Dr. Pamita Bhandari

Senior Scientist
Natural Product Chemistry & Process Development
CSIR-IHBT, Palampur, Himachal Pradesh, India
e-mail: pamita@ihbt.res.in, pamita_np@rediffmail.com

Research Experience

14 years' research experience in the field of natural products chemistry in terms of exploring unique chemical diversity of Himalayan flora; specifically, the isolation and structure elucidation of the novel scaffolds of biological relevance, methodologies development for quality assurance and chemical fingerprinting of medicinal plants and value addition of natural products.

Positions Held

Senior Scientist Natural Product Chemistry & Process Development, CSIR- Institute of Himalayan Bioresource Technology, Palampur (Sept 2017- Present)

Scientist Department of Natural Products, National Institute of Pharmaceutical Education & Research (NIPER), Mohali (April 2010-Sept 2017)

Awards/Honours

- Dr. P.D. Sethi Annual Award, Certificate of Merit for Best publication "Stability-Indicating HPLC-PDA Method for Determination of Picrosides in Hepatoprotective Indian Herbal Preparations of *Picrorhiza kurroa"* 2009
- Dr. P.D. Sethi Best Publication Award for "A validated and Densitometric HPTLC Method for the quantification of Withaferin-A and Withanolide-A in Different Plant parts of Two Morphotypes of Withania somnifera" 2007
- Life member of Society of Analytical Scientist
- CSIR- Senior Research Fellowship
- National Talent Merit Scholarship
- HMT Scholistic Award
- 3rd rank in HPBSE during Matriculation

Research contribution (Achievements)

For the last 14 years Dr Bhandari has been working on phytochemistry of Himalayan medicinal plants for bioactive molecules. She has made significant research contribution in natural products chemistry in terms of isolation and structure elucidation of novel bioactive molecules from Himalayan medicinal plants, development of new efficient analytical procedures for quality analysis of herbals and chemical fingerprinting of plants. Her focus has hitherto been largely on molecules of use, on substances of medicinal, agricultural and industrial interest.

i. Discovery of novel compounds from Himalayan flora

Dr Bhandari has made noteworthy contribution in the chemistry and biological activities of *Lonicera japonica*, used in Traditional Chinese System of Medicine (TCM) as "Jin

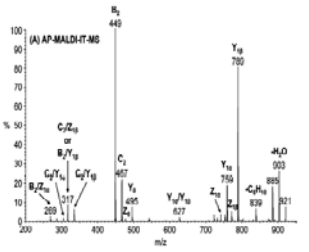
Yin Hua" for anticancer and anti-inflammatory activities. She had reported two biflavonoids having novel 4′-4‴ ether linkage and novel cerebrosides. This was the first report on existence of such biflavone in nature and discovery of cerebrosides from higher plants having more than one sugar residues. Cerebrosides are the important components of animal muscle and nerve cell membranes earlier known to have single sugar residue which can be either glucose or galactose and are known to have potent anticancer and neuritogenic activities.

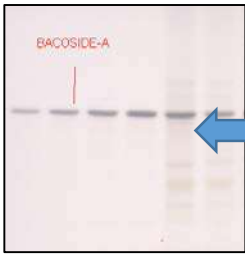
The contribution on the chemical investigation of *Bacopa monnieri* known for memory enhancing effect and other medicinal plants is noteworthy. First time report of novel cucurbitacins including anticancer cucurbitacin E was of the chemotaxonomic significance. The existence of cucurbitacins in *B. monnieri* justifies its classification under Scrophulariaceae family. The characterization of novel bioactive compounds in the categories of alkaloids, triterpenoid saponins, steroidal saponins, flavonoiods, cucurbitacins etc. from *Lonicera japonica*, *Bacopa monnieri*, *Holarrhena antidysenterica* and *Rosa damascena* is noticeable.

Novel Compounds from Indian Medicinal Plants

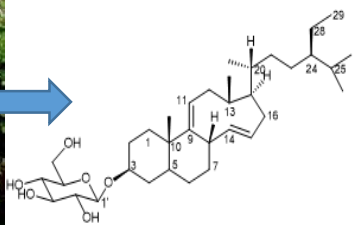
She had isolated novel compounds from natural sources and characterized their complex structures using spectroscopic tools (^{1}H, ^{13}C, DEPT, COSY, HMQC, HMBC, ROSY, MS, IR etc).

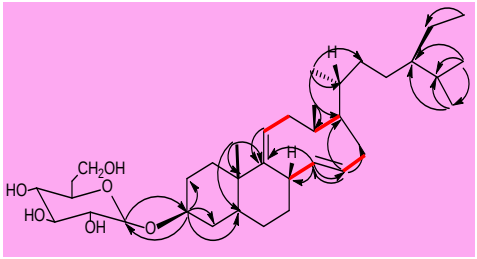
New Analytical Approaches





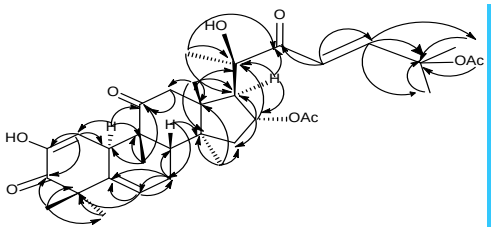
Novel Bioactive Molecules



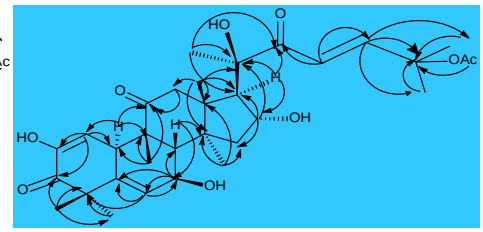


^{1}H-^{1}H COSY : H-11 (δ5.31) and H-12 (δ1.05α, 1.85β), H-13 (δ1.51) and H-17 (δ1.45), H-14 (δ5.13) and H-15 (δ5.16), H-8 (δ1.35) and H-14 (δ5.13), H-15 (δ5.16) and H-16 (δ1.61α, 1.12β) indicating the absence of bond between C-13 and C-14.

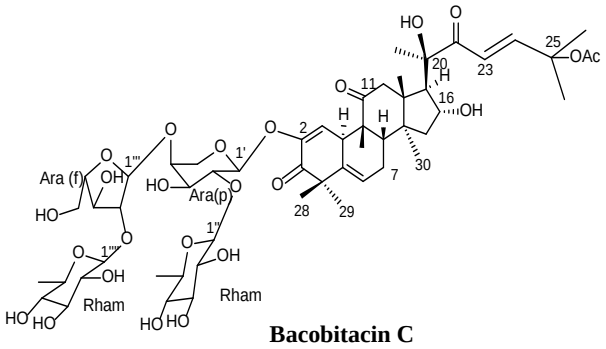
Bacosterol glycoside



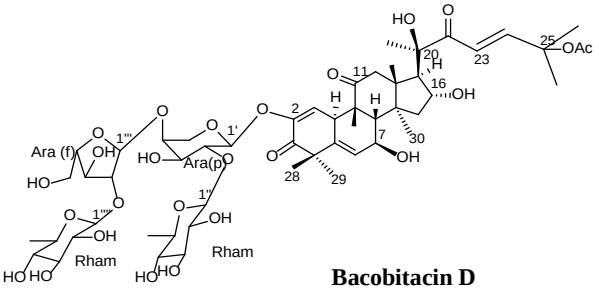
Bacobitacin A



Bacobitacin B

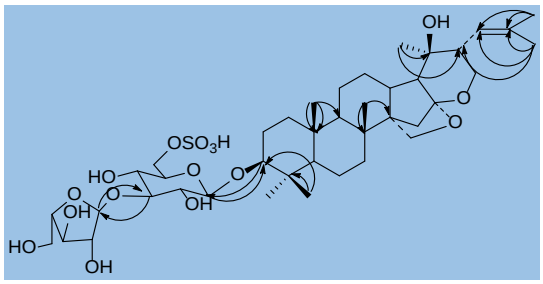


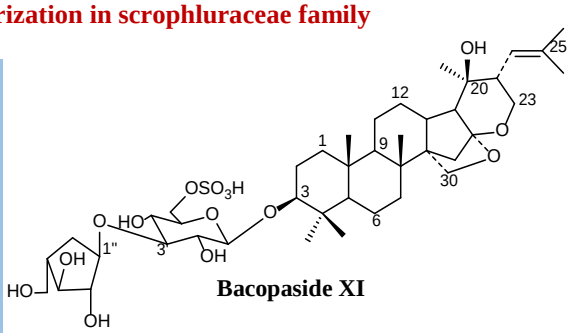
Bacobitacin C



Bacobitacin D

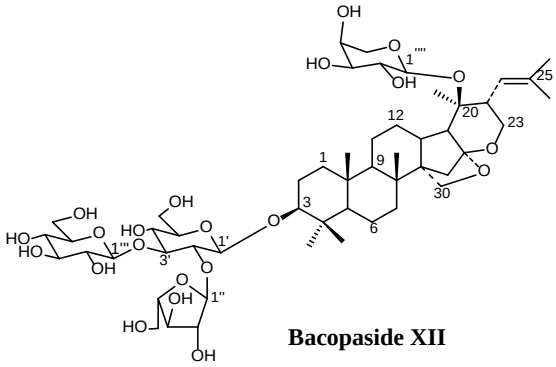
Presence of Cucurbitacins justified its categrization in scrophluraceae family



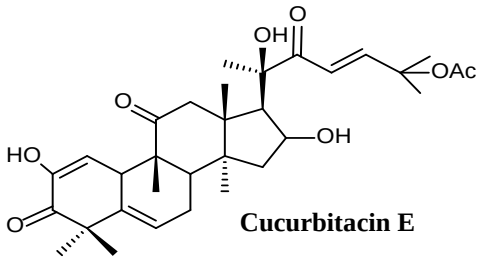


Bacopaside XI

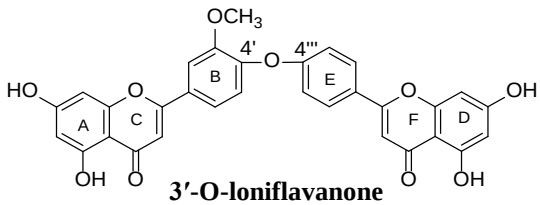
In ^{1}H NMR, the upfield signals of H-23 at δ 3.78 (1H, d, *J* = 10.2) and 3.70 (overlapped) and further upfield of C-23, C-24 and C-25 (δ 65.6, 123.0 and 132.7, respectively) in ^{13}C NMR confirmed the aglycone as pseudojujubogenin.



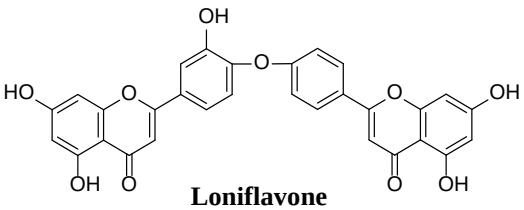
Bacopaside XII



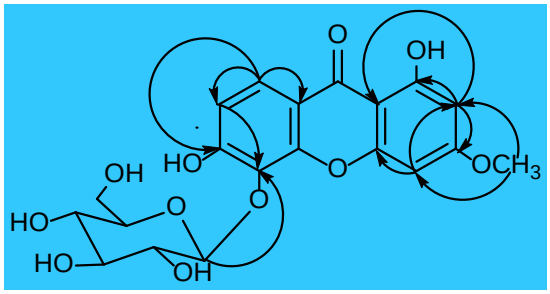
Cucurbitacin E



3′-O-loniflavanone

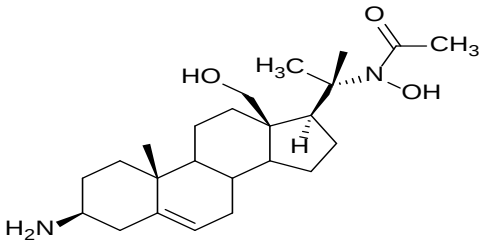


Loniflavone



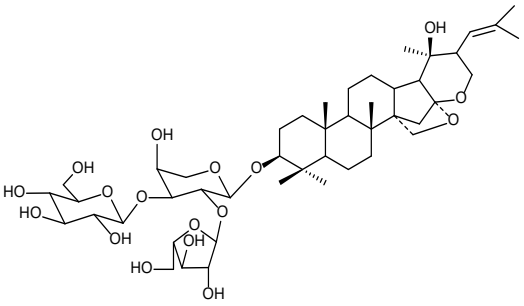
Two meta-coupled aromatic protons at δ 6.36 and 6.12 (H-2, H-4),
Two sets of ortho-coupled aromatic protons at δ 7.32 (d, *J* = 9.0 H- 7) & 7.53 (d, *J* = 9.0 Hz, H-8)
Aromatic methoxyl signal at δ 3.53 (3H, s)
Anomeric proton signal δ 5.39 (d, *J* = 7.2 Hz)

1,6-Dihydroxy-3-methoxy-5-*O*-β-*D*-glucopyranosyl xanthone

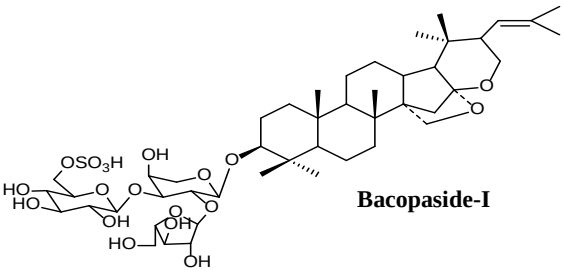


Holadysenterine

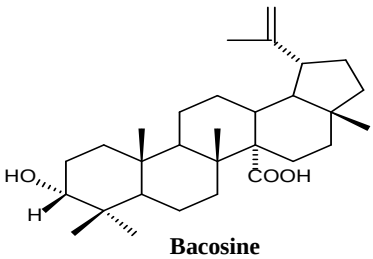
Important Bioactive Compounds from Indian Medicinal Plants



