pesticides**



Submission
date

1/05/2023

Session 22-23

Department of Chemistry

Submitted to:

Dr. Maheep Kumar

Submitted by:

Bhumika Varshney (2322020571002)

Gunjan Sharma (2322020571003)

Mansi Varshney (2322020571013)

Bhoopendra Singh (2322020571001)

Verified
[Signature]

Head
Department of Chemistry
Shri Varshney College, Aligarh

A Project Report
On
Exploring Alkaloids: Nature's Complex Compounds

The Research Project submitted to the
Raja Mahendra Pratap Singh University

for the Degree of
Master of Science



Under the
Supervision of
Dr. Maheep Kumar

By

Km. Yogeshwari Rovila -2522023220012

Lata Kumari (2522023220013)

Km. Puneeti Sharma (2522023220011)

Head
Department of Chemistry
Shri Varshney College, Aligarh

Submitted on
2/06/2025

10/7/25

Head
Department of Chemistry
Shri Varshney College, Aligarh

Department of Chemistry,
Shri Varshney College
Raja Mahendra Pratap Singh State University Aligarh-
202001, U.P. (India)

Research paper publication:

1. Imperative role of Geo-Economic factors in developing efficiency of Agricultural Marketing (Volume 15, issue 1-March 2025)
URL-(<https://jetjournal.us/>)
2. Geo-Environmental Assessment for Potential Reforms in Indian Sugar Industries (Volume 15, issue 3-Sep 2025)
URL-(<https://jetjournal.us/>)
3. Soil Ecosystem: A Complex Web of Life(Volume 13, issue 3-March 2024)
URL-(www.ajasra.in)
4. India and China in the Indo-pacific: India's Maritime Security Strategy and Responsibilities in the Indo-Pacific Region(Volume 17, issue 3-March 2023)
URL-(<https://ijeponline.com/>)
5. Environment Change Enhancing Combined Approach of Organic and Conventional Farming for Sustainable Productivity (Volume 19, issue 1 , 2024)
URL-(<https://cgscopus.com/>)
6. Rural Energy Planning in India(Volume 15, issue 01-April 2021)
URL-(<https://ijeponline.com/>)
7. Selection of Rural Markets: A combination of Products and Geographies Creating Value(Volume 10, issue 8-Aug 2020)
URL-(www.zenithresearch.org)
8. Energy Resources: An Analytical Study(Volume 12, issue 4-April 2020)
URL-(<https://jicrjournal.com/>)
9. Scaling Across Geographic Economies by Increasing Purchasing Power of Rural Communities(MHRDC-2024)
URL-(www.swaranjalipublication.co.in)
- 10.Environmental Pollution-A Heinous Crime Against Humanity(Volume 9, issue 2-Feb 2020)
URL-(<https://parishodhpu.com/>)

15. Number of books and chapters in edited volumes/books published and papers in national/international conference-proceedings till date:

Sl. No	Title of the book/ chapters published	Title of the paper	Year of publication	ISBN/ISSN number	Name of the publisher	Relevant link
1.	Multidisciplinary Higher Education Research Dynamics & Concepts	Reforming Higher Education in the Rural Area	2018	ISBN 978-93-87663, 12-4	Swaranjali Publication	www.nrjp.co.in
2.	Manegerial & Enterprenurial Intervention for sustainable development in India	पर्यावरण-सतत् पोषणीय विकास- वैश्विक विधि	2019	ISBN-978-93-89703-07-8	Swaranjali Publication	www.nrjp.co.in
3.	Environmental Challenges causes & effect	Environmental Protection and Constitutional Provisions: An overview	2021	ISBN-978-93-85420-41-2	Book Publication 106, Vikram Khand 3 Gomti Nagar, Lucknow	book publication @gmail.com
4.	Environmental Protection (Edited book)	Industrialization: An Abstruse Business towards environment	2020	ISBN-978-93-88996-37-2	Kav Publication 203, 2 nd floor Plot No.7 New Delhi	kaavpublication@gmail.com www.kaav.org www.kaavpublication.org
5.	Environment and Conservation	An Analysis of Right of clean water in India	2021	978-93-5470-308-9	Swaranjali Publication	swanrajali publication @gmail.com
6.	Environment and Conservation	Traditional Knowledge: An Aspect for biological patenting in contemporary Region	2021	978-93-5470-308-9	Swaranjali Publication	swanrajali publication @gmail.com
7.	भारतीय सामाजिक न्याय की कुछ अर्द्ध प्रछन्न आकृतियां	Book Translated	2022	978-93 5470-439-0	Swaranjali Publication	swanrajali publication@gmail.com
8.	पर्यावरण विधि: भारतीय संदर्श	Book Written	2022	978-93 5470-431-4	Swaranjali Publication	swanrajali publication@gmail.com

16. Number Paper Published in Journals from 2010 till date:

S.N.	Title of the Paper	Title of the Journal	Year of Publication	ISSN No & Volume	National/ International	Impact Factor & Link
1.	Rastra Ke Unnayan me Acharya Ki Bhumika	Quarterly Journal of Management Development	July-Sep.2011 Vol.-42 No.-3	ISSN(P): 0048-6175	International	
2.	Enviornmental Pollution by Nuisance with its Summary & Urgent Cure	International Journal of Research in Social Sciences & Humanities IJRSSH/01423	2012 Vol.-2 Issue; 4	e-ISSN: 2249-4642 p-ISSN: 2454-4671	International	
3.	Protection of Violence Against Children in India	International Journal in Social Sciences and Humanities IJSSH/101378	Oct-Dec. 2013 Vol.-3 Issue-4 AC-12-12-13	eISSN;2249-4642 pISSN; 2454-4671	International	www.ijssh.com
4.	Human Rights : An Exordium	Venketeswar International Journal of Multi-Disciplinary Research VIJMR	Jan-June 2014 Volume-1 Issue-1	PISSN 2348-7097	International	www.suv.edu.in
5.	Right to Privacy: An Overview	International Journal of Research in Social Science & Humanities IJRSSH/01394	Oct-Dec. 2014 Vol.-4 Issue-4 AC-14.12.14	eISSN; 2249-4642 pISSN; 2454-4671	International	www.ijrssh.com
6.	The Impact of Regional Disparities in the Development of the Indian Economy	Multidisciplinary International Journal MIJ.	Jan.-Dec. 2015 Vol.-1 AC-14.12.15	EISSN: 2454-924X PISSN: 2454-8103 MIJ/01159	International	www.mijjournal.in
7.	Human Rights: Exercise of Judicial Control over the execution of Sentence in the Prisons.	International Journal of Research in Social Science & Humanities IJRSSH/01363	Apr.-June 2015 Vol.-5 Issue-2 AC-23.5.15	EISSN: 2249-4642 PISSN: 2454-4671	International	www.ijrssh.com
8.	Terrorism: An Universal Challenge to Humanity	Venketeswar International Journal of Multi-disciplinary ResearchVIJMR	Jan.-June 2016 Vol.-III Issue-I	ISSN: 2348-7097	International	www.suv.edu.in
9.	Salt Loosing Saltage: Judicial Prestige at Stake?	IOSR Journal of Humanities and Social Science (IOSR-JHSS)	Jan. 2017 Vol.-22 Issue-I Ver.-I	DOI: 10.9790/0837-2201015861 eISSN;2279-0845 pISSN;2279-083 UGC: 5070	International	www.iosrjournal.org
10.	Wild Life Forensic: An Emerging Field in Wild Life	IOSR Journal of Environment Science, Toxicology & food technology (IOSR-JESTFT)	Jan.- 2018 Vol.-12 Issue: Ver.-II	DOI: 10.9790/2402-1201028285 pISSN;2319-2390 eISSN;2319-2402	International	www.iosrjournal.org
11.	Polygraph Test & its relevancy in criminal Justice System.	IOSR, Journal of Biotechnology & Bio Chemistry IOSR-JBB	Jul.- Aug.2018 Vol.-II Issue-4	ISSN;2455-264X UGC:4033 JN: 44202	International	www.iosrjournal.org

12.	Child Trafficking Affliction: A Scourge Towards Progressiveness.	International Journal of Professional Studies	Jul.-Dec.2018 Vol.-6 ACO-10 Sep. 2018	eISSN:2455-6270 pISSN:2455-7455	International	1.976 www.ijps.in
13.	<i>Marriage System Under Hindu Law:A Brief Study.</i>	Excellence Journal of Educational Research EIJER.	Oct-2019 Vol.-7 Issue-3	ISSN;2349-8838	International	5.085 www.eijer.com
14.	Domestic Violence and Judiciary: An Analysis.	IOSR Journal of Humanities and Social Sciences JHSS	Jan.-2020 Vol.-25 Issue-1 Series-1	DOI-10.9790/0837-2501011680 E-2279 0837 P-2279 0845 UGCSN: 25/5070	International	www.iosrjournal.org
15.	Problem and perspective in sustainable environment in the world : A Legal Study.	The Scientific Tempor.	Jan.-July 2021 Vol.12, No 1-2.	DOI: 03960.2021.12.127 ISSN: 0976- 8653	International	www.connectjournal.com scientifictempor.com
16.	Electronic Records as evidence in the courts: An Analysis.	The Scientific Tempor	Jan-July 2021 Vol.12 , No 1-2	DOI: 03960.2021.12.127 0976 8653	International	www.connectjournal.com
17.	Ayam aur chunotiyo ke madhya badalte parivesh me Samajik Nyay ebam Vidhik Sansthan.	International Literacy Quest.	Jul.-Dec.2021 Vol.-14 Issue-1 Accp-April, 2021	2319- 7137	International	www.internationalliteracyquest
18.	Maintenance of wife under personal laws: An Evaluative Analysis.	International Journal of Criminal Common and Statutory Law.	Jul.-Dec. 2021 Part-A Vol.-1 Issue-2 Accp-Jun. 2021	2789- 9497 EISSN: 2789- 9500	International	RIF:5.64 www.criminallawjournal.org
19.	Significant Role of Judiciary in Juvenile Delinquency.	International Journal of Law, Justice and Jurisprudence.	Jul.-Dec. 2021 Vol.-1 Issue-2 Accp-June, 2021	PISSN: 2790-0673 EISSN: 2790- 0681	International	5.03 www.ijljj.com
20.	Judicial Activism as a means for attaining good governance.	International world Translation.	Jul.-Dec. 2021 Vol.-14 Issue-1	ISSN: 2278- 0408	International	www.worldtranslation.in
21.	Moral and Ethical Values: Significance and Relevance.	International Literacy Quest.	Jul-Dec. 2021 Vol.-14 Issue-2 Accp-July, 2021	ISSN: 2319- 7137	International	www.internationalliteracyquest.in
22.	Ganga Pauranik ebamParyavarniya Chetna.	International Journal of Applied Research IJR: 2022	Jan. 2022 Vol.-8 Issue-1	ISSN: 2394- 7500 EISSN:2394-5869 CODEN:IJARF	International	RJIF : 8.4 www.ijar.com
23.	Bharat me Santamulak Samarjik Nyay me Nari ki Praistithi :Sambhavya Bhavisya.	International Journal of Humanities & Social Science Invention IJHSSI	Feb. 2022 Vol.-11 Issue-2 Series-II	ISSN Online-2319- 7722 ISSN Print: 2319- 7714 UGC 4098	International	5.34 www.ijhssi.org
24.	Implementation of Human Rights: An Universal challenge towards Humanity.	The Scientific Tempor.	Jan-June 2022 Vol.13,No 1,	DOCID: 2022.13.1.67 ISSN: 0976 8653 EISSN: 2231- 6396	International	www.scientifictempor.com
25.	Proceedings National	Status of woman	2022-2023	-	-	-

	Seminar sponsored by ICHR, New Delhi	in India during Nationalist Movement and Present Scenario: An Overview				
26.	Inalienable Determinant of Child Violence: A Perusal	International Literacy quest impact factor 5.125	Jan-June 2023 Vol.-17	ISSN: 23197137	International	www.internationalliteraryquest.com
27.	Socio Legal Status in Live-in-Relationship under Hindu Law: A balance Need to be drawn	International Literacy Quest	Jan.-June 2024 Vol. 19	ISSN: 2319-7137 Impact factor 5.125	International	www.internationalliteraryquest.com
28.	Status of women in India	Sodh	May-Dec 24 Issue No.II&III	ISSN:0979-1745 Impact factor- 5.875	International	www.sodh.com

Prof. (Dr.) SEEMA YADAV

Publication Type	Publisher	Article Name	Journal Name	Digital Object Identifier (DOI)	Role in Publication	Author Name	Volume	Total no. of pages/Page Range	ISSN/e-ISSN	Impact Factor	Url	Keywords	Published Date Online	Published Date Print	Date Of Acceptance	Review Initiated On	Status
Research Papers in Peer Reviewed Journals	ANNALS OF EDUCATION	Ecological Perspectives in the Selected Novels of R.K. Narayan: A Comparative Study	ANNALS OF EDUCATION Research Journal		Single Author	DR. Shajar Uddin	10(1)	12-18	2455-6726		https://ojs.annals.com/issue.html	Ecocriticism, environmental crisis, ecological perspectives, anthropocentrism, ecocriticism, R.K. Narayan, Maaigudi, human-nature interaction			20-03-2024		
Research Papers in Peer Reviewed Journals	The SPL Journal of Literary Hermeneutics	Quest for Love and Obsession: A Thematic Analysis of Ismat Chughtai's The Gilt and Shobha De's Strang Obsession	The SPL Journal of Literary Hermeneutics		Single Author	Dr. Shajar Uddin	2, Issue 1	114-123	2583-1674		https://literaryherm.org/index.php/bs/article/view/28	Obsession, Love, Homosexual, Lesbian, Patriarchy, OCD, LGBT, Feminist, Sexual Satisfaction, Neurotics.			11-02-2022		
Research Papers in Peer Reviewed Journals	World Translation An International Multidisciplinary Peer Reviewed Refereed Research Journal	Female Characters of Chitra Banerjee and Meena Alexander with Special Reference of Arranged Marriage and Fault Lines: An Analysis	World Translation An International Multidisciplinary Peer Reviewed Refereed Research Journal	https://www.translati on.in/?page-Id=445628	Single Author	Dr. Shajar Uddin	17	52-58	2276-0408		https://www.translati on.in/?page-Id=445628	Indian Diaspora, Female Characters, Self-identity, Social and economical condition			10-02-2023		
Research Papers in Peer Reviewed Journals	The Criterion: An International Journal in English	Quest for Identity and Loneliness are the Theme of Women Writers in Indian English Literature	The Criterion: An International Journal in English	https://doi.org/10.5251/zenodo.10448030	Single Author	Dr. Shajar Uddin	12, Issue 6	10-17	0976-8165		https://www.the-criterion.com/archive/	women authors, quest for identity, realistic description, loneliness, isolates, social, psychological, emotional, journalistic, traditional and cultural, poetry, fiction, short stories, feminine confession.	31-12-2021		27-12-2021		
Research Papers in Peer Reviewed Journals	Awadh International Journal of Information Technology and Education	Corona Transition: The Role of Various Genres of Literature in Public Awareness	Awadh International Journal of Information Technology and Education	Print Form	Co-Author	Dr. Shajar Uddin, Muhammad Iqbal Yusuf Ansari	9 Issue 2	8-15	2277-8985			Muskurayaga India, English Literature, Data base of journal of covid-19, cues of Indian Railways,			10-09-2020		
Research Papers in Peer Reviewed Journals	Think India Journal	Yoga : from Vedic to the present time and its role in Learning English Language	Think India Journal		Single Author	Dr. Shajar Uddin	23, Issue 03	204-207	0971-1260		https://thinkindiaquarterly.org/index.php/thinkindia/issue/view/235	Yoga , Learning, English, Language	06-01-2020		14-12-2019		
Research Papers in Peer Reviewed Journals	Think Criterion	Presentation of Young Adult Culture in E-cigarette of Tauseef Barekvi and Shajar Uddin's Hubble-Bubble(A Hookah Party): A Comparative Analysis	The Criterion: An International Journal in English	online	Single Author	Dr. Shajar Uddin	vol16, Issue 06	1172-1184	0976-8165		https://www.the-criterion.com/v16/issue/025V16n6044.pdf	Young Adult Literature, adolescent, cultural change, drugs, smoking, consumerism, exploitation, E-cigarette, Hubble-Bubble (A Hookah Party), comparative, traditional, postmodern.	12-01-2025		21-12-2025		

