



Phyllanthus niruri: A Review on its Ethno Botanical, Phytochemical and Pharmacological Profile

K. Narendra, J. Swathi, K. M. Sowjanya, A. Krishna Satya *

Department of Biotechnology, Acharya Nagarjuna University, Nagarjuna Nagar, Guntur-522510. A.P. India

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ABSTRACT

Phyllanthus niruri Linn. belongs to Euphorbiaceae family and it is a small herb having wide range of medicinal properties, and it is used widely across the world. In Indian ayurvedic system it is used for Jaundice, ulcers, skin diseases, diabetes, chest pain and urinary complications. Its taste is bitter and acts as astringent and show laxative effect. This review covers information about ethano medicinal uses of *P. niruri* in different countries with various pharmacological profile of the plant. The phytochemical studies were characterized and the presence of various compounds such as lignans, phyllanthin, hypophyllanthin, flavonoids, glycosinoids & tannins was mentioned. The extracts of *Phyllanthus niruri* have a wide range of pharmacological activities like antimicrobial, antiviral, hepato protective, antioxidant, anticancer, anti-inflammatory, antiplasmodial and diuretic. This review summarizes the information about its botanical, morphological, ethanobotanical, pharmacological and biological activities of the plant. In addition this review provides information about the structure of the phytochemical compounds that promotes better commercial exploitation.

Key words: *Phyllanthus niruri*, Ethano Botany, Phytochemistry, Hepatoprotective, Antiviral, Kidney stones, HIV replication inhibition.

INTRODUCTION

Chanka piedra (*Phyllanthus niruri* Linnaeus., *Euphorbiaceae*), is sparsely spread throughout the tropical and subtropical countries of the world. This is an annual herb and widely spread in coastal areas of India. It is used in the Indian ayurvedic systems from the ancient times (more than 2000 years), It is having very short life. *P. niruri* is a field weed and its genus *Phyllanthus* comprises of 600-700 species with minor distinguishing features among them. In Indian ayurvedic system *Phyllanthus niruri* plant extract is used as a medicine and is recommended for Bronchitis, Anaemia, Leprosy, Asthma, Urinary disorders etc., In Chakra Samhita book *P. niruri* is used in effective treatment of asthma, stimulating liver, improving digestion, increase appetite and produce laxative effects. Maharshi Charaka has categorized it as Kasahara: alleviates cough, Swasahara: relieves asthma, mootrarogahara: cures urinary disorders, Kaphapittahara: relieves the kaphapitta dosha, Kaamalaahara: cures jaundice, and Bhava prakasa Nighantu: cures cough and blood disorders. It is bitter in taste but sweet in the post digestive effect (vipaka) and it is also used as astringent.

Sidha medicinal uses

1. For jaundice: The whole plant juice with 10-20ml of dose is recommended three times daily.
2. The fresh roots (10gms) powder is mixed with fresh milk. This is recommended to take in the early mornings for effective cure for jaundice.
3. The leaves were crushed with salt and applied for skin diseases.
4. The plant decoction was very effective for diabetes and chest pain.
5. The decoction of leaves or roots is used for ulcers.
6. The dried powder of the plant mixed with gruel water is applied over ulcers and wounds.
7. The juice of whole plant can be taken as a dose of 45-50 ml in the early morning for leucorrhoea, gonorrhoea, menorrhoea and other urinary complaints.

***Corresponding author.**
Dr. A. Krishna Satya
Assistant Professor
Department of Biotechnology
Acharya Nagarjuna University
Nagarjuna Nagar, Guntur-522510,
A.P. India

In Unani medicine the roots of this plant are used for the remedy of liver diseases and seeds were used in the treatment of ulcers, wounds and scabies & ring worms.

The extract of this plant can cure Hepatitis very effectively^[83] and it can be a remedy for HIV-AIDS^[48]. *P. niruri* is having various properties like anti-inflammatory^[76], anti-fungal, anti-viral, anti-bacterial^[21], anti-oxidant^[3,8,30], hepatoprotective^[56], hypoglycemic^[77,28], hypotensive, analgesic^[7,57], inhibitory effect on renal stone formation^[20] etc., *P. niruri* is used as an ingredient of almost 175 ayurvedic formulations, the fruits of this plant is commonly used in the treatment of hemorrhages, diarrheas, dysentery, jaundice, cough and anaemia. It is also used in the preparation of various health care and personal products like chavanprash, hair oil dye, face cream, tooth powder^[55].

The aqueous infusions of the whole plant is employed as a stomachic, appetite, anti-spasmodic, laxative, diuretic^[80], carminative, against constipation, fever including malaria, hepatitis B^[70], dysentery, gonorrhoea, syphilis, tuberculosis, cough, diarrhea, vaginitis^[44, 47].

Majorly scientists focused on hepatoprotective activity of *P. niruri*, the hepatoprotective effects of crude methanol and aqueous extracts against CCl₄ induced liver damage in rats have been investigated^[24]. The hexane fractions of extract reported to be hepatoprotective against CCl₄ and Gal N induced cytotoxicity in primary cultured rat hepatocytes^[60]. radical scavenging activity along with the hepatoprotective activity was found in aqueous extract of this plant^[12].

The *Phyllanthus niruri* fresh root is believed to be an excellent remedy for jaundice, dropsy and genitor urinary infections^[13, 78, 83]. *P. niruri* promote stone elimination in patients with kidney stones, as well as normalization of Ca levels in hypercalciuric patients^[43] so it is best familiar remedy for gall stones & kidney stones in the continent^[75]. The extract shows an inhibitory effect on CaOx growth & aggregation in *invitro* model of crystallization^[10]. The fruits are used in treatment of tubercular ulcers, wounds, sores, scabies & ring worms^[11].

It is having high potential anticancer and antioxidant agents^[29] to cure viral hepatitis^[33] and increased vinblastin cytotoxicity towards multi drug resistant cancer cells^[61]. It also inhibits the endogenous DNA polymerase of Hepatitis B virus in both *invitro* and *invivo* models^[83].

The active component of *P.niruri* is niruriside, which has antiviral activity that extends to Human Immuno Deficiency Virus by inhibiting the reverse transcriptase enzyme^[48]. *P.niruri* also shows anti plasmodial activity of the ethanolic and dichloromethane extracts as well as the toxicity of the lyophilized aqueous extract previously reported^[73,74].

Phyllanthus niruri has several bioactive molecules such as lignans, phyllanthin, hypophyllanthin, flavonoids, glycosides, tannins, alkaloids, ellagitannins, triterpenes, phenyl propanoids, steroids, ricinolic acid, niruriside & phyltetralin^[14, 54, 31, 84]. The alkaloids have the anti spasmodic activity leading to smooth muscle relaxation. It even contains acidic Arabinogalctan^[32] and Diterpene^[25].

A protein isolated from the aqueous extract of *P.niruri* posses protective activity against number of drugs & toxins induced organ pathophysiology. The protein weigh about nearly 35Kda, posses anti oxidant activity and also radical scavenging activity and it even enhances intra cellular anti oxidant property^[62]. The seeds of this plant contain Ricinoleic acid, and Linolenic acid [54%], Fisetin-4-0-glucoside and a new Flavon glycoside has been isolated from the aerial parts of this plant.

P. niruri has enormous pharmacological activities such as antiviral activities against hepatitis B, antimicrobial, hepatoprotective, anticancerous and hypocalcemic agent. Methanolic extract of *P. niruri* exhibited immunomodulatory activity and anti HIV activity. Phyllanthin and hypophyllanthin shows antitumor activities. In this review we tried to assess the potential activities of *P.niruri*, its relation with the traditional and bioscientific research to establish several biochemical and pharmacological studies. This review contains several issues of ethanopharmacology, phytochemistry and pharmacology of *Phyllanthus niruri*.

Ethnobotany

Phyllanthus niruri has extensive medicinal properties and has long history in the health care system of tropical countries. The plant is known in traditional health care systems. *P.niruri* is commonly known as “Chanca pedra” (or) “stone breaker”. However there is a lot of confusion about this species identification. *Phyllanthus niruri* is used as a folk medicine for treating kidney stones, gallbladder stones, liver related diseases such as liver cancer & jaundice, apart from these it is also administered for diuretic, hypoglycemic and hypertension cases and it also shows anti inflammatory, anti tumor, antinociceptive and anti oxidant properties.^[9]

Worldwide Ethnobotanical uses:

Amazonia

Apertif, anodyne, colic, carminative, digestive, diabetes, dropsy, diuretic, dyspepsia, dysentery, flu, fever, gonorrhoea, gallstones, itch, kidney stones, jaundice, malaria, laxative, proctitis, stomachache, vaginitis, tumor, vermifuge.

Bahamas/ Caribbean

Antiviral, aperitif, antispasmodic, antihepatotoxic, appetite stimulant, bactericidal, constipation, cold, diuretic, fever, typhoid, flu, laxative, hypoglycemic, stomachache,

Brazil

Analgesic, Abortifacient, aperient, anti-bacterial, anti-inflammatory, anti-

cancerous, antiviral, arthritis, ache (joint), antilithic, albuminuria, antispasmodic, bladder stones, calculi, cystitis, catarrh (liver and kidney), diabetes, digestion stimulant, diaphoretic, diuretic, fever, gout, gastrointestinal problems, hepato-protective, hepatitis, hydropsy, hypoglycemic, hypertension, jaundice, kidney stones, malaria, obesity, muscle relaxant, purgative, prostatitis, renal problems, stomachic, tonic, uric acid excess, uterine relaxant, urinary problems.

Haiti

Colic, carminative, diuretic, digestive, indigestion, fever, spasmolytic, malaria, stomachache.

India

Asthma, anemia, astringent, conjunctivitis, bronchitis, cough, dropsy, diarrhea, diabetes, dysentery, diuretic, eye disorders, galactagogue, gonorrhoea, genitourinary disorders, jaundice, hepatitis, menorrhagia, leucorrhoea, ringworm, oligogalactia, stomachic, scabies, tuberculosis, thirst, urogenital tract infections, tumor (abdomen).

Malaya

Caterpillar sting, diarrhea, dermatitis, diuretic, itch, piscicide, miscarriage, renosis, purgative, vertigo, syphilis.

Peru

Diuretic, calculus, gallstones, emmenagogue, hepatitis, kidney problems, kidney pain, kidney stones, urinary infections, renal problems, vermifuge.

United States

Bronchitis, analgesic, deobstruent, chologogue, fever, diabetes, gallstones, gallbladder problems, hepatitis, gout, hypertension, kidney stones, kidney problems, uric acid excess, liver disease, urinary tract infections.

In India, Chhattisgarh state has medicinal tradition of this weed. Mainly it is used for the snake bite. Chanca pedra was popularly grown throughout India it is more common in southern and central regions.

Botanical Description and Vernacular Names

Phyllanthus niruri is an erect annual herb, growing 40 - 70cm height having ascending herbaceous branching; it is quite glabrous and branching at the base. The genus *Phyllanthus* means “leaf and flower” because the flower and fruit can be associated with the leaf. It is a plumose leaf that carries flower and fruit.

Leaves

Numerous, small, green, sub sessile, closely arranged, elliptic ablong shaped, obtuse, having short petiole and stipules present, they are arranged alternatively on each side of the stem.

Flowers

The flowers are yellowish, small, numerous, axillary. These are unisexual, monoecious flowers, male flowers having 1-3 sessile stamens and female flowers were solitary in nature.

Fruits

Fruit is a capsule, very small, depressed globose and more over capsule is smooth, 2-3mm in diameter,

Stem

It is having horizontal branches and height of 30-60cm, 1-2.5mm width.

Root

It is somewhat branched and large.

Botanical classification: *Phyllanthus niruri* L.

Kingdom – Plantae
 Division – Magnoliophyta
 Class – Magnoliopsida
 Order – Euphorbiales
 Family – Euphorbiaceae
 Genus – Phyllanthus
 Species – *Niruri*

Vernacular names: In India

Assamese: Holpholi; Poram-lokhi
 Bengali: Noar
 Hindi: Chalmeri, Harfarauri, Bhuaionla.
 Kannada: Kirunelli, Nela Nelli,
 Konkani: Bhuin-avalae
 Telugu: Ratsavusirike, Nela Usiri,
 Tamil: Arunelli, Keela Nelli,
 Malayalam: Arinelli, Kizhanelli, Nellipuli
 Marathi: Rayavali, Bhuiavli,
 Oriya: Narakoli
 Sanskrit: Amala, Bhumymlaki, Sukshmadala, Vitunika, Bhoodatri.

Vernacular names around the world

S.No	Country	Names
01.	Admiralty Islands	Phyllanto, Querb pedra
02.	Bangladesh	Bhui amla
03.	Bimini	Graine en bas fievre
04.	Brazil	Shka –ninn- du, erva pombinha
05.	Colombia	Holy Friday
06.	East Indies	Bhuimy-amli, Daun marisan Pombinha
07.	Fiji	Chanca Piedra
08.	French Guiana	Para – Pararimi
09.	Haiti	Elargeig
10.	India	Bhoomi amlaki, Bhui-amla Bhuianvalah, Jar-amla, Kizha nelli, Chanca piedra, Quebra Pedra, Pitirishi, Stone Breaker, seed in the leaf, urinary filante, poor man's quinine, girl's herb, niruri
11.	Mexico	Viernes santo
12.	Papua	New Guinea – Gale-o-Wind
13.	Paraguay	Pei Creole quinine, arrebentapedra, Paraparaimi (Paraguay).
14.	Peru	Creole senna
15.	Philippians	Santa Maria, San Pedro, herb of San Pablo, sampasampalkan
16.	Puerto Rico	Ya-tai-bai, permilla del pasto
17.	Sudan	Eruption plant Mapatam, Sasi, Se
18.	Thailand	yerba. De sanpablo
19.	Virgin Islands	Derriere- dos Deye do
20.	West Indies	Cane peas senna, carry me seed, hamber bitters, chick weed, enbas, gale- wind grass, hurricane weed, mimosa, uinine weed, jar amla.

Phytochemistry

Phyllanthus niruri plant shows significant activities on various diseases in many ways and it was essentially evaluated and analyzed.

S.No	Class	Compounds
01.	Alkaloid	4-Methoxy-nor-securinine, nirurin, ent-norsecurin
02.	Benzenoid	Gallic acid, Corilagin
03.	Coumarin	Ellagic acid, ethyl brevifolin carboxylate
04.	Flavonoid	Quercetin, rutin, astragalol, quercitrin, isoquercitrin, kaempferol-4-rhamnopyranoside, eridictyol-7-rhamnopyranoside, fisetin-4-O-glucoside, nirurin
05.	Lignin	Phyllanthin, hypophyllanthin, niranthin, nirtetralin, phyltetralin, hinokinin, isolintetralin
06.	Lipid	Ricinoleic acid
07.	Phytallate	Phyllester
08.	Sterol	Estradiol, β -sitosterol, isopropyl-24-cholesterol
09.	Tannin	Geranin
10.	Triterpene	Lupeol acetate, lupeol, 3,7,11,15,19,23-hexamethyl-2Z,6Z,10Z,14E,18E, 22E-tetracosenen-1-ol, phyllanthenol, phyllanthenone, phyllantheol

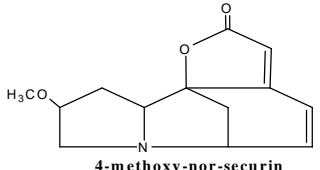
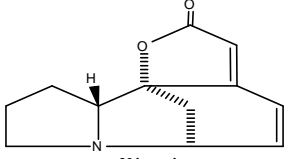
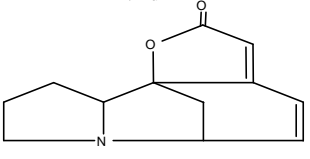
(Adapted from Calixto et al. 1998)

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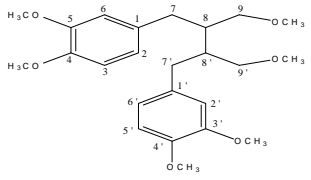
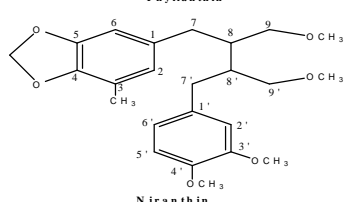
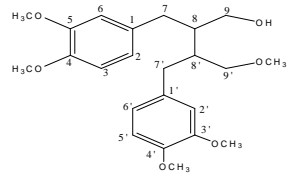
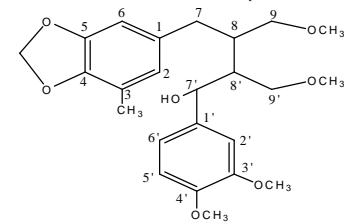
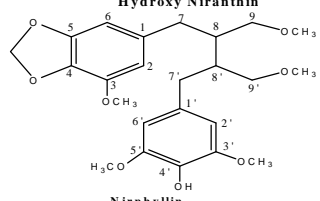
In *P. niruri* phytochemical studies were conducted since mid of 1960s.

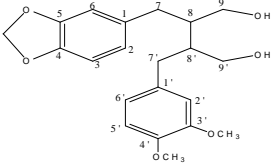
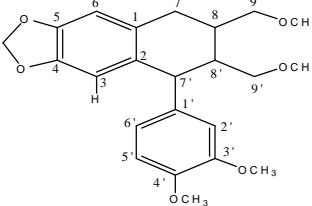
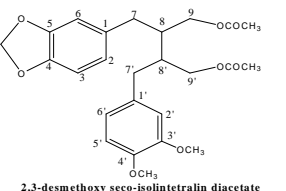
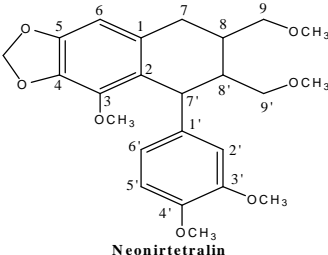
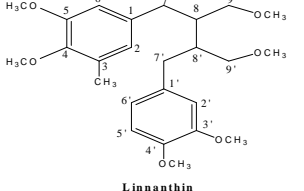
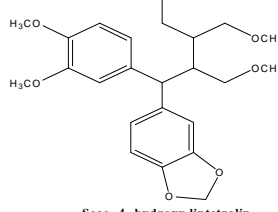
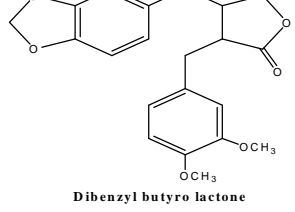
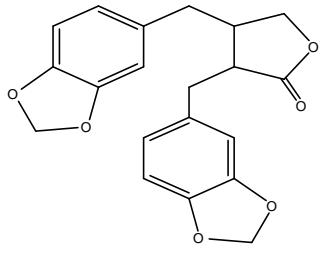
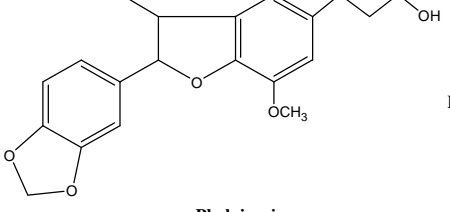
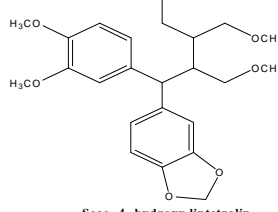
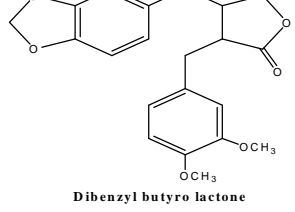
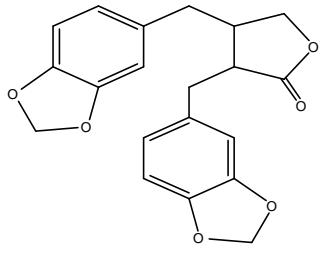
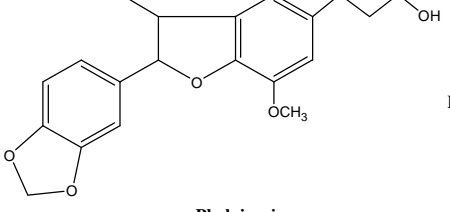
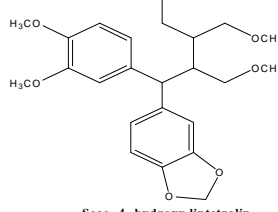
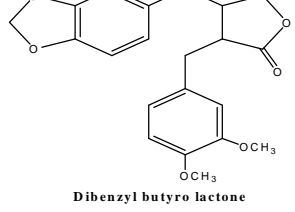
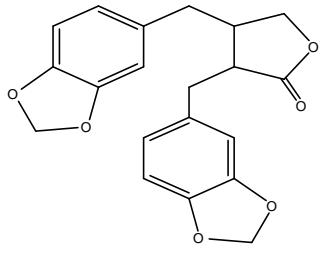
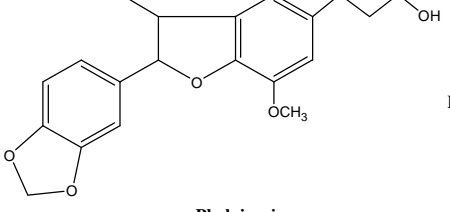
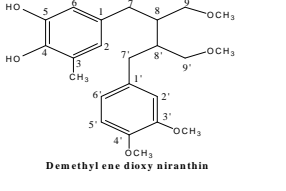
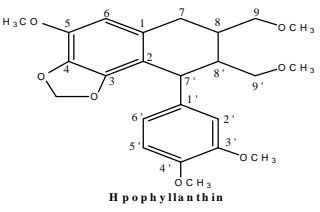
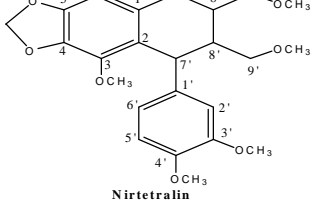
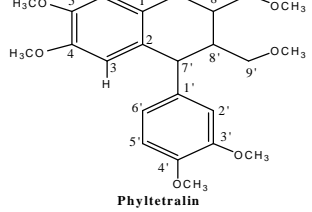
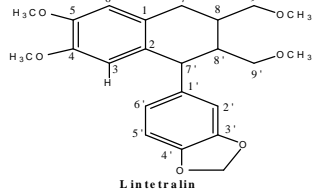
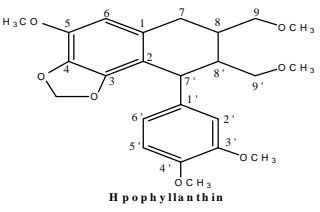
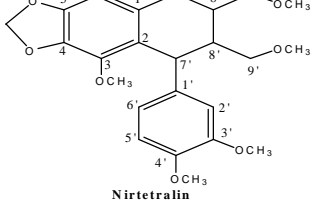
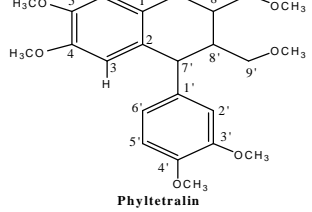
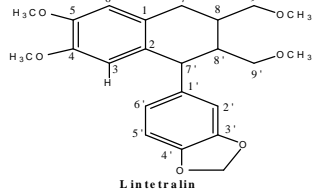
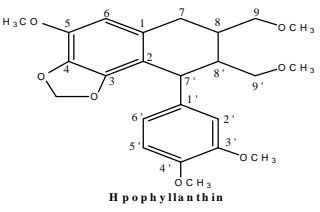
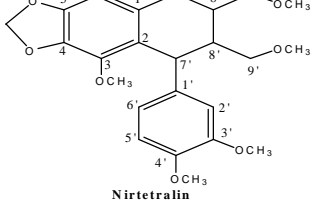
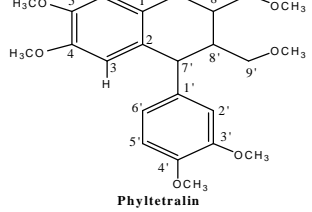
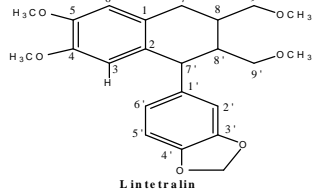
Different classes of organic compounds with various medical interests have been reported. Majorly we can find lignans, tannins, polyphenols, alkaloids, flavonoids, terpenoids and steroid^[14]. The following chemical constituents have been isolated from *P. niruri*. Pharmacological Activity

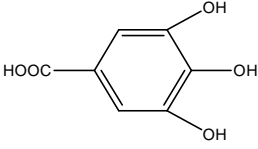
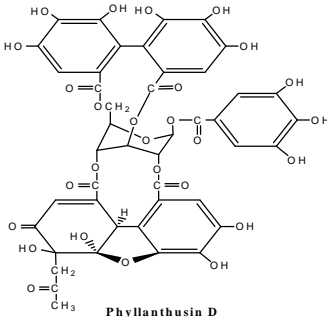
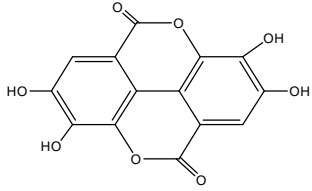
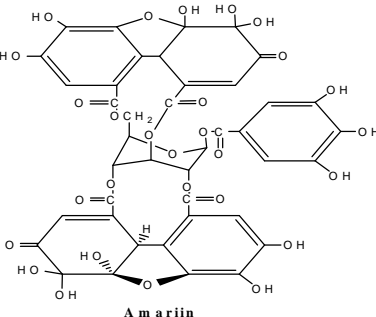
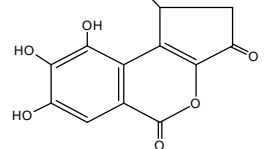
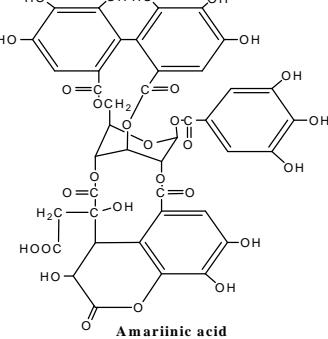
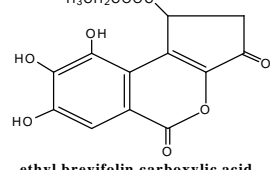
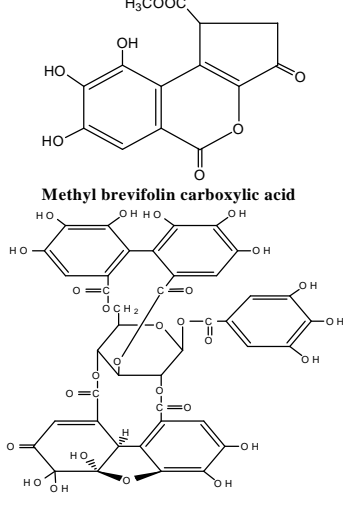
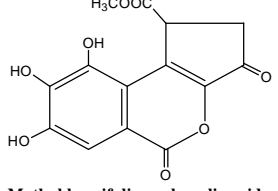
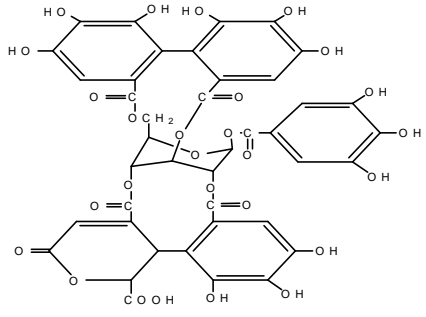
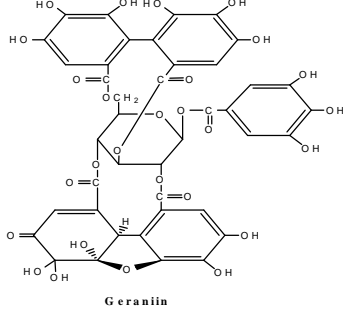
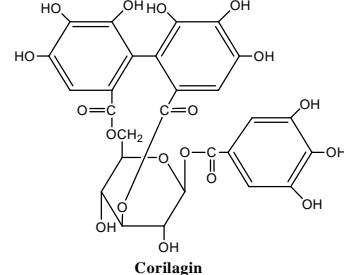
Alkaloids

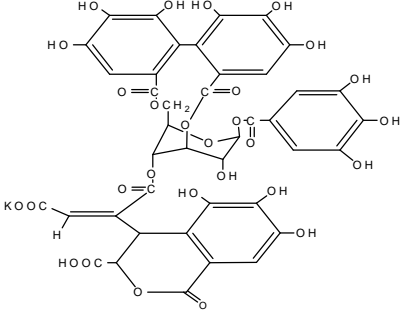
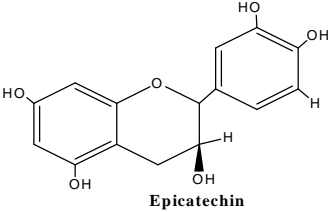
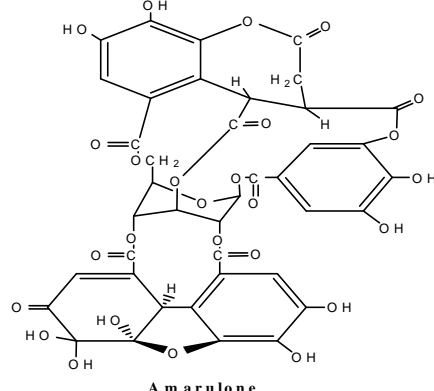
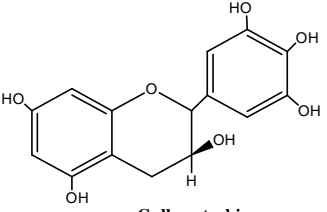
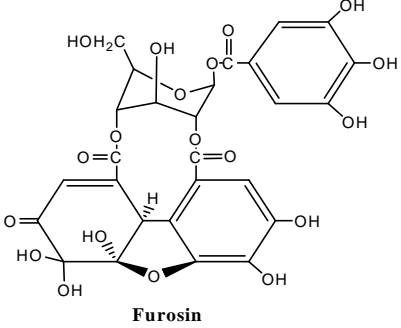
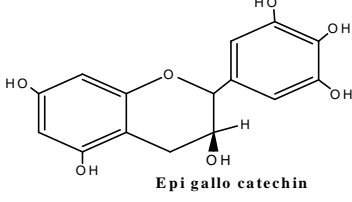
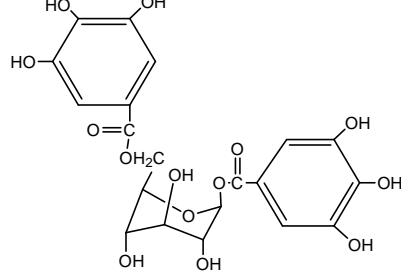
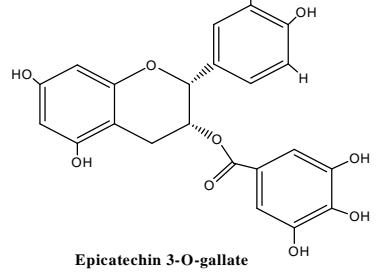
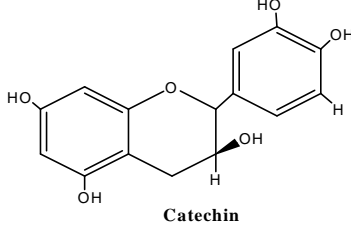
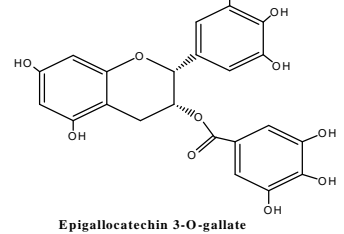
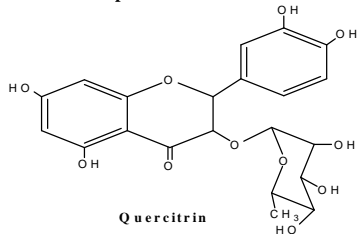
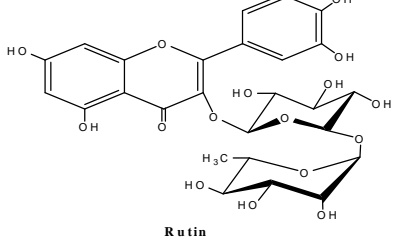
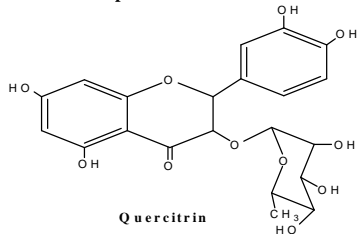
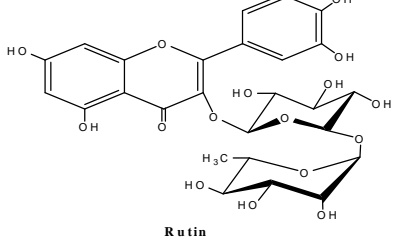
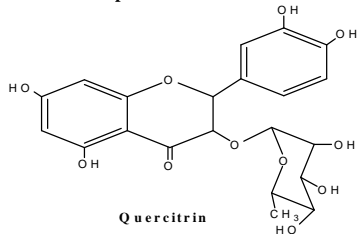
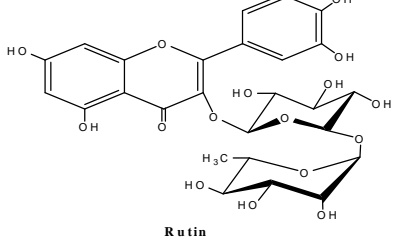
S.No	Compound	Source and Reference
01.	 4-methoxy-nor-securin	Stem, Aerial plant, Roots(87)
02.	 Nirurin	Whole plant(87)
03.	 nor-securin	Roots (87)

Diaryl butane lignans

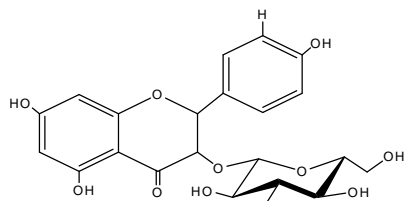
S.No	Compound	Source and Reference
04.	 Phyllanthin	Leaf and aerial parts (52)
05.	 Niranthin	Leaf (02)
06.	 Seco-isolaricresinol trimethyl ether	Leaves (63)
07.	 Hydroxy Niranthin	Leaves (63)
08.	 Nirphyllin	Aerial parts(64)

09.	 <p>2,3-desmethoxy seco-isolintetralin</p>	Leaves (65)	17.	 <p>Isolintetralin</p>	Plant(23)															
10.	 <p>2,3-desmethoxy seco-isolintetralin diacetate</p>	Leaves(65)	18.	 <p>Neonirtetralin</p>	Plant(86)															
11.	 <p>Linnanthin</p>	Leaves(65)	<p>Other lignans</p> <table border="0"> <thead> <tr> <th>S.No</th> <th>Compound</th> <th>Source and Reference</th> </tr> </thead> <tbody> <tr> <td>19.</td> <td>  <p>Seco-4-hydroxy lintetralin</p> </td> <td>Leaves(63)</td> </tr> <tr> <td>20.</td> <td>  <p>Dibenzyl butyro lactone</p> </td> <td>Leaves(63)</td> </tr> <tr> <td>21.</td> <td>  <p>Hinokinin</p> </td> <td>Plant(Huang et al., 1989a)</td> </tr> <tr> <td>22.</td> <td>  <p>Phyllinurin</p> </td> <td>Plant(64)</td> </tr> </tbody> </table>			S.No	Compound	Source and Reference	19.	 <p>Seco-4-hydroxy lintetralin</p>	Leaves(63)	20.	 <p>Dibenzyl butyro lactone</p>	Leaves(63)	21.	 <p>Hinokinin</p>	Plant(Huang et al., 1989a)	22.	 <p>Phyllinurin</p>	Plant(64)
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12.	 <p>Demethyl ene dioxy niranthin</p>	Leaves(65)	<table border="0"> <thead> <tr> <th>S.No</th> <th>Compound</th> <th>Source and Reference</th> </tr> </thead> <tbody> <tr> <td>13.</td> <td>  <p>Hophyllanthin</p> </td> <td>Leaves and aerial parts(53)</td> </tr> <tr> <td>14.</td> <td>  <p>Nirtetralin</p> </td> <td>Plant and leaves(02)</td> </tr> <tr> <td>15.</td> <td>  <p>Phylltetralin</p> </td> <td>Plant and leaves 0.14%(02)</td> </tr> <tr> <td>16.</td> <td>  <p>Lintetralin</p> </td> <td>Leaves(85)</td> </tr> </tbody> </table>			S.No	Compound	Source and Reference	13.	 <p>Hophyllanthin</p>	Leaves and aerial parts(53)	14.	 <p>Nirtetralin</p>	Plant and leaves(02)	15.	 <p>Phylltetralin</p>	Plant and leaves 0.14%(02)	16.	 <p>Lintetralin</p>	Leaves(85)
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S.No	Compound	Source and Reference	S.No	Compound	Source and Reference
23.	<p>Coumarins, tannins, other polyphenols</p>  <p>Gallic acid</p>	Root Culture(66)	30.	 <p>Phyllanthusin D</p>	Plant(19)
24.	 <p>Ellagic acid</p>	Plant(66)	31.	 <p>Amariin</p>	Plant (17)
25.	 <p>Brevifolin carboxylic acid</p>	Leaves(66)	32.	 <p>Amariinic acid</p>	Plant (18)
26.	 <p>ethyl brevifolin carboxylic acid</p>	Leaves(66)	33.	 <p>Geraniin</p>	Plant(18)
27.	 <p>Methyl brevifolin carboxylic acid</p>	Leaves (72)	34.	 <p>Geraniinic acid</p>	Plant(18)
28.	 <p>Corilagin</p>	Plant 23%(79)			
29.	 <p>Corilagin</p>	Plant(66)			

35.	 <p>Repandusinic acid</p>	Plant(18)	40.	 <p>Epicatechin</p>	Root Culture(26)									
36.	 <p>Amarulone</p>	Plant(18)	41.	 <p>Gallo catechin</p>	Root Culture(26)									
37.	 <p>Furosin</p>	Plant(18)	42.	 <p>Epi gallo catechin</p>	Root Culture(26)									
38.	 <p>1,6 - digalloyl glucopyranoside</p>	Plant(18)	43.	 <p>Epicatechin 3-O-gallate</p>	Root Culture(26)									
39.	 <p>Catechin</p>	Root Culture(26)	44.	 <p>Epigallocatechin 3-O-gallate</p>	Root (26)									
				<p>Flavonoids</p> <table border="1"> <thead> <tr> <th>S.No</th> <th>Compound</th> <th>Source and Reference</th> </tr> </thead> <tbody> <tr> <td>45.</td> <td>  <p>Quercitrin</p> </td> <td>Leaf(42)</td> </tr> <tr> <td>46.</td> <td>  <p>Rutin</p> </td> <td>Plant, Leaf(42)</td> </tr> </tbody> </table>	S.No	Compound	Source and Reference	45.	 <p>Quercitrin</p>	Leaf(42)	46.	 <p>Rutin</p>	Plant, Leaf(42)	
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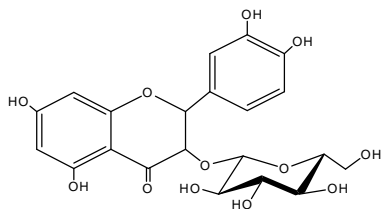
47.



Astragalin

Leaf(42)

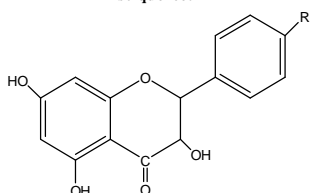
48.



iso quercetin

Leaf(42)

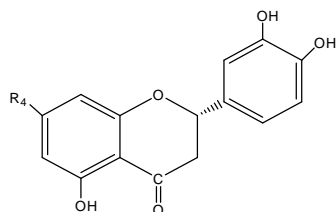
49.



R₁=O- α -L-(-)Rha (Kaempferol-4-rhamnopyranoside)

Leaf(42)

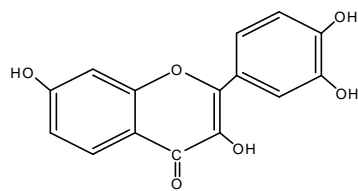
50.



R₄=O- α -L-(-)Rha (eridictyol-7-rhamnopyranoside)

Aerial Plant 0.9%, Root(15)

51.



Fisetin

Root(15)

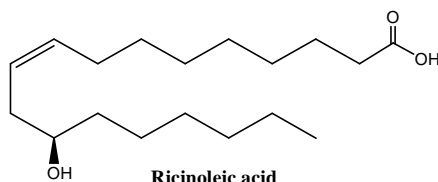
lipids

S.No

Compound

Source and Reference

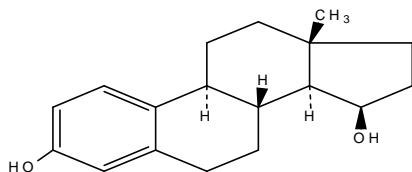
52.



Ricinoleic acid

Seed oil 1.2%(87)

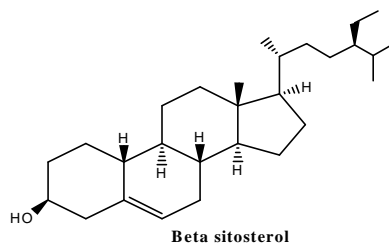
53.



Estradiol

Plant (87)

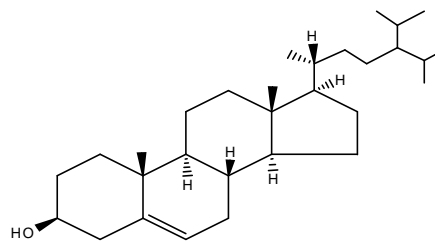
54.



Beta sitosterol

Leaf (87)

55.



24-isopropyl cholesterol

Aerial plant(87)

Pharmacological Activity

Action of kidney stones & uric acid

Kidney stone is a common problem that accumulates calcium oxalate crystals, and it includes urinary calculi formation, nucleation, growth, and aggregation of crystals. Phyllanthus niruri's extract interferes in the growth and aggregation of calcium oxalate [CaOx] crystals in the calculi. The extract inhibits CaOx crystal aggregation in the early stages of stone formation in the urine samples of male wister rats. It is advisable to treat stone formation in the early stages^[10]. The CaOx metastable limit was decreased by the treatment of P. niruri [5% [v/v]] extract and it can also deprive the CaOx crystals and formation of nucleation.^[51] The extract has the ability to prevent the growth of calculi and also change the shape and texture of the calculi. When treated on the preformed calculi it can form a matrix like material on its surface and it can modify the appearance and texture of the calculus.^[11] The extract is also administered in hyper calciuric patients; it can decrease the urinary calcium levels^[43] and also reduces the excess uric acid in hyperuricemic people by the lignans with uricosuric action in the extract^[34].

Anti spasmodic, pain relieving& anti inflammatory

The wound healing nature of Phyllanthus niruri has been evaluated by the healing of wounds by oral and topical administration. P. niruri was proved to have a significant role in wound contraction and epithelialisation. When Dexamethasone (suppress the wound healing) suppressed rats were treated with the extract a significant increase in wound contraction was found by both oral and topical administration^[71].

Liver protective, detoxification & antioxidant activity

The carbon tetrachloride and galactosamine induced cytotoxicity in rat hepatocytes can be decreased by the P. niruri hexane extract. Phyllanthin and hypophyllanthin protects against the CCl₄ induced cell lesions and GalN induced Hepato toxicity^[60].

Phyllanthus niruri can reduce nimesulide induced hepatic damage. By measuring the levels of glutamate oxaloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT) and alkaline phosphatase (ALP) in serum it was concluded that the levels of three enzymes are decreased in the extract treated group. By these observations intra peritoneal treatment was found to be more effective than oral administration and by combining this data we can conclude that P.niruri protects the liver from nimesulide induced liver toxicity^[12] & Oxidative stress^[35].

The over dose of paracetamol leads to hepatotoxicity same as viral infection. The glutamic pyruvic transaminase (GPT) levels of serum were decreased in the P.niruri treated group^[41]. The serum glutamate pyruvate transaminase (SGPