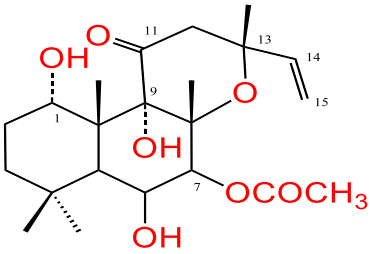
➢ Natural Products

- ***Forskolin***

Among her research contributions the prominent molecule is Forskolin.[23] This molecule was discovered by her at basic Research Centre of Hoechst Pharmaceutical, Mulund, India, during Indian plant screening program for bioactive molecules. The extracts of roots of *Coleus forskohlii* (Fam. Lamiaceae) displayed blood pressure lowering activity. This plant has been used in traditional Indian Ayurvedic medicine under the name "Makandi" or "Mayani", and Southeast Asian medicine since ancient times. Bioassay guided fractionation and isolation gave a nice crystalline solid m. p. 230-232 °C, $C_{22}H_{34}O_7$, which was named as Forskolin. The structure of the molecule was identified by spectral data, which showed forskolin is a labdane diterpene with substitution of tri-hydroxy, acetyl, keto and vinyl moieties. Subsequently with high resolution NMR, Spin decoupling study the structure of forskolin was elucidated.

After her first report on Forskolin in 1977[24] and her report on the structure-activity study of Forskolin in 1983[25] the last few decades have witnessed an increasing amount of global research on various aspects of Forskolin.[26] The global demand for forskolin increased, which resulted in the large scale extraction of this molecule in several Kgs by her. Her extraction and isolation procedures were adapted by several companies globally.



Melting Point 230-232 ^{0} C,
$C_{22}H_{34}O_7$
Optical Rotation - 26.19 ($CHCl_3$)

Forskolin

Coleus Forskohlii (Fam. Lamiaceae)

Subsequently, many researchers have contributed to the growth of Forskolin, unique adenylate cyclase stimulant and thus increases the intracellular cAMP concentration. The second messenger cAMP activates cAMP-dependent protein kinase (cAPK) and controls many cellular mechanisms such as gene transcription, ion transport and protein phosphorylation. Activation of cAMP results in inhibition of platelet activation, increased force of contraction of heart muscle, relaxation of smooth muscle, increased insulin secretion and increased thyroid

function. Presently, Forskolin and its different formulations are being sold as dietary supplement[27] by many companies, in USA, Europe and many other countries mainly for

● Weight Management, Lean body mass,

● Respiratory Disorders, Cardiotonic,

● Digestive Disorders,

● Sports Nutrition, Muscle toning properties

(https://www.marketwatch.com/press-release/global-forskolin-market-research-report-2021). Currently, 31 companies are exporting Forskolin from India.

Patents and publications S. V. Bhat *et al.*

- US Patent U.S..4,088,659 May 9, 1978,
- US Patent US 4,118,508, October, 3, 1978,
- US Patent, US 4,134,986, January 16, 1979,
- India No. 143875, Sept. 6, 1975,
- *Tetrahedron letters 1977,*
- *J. Chem. Society, Perkin I 1982,*
- *ACS J. Med. Chem. 1983.*

Sujata Bhat Forskolin and congeners *Progress in Chemistry of Organic Natural Products,* 62, 1-74,**1993**.

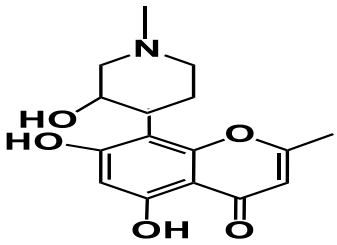
Alkaloid Rohitukine

During plant screening program at Hoechst Pharmaceutical's basic research, her group discovered second interesting molecule isolated from *Disoxylum binectariferum* (Meliaceae) stem bark. This molecule was identified as a chromone alkaloid Rohitukine, which is 2-methyl-5,7-dihydroxy-8- (N-methyl -3'-hydroxy-piperidin-4-yl)benzopyrone, an unique alkaloid. This molecule displayed anti-inflammatory and immuno-modulatory properties.

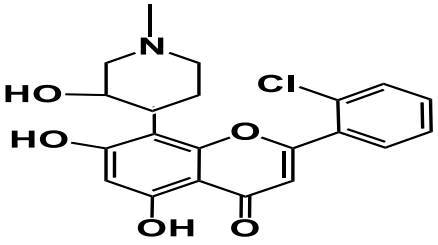
Several semi-synthetic derivatives of rohitukine were synthesised for the structure activity study. The total synthesis of the molecule was achieved, which led to flavopiridol, unique antitumor molecule at Hoechst Basic Research Centre.

Flavopiridol Analogue IIIM-(N)-290/13: This analogue is being followed at **Indian Institute of Integrative Medicine, Jammu**. (Target: CDK) IIIM(N)-290/13 is a synthetic chromone alkaloid possessing potent Cdk inhibitory activity. It is a potent inhibitor of Cdk-1/A, Cdk-2/A, Cdk4/D3 Cdk5/p25, Cdk-6/D1 and Cdk-9/T1 showing IC50 values < 100 nM. It possesses cytotoxicity in different types of cancer tissues, with most potent cytotoxicity in leukemia and pancreatic cancer cells (IC50 < 1 μM) (from Annual report of this Institute).

Immunomodulatory and Antitumor activity



ROHITUKINE



FLAVOPIRIDOL

S. V. Bhat et al. US 46,03,137. July 29, CA 1083589.

R. G. Naik, K. Kattige, **Sujata V. Bhat**, B. Alreja, N. J. De Souza and R. H. Rupp, **1988**,
Isolation structure elucidation and total synthesis of chromone-alkaloid, *Tetrahedron*, 44, 2081-2086.

- ***Andrographolide***

Andrographolide is a diterpene with dihydroxy- decalin skeleton attached to hydroxyl-γ-lactone side chain through ethylene bridge. This molecule was isolated from *Andrographis paniculata* (Fam.Acanthaceae), which is an Indian Ayurvedic plant. This plant has been used in several Ayurvedic preparations, which are sold for the treatment of diseases such as Meningitis, Acute Hepatitis, Common cold & fever, acute respiratory tract infections etc. Dr. Bhat's group has isolated andrographolide in large quantity from the plant and prepared several semisynthetic derivatives of the molecule. These semisynthetic derivatives displayed interesting anti-tumor, anti-HIV and anti-malarial activities. Computer-aided design was also used in this study.

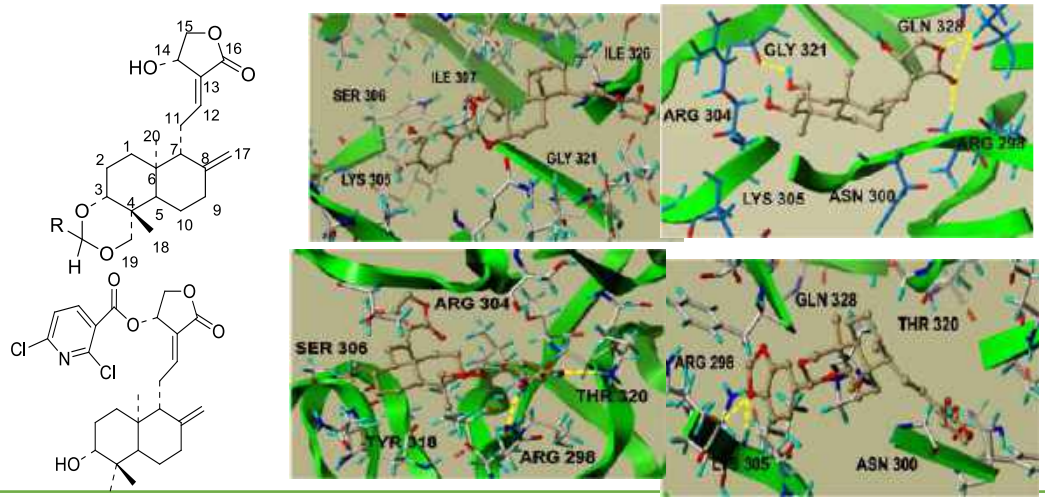
Anti-HIV activity of Andrographolide derivatives

Her group has achieved the selective semi-synthesis of derivatives of andrographolide (Andro). Andro and its two derivatives show IC_{50} values less than 1μM in HIV
infectivity assay and these molecules were also evaluated for their efficacy to inhibit gp120-mediated cell-based fusion using HL2/3 HeLa derived cells and TZM-bl cells. Further, these compounds were docked into the V3 loop region of gp120 HIV-1 envelope protein (PDB ID: 2B4C) using the software Sybyl-X 1.2 (Tripos Ltd. St. Louis, MO, USA) to study the molecular interactions. These molecules displayed good docking scores and are comparable .