शोध पत्र का शीर्षक	शोधकर्ता का नाम	वर्ष/अंक	शोधपत्र में स्थिति का स्थिति	पेज नं.	ISSN/ISBN नं.	शोध पत्र का संपादक	शोध प्रकरण (3)
1. लुठघामों का समाजशास्त्रीय एवं शैक्षिक महत्व	बलदेव ब्रांठ	जून-सितंबर 2020-21-19	27-01-2024	200-200	2278-4988, 3-4-5-5-375 (IIFS)	इंटरनेशनल मॉडर्निजिज्म विचार-विमर्श रिचर्ड	अनुवाद पाठ्यक्रम के अंतर्गत दिवसी
42. सामाजिक नियंत्रण में शिक्षा की भूमिका	"	"	"	200-215	"	"	"
43. आश्रम व्यवस्था एवं शिक्षा	शोध	जून-सितंबर 2020-21-19	04-02-2024	72-79	0970-174-6, Reg. No. - 2607/1-V8E22	माइनिंगुअल पिपरी रिचर्ड	दिल्ली विश्वविद्यालय के अंतर्गत दिवसी
44. शैक्षिक स्तर में गिरावट : एक गम्भीर चुनौती	बलदेव ब्रांठ	जून-सितंबर 2020-21-19	10-07-2024	29-35	2278-4988, 3-4-5-5-375 (IIFS)	इंटरनेशनल मॉडर्निजिज्म विचार-विमर्श रिचर्ड	अनुवाद पाठ्यक्रम के अंतर्गत दिवसी
45. पर्यावरण शिक्षा की महत्ता	इंटरनेशनल डिप्लोमा इन एडमिनिस्ट्रेशन	"	"	32-37	"	"	"
46. अन्तर्देशीय सन्धानना एवं शिक्षा	प्रोफेसर डॉ. वि. के. शर्मा	9-10 नवंबर 2024	05-11-2024	50-59	ISBN-978-81-981016-6-2	Proceedings of N-Sem	शोध पत्र के अंतर्गत दिवसी
47. लोटे के, दार्शनिक एवं शैक्षिक विचार	द. गुंजन	जून-सितंबर 2020-21-19	28-11-2024	46-50	ISSN-2349-5273	अन्तर्देशीय शैक्षिक विचार-विमर्श रिचर्ड	शोध पत्र के अंतर्गत दिवसी
48. लोटे की शैक्षिक विचारधारा	अभिमान गवेषणा	जून-सितंबर 2020-21-19	20-12-2024	138-144	ISSN-2349-4366	"	शोध पत्र के अंतर्गत दिवसी
49. मैथिली में शैक्षिक चिन्तन	द. गुंजन	जून-सितंबर 2020-21-19	28-02-2025	12-15	ISSN-2349-5273	"	"
50. जैन धर्म की शैक्षिक विचारधारा	अभिमान गवेषणा	जून-सितंबर 2020-21-19	28-03-2025	73-77	ISSN-2349-4366	"	"
51. रंगीन-नाथ ढंग के शिक्षा दर्शन की विशेषता	बलदेव ब्रांठ	जून-सितंबर 2020-21-19	31-03-2025	60-60	ISSN-2278-4988	इंटरनेशनल मॉडर्निजिज्म विचार-विमर्श रिचर्ड	अनुवाद पाठ्यक्रम के अंतर्गत दिवसी
52. महात्मा गांधी के शिक्षा दर्शन का शिक्षा दर्शन	इंटरनेशनल डिप्लोमा इन एडमिनिस्ट्रेशन	जून-सितंबर 2020-21-19	03-04-2025	128-131	ISSN-2349-5273	"	"
53. परिवार : शिक्षा का सक्रिय व अनौपचारिक साधन	पद चिन्ह	जून-सितंबर 2020-21-19	14-01-2025	89-94	ISSN 2231-1351	पीपरी रिचर्ड	शोध पत्र के अंतर्गत दिवसी
54. विद्यालय : रुढ़ि म औपचारिक साधन	"	"	"	26-33	"	"	"
55. विद्यालय में पुस्तकालय का महत्व	विद्यावार्ता	जून-सितंबर 2020-21-19	"	40-42	ISSN-2349-5273	"	"
56. शैक्षिक प्रयोगशाला की आवश्यकता एवं महत्ता	"	"	"	81-83	"	"	"
57. विद्यालय और समुदाय का सम्बन्ध	प्रॉब्लम सॉल्यूशन	जून-सितंबर 2020-21-19	"	46-48	ISSN-2349-5273	"	"
58. विद्यालय में पाठ्य सहकार्य क्रियाओं के आयोजन की महत्ता	"	जून-सितंबर 2020-21-19	"	90-93	"	"	"
59. महात्मा गांधी के शैक्षिक विचारों का विश्लेषण	विद्यावार्ता	अक्टूबर-दिसंबर 2025	"	72-76	ISSN-2349-5273	पिपरी रिचर्ड	"
60. नारी शिक्षा	"	"	"	"	"	"	"
61. शिक्षित नेतृत्व	"	"	"	"	"	"	"
62. जनसंख्या शिक्षा की आवश्यकता एवं महत्व	अभिमान गवेषणा	जून-सितंबर 2020-21-19	28-03-2025	88-	ISSN-2349-4366	अन्तर्देशीय शैक्षिक विचार-विमर्श रिचर्ड	अनुवाद पाठ्यक्रम के अंतर्गत दिवसी
63. अरविन्द आश्रम	द. गुंजन	जून-सितंबर 2020-21-19	"	20	"	"	"
64. रंगीन-नाथ ढंग के शैक्षिक चिन्तन का सांसारिक प्रयोग	अभिमान गवेषणा	जून-सितंबर 2020-21-19	28-03-2025	16	ISSN-2349-4366	अन्तर्देशीय शैक्षिक विचार-विमर्श रिचर्ड	अनुवाद पाठ्यक्रम के अंतर्गत दिवसी
65. नालक पर समाज का शैक्षिक प्रभाव	शोध-वर्तिका	"	"	"	"	"	"
66. शैक्षिक समाज शास्त्र की आवश्यकता एवं महत्ता	शोध-वर्तिका	जून-सितंबर 2020-21-19	15-06-2025	35-40	ISSN-2349-4654	पिपरी रिचर्ड	शोध पत्र के अंतर्गत दिवसी
67. श्री अरविन्द का शैक्षिक दर्शन	"	"	"	"	"	"	"
68. सामान्य प्रवृत्तियों का शैक्षिक महत्व	"	"	"	"	"	"	"
69. स्वामीजी का शैक्षिक महत्व	"	"	"	"	"	"	"
70. प्रयोजनवाद का कलावाद या व्यवहारवाद या प्रयोजनवाद का शैक्षिक विवेचन	"	"	"	"	"	"	"

Research article-

1. Issues in qualitative issues: a review and analysis

DOI: 10.25215/1201.065

2. Book Chapter- Evolution of female character: From the lens of media, art and literature

ISBN: 978-93-6631-328-3

Research Paper Published in Journals

1. Paper Title: **Vartman main Manav jeevan ke sarvangeen vikas main pryavarneeya shiksha ki bhomika**
Journal Name: The Gunjan (Peer Reviewed Journal)
Vol. 7, Page- 153-158, April- June 2021
ISSN- 2349-9273