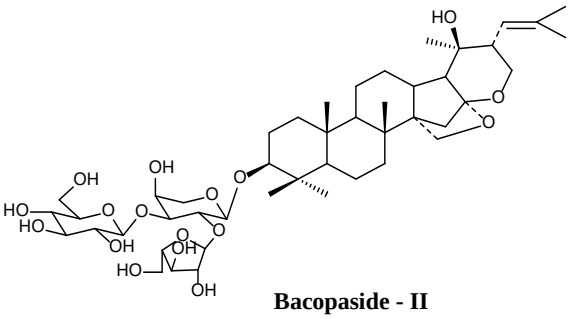
Bacopasaponin C



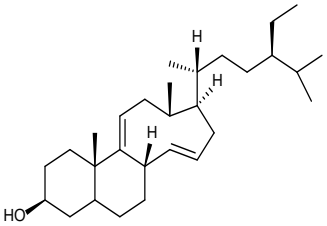
Bacopaside-I



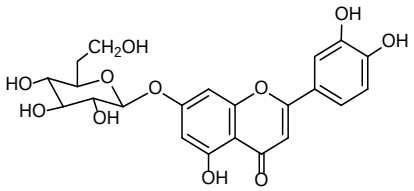
Bacosine



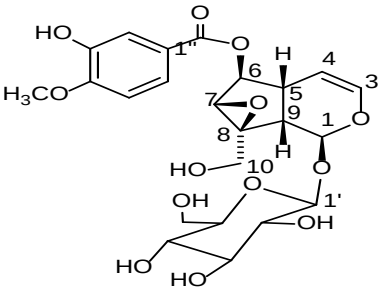
Bacopaside - II



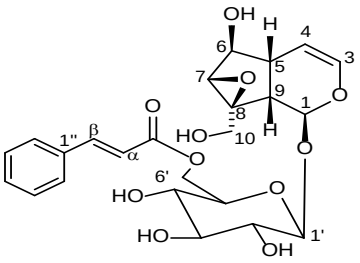
Bacosterol



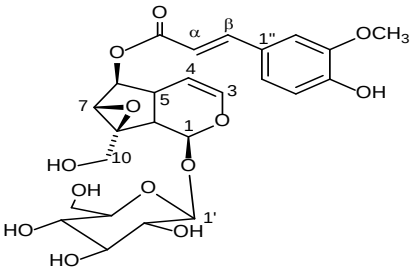
Luteolin glycoside



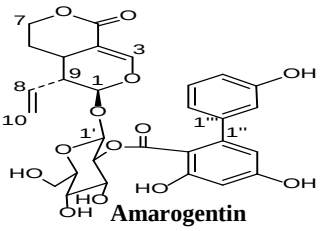
Picroside - I



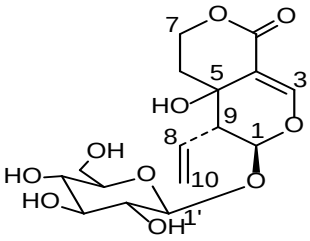
Picroside - II



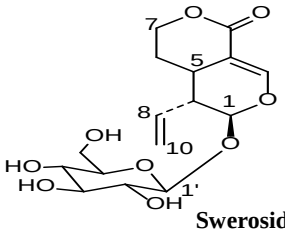
Trans- 6-Feruloylcatalpol



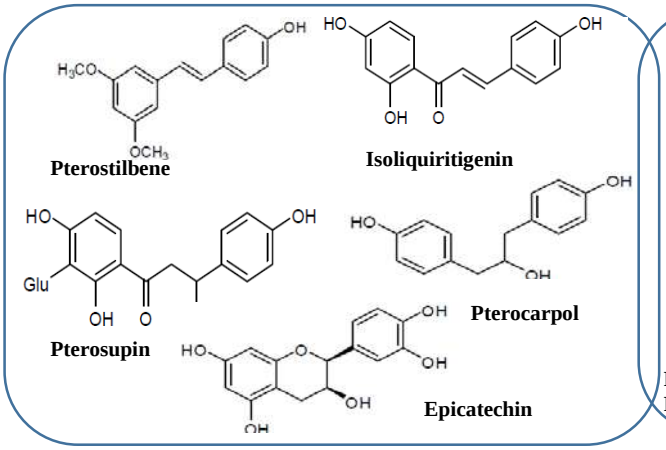
Amarogentin

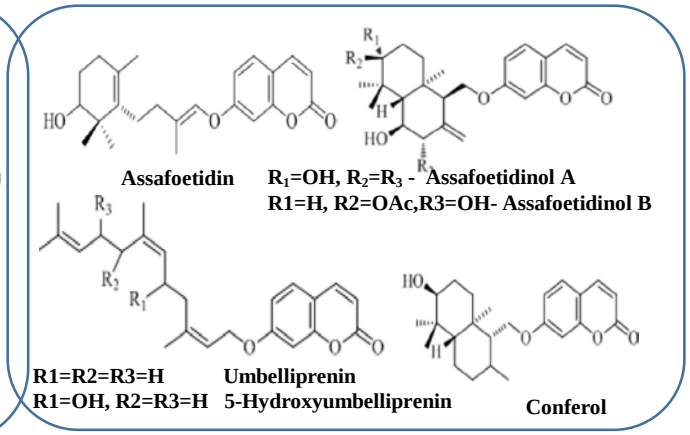


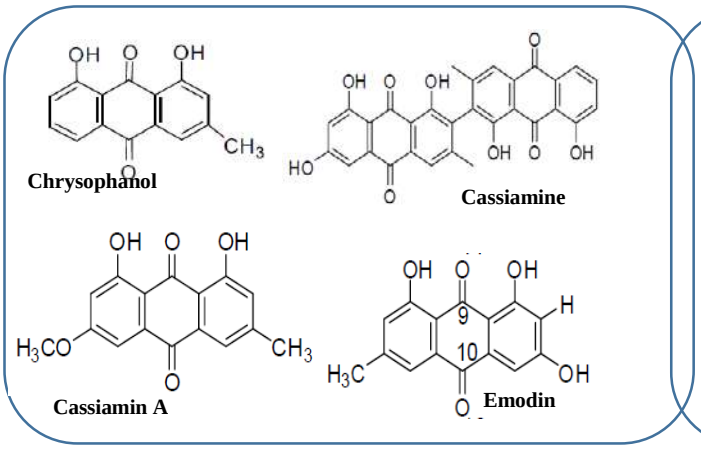
Swertiamarin

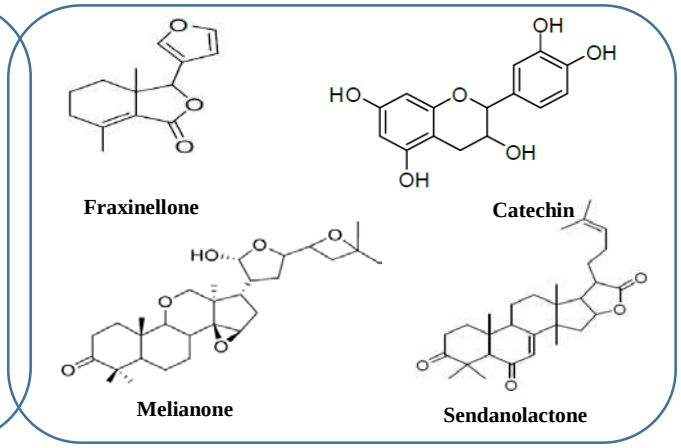


Sweroside







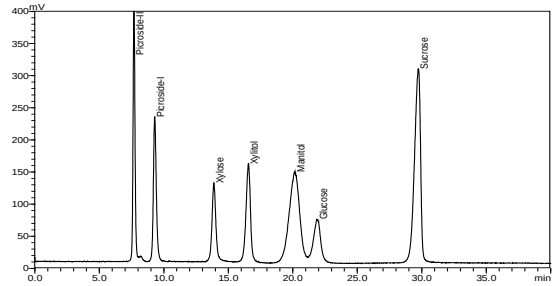


ii. Development of analytical procedures

Traditional herbal medicines are facing challenges of meeting global requirements in terms of quality. She has developed analytical methods for quality evaluation and understanding of the phytochemical complexity of herbals. The determination of sugars in