Semi-synthetic andrographolide derivatives-

Anti-HIV activity due to Inhibition of virus entry in Host cell.

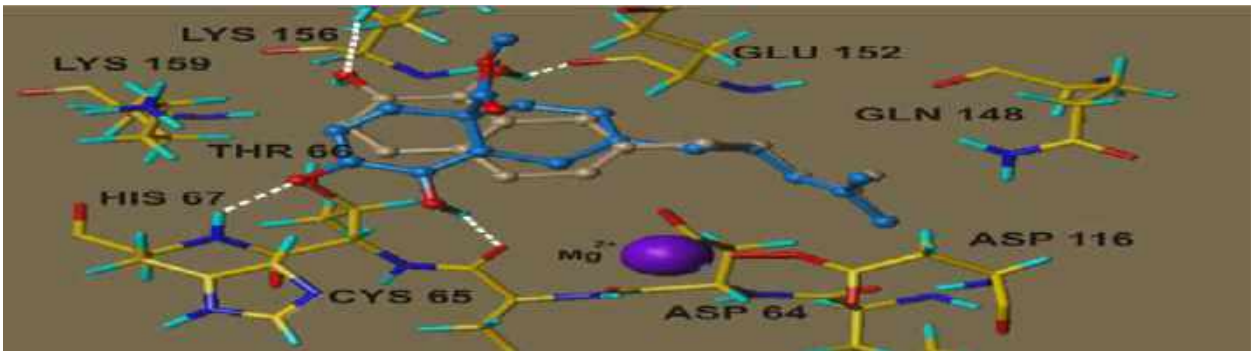
Active derivatives are docked into V3 loop region (residues 296-330) of gp120 HIV-1 envelope protein (PDB ID: 2B4C).



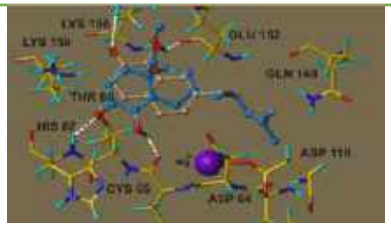
Anti-HIV activity was evaluated by Dr. S. K. Gupta, at National Institute of Immunology, New Delhi, India.

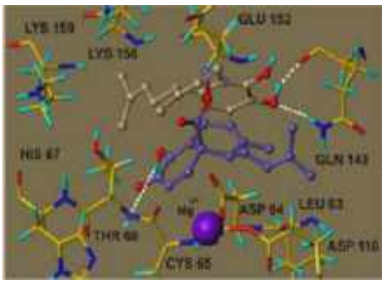
- ***Integric acid analogs***

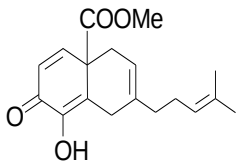
This molecule, isolated from *Xylaria sp.* reported to have anti-HIV activity through HIV-Integrase enzyme inhibition. Dr. Bhat's group had achieved synthesis new analogues assisted through computer-aided software design and evaluated the synthetic molecules for anti-HIV activity. Synthetic Quinol and hydroquinone labdane analogues had considerable anti-HIV activity with HIV-Integrase inhibition.

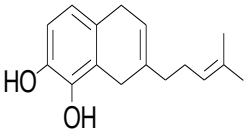


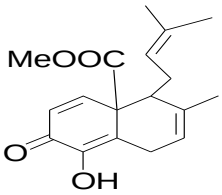
HIV Integrase Inhibition

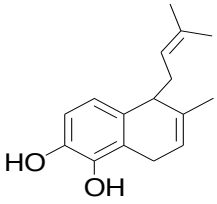












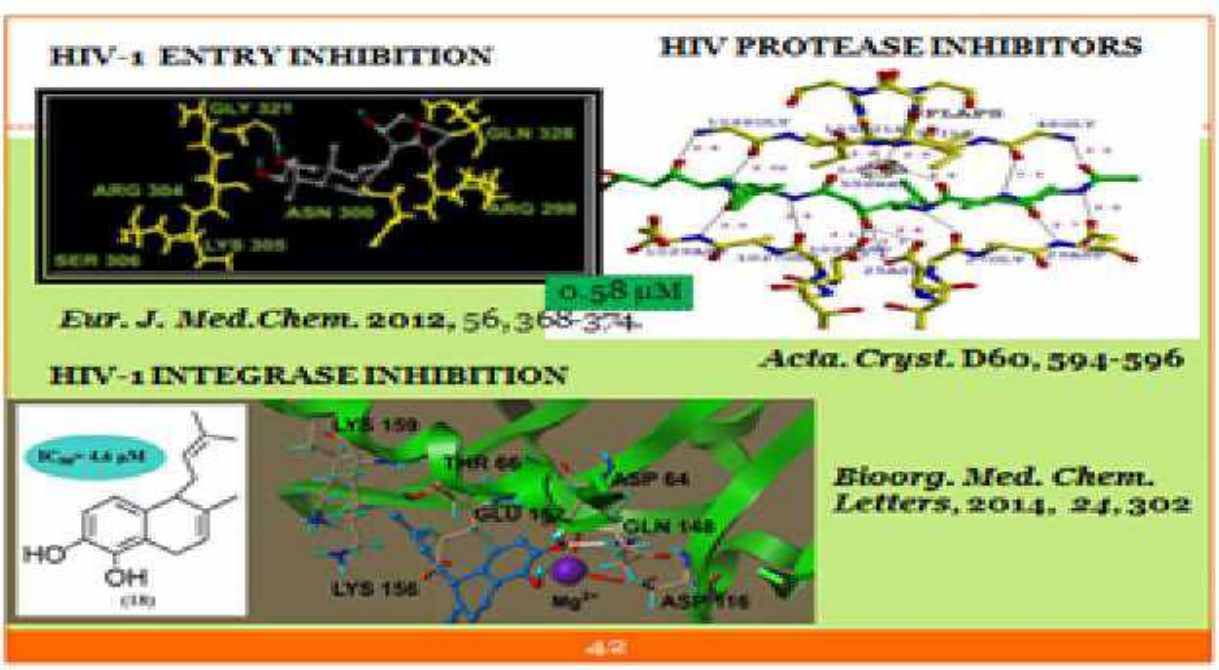
IC_{50} = 5.9 ± 1.0 µM, (TI = 11)

Anti-HIV Molecules docked in HIV integrase enzyme -IN CCD

Rohan Pawar, Sujata V. Bhat, S. K. Gupta *et al.*

Bioorganic & Medicinal Chemistry Letters (2014), 24(1), 302-307

- **Summary of her anti-HIV research:**



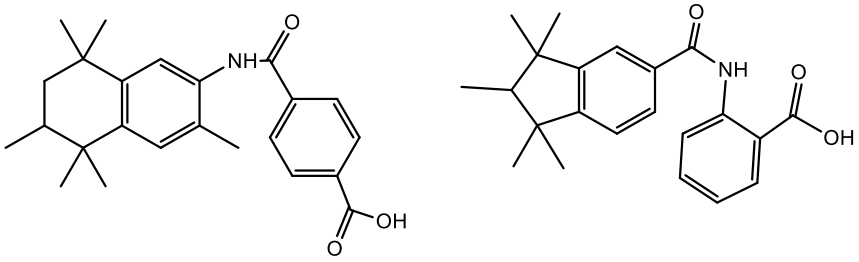
- ***New Anti-cancer Agents***

Synthesis and Evaluation of new Retinobenzoic Acid derivatives

The most important activities of retinoids are certainly the effects on the differentiation and proliferation of many types of cells and include the treatment of the neoplastic disorders. Recently, *trans*-retinoic acid and isotretinoin® have revolutionized the treatment of acute promyelocytic leukemia (APL) by causing terminal differentiation of the malignant cells.

Tamibarotene® (AM 80) and tazarotene® are novel synthetic retinobenzoic acid derivatives

with considerable activity against acute promyelocytic leukaemia. Dr. Bhat has achieved synthesis of new retinobenzoic acid analogues. Two examples of her synthetic retinobenzoic acid analogues molecules are given here.

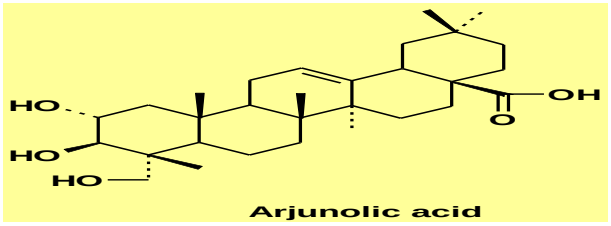


Several molecules were synthesised and evaluated for antitumor activity, some of them are more active than tamibarotene. Thus, these molecules can be further evaluated for the toxicity treatment of human leukaemia and breast cancer.

R. P. Khandare, K. R. Vaze and Sujata V. Bhat, **2011,** *Chemistry Biodiversity*, *8*, 841-849.

- Semisynthetic derivatives of Andrographolide, Asiacoside and Arjunolic acid displayed interesting antitumor activity.

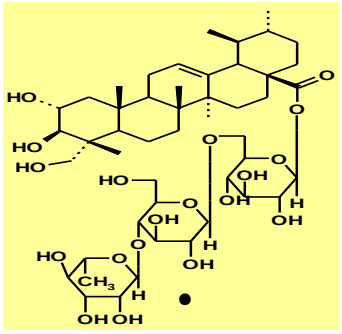
Semisynthesis & Antitumor activity of arjunolic acid



V. Menon , S, V, Bhat.

Terminalia arjuna
Combretaceae.

Antitumor activity of Asiaticoside



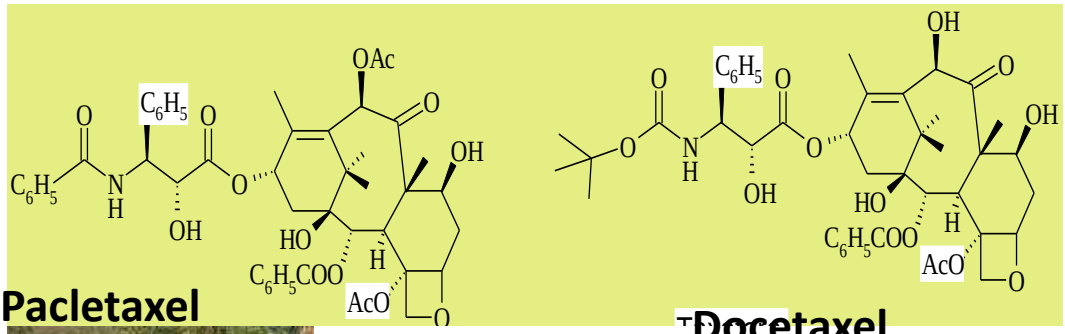
- **Asiaticoside**

V. Menon and **Sujata V. Bhat, 2010, A**ntitumour activity of semisynthetic derivatives of andrographolide, *Natural Products Communications, 5,* 717-720**.**

- ***Pacletaxel and Docetaxel***

Taxol® (NSC 125973) Paclitaxel, the most well-known natural-source cancer drug is derived from the bark of the Pacific yew tree (*Taxus brevifolia*) and is used in the treatment of breast, lung, and ovarian cancer, as well as Kaposi's sarcoma. Taxotere© (docetaxel) is a synthetic analog. The natural source of Paclitaxel is insufficient for market demand. Taxol is present in the bark of the tree, after removal of bark tree dies. Therefore, synthetic production is required. Bhat has achieved the synthesis of these molecules through asymmetric synthesis of side chains and coupling with respective side chains with 7-triethylsilyl-baccatin-III followed by de-protection. Fortunately baccatin-III is present in the leaves of *Taxus* tree, which are renewable.

Pacletaxel and Docetaxel Synthesis



Taxus brevifolia

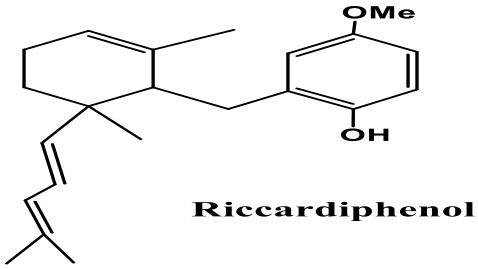
Shrikant Nalawade, Sanjay Mishra, Sujata V. Bhat, Process transfer to Company.

- ***Design, Synthesis and anti-tumor activity evaluation of novel Riccardiphenol***

Her group has achieved the total synthesis of Riccardiphenol, which occurs naturally in *Reccardia crassa. Riccardia* is a plant genus in the liverwort family Aneuraceae. A novel, facile and simple synthesis of this molecule has been achieved, Key step being sulfolene alkylation. Various derivatives were synthesized in collaboration with Dr. S. R. Khan of USA and evaluated

for anti-cancer activity, which indicated riccadiphenol analogs have effective action against human-derived cancer cells *in-vitro*.

Riccardia crassa

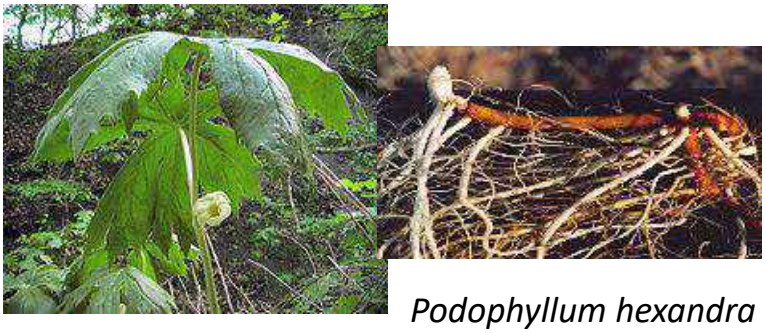


Riccardiphenol

S. K. Kumar, M. Amador, M. Hidalgo, **Sujata V. Bhat** and S. R. Khan, **2005** *Bioorganic and Medicinal Chemistry*, *13*, 2873-2880.