Chapter in Book/ Conference Proceedings

1. Chapter Title: **भारत की स्नातजिक संस्कृति - एक एतिहासिक अवलोकन**
Book Name: India's Strategic Culture
Editors: Dr. Amar Singh, Dr. Pankaj Kumar Verma & Dr. Chirantan Kumar
Publisher: Educational Book Service, New Delhi
ISBN: 978-93-93469-80-9
Year: 2025
2. Chapter Title: **भारत की विदेश नीति का भविष्य : विस्तृत विश्लेषण**
Book Name: **भू-राजनीतिक गतिशीलता और भारत की विदेश नीति उभरती चुनौतियाँ और अवसर**
Editors: Dr. Akshay Kumar & Dr. Viresh Kumar
Publisher: मोहित पब्लिकेशन्स, नई दिल्ली
ISBN: 978-81-981016-6-2
Year: 2025
3. Chapter Title: **Bhartiya Cyber Suraksha ke Ubharte Khatre**
Book Name: India's Defence Achievements
Editors: Dr. Pankaj Kumar Verma & Dr. Amar Singh
Publisher: Satyam Publishing House, New Delhi
ISBN: 978-93-91993-86-3
Year: 2023

List of Research Papers till September

1. Job satisfaction as correlates of psychological well-being of employees of private and government sector. (August 2025)
2. Mobile technology: A boon or curse, a qualitative psychological analysis (April 25 to June 25)
3. Short-form videos and attention span in college students (Feb. 24)
4. Importance of interplay of education and technology in higher education in NEP-2020
5. Challenges of parenting in present scenario
6. ~~How perceived~~ How perceived role of father associated with aggressive behaviour of early adolescents?
7. How gender and age affect aggressive behaviour?
8. Do perceived parenting standards cause aggression?
9. Educational stress as related to boys and girls of various faculties.

Research Papers in Peer-Reviewed or UGC listed Journals

#	Publication Type	Title of the Paper	Journal Name	Year	Vol. No.	Page No.	ISSN No.	Impact Factor	Authorship	UGC listed Journal	Scopus Index	Plagiarism/Similarity Level	Research Score
1	Peer Reviewed	SYNTHESIS CHARACTERIZATION AND ANALYTICAL APPLICATIONS OF ANTIMONY (III)	ORIENTAL JOURNAL OF CHEMISTRY	2017	33	725-732	0970-020	less than 1	One of the two author/ First and Principal/Corresponding author	Yes	Yes		2
2	Peer Reviewed	A NEW METHOD QUANTITATIVE ESTIMATION AND ASSAY OF SOME ANTI ARRHYTHMIC	IQSR	2017	10	41-46	2278-5736	less than 1	Other/Joint Author	Yes	Yes		2
3	Peer Reviewed	CADMLUM (II) SELECTIVE A NEW INORGANIC CATIONIC EXCHANGER BASED ON ANTIMONY (III)	INTERNATIONAL TRANSACTION IN APPLIED SCIENCES	2013	5	467-478	0974-7273	less than 1	Other/Joint Author	Yes	Yes		2
4	Peer Reviewed	SYNTHESIS AND CHARACTERIZATION OF AN INORGANIC ION EXCHANGER BASED ON TIN (IV)	INTERNATIONAL TRANSACTION IN APPLIED SCIENCES	2010	2	181-190	0974-7273	less than 1	Other/Joint Author	Yes	Yes		2
5	Peer Reviewed	OXIDATIVE DETERMINATION OF SOME NEW ANTIHISTAMINE DRUGS IN PURE FORM AND IN THEIR PHARMACEUTICAL PREPARATIONS BY USING CU (III) REAGENT	INTERNATIONAL JOURNAL OF SCIENTIFIC AND TECHNICAL ADVANTAGES	2017	3	13-17	2454-1532	less than 1	Other/Joint Author	Yes	Yes		2
6	Peer Reviewed	SYNTHESIS AND APPLICATIONS OF STANNIC (IV) OXOARSENOTUNGSTATE BASED CATION EXCHANGER	INTERNATIONAL JOURNAL OF SCIENTIFIC AND TECHNICAL ADVANTAGES	2017	3	1-6	2454-1532	less than 1	Single Author	Yes	Yes		2
7	Peer Reviewed	STUDY OF NEW SYNTHESIZED CERIUM (IV) IODOARSENATE AN INORGANIC CATIONS EXCHANGER AND ITS APPLICATION	INTERNATIONAL JOURNAL OF SCIENTIFIC AND TECHNICAL ADVANTAGES	2017	3	7-11	2454-1532	less than 1	One of the two author/ First and Principal/Corresponding author	Yes	Yes		2
8	Peer Reviewed	SYNTHESIS CHARACTERIZATION AND ANALYTICAL APPLICATION OF A NEW CATION EXCHANGER CERIUM (IV) IODOVANADOSILICATE	INTERNATIONAL JOURNAL OF BASIC AND APPLIED CHEMICAL SCIENCES	2018	8	9-20	2277-2073	less than 1	Other/Joint Author	Yes	Yes		2
9	Peer Reviewed	ANALYTICAL APPLICATION OF SOME THREE COMPONENT CATION EXCHANGER BASED ON TIN (IV) AND ANTIMONY (III)	INTERNATIONAL JOURNAL OF BASIC AND APPLIED CHEMICAL SCIENCES	2015	55	29-39	2277-2073	less than 1	Other/Joint Author	Yes	Yes		2
10	Peer Reviewed	STUDIES ON NEWLY SYNTHESIZED TIN (IV) VANADOMOL YBDATE AN EXCHANGER SELECTIVE FOR NICKEL (II) IONS	INTERNATIONAL JOURNAL OF BASIC AND APPLIED CHEMICAL SCIENCES	2017	7	6-13	2277-2073	less than 1	One of the two author/ First and Principal/Corresponding author	Yes	Yes		2
11	Peer Reviewed	SYNTHESIS AND CHARACTERIZATION OF CERIUM (IV)	ASIAN JOURNAL OF CHEMISTRY	2017	29	1533-1537	4233	less than 1	One of the two author/ First and Principal/Corresponding author	Yes	Yes		2

4.4 Awards

5.1 Additional/Miscellaneous Information

Research Papers.

S. N.	Title	URL/Journal Name with ISSN No	Year
1-	Feminist considerations in Anita Desai's voices in the city	Creative writing and criticism (0975-2390)	31/10/2010
2-	Untouchability in the novel of Arundhati Roy: The God of Small Things	Shodh Akshara (2249-9113)	30/07/2014
3-	Impact of Indian Mythology on the Literature of Herman Melville	www.srjis.com (2278-8888)	04/07/2017
4-	Indian Influence on American English Literature in special reference to Herman Melville	www.srjis.com (2278-8888)	04/03/2010
5-	Socio-Economic Disparity Faced by Dalits in Modern Scenario: An Analysis	www.srjis.com (0976-5255)	31/05/2019
6-	Universal Declaration of Human Rights: An Analytical Study	SHODH (0976-1745)	31/12/2019
7-	Learning English Literature At Home with ICT Tools: The Appropriate use of 'Corona' Lockdown period	http://jicrjournal.com (0022-1945)	30/03/2020
8-	Theme and Structure in T.S. Eliot's Poem 'The waste land'	SHODH (097-1745)	31/12/2020
9-	Pandemic Literature: Ancient to Present	www.sjifactor.com (2277-5730)	21/01/2021
10-	Gender Discrimination As a Center of Attention in Shashi Deshpande's Fiction, 'That Long Silence'	shodh-city (2454-6283)	30/01/2022