Picrorhiza species, *P. kurroa* and *P. scrophulariiflora* growing in alpine Himalaya where abiotic stress is very prominent was an important contribution. Sugars play a critical role in regulating overall cellular metabolism in plants growing at high altitude where abiotic stresses such as drought and freezing temperature are prominent.

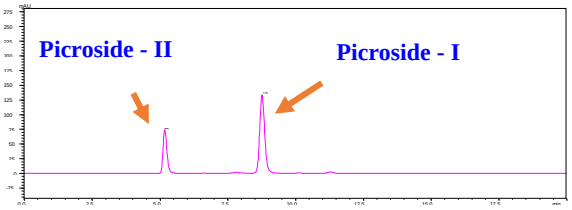
Simultaneous determination of sugars and picrosides in Picrorhiza species using ultrasonic extraction and high-performance liquid chromatography with evaporative light scattering detection

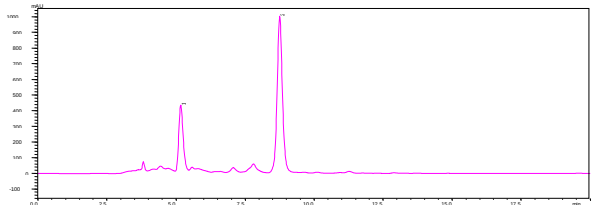


Column : Zorbax amino (250mm×4.6mmi.d., 5m) with isocratic elution of acetonitrile:water (78:22, v/v).
Drift tube temperature of the ELSD : 81 C
Nitrogen flow rate : 2.0 standard liter per minute (SLM).
Correlation cofficient (*r*2) = 0.9997±0.0012
LOD and LOQ were less than 0.98 and 2.95 µg

Glucose = 1.32-3.57 %, Sucrose = 0.58-1.68%, Xylose = 0.33-1.39%, mannitol = 0.24-0.48% *P. Scrophuloriflora* = 4.35--5.49 % picrosides *P. Kurroa* = 2.16-3.76 % picrosides

Stability-Indicating LC-PDA Method for Determination of Picrosides in Hepatoprotective Indian Herbal Preparations of *Picrorhiza kurroa*