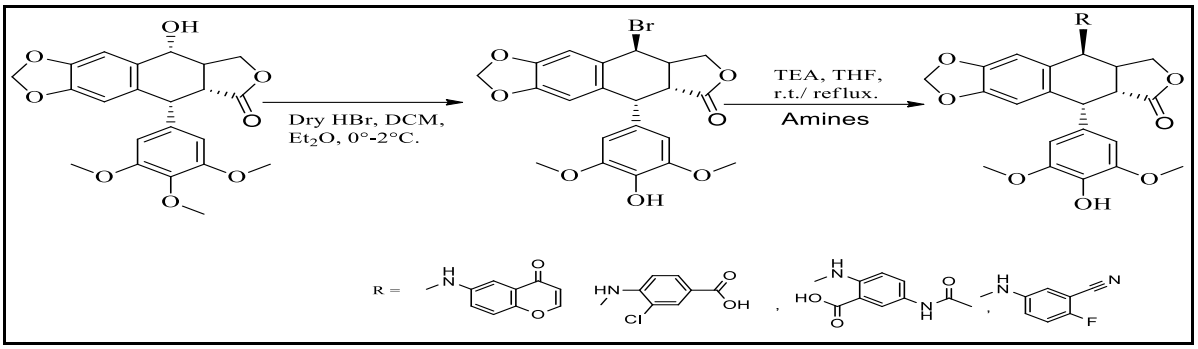
• ***Podophyllotoxin***

A large scale isolation of podophyllotoxin from roots of *Podophyllum hexandra* (Fam. Berberidaceae) was achieved by her group. Podophyllotoxin is the precursor of antitumor drugs etoposide and teneposide and recently several amino- derivatives of podophyllotoxin are in various stages of evaluations.



Podophyllum hexandra

Dr. Bhat and Dr. Sylvia also have synthesized several amino derivatives of podophyllotoxin and evaluation of their antitumor activity is in progress.



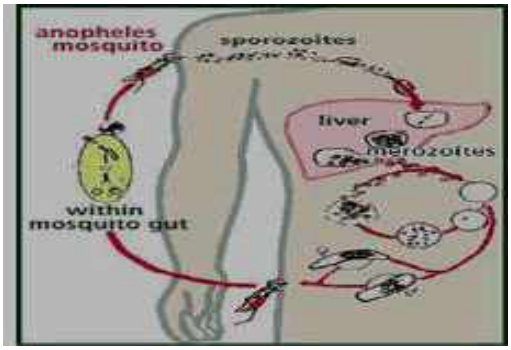
- ***New Antimalarials***

The disease that seemed vanquished in the 50s makes come back. Every year more than 300 million people contract the disease, 1-2 million die from it. The large number (~3/4) are children below 5 years of age.

Causative agents are *Plasmodium vivax, P. ovale, P. malariae, P. falciparum, P. knowlesi . The* exposed countries are Africa, South East Asia, Oceania and Central & south America.

Control of Malaria

Insect Control



Parasite Control

No Vaccine

Prophylaxis

Azadirachta indica (Fam. Meliaceae) commonly known as neem**,** nim tree or Indian lilac.

Its fruits and seeds are the source of neem oil. Neem is a key ingredient in non-pesticidal management (NPM), providing a natural alternative to synthetic pesticides. Several terpenoids and sulphur-containing molecules are known to be present in the neem oil.

For insect control Dr. Bhat isolated several tetra-nor-triterpenoids of Neem seed oil and modified these molecules semi-synthetically and studied insect-control activity. She has also isolated & characterized five new molecules in neem seed oil.

B. R. Gaikwad, T. Mayelvaganan, B. A. Vyas, **S. V. Bhat**, *Phytochemistry*, 29, 3963,**1990,**

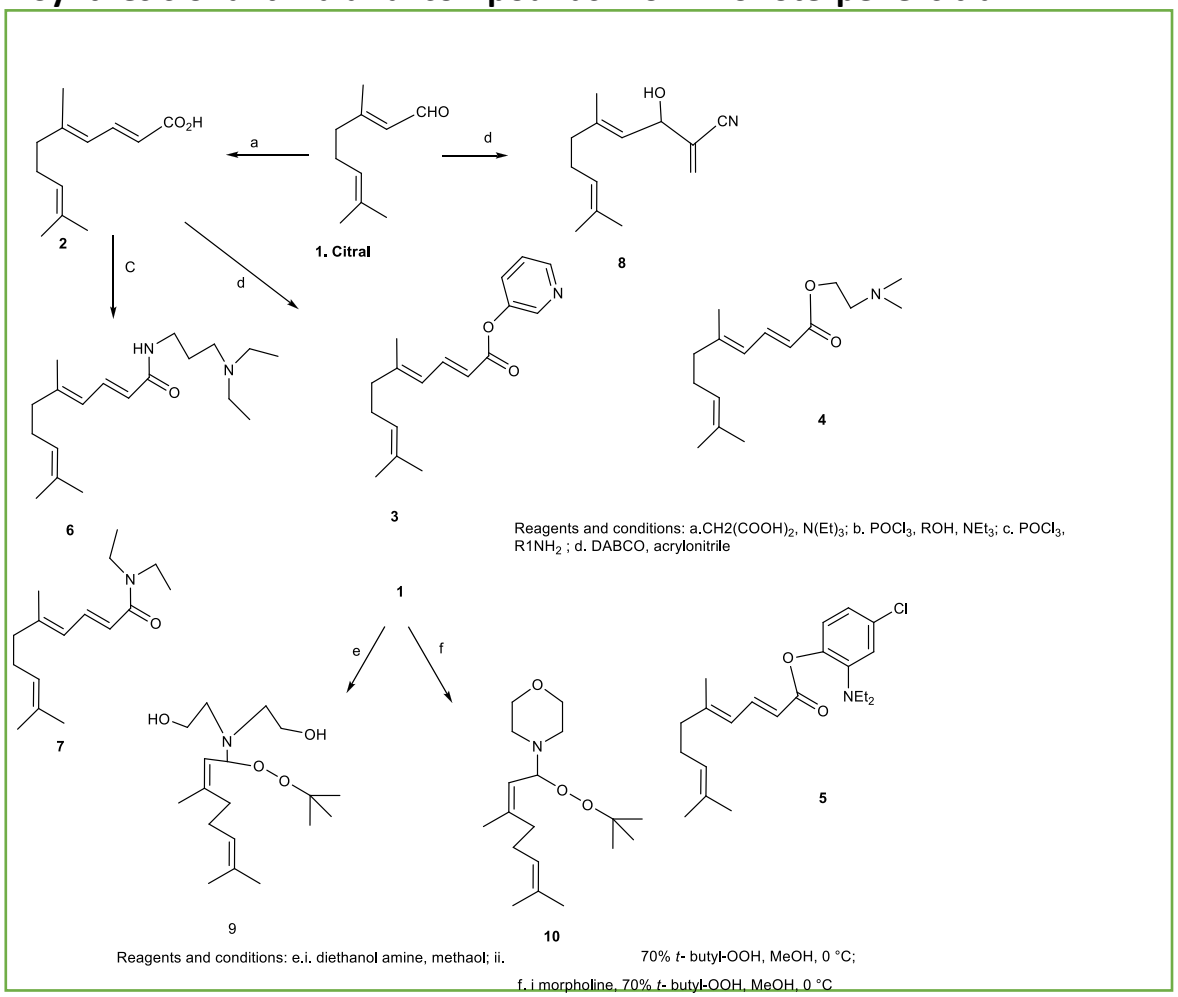
H.Gurulingappa, S. Apoorba, **S. V. Bhat**, *J. Natural Products,* 1177-1179, **2002,**

H. Gurulingappa, Y. R. Jorapur, S. Madhavi, **S. V. Bhat,** V. Tare, P. Pawar, V. Tungikar, *Chemistry and Biodiversity*, 6, 897-902, **2009**.

- ***Antibiotic Aplasmomycin monoterpene analogues***

Only a few medicines containing boron are known. Two boron-containing natural products isolated so far are boromycin (the first isolated) and aplasmomycin. Both have a tetrahedral

Synthesis of antimalarial compounds from monoterpene citral



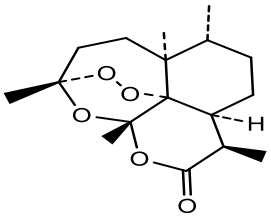
boron atom in the center of the structure, complexed with two vicinal diol groups and have antibiotic activity against Gram-positive bacteria. This boron containing antibiotic displays some anti-malarial activity, therefore easily available monoterpene analogues were synthesised and evaluated for anti-malarial activity. Some molecules displayed appreciable antimalarial activity.