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|------|---|--|------------|
| 11 - | Significance of fairy Tales in Children Literature | http://ijerjournal.com
(0022-1945) | 02/01/2023 |
| 12 - | Identity - crisis and its reaffirmation of Transgender in the autobiography : Red Lipstick | http://www.socialresearchfoundation.com/
stinkhdala.php#8
(2349-980X) | 25/04/2023 |
| 13 - | Identity crisis under the compulsion social forces in Recreational Novel 'One Part woman' | SHODH (0970-1745) | 30/04/2023 |
| 14 - | From Hermitage To Metropolis: A Comparative study of feminine Identity in classical and Modern Drama Through Shakuntala | https://ijpub.org/ijpub/viewpaperforall.php?paper=IJRAR2307001
(2984-8903) | 11/07/2023 |
| 15 - | From Silence To Self-Articulation; Transgender voice in Aundhati Roy's the Ministry of Utmost Happiness | https://ijpub.org/ijra/viewpaperforall.php?paper=IJRAR2309001
(2984-8903) | 16/09/2023 |
| 16 - | Maternal Ethics and Moral Legitimacy in Kalidasa's Abhijnanashakuntalam | www.ijmra.us
(2249-2496) | 30/01/2024 |
| 17 - | GC3 - Spirituality in Indian English Poetry | www.aarf-aria
(2394-1642) | 27/04/2024 |
| 18 - | Snake Symbolism and cultural myth in Indian Tradition: A study of Nagamandala by Girish Karnad | www.zenithresearch.org
.in
(2231-5700) | 25/06/2024 |
| 19 - | Anita Desai's Novel 'Cry, The Peacock' and feminine Sensibility | https://www.sriis.com/issuesdate/236 | 01/09/2024 |
| 20 - | fixes as Cultural memory in India and western Literature | www.ijciss.com
(2632-7597) | 25/03/2024 |

21-	The Rise of Eco-Literature: Nature and Climate Anxiety: A study of Amitav Ghosh's The Hungry Tide	www.ijcils.com (2632-7597)	30/03/2025
22-	Emily Dickinson's Feminisms: Challenging Patriarchy Through Lyric voice	www.ijmra.us (2249-2496)	03/04/2025
23-	Explores the theme of intoxication across two decades in Indian Novels: Jeet Thayil's Narcopolis and Anundhati Roy's The God of Small Things	https://internationalinterquest.com (2319-7137)	30/06/2020
24-	Female Agency Across cultures: A comparative study of Shakespeare's Rosalind and Kalidas's Shakuntla	https://shodh.co.in/ books/shodh_journal- sep-dec-2025.pdf (0970-1745)	31/12/2025
Chapters in Books with ISBN			
25-	The social inequalities of Dalits: An Agenda on Nulk Raj Anand's Untouchable	Socio-Economic condition of Dalits (978-81-932029-1-5)	30/10/2014
26-	Quality Assurance of Higher Education & Research	Multidisciplinary Higher Education Research Dynamics & Concepts, Opportunities & Challenges for Sustainable Development (978-93-07662-72-4)	15/01/2010
27-	Participation of Dalit Veeranganas in The Revolt of 1857	Revisiting The Great Revolt of 1857 (978-81-959053-5-5)	8/12/2021

28 -	A strong Bonding in the Relationship of India and China through Literary Translation	India - China Relations Issues and Emerging Trends (970-93-83246-96-0)	10/03/2023
29 -	A Study of Religious Thoughts in Dr. S. Radhakrishnan's works	Multidisciplinary Higher Education Research Dynamics - Concepts Sustainable Approaches for Developed India (970-93-6559-970-3)	01/12/2024
30 -	Literature as Resistance: The Role of Fiction in Shaping Political Consciousness during Geopolitical Crisis	(970-01-901016-0-2)	25/04/2025

□ Research Papers Table

S.No	Publication Type	Publisher	Article Name	Journal Name	Author(s)	Role	Volume/Issue	Pages	ISSN	Published Date
1	Peer Reviewed	APH Publishing Corporation	Multiple Shades of Metropolis of Bombay & Existential Struggle...	Education For All	Ajai Raj Singh, Prof. Neeta	First Author	Vol 15, No. 9	54-64	2319-2437	23-07-2025
2	Peer Reviewed	Novel Academy, Nepal	From Wounds to Words: Exploring Therapeutic Dimensions...	Journal of Management and Health Sciences	Dr. Neeta, Deepti Yadav	Co-Author	Vol. 3 No. 2	153-163	2505-0680	—
3	Peer Reviewed	Perception Publishing	The Duality of India: Exposing Lesser-Known Realities...	The Creative Launcher	Prof. Neeta, Ajai Raj Singh	Co-Author	Vol. 9 Issue 5	110-118	2455-6580	31-10-2024
4	Peer Reviewed	Atlantic Literary Review	Ecological Concerns in the Poetry of North-East India	Atlantic Literary Review	Neeta	Single Author	Vol.20 No. 2	20-29	0972-3269	10-01-2019
5	Peer Reviewed	Atlantic Publishers	Banality of Feminism: Post-feminist Critique...	Atlantic Review of Feminist Studies	Neeta	Single Author	Vol.6 No.1-2	58-68	2320-5105	09-10-2017
6	UGC Listed	Atlantic Publishers	Eco-Feminist Reading of	Atlantic Review of	—	Single Author	Vol.5 No.3-4	31-39	2320-5105	15-04-2017

7	UGC Listed	Atlantic Publishers	Mahasweta Devi's Hunt The Prison We Broke: Journey of Dalit Women... Eco-critical Reading of Anita Desai's Work	Feminist Studies Atlantic Review of Feminist Studies Impressions Journal	Neeta	Single Author	Vol.5 No.1	30-38	2320-5105	07-11-2017
8	Peer Reviewed	Impressions Journal	Dichotomy of Illusion and Reality... Arundhati Roy's Walking with Comrade	Atlantic Review of Feminist Studies Shodh Akshra	Neeta	Single Author	Vol.4 No.1-2	60-68	2320-5105	18-02-2016
9	Peer Reviewed	Shri Varshney College	Reflection of Eco-criticism in 19th Century Poetry Literature as Commitment to Human Values	Shodh Akshra	Neeta	Single Author	Vol.5 No.1	27-31	2249-9113	28-04-2015
10	Peer Reviewed	Shri Varshney College	Relevance of Buddhist Tenets of Morality Cultural	Shodh Akshra AJANTA	Neeta	Single Author	Vol.4 No.1	47-52	2249-9113	11-03-2014
11	Peer Reviewed	Shri Varshney College	Relevance of Buddhist Tenets of Morality Cultural	Shodh Akshra AJANTA	Neeta	Single Author	Vol.3 No.1	57-65	2249-9113	05-03-2013
12	Peer Reviewed	Ajanta Prakashan	Cultural	Shodh	Neeta	Single Author	Vol.1 Issue 2	170-174	2277-5730	04-01-2012
13	Peer Reviewed	Shri		Shodh	Neeta	Single Author	Vol.1 No.2	28-	2249-	09-11-

	Reviewed	Varshney College	Displacement in A.K. Ramanujan	Akshra	Author	36	9113	2011
15	Peer Reviewed	Shri Varshney College	Hindoo in A.K. Ramanujan's Poetry	Shodh Akshra	Single Author	53-58	—	28-01-2011
16	Peer Reviewed	Amit Jain	Electronic Media & English Language	Deliberative Research	First Author	—	0976-1136	08-02-2011
17	Peer Reviewed	Dr. Ram Sharma	Dynamics of Man-Woman Relationship	Ruminations	Single Author	209-219	2229-6751	03-07-2010
18	Peer Reviewed	APH Publishing	East-West Ethos in Raja Rao's Novels	Journal of Education & Humanities	Single Author	265-272	2278-232X	11-01-2010
19	Peer Reviewed	Shri Varshney College	Shades of Terrorism in Indian Fiction	AKSHRA	Single Author	48-56	—	02-02-2010
20	Peer Reviewed	Shri Varshney College	Indian Sensibility & Globalization	AKSHRA	Single Author	30-35	—	12-08-2009
21	Peer Reviewed	Society for Education	Fiction by Contemporary Women Writers	JOSSH	Single Author	61-66	—	06-05-2009
22	Peer Reviewed	Impressions Journal	Female Protagonist in Bapsi Sidhwa	Impressions Journal	Single Author	61-67	—	16-10-2007
23	Peer Reviewed	P.U. Academy	Satiric Strain in Emily Dickinson	Purvanchal Journal	Single Author	33-40	—	17-07-1993