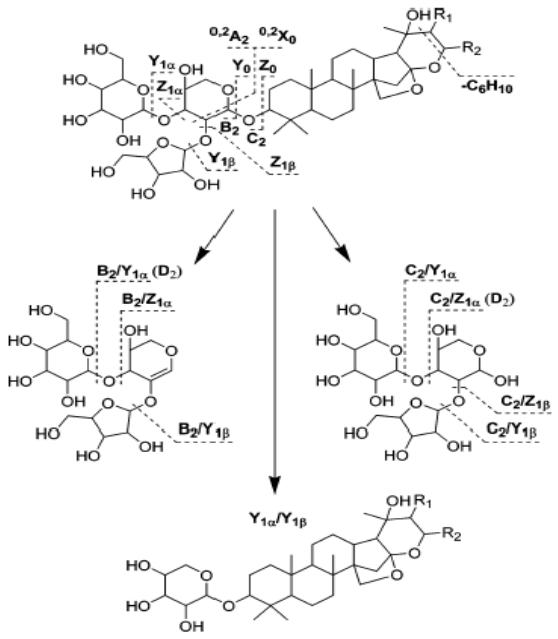


Sample	Picroside-I (%)	Picroside-II (%)	Total picrosides content (%)
Katuki, Zandu Pharma Works Ltd. (Mu	1.29	1.16	2.45
Arogya, Zandu Pharma Works Ltd. (Vapi	1.01	0.55	1.56
Kutaki, Tansukh Herbal Pvt. Ltd.	4.17	3.25	7.42
Livocare, Dindayal Aushdi Pvt. Ltd.	0.06	0.14	0.20
Livomap, Maharishi Ayurveda Pvt. Ltd.	0.12	0.06	0.18
Livomyn, Charka Pharma Pvt. Ltd. (M	0.07	0.01	0.08
Livplus, BACFO Pharmaceuticals	0.22	0.49	0.71
Pravekliv, Pravek Kalp Herbal products Pvt.	0.15	0.12	0.27
Vimliv, OM Pharma Ltd. (Bangalore, India)	0.001	Traces	0.001

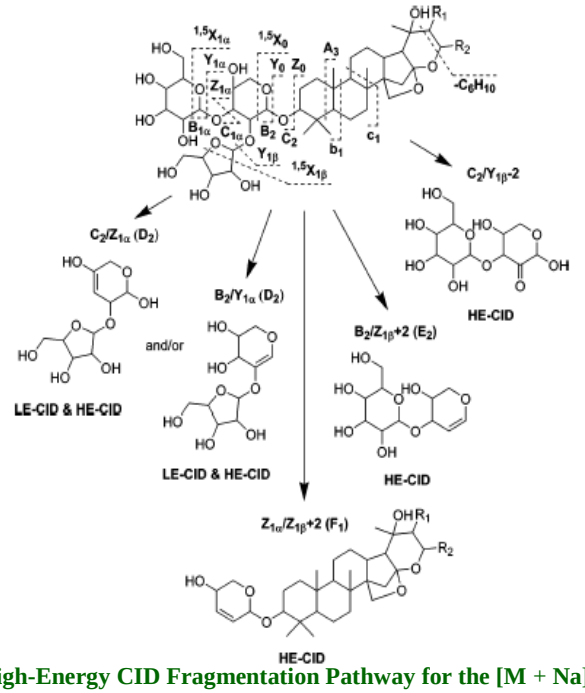
PD Sethi Best Paper Award

Multistage and Tandem Mass Spectrometry of Glycosylated Triterpenoid Saponins Isolated from *Bacopa monnieri*: Comparison of the Information Content Provided by Different Techniques

She has made significant contribution to study the dammarane triterpenoid saponins from *Bacopa monnieri*. The structural information was provided by ESI-ion trap (IT)-, APMALDI-IT-, and MALDI-IT/reflectron time-of-flight (RTOF)- MS, all utilizing low-energy collision-induced dissociation (CID), and MALDI-TOF/RTOF-MS, facilitating postsource decay and high-energy CID analysis.



Low-Energy CID Fragmentation Pathway (MS2) for the [M + Na]+ Ion at m/ z 921.5 (R1 = H and R2= CH=C(CH3)2 forBacopasaponin C, Whereas R1 = CH=C(CH3)2and R2 = H for Bacopaside X)

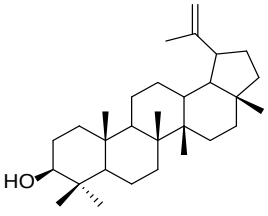


High-Energy CID Fragmentation Pathway for the [M + Na]+ Ionatm/ z 921.5 (R1 = H and R2 = CH=C(CH3)2 for Bacopasaponin C, Whereas R1= CH=C(CH3)2 and R2 = H for Bacopaside X)

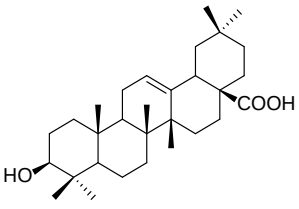
Anti-inflammatory agents from Indian Medicinal Plants

Natural products represent promising scaffolds with high chemical and structural diversity and wide array of biological activities. Out of the structurally diverse compounds from plants, the triterpenoids are often found in significant quantities, and a wide array isolated and characterized and are reported to exhibit a broad spectrum of pharmacological activities against some prominent diseases such as inflammation, diabetes, arthritis, cardiovascular ailments, hepatic toxicity, microbial infections and cancer.