Soni Singh, Reena P. Khandare, Manish Sharma, Virendra K. Bhasin and Sujata V. Bhat, *Natural Products Communications*, *9*, 299-302., 2014,

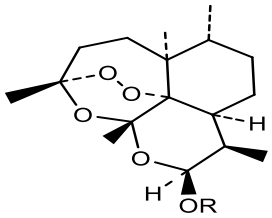
N Balu, J.V. Thomas , S.V. Bhat ,, *J. Med. Chem.* 34, 2821 1991. M. K. Kundu, J. V. Thomas, S. V. Bhat, *Indian Journal of Chemistry Sec-B,* 38B. 1299,1999.

N. Sundar, J. V. Thomas and S. V. Bhat, *Bioorganic and Medicinal Chemistry Letters*, 2269-2272, 2001.

Artemisinin (qinghaosu)



Artemisinin



Arteether,R=Et,
Artemather, R=Me
Artesunate, R+$CO(CH_2)_2COOH$

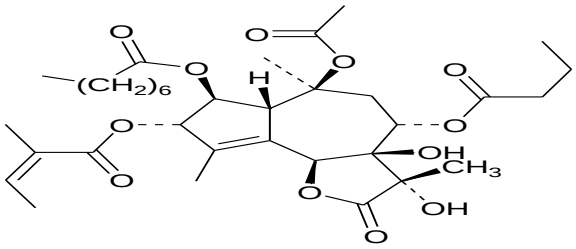
Artemisinin (Qinghaosu) is a potent antimalarial sesquiterpene lactone isolated from the Chinese herb *Artemisia annua* (Fam. Asteraceae). Arteether, artmether and artesunate are potent semisynthetic analogue derived from dihydroartemisinin, which have been approved by the World Health Organization as the artemisinin derivatives of choice for the treatment of malaria.

Dr. Bhat has achieved one pot synthesis of several new derivatives starting from artemisinin.
It is recently known that antimalarial sesquiterpene lactone Artemisinin and derivatives inhibit the sarco/endoplasmic reticulum Ca^{2+}-ATPase (SERCA)-orthologue (PfATP6) of *P. falciparum* in *Xenopus oocytes.* PfATP6 is the only SERCA-type Ca^{2+}-ATPase sequence in the parasite's genome.

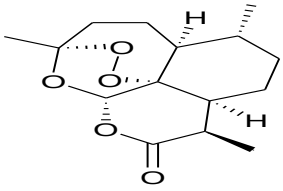
- ***Andrographolide derivatives as anti-malarials***

Ayurvedic formulations containing *Andrographis panucalata* plant are routinely used for the treatment of fever. Therefore, Dr. Bhat decided to test antimalarial activity of Andrographolide derivatives. Some molecules displayed promising antimalarial activity.

In computer aided modeling studies, binding of Andro and its derivatives to sarco/endoplasmic reticulum Ca^{2+}-ATPase was investigated. These studies were carried out using the X-ray crystal structure of Ca^{2+}-ATPase protein and were compared with well-known Ca^{2+}-ATPase inhibitors Thapsigargin and Artemisinin.

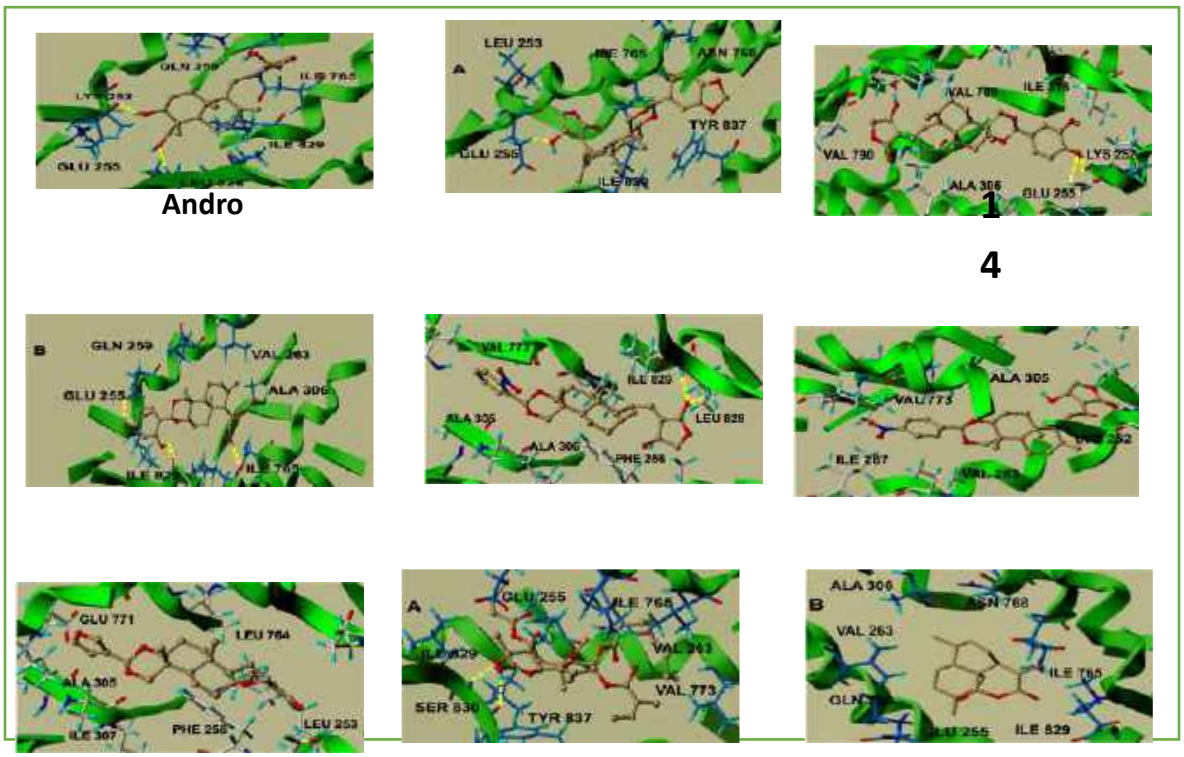


Thapsigargin



Artemisinin

Sujata V. Bhat,* Mayur Uttekar , Manish Sharma, Rohan Pawar and Virendra Bhasin 2021, Synthesis, Antimalarial Activity of Andrographolide Derivatives and Computational Studies for binding with Ca2+-ATPase, G P Globalize Research Journal of chemistry, volume, 3, 69-76.



Docking of Andro derivatives at the active site of 1IW0 and compared with andro, Thapsigargin and Artemisinin

- ***Antibacterials***

Synthesis of Magnesidin analogs teramic acid derivatives and evaluation of antibacterial activity

Magnesidin is a magnesium containing antibiotic isolated from cultures of *Pseudomonas magnesiorubra*. Twenty-three Magnesidin related tetramic acids were prepared and evaluated as bactericides. The antibiotic activity was influenced by the length of the alkanoyl substituent in the 3 position and the presence of a 1-Ac group; the derivatives with C8-C10 alkanonyl substituents were the most potent compounds.

Sujata V. Bhat *et al.* **1974**, Structure elucidation of Magnesidin, *Tetrahedron Letters*, (12), 983-6; **Sujata V. Bhat**; B. N. Ganguli, and N. J. de Souza, **1977**, Magnesidin related tetramic acids, Synthesis and Structural requirements for antibacterial activity; *Eur. J. Medicinal Chem.*, 12, 53-57.