□ Edited / Translated & Reference Books Table

S.No	Category	Book Title	Publisher	Author(s)	Role	Pages	ISBN	Year	Status
1	Edited Book	Historical Foundations of India's Global Strategy Today	Mohit Publications, New Delhi	Dr. Akshay Kumar, Dr. Viresh Kumar	Author	142–152	978-81-981016-6-2	2024	Verified
2	Reference Book	Dramatic World of Arthur Miller: A Critical Evaluation	AADI Publication, Jaipur	—	Author	186	978-93-92586-12-5	2022	Verified
3	Book Chapter	India–China Relationship Through the Lens of Bollywood	Academic Excellence Publishers, New Delhi	Dr. Akshay Kumar, Dr. Viresh Kumar, Dr. Shivendra Shahi	Author	149–158	978-93-83246-96-0	2023	Verified
4	Reference Book	Ecocriticism in Indian English Literature	AADI Publication, Jaipur	—	Co-Author	211	978-93-920586-03-3	2022	Verified
5	Edited Book	Paradigm Shift in Human Relationship in Manju Kapur's Fiction	AADI Publications	Dr. Beena Agarwal	Author	—	978-93-87799-45-5	2020	Verified
6	Edited Book	Portrayal of Women in Media	AADI Publications, Jaipur	Dr. Beena Agarwal, Dr. Madhu Kumari	Author	68–73	978-93-82630-94-4	2017	Verified
7	Edited Book	Manjula Padmanabhan: A Voice Beyond Domestic Domain	Y King Books, Jaipur	Shiv Govind Puri	Author	112–123	978-93-85528-84-2	2016	Verified
8	Edited Book	Study of Bapsi Sidhwa's Fiction	Y King Books, Jaipur	Shiv Govind Puri	Author	14–27	978-93-85528-27-9	2016	Verified

9	Edited Book	Mahesh Dattani's Tara: A Critical Perspective	AADI Publication, Jaipur	Dr. Beena Agarwal	Author	45-51	978-93-82630-84-5	2016	Verified
10	Edited Book	Eco-Criticism in Judith Wright's Poetry	Atlantic Publishers, New Delhi	Shiv Govind Puri	Author	74-84	978-81-269-2113-3	2015	Verified
11	Edited Book	Manjula Padmanabhan's Harvest	Associated Publishing House, Agra	Dr. Nirupma Misra, Dr. Gunjan Chaturvedi	Author	293-300	978-93-81778-24-1	2012	Verified
12	Edited Book	Catharsis: An Agenda of Dalit Poetry	Lingaya's University, New Delhi	Dr. Omana Antony	Author	36-39	978-81-909732-9-8	2012	Verified
13	Edited Book	Miller's Dramatic World	Author Press, New Delhi	Beena Agarwal	Author	119-141	978-81-7273-688-0	2012	Verified
14	Edited Book	Eco-Feminist Reading of Anita Desai	Sarup Book Publishers, New Delhi	Alka Rastogi	Author	285-295	978-81-7625-798-5	2011	Verified
15	Edited Book	Amitav Ghosh's Sea of Poppies: A Postcolonial Study	Sarup Book Publishers	Dr. B.K. Sharma	Author	93-104	978-81-7625-718-3	2011	Verified
16	Edited Book	Society of Technocrats & Women	Atlantic Publishers, New Delhi	Malti Agarwal	Author	254-261	978-81-269-1465-4	2011	Verified
17	Edited Book	Eco-consciousness in Contemporary Women Fiction	AADI Publication, Jaipur	Malti Agarwal, Beena Agarwal	Author	22-34	978-93-80902-67-8	2010	Verified
18	Edited Book	Metro Culture & Human Behaviour	Sharda Pustak Bhawan, Allahabad	Dr. U.K. Dwivedi	Author	31-37	978-93-80285-55-9	2010	Verified
19	Edited Book	Dalit Literature: Contents & Concerns	Sarup Book Publishers	Harbir Singh Randhawa	Author	215-223	978-81-7625-621-6	2010	Verified

20	Reference Book	Contextualizing Dalit Consciousness	Y King Books, Jaipur	—	Co-Author	—	978-81-910588-3-3	2010	Verified
21	Edited Book	Ecocritical Reading of Kiran Desai	Atlantic Publishers, New Delhi	Sunita Sinha, Bryan Reynolds	Author	232–241	978-81-269-1242-1	2009	Verified
22	Edited Book	Psyche of Crisis in A.K. Ramanujan	Atlantic Publishers, New Delhi	Malti Agarwal	Author	184–195	978-81-269-1048-9	2008	Verified
23	Edited Book	Gender Construction in Mahesh Dattani	Author's Press, New Delhi	Dr. Anjubala Agarwal	Author	95–102	978-81-7273-448-0	2007	Verified

8.1.1 Research Publications

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IDENTIFIER(DOI)		PAGE/PAGE RANGE			
BHARAT KI AARTHIK CHHALANG : CHOTHI SABSE BADI ARTHVYVASTHA BANNE KI VIKASH YATRA	VIDYAWARTA	Single Author	"Dr. DHARMENDRA KUMAR"	vol. 15	97-103
Aarthik shashktikarn mei Pradhanmantri Mudra Yojna ki Uplabdhion ka ek Tulnatmak Aadhyan	SHODH	Single Author	Dr. DHARMENDRA KUMAR	Vol. XXII	47-59
Pradhanmantri Mudra Yojna ka Vittiya Pradarshan : Ek Vishleshnatmak Aadhyan	WORLD TRANSLATION	Single Author	Dr. DHARMENDRA KUMAR	Vol 21	82-93

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Table – 2

ACADEMIC AND RESEARCH ACTIVITIES

(Note: Give separately for each year of the assessment period.)

Assessment Year 2022-2025

1. Published Research Papers in Peer Reviewed or UGC listed Journals: (Please enclose the documentary evidence for your claim)

S.N	Description	Academic/Research Score claimed	Enclosure
1	<p>Publication Type: Research Papers in Peer Reviewed Journals Title: Innovation Management Practices in Small Business Market Oriented Strategy Volume: Volume 7. Issue 1 Page No.: 249-254 Name of Journal: International Journal Of Enhanced Research in Management & Computer Application(An International Multidisciplinary Peer Reviewed Journal) ISSN/ISBN No.: 2919-7471 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Peer Reviewed Committee Sl. No. of UGC list of approval journals: Authorship: Single Author No. of authors: 1</p>	0	View Document
2	<p>Publication Type: Research Papers in UGC listed Journals Title: Improvisation of Retail Banking Services- A selective Study on Nationalized Banks of India Volume: Volume 5, Issue 2 Page No.: 40-47 Name of Journal: GGGI Management Review (A Bi-Annual Refereed International Journal Of Management) ISSN/ISBN No.: ISSN 2249-4103 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: 4037 Authorship: First/Principal/Corresponding author No. of authors: 1</p>	0	View Document

S.N	Description	Academic/Research Score claimed	Enclosure
3	<p>Publication Type: Research Papers in Peer Reviewed Journals Title: Predominant Role of Rural Production and Consumption Process In Developing Indian Economy Volume: Volume XIX Page No.: 16-25 Name of Journal: Shodh (A Triannual Bilingual Peer Reviewed Refereed Research Journal of Art & Humanities) ISSN/ISBN No.: 0970-1745 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Peer Reviewed Committee SI. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 1</p>	7	View Document
4	<p>Publication Type: Research Papers in Peer Reviewed Journals Title: Financial Distress in Indian Banking Sector: An Impact of Non-Performing Assets(NPAs) due to Covid-19 Volume: Volume 17 Page No.: 3-12 Name of Journal: International Literary Quest (An International Multidisciplinary Peer Reviewed Refereed Research Journal) ISSN/ISBN No.: ISSN- 2319-7137 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Peer Reviewed Committee SI. No. of UGC list of approval journals: Authorship: Single Author No. of authors: 1</p>	10	View Document
5	<p>Publication Type: Research Papers in Peer Reviewed Journals Title: Empowering Employable Youth with the Skill Sets Making them More Productive: Skill India Mission Volume: Volume XII, Issue IV Page No.: 774-783 Name of Journal: Journal of Interdisciplinary Cycle Research(Monthly Peer Reviewed Multi Disciplinary Journal) ISSN/ISBN No.: 0022-1945 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : SI. No. of UGC list of approval journals: Authorship: Single Author No. of authors: 1</p>	0	View Document

S.N	Description	Academic/Research Score claimed	Enclosure
6	<p>Publication Type: Research Papers in Care Listed Journals Title: Analysing The Emerging Role of M-commerce in Retail Sector of India Volume: Volume XIII, Issue XI Page No.: 1058-1067 Name of Journal: The International Journal Of Analytical and experimental Modal Analysis(International Peer Reviewed Journal)d ISSN/ISBN No.: 0886-9367 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 2</p>	0	View Document
7	<p>Publication Type: Research Papers in Care Listed Journals Title: New Age Retail Banking: A Shift Towards Socio Financial Inclusive services Volume: Volume XIII, Issue I Page No.: 2144-2152 Name of Journal: Journal of Interdisciplinary Cycle Research(Monthly Peer Reviewed Multi Disciplinary Journal) ISSN/ISBN No.: 0022-1945 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 2</p>	0	View Document
8	<p>Publication Type: Research Papers in UGC listed Journals Title: Micro Finance in India For Achievement of Millennium Development Goals (MDGs) Volume: Volume 5 Page No.: 41-47 Name of Journal: Kaav International Journal Of Economics, Commerce & Business Management (A Refereed Blind Peer Review Online Journal) ISSN/ISBN No.: ISSN- 2348-4969 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: 47663 Authorship: No. of authors:</p>	0	View Document
9	<p>Publication Type: Research Papers in Care Listed Journals Title: Sustainable Development For Women's Financial Independence & Empowerment: Opportunities and Challenges Volume: Page No.: 185-194 Name of Journal: International Journal of Economic Perspectives (Blind Peer Reviewed Journal) ISSN/ISBN No.: 1307-1637 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 2</p>	7	View Document

S.N	Description	Academic/Research Score claimed	Enclosure
10	<p>Publication Type: Research Papers in Scopus Listed Journals Title: Entrepreneurial Interventions Creating Plethora of Startups in India Volume: Volume 11 Issue 1 Page No.: 347-359 Name of Journal: International Journal of Economic Perspectives (Blind Peer Reviewed Journal) ISSN/ISBN No.: 1307-1637</p> <p>Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Peer Reviewed Committee Sl. No. of UGC list of approval journals: Authorship: Single Author No. of authors: 1</p>	0	View Document
11	<p>Publication Type: Research Papers in UGC listed Journals Title: Analysis of Indian Life Insurance Companies of Financial Growth of Indian Financial System Volume: Volume 6 Page No.: 48-53 Name of Journal: International Journal Of Advance and Innovative Research ISSN/ISBN No.: ISSN 2394-7780</p> <p>Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: 63571 Authorship: First/Principal/Corresponding author No. of authors: 2</p>	0	View Document
12	<p>Publication Type: Research Papers in UGC listed Journals Title: Aatmanirbhar Bharat Initiatives Empowering Rural MSMEs: Opportunities and Challenges Volume: Volume 13, Issue 2 Page No.: 395-399 Name of Journal: International Journal of Creative Research Thoughts(An International Open Access, Peer-Reviewed, Refereed Journal) ISSN/ISBN No.: 2320-2882</p> <p>Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Peer Reviewed Committee Sl. No. of UGC list of approval journals: 49023 Authorship: Single Author No. of authors: 1</p>	10	View Document
13	<p>Publication Type: Research Papers in Care Listed Journals Title: Environmental Assessment of Emerging Entrepreneurial Potentials For Sustainable Economic Development Volume: issue I Page No.: 109-114 Name of Journal: Sanshodhak ISSN/ISBN No.: 2394-5990</p> <p>Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Peer Reviewed Committee Sl. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 1</p>	7	View Document

S.N	Description	Academic/Research Score claimed	
14	<p>Publication Type: Research Papers in Peer Reviewed Journals Title: Comparative Analysis of Cash Flow Statements :A Study of Tata Motors Ltd. and Maruti Suzuki India Ltd Volume: Volume 11 Issue 1 Page No.: Name of Journal: International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences(Online Refereed Peer Reviewed Journal) ISSN/ISBN No.: 2349-7300 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: Co-Author No. of authors: 2</p>	7	
15	<p>Publication Type: Research Papers in Care Listed Journals Title: Financial Inclusion of Rural Markets: An Indian Banking Framework Volume: Volume 14 Page No.: 793-803 Name of Journal: Monthly Baraheen ISSN/ISBN No.: 2395-3640 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 2</p>	7	View
16	<p>Publication Type: Research Papers in UGC listed Journals Title: FDI linkage to Rural and Agriculture Markets: A Developmental Prospect for Retailing in India Volume: Volume 6, Issue 1 Page No.: 66-69 Name of Journal: GGGI Management Review (A Bi-Annual Refereed International Journal Of Management) ISSN/ISBN No.: 2249-4103 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: 4037 Authorship: First/Principal/Corresponding author No. of authors: 2</p>	0	View Doc
17	<p>Publication Type: Research Papers in UGC listed Journals Title: Understand the Retail Landscape of India Volume: Volume 12, Issue 6 Page No.: 2404-2411 Name of Journal: International Journal of All Research Education & Scientific Methods ISSN/ISBN No.: 2455-6211 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: 7647 Authorship: First/Principal/Corresponding author No. of authors: 2</p>	7	View Document

S.N	Description	Academic Research Score claimed	Enclosure
18	<p>Publication Type: Research Papers in Care Listed Journals Title: A Comparative Study of Usage of Green Banking in India Volume: Volume XI, Issue 1 Page No.: 151-15115 Name of Journal: The International Journal Of Analytical and experimental Modal Analysis(International Peer Reviewed Journal)d ISSN/ISBN No.: 0886-9367 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Peer Reviewed Committee Sl. No. of UGC list of approval journals: Authorship: Single Author No. of authors:</p>	0	View Document
19	<p>Publication Type: Research Papers in UGC listed Journals Title: Breakthrough Management and Future Outlook Of Startups In India Volume: Volume X Page No.: 74-78 Name of Journal: SHODHMANTHAN A Peer Reviewed & Refereed International Journal ISSN/ISBN No.: ISSN(P)- 0978-5255 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: 40908 Authorship: Single Author No. of authors: 1</p>	0	View Document
20	<p>Publication Type: Research Papers in Care Listed Journals Title: Developmental Impact of Education Policy on Knowledge Based Economy Volume: Volume VIII, Issue XII Page No.: 448-453 Name of Journal: Parishodh Journal(UGC- CARE List- Group I) An ISO: 7021-2008 Certified Journal ISSN/ISBN No.: ISSN- 2347-6648 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: Co-Author No. of authors: 2</p>	0	View Document
21	<p>Publication Type: Research Papers in Care Listed Journals Title: Global Investments and Growth Realization of Indian Rural Markets Volume: Volume XIII, Issue XI Page No.: 1548-1556 Name of Journal: The International Journal Of Analytical and experimental Modal Analysis(International Peer Reviewed Journal)d ISSN/ISBN No.: ISSN 0886-9367 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: Co-Author No. of authors: 2</p>	0	View Document

S.N	Description	Academic/Research Score claimed	Enclosure
22	<p>Publication Type: Research Papers in Scopus Listed Journals Title: Transforming profusion of Capable Human Capital in Knowledge Based Economy Through Skill Development Initiatives In India Volume: Volume 34, Issue 2 Page No.: 83-92 Name of Journal: Corrosion Management (UGC-CARE Group 2 Scopus Indexed Journal) ISSN/ISBN No.: ISSN- 1355-5243 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : SI. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 3</p>	7	View Document
23	<p>Publication Type: Research Papers in Scopus Listed Journals Title: Education Based Commercial Cultivation & Agro Chemical Inputs in Horticulture of U.P.(India) Volume: Volume 34. Page No.: 93-99 Name of Journal: Corrosion Management (UGC-CARE Group 2 Scopus Indexed Journal) ISSN/ISBN No.: ISSN- 1355-5243 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : SI. No. of UGC list of approval journals: Authorship: First/Principal/Corresponding author No. of authors: 3</p>	7	View Document
24	<p>Publication Type: Research Papers in Care Listed Journals Title: Impact of Advertising & Media Consumption on Buying Behavior of "Gen Z & Alpha" Volume: Page No.: 296-304 Name of Journal: Ajasraa (Peer Reviewed Refereed Journal) ISSN/ISBN No.: ISSN-2278-3741 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : SI. No. of UGC list of approval journals: Authorship: Single Author No. of authors: 1</p>	10	View Document
25	<p>Publication Type: Research Papers in Care Listed Journals Title: Inventory Management Techniques Determining Supply Chain And Financial health of Hotel Industry Volume: Volume 18, Issue 02 Page No.: 104-117 Name of Journal: International Journal of Economic Perspectives (Blind Peer Reviewed Journal) ISSN/ISBN No.: ISSN-1307-1637 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : SI. No. of UGC list of approval journals: Authorship: Single Author No. of authors: 1</p>	10	View Document

S.N	Description	Academic/Research Score claimed	Enclosure
26	<p>Publication Type: Research Papers in Care Listed Journals Title: Impact of Changing Demographics & Ageing Populace On Development In south Asian Economies Volume: Volume 18, Issue 10 Page No.: 87-97 Name of Journal: International Journal of Economic Perspectives (Blind Peer Reviewed Journal) ISSN/ISBN No.: ISSN-1307-1637 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: Single Author No. of authors: -27</p>	10	View Document
27	<p>Publication Type: Research Papers in Care Listed Journals Title: A study on perception of Business Owners towards GST Volume: Volume 18, Issue 12 Page No.: 2176-2181 Name of Journal: Leadership, Education, Oersonality: An Interdisciplinary Journal (A monthly Peer -Reviewed, Refereed and UGC CARE 1 International Journal) ISSN/ISBN No.: 2524-6178 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: Single Author No. of authors: 1</p>	10	View Document
28	<p>Publication Type: Research Papers in Peer Reviewed Journals Title: Conceptual Framework & Role of Management Control System in Implementing Strategic Change Volume: Volume 17 Page No.: 3-15 Name of Journal: World Translation (An International Multidisciplinary Peer Reviewed Refereed Research Journal) ISSN/ISBN No.: ISSN 2278-0408 Impact factor, if any: Impact Factor Agency: Refereed : No Refereed By : Sl. No. of UGC list of approval journals: Authorship: No. of authors: 1</p>	10.00	View Document

2 . Publications (other than Research Papers)

a) Books Authored / Editor of Book: (Please enclose the documentary evidence for your claim)

I: Research papers (Journals, etc)

S.No.	Title with page no.	Journal Name	UGC Sr. No/CARE list NO.	Year	ISSN No.	Total No of authors	Whether you are the First/ Principal / corresponding author /supervisor / mentor author
1.	“Study of mineral composition and organic composition of the eye lens at three different stages of growth of the fish Labeo pangusia” P.P.255-258	J. Chemtracks Vol.18(2) An International Peer Reviewed Research Journal of Science		2016	0973-239X	1	Single Author
2	“Traditional Uses and Pharmacological Action of Ocimum Kilimandscharicum : A Review” P.P. 140-144	Journal of Ultra Chemistry - International Peer Reviewed Research Journal of Chemical Science and Chemical Engineering Vol. 13No.4,5&6	43844	2017	0973-3450 (Print) 2319-8036 (Online)	1	Single Author
3	‘Green Chemistry : Principles and Goals’ P.P. 11-13	ISST Journal of Applied Chemistry Vol.8 No.2	48716	2017	0976-7355	1	Single Author
4	‘Biogas – An Overview of Environmental Impacts’ PP - 418	International Journal of Research in Social Sciences, Vol. 9;	Issue 3(2) UGC-48887	2019	ISSN: 2249-2496	1	Single Author

5	'Carbon Cycle Effects on Climate' PP. 16-22	Science Phenomenon Peer Reviewed & Refereed International Research Journal of Higher Science Vol. 27, Issue -27		2020	ISSN: 2349-2597	1	Single Author
6	'Protective Effects of the indigenous Indian Medicine Plant Aegle Marmel in Gastrointestinal Disorders' PP 01-06	Deliberative Research Peer Reviews, Referred International Journal Vol. 52 Issue - 52		2021	0976-1136	1	Single Author
7	Chemical Profiling and Therapeutic Potential of Organic Compounds in Medicinal Plants:- A Comprehensive Review PP. 151-158	International Journal of Innovation in Engineering Research & Management Vol. 8 Issue - 5		2021	2348-4918	1	Single Author
8	'An Analytical Research Based on Medicinal Plants with Respect to Ecological Education' PP. 274-280	Accent Journal of Economics Ecology & Engineering International Peer Reviewed and Refereed Journal Vol. 7, Issue - 07		2022	2456-1037	1	Single Author
9	Extraction, Physicochemical Properties, Phenol and Tocopherol of Cassia, Siamea Lam Seed Oil PP. 01-04	World Journal of Research and Review (WJRR) Vol. 19, Issue - I		2023	2455-3956	1	Supervisor
10	Fatty Acids Composition and Elements Analysis of Cassia, Siamea Lam Seed Oil	International Journal of Creative Research Thoughts		2023	2320-2882	2	Supervisor

11	Effect of Ultraviolet radiation on mineral composition of hair and nails of mammals (Labrador retriever) different age group PP. 2368-7487	Journal of Survey in fisheries Sciences Vol. 10 Issue – (2S)		2023	2878-2884	4	Second-Author
12	Effect of U.V. Irradiation on Chemical Profile of Mammals Exoskeleton and Protective role of Antioxidants PP. 20548-20557	European Chemical Bulletin Vol. 12 Special Issue – 04		2023	2063-5346	4	Third Author
13	A Study of Nutritional Potential and Perspective of Funnel Seeds PP. 31-36	Science Phenomenon Peer Reviewed & Refereed International Research Journal of Higher Science Vol. 39, Issue -39		2023	2349-2597	1	Single Author
14	Vitamins and Antioxidants Activity of Cassia Siamea Lam Seed's Oil	Journal of Chemical Health Risks Vol. 13(4)		2023	2251-6727	2	Supervisor
15	Facilitating Continued Excellence Approach Towards Education and Research through 'New Education' Policy PP. 1866-1875	Monthly Baraheen Vol. 15, Issue No. 177	UGC Care Group -I	2023	2395-3640	2	Co-Author
16	Phytochemical Investigation and Structure Elucidation of Bioactive Compounds from Indigenous Medicinal Plants	Accent Journal of Economics Ecology & Engineering International Peer Reviewed and Refereed Journal Vol. 10, Issue – 07		2025	2456-1037	1	Single Author