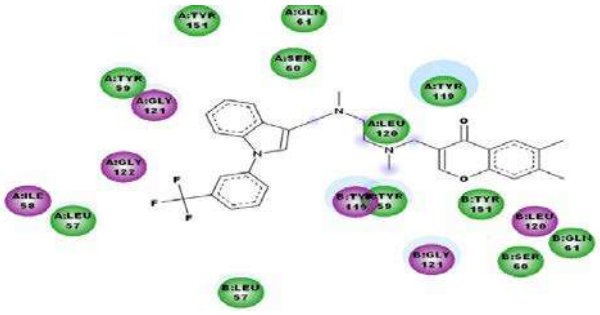
Some of the important triterpenoids, were isolated from medicinal plants in excellent amount and different analogues were synthesized to evaluate their anti-inflammatory activity.



Lupeol



Oleanolic acid



Development of green processes for extraction of natural colours from various plants/vegetable sources The usage of synthetic dyes in various domain of our life has detrimental effects on environment and associated with allergic, toxic, carcinogenic and harmful responses. With the public's enhanced cognigance to eco-safety and health concerns, environmentally benignant and non-toxic bio resource products from sustainable resources, natural colours/dyes attracted researchers in traditional and diversified applications to develop effective, eco-friendly and cleaner process technologies. In this regard we had developed green processes for extraction of natural colours from plants having multi-fold benefits like non-hygroscopic, crystalline nature, stability, reproducibility which are applicable for food and cosmetics.

At present, her research group is involved in the role of natural colours/dyes towards food & cosmetics and natural products as leads (cognition impairment, & antidiabetics) for the pharmaceutical industry focusing on the isolation, design and synthesis of bioactive natural products for commercial use.

Publications

Pamita Bhandari, Neeraj Kumar, Bikram singh, Vijay K. Kaul. Bacosterol glycoside, A New 13, 14-Seco-steroid glycoside from Bacopa monneiri. Chem. Pharm. Bull., vol. 54, 2, 240-241, 2006.

Pamita Bhandari, Ajai P. Gupta, Bikram Singh, Vijay K. Kaul, Simultaneous densitometric determination of artemisinin, artemisinic acid and arteannuin-B in Artemisia annua using reversed- phase-thin-layer chromatography. J. Sep. Sci., 28, 2288-2292, 2005.

Neeraj Kumar, Bikram Singh, Pamita Bhandari, Ajai P. Gupta, Sanjay K. Uniyal, Vijay K.Kaul. Biflavonoids from Lonicera japonica. Phytochemistry, vol. 66, 3, 2740-2744, 2005.

Pamita Bhandari, Neeraj Kumar, Bikram singh, Vijay K. Kaul. Micro-LC determination of swertiamarin in Swertia species and bacoside-A in Bacopa monnerie. Chromatographia, 64, 599-602, 2006.

Pamita Bhandari, Ajai P. Gupta, Bikram Singh, Vijay K. Kaul, HPTLC Determination of Swertiamarin and Amarogentin in Swertia species from Western Himalayan Region. J. Planar Chromatography-Modren TLC, 19, 212-215, 2006.

Neeraj Kumar, Pamita Bhadari, Bikram Singh, Ajai P. Gupta and Vijay K. Kaul. Steroidal alkaloids from Holarrhena antidysenterica. Chem. Pharm. Bull., 55 (6), 912-914, 2007.

Pamita Bhandari, Neeraj Kumar, Bikram Singh, Vijay K Kaul, Cucurbitacins from Bacopa monnieri. Phytochemistry, 68, 1248-1254, 2007.

Neeraj Kumar, Pamita Bhandari, Bikram Singh and Vijay K. Kaul. Saponins and volatile constituents and from Lonicera japonica growing in Himalayan region of India. Nat. Prod. Comm., 06, 633-636, 2007.

Pamita Bhandari, Neeraj Kumar, Ajai P. Gupta, Bikram Singh, Vijay K. Kaul, A rapid RP-HPTLC densitometry method for simultaneous determination of major flavonoids in important medicinal plants, J. Sep. Sci. 30, 2092-2096, 2007.

Martin Zehl, Ernst Pittenauer, Leopold Jirovetz, Pamita Bhandari, Bikram Singh, Vijay K. Kaul, Andreas Rizzi, and Guenter Allmaier, Multistage and Tandem Mass Spectrometry of Glycosylated Triterpenoid Saponins Isolated from Bacopa monnieri: Comparison of the Information Content Provided by Different Techniques, Analytical Chemistry, 79, 8214-8221, 2007.

Vivek Sharma, Ajai P. Gupta, Pamita Bhandari, Raghbir C. Gupta, Bikram Singh, A validated and Densitometric HPTLC Method for the quantification of Withaferin-A and Withanolide-A in Different Plant parts of Two Morphotypes of Withania somnifera. Chromatographia, 66, 801–804, 2007.

Pamita Bhandari, Neeraj Kumar, Bikram Singh, Vijay K Kaul Simultaneous determination of sugars and picrosides in Picrorhiza species using ultrasonic extraction and high-performance liquid chromatography with evaporative light scattering detection, J Chromatography A, 1194, 257-261, 2008.

Neeraj Kumar, Pamita Bhadari, Ajai P. Gupta, Bikram Singh and Vijay K. Kaul. Reversed phase-HPLC for rapid determination of polyphenols in flowers of Rose species. J. Sep. Sci. 31, 262-267, 2008.

Pamita Bhandari, Neeraj Kumar, Ajai P. Gupta, Bikram Singh, Vijay K. Kaul, Stability-Indicating HPLC-PDA Method for Determination of Picrosides in Hepatoprotective Indian Herbal Preparations of Picrorhiza kurroa. Chromatographia, 69, 221-227, 2009.

Neeraj kumar, Pamita Bhandari, Bikram singh, Shamsher S. Bari. Antioxidant Potential and Electrospray Ionization Mass Spectrometric Fingerprinting of Phenolic Constituents in Flowers of Rose Species: Rosa damascena, R. bourboniana and R. brunonii. Food chem. Tox., 47(2), 361-367, 2009.

Pamita Bhandari, Neeraj Kumar, Bikram Singh, Virendra Singh, Inderjeet Kaur. Silica-based monolithic column with evaporative light scattering detector for HPLC analysis of bacosides and apigenin in Bacopa monnieri. Journal of Separation Science, 32, 2812-2818, 2009.

Pamita Bhandari, Neeraj Kumar, Bikram Singh, Inderjeet Kaur. Dammarane triterpenoid saponins from Bacopa monnieri. Canad. J. Chem. 87 (9), 1230-1234, 2009.

Upendra Sharma, Pamita Bhandari, Neeraj Kumar, Bikram Singh Simultaneous Determination of Ten Sugars in Tinospora cordifolia by Ultrasonic Assisted Extraction and LC-ELSD. Chromatographia, 71, 633–638, 2010.

Pranay Bantawa, Swapan Kumar Ghosh, Pamita Bhandari, Bikram Singh, Partha Deb Ghosh, Paramvir Singh Ahuja, Tapan Kumar Mondal. Micropropagation of an elite line of Picrorhiza scrophulariiflora, Pennell, an endangered high valued medicinal plant of the Indo-China Himalayan region, Medicinal and Aromatic Plant Science and Biotechnology, 2010, 4 (1). 1-7.

Rakesh Kumar, Pamita Bhandari, Bikram Singh, P. S. Ahuja. Evaluation of Picrorhiza kurrooa accessions for growth and quality in north western Himalayas. Journal of Medicinal Plants Research, 2012, 6 (13), 2660-2665.

Vivek Sharma, Pamita Bhandari, Bikram Singh, Amita Bhatacharya, Veerubommu Shanmugam. Chitinase Expression Due to Reduction in Fusaric Acid Level in an Antagonistic Trichoderma harzianum S17TH. Indian Journal of Microbiology, 2012, 53 (2), 214-220.

Pamita Bhandari, Neeraj Kumar Patel, Kamlesh Kumar Bhutani. Synthesis of new heterocyclic lupeol derivatives as nitric oxide and pro-inflammatory cytokine inhibitors, Bioorganic and medicinal chemistry letters, 2014, 24 (15) 3596-3599.

Pamita Bhandari, Neeraj Kumar Patel, Rahul P. Gangwal, Abhay T. Sangamwar, Kamlesh Kumar Bhutani, Oleanolic acid-based analogues as NO, TNF-α and IL-1β inhibitors: synthesis, biological evaluation and docking studies. Bioorganic and medicinal chemistry letters, 2014, 24 (17) 4114-4119.

Saranjeet Kaur, Pamita Bhandari, K.K. Bhutani, Characterization of bioactive compounds at seedling stage and optimization of seed germination, culture multiplication of Dendrobium nobile lindl.-a study in vitro. International Journal of Advance Research, 2015, 3 (4) 1041-1052.

Pamita Bhandari, Neeraj Kumar, Kamlesh Kumar Bhutani, Online Antioxidant Activity and Ultra-performance LC-Electrospray Ionization-Quadrupole Time-of-flight Mass Spectrometry for Chemical Fingerprinting of Indian Polyherbal Formulations. Natural Product Research, 2016, 30 (5) 530-535.

Papers presented in Conferences/Seminars : 13