- ***Antibacterial Activity of 3-hydroxy-2-methylene-3-phenyl-propionic acid derivatives***

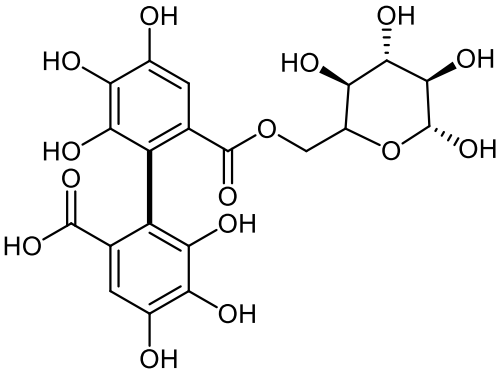
These molecules were obtained through Morita-Bayllis-Hillman reaction of various aldehydes with vinyllic conjugated molecules. Some molecules displayed appreciable Anti-bacterial property. Similarly, monoterpene citral was converted to conjugated molecules and some of the products displayed an appreciable Anti-bacterial property.

Soni A. Singh and Sujata V. Bhat**, 2011**, Synthesis and antimicrobial potential of 3-hydroxy-2-methylene-3-phenyl-propionic acid derivatives, *Acta Pharmaceutica*, *61*, 447-455; Soni A. Singh, Y. Potdar, R, Pawar and Sujata V. Bhat, **2011**, Antibacterial potential of monoterpene citral, *Natural Products Communications*, *6*, 1221-1224.

- ***Anti-Allergic Activity***

Osbeckia stellata Var. Crinita

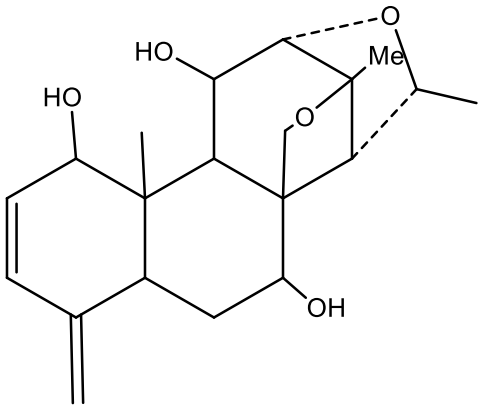
During plant screening program at Hoechst research centre, aqueous extract of shoots of *Osbeckia stellata* var. Crinita (Fam. Melastomaceae) displayed appreciable anti- allergic and broncho-spasmolytic activities. Bioassay guided fractionation led to active principle, which was identified as Mono-β-D-glucopyranos-6 -yl-3.3',4,4',5,5'-hexahydroxy-diphenate. The hydrolysis of this molecule yielded ellagic acid. The structure of glycoside was supported by its total synthesis.



Osbekia stellata Var Crinita Diphenic acid-mono-glucoside

S. V. Bhat *et al., (***1981),** IN, 148938, B1981 0725; Ger.Offen. (**1981**) DE 3021108 A11981 1217.

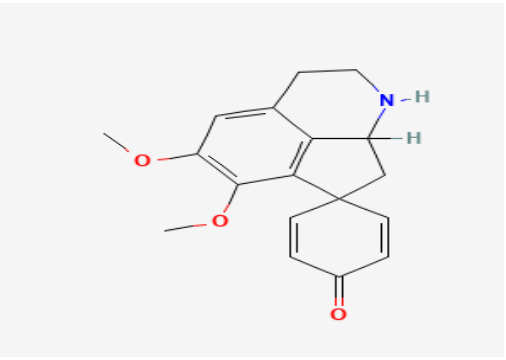
Anti-amoebic Activity- *Samadera indica* (Fam. Simaroubaceae) is an evergreen shrub or tree growing up to 20 metres tall.The tree is gathered from the wild to treat a range of medical conditions. It is also used locally as an insecticide. Antifungal and antibacterial activities of this plant have been reported. In the plant screening program at Hoechst research centre, her group observed the methanolic extract of this plant displayed Anti-amoebic Activity. The active principal was identified as trihydroxy-pentacyclic-diterpene.



Isoquinoline Alkaloids

During plant screening program at Hoechst research center, the extracts *Stephania glabra* (Roxb.) Miers (Fam.Menispermaceae) roots displayed considerable blood pressure lowering activity. This plant has long been used for the treatment of asthma, tuberculosis, dysentery, hyperglycaemia, cancer, fever, intestinal complaints, sleep disturbances and inflammation in many Asian countries. Bioassay guided fractionation led to active principle, which was identified as the isoquinoline alkaloid stepharine. Several salts of this molecule were evaluated

for blood- pressure lowering activity. This Molecule gave the lead for total synthesis of blood pressure molecule HL 725.

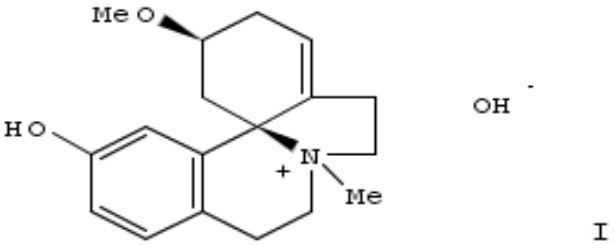


Stephania glabra *Stepharine*

S. V. Bhat *et al*. (1977) IN 141311 B 19770212; S. V. Bhat *et al*. (1977) DE2557265 A119770630.

- ***N-Methylcocculium hydroxide***

This isoquinoline alkaloid was isolated from roots of *Pachygone ovate* (Fam. Menispermaceae). This alkaloid displayed negative chronotropic activity.

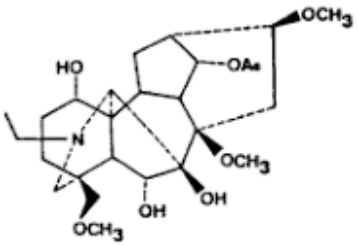


Pachygone ovata N-methylcoccculium hydroxide

S. V. Bhat *et al.*(1981) IN 148968B 1981 B 19810801;S. V. Bhat *et al. J Natural Products* (1980), 43(5), 588-91.

Neuromuscular blocking Activity

Inula royleana (Fam. Asteraceae) is Himalayan Plant. The plant is disinfectant. It is considered to be poisonous. It contains 3% alkaloids that produce blood pressure fall and stimulate tone and peristaltic movements in the intestine. Lycoctonine related alkaloids have been related from this plant.



Lycoctonine

Neuromuscular blocking effects of an alkaloidal extract from *Inula royleana*: contractile and electrical studies on amphibian skeletal muscle *in vitro* has been evaluated

R. Manchanda, R.; **Sujata V. Bhat**, B.Mehta, B.; J.Karunakaran, K. Venkateswarlu,

Indian Journal of Physiology and Pharmacology **2000**, 44(2), 143-152.

- ***Insect control activity***

Azadirachta indica (Fam. Meliaceae) commonly known as neem**,** nim tree or Indian lilac.

Its fruits and seeds are the source of neem oil. Neem is a key ingredient in non-pesticidal management (NPM), providing a natural alternative to synthetic pesticides. People also use it in hair and dental products

Several terpenoids and sulphur-containing molecules are known to be present in the neem oil.

For insect control Dr. Bhat isolated several tetra-nor-triterpenoids of Neem seed oil and modified these molecules semi-synthetically and studied insect-control activity. She has also isolated & characterized five new molecules in neem seed oil.

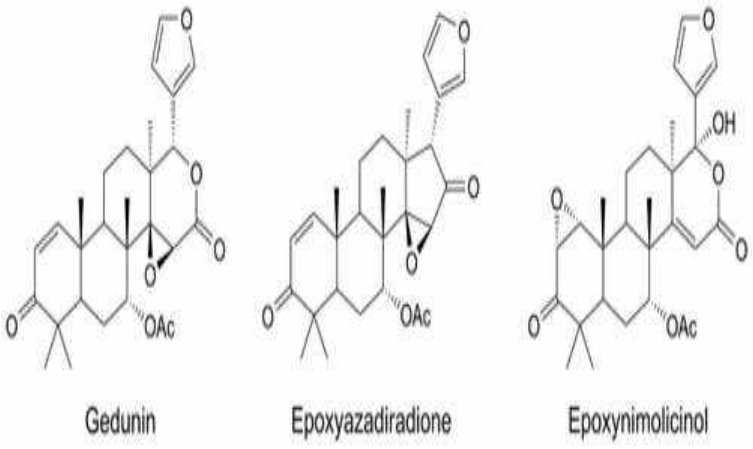
B. R. Gaikwad, T. Mayelvaganan, B. A. Vyas, **S. V. Bhat**, *Phytochemistry*, 29, 3963,**1990,**

H.Gurulingappa, S. Apoorba, **S. V. Bhat**, *J. Natural Products*, 1177-1179, **2002,**

Pesticidal and Insecticidal Applications of Neem- Dr. Bhat's group achieved synthesis of several Semi- synthetic derivatives for insect control.

Fruits of Neem Plant

Gedunin derivatives showed enhanced insecticidal activity.

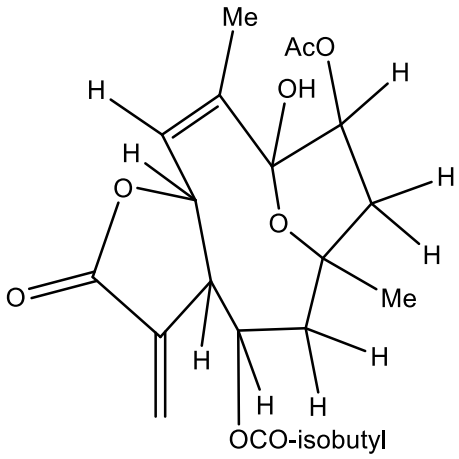


Dr. Bhat supported *Godrej* Agrovet Pvt Ltd in Neem studies during their development of *NEEM-Urea* formulation development. Gedunin and hydroxyl-gedunin had appreciable insecticidal and larval antifeedant activities. **S. V. Bhat** *et al., Chem. Biodiversity,* ***2009.***

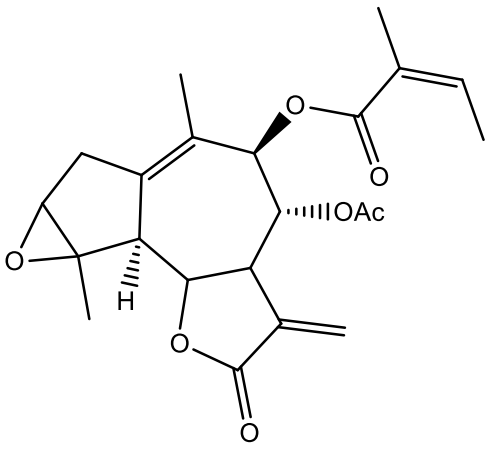
Sesquiterpene lactones (SLs)

These are a diverse group of naturally occurring terpenoids (15-carbon compounds) with a characteristic isoprenoid ring system, a lactone ring containing a conjugated α-methylene-γ-lactone moiety. They are most often found in plants of the family Asteraceae (daisies, asters). Other plant families with SLs are Umbelliferae (celery, parsley, carrots) and Magnoliaceae (magnolias). To date, studies have shown antitumor, anti-inflammatory antimicrobial, antidepressant, antidiabetic, antioxidant, hypoglycemic, vasorelaxant and hepatoprotective activities, among others associated with SLs

Sujata Bhat had isolated several new sesquiterpene lactones from different plants of Asteraceae Family and achieved the structure elucidation of new molecules. Some examples are as follows:



Woodhousin



Berlandin

Bahia woodfordia

Berlandiera subacaulis

1. W. Herz and **Sujata V. Bhat**, **1973,** Maculatin, an isomer of uvedalin epoxide from *Polymnia maculata, Phytochemistry,* 12, 1737-1740.
2. W. Herz and **Sujata V. Bhat, 1972,** 'Woodhousin, a new germacranolide from *Bahia woodhousei* Gray', *J. Org. Chem*. 37, 906-912 (*).DOI:10.1021/jo00971a020
3. W. Herz, **Sujata V. Bhat** and A. Srinivasan, **1972,** Berlandin and Subacaolin two new guainolides from *Berlandiera subacaolis, J. Org. Chem*., 37, 2532-2536 (*).
4. T. Saitoh, T. A. Geissman, T.G. Waddall, **Sujata V. Bhat** and W. Herz, **1971,** Sesquiterpene lactones of *Eriophyllum confertiflorum, Rivista Latinoamericana de Quimica*, 1, 69-80.
5. W. Herz, **Sujata V. Bhat** and P.S. Santhanum, **1970,** Coumarins of *Artemisia dracunculoides* and 3',6-dimethoxy-4',5,7-trihydroxy-flavone in *A. artica, Phytochemistry*, 9, 891-894. DOI:10.1016/S0031-9422(00)85199-7
6. W. Herz and **Sujata V. Bhat**, **1970,** Isolation and structure of two new germacranolides from *Polyminia uvedalia, J. Org. Chem.*, 35, 2605-2611(*).DOI:10.1021/jo00833a028
7. W. Herz, **Sujata V. Bhat** and A. L. Hall**, 1970,** Parthemollin, a new xanthanolide from *Parthenice mollis, J. Org. Chem*. 35, 1110-1114. DOI:10.1021/jo00829a054

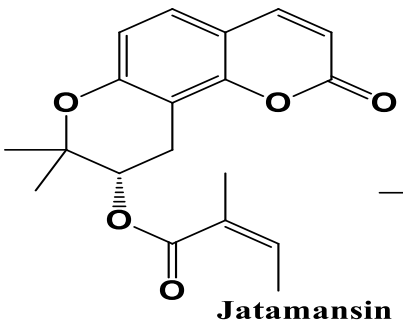
Eupatorium *capillifolium*

Natural Coumarins and Flanones

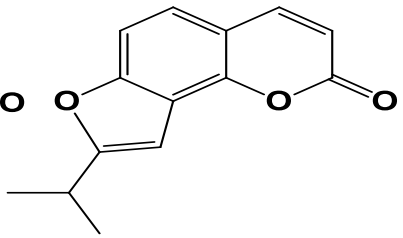
Nardostachys jatamansi DC (Fam. Valerianaceae) is a small, perennial, rhizomatous, herb which grows in steep, moist, rocky, undisturbed grassy slopes of India, Nepal, China, Tibet and Bhutan. Its rhizomes are used in traditional medicines in different medicinal system. Jatamansi has been widely used for medicine and in perfumery for centuries in India. It is valued for many medicinal properties such as anti-lipid peroxidative, hypolipidemic, antioxidant, hepatoprotective, sedative, tranquilizing, antihypertensive, antiinflammatory, antidepressant-like activity, anticonvulsant activity and hypotensive properties.

Dr. Bhat during her doctoral studies, isolated and identified several coumarins from this plant, (which was later identified as *Selinum vaginatum*). Selinum vaginatum (Family-Apiaceae) has hypotensive, pain-relieving and nervine narcotic activity. These coumarin molecules are with additional pyran and furan rings attached. The major constituent was a pyrano-coumarin Jatamansin.

She had achieved semisynthetic modifications of this molecule and achieved synthesis of dihydrosamidin, visnadin and the vasodilatory drug suksdorfin..



Jatamansin

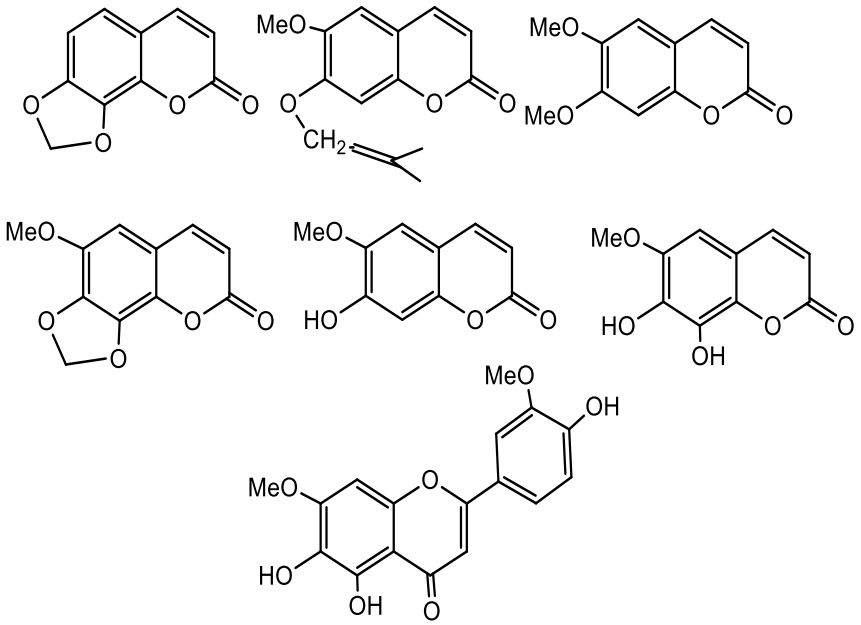


Oroselol

Selinum vaginatum

1. **S. N. Shanbhag**, M. L. Maheshwari and S. C. Bhattacharyya, **1967**, Synthesis of suksdorfin and related products from jatamansin, *Tetrahedron,* 23, 1235-1240.
2. **S. N. Shanbhag**, C. K. Mesta, M. L. Maheshwari and S. C. Bhattacharyya, **1965,** Constituents of *Nardostachys jatamansi*, and synthesis of samidin and visnadin from jatamansin, *Tetrahedron* , 21 , 3591-3597.
3. **S. N. Shanbhag,** M. L. Maheshwari, S. K. Paknikar and S. C. Bhattacharyya **1964,** Jatamansin, a new sesquiterpene coumarin from *Nardostachys jatamansi, Tetrahedron,* 20, 2605-2616 (*)**.**

(Maiden Name: S. N. Shanbhag)



A. dracunculoides

Coumarin was also found in *Amblyolepsis setigera* (Fam. Asteraceae) and several dihydro-flavanonols were found in *Eupatorium sp*. (Fam. Asteraceae).

W. Herz, **Sujata V. Bhat** and P.S. Santhanum, **1970,** Coumarins of *Artemisia dracunculoides* and 3',6-dimethoxy-4',5,7-trihydroxy-flavone in *A. artica*, *Phytochemistry*, 9, 891-894.

W. Herz, S. Gibata, **Sujata V. Bhat** and A. Srinivasan, **1972,** Dihydroflavonols and other flavonoids of *Eupatorium sp, Phytochemistr*y, 11, 2859-2863.

W. Herz and **S. V. Bhat** ,1970, Coumarin in *Amblyolepsis setigera, Phytochemistr*y, 9, 817/.

Natural DihydroFlavones and Flavones of Eupatorium species and Iva frutescens

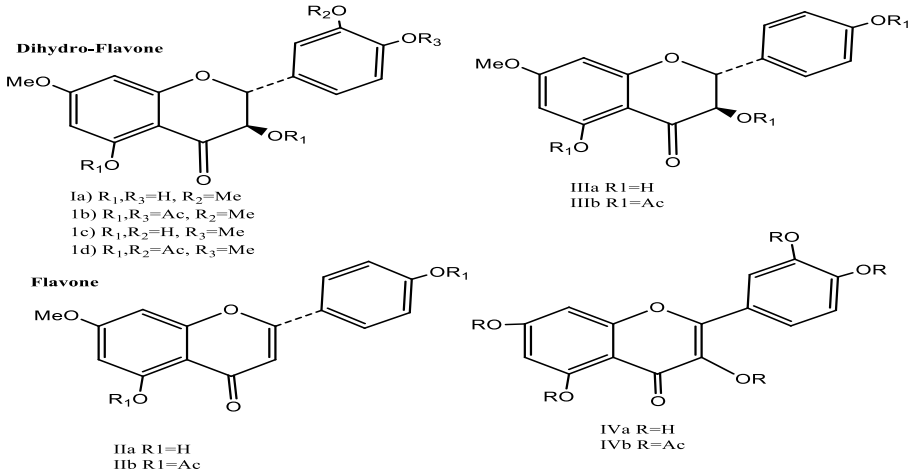
Herz**, Sujata V. Bhat** and V. Sudarshanam, **1972,** Sesquiterpene lactones and flavones of *Iva frutescens, Phytochemistry,* 11, 1829-1831.DOI:10.1016/0031-9422(72)85045-3.

W. Herz, S. Gibata, **Sujata V. Bhat** and A. Srinivasan, **1972,** Dihydroflavonols and other flavonoids of *Eupatorium sp*, *Phytochemistr*y, 11, 2859-2863.

W. Herz, **Sujata V. Bhat**, H. Crawford, H. Wagner, G. Maurer and L. Farkas, **1972.**, Bahifolin, a new sesquiterpene lactone and 5,7-dihydroxy-3,3',4',6-tetramethoxy-flavone a new flavone from *Bahia oppositifolia*, *Phytochemistry*, 11, 371-375.

W. Herz and **Sujata V. Bhat**, **1970,** Coumarin in *Amblyolepis setigara*, *Phytochemistry*, 9, 817-820.DOI:10.1016/S0031-9422(00)85186-9

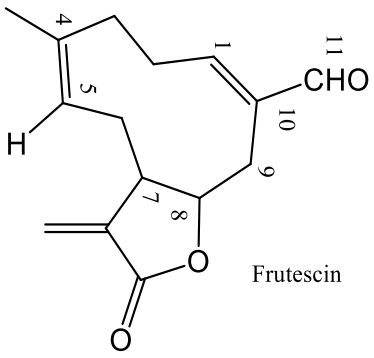
The following Dihydroflavones (I & II) and Flavones (III & IV) were isolated and identified by her group.



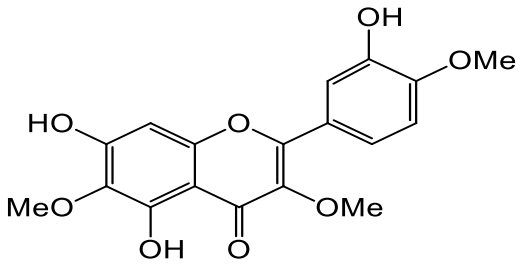
Iva frutescens

Two distinct subspecies of *Iva fiutescens* L., a shrubby perennial endemic to the East and Gulf coast of the U.S.A., have been recognized by Jackson . Our work indicated their constituents. Collections of subspecies frutescens found in the coastal area, generally in salt marshes, from virginia to Florida and Texas yielded Centaureidin (5,7,3'-trihydroxy-3,6,4'-trimethoxyflavone) and a new sesquiterpene lactone ***frutescin,***

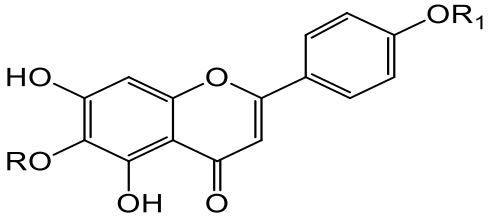
Chloroform extraction of a collection of *I. frutescens* subspecies oraria (Bartlett) Jackson, which occurs in coastal areas north of Virginia gave as the only crystallizable components the flavones pectolinarigenin (5,7-dihydroxy-6,4'-dimethoxyflavone) and hispidulin (6-methoxy-5,7,4trihydroxyflavone).



Frutescin



Centaureidin



Pectolinarigenin R=R_1=Me
Hispidulin R=Me, R_2=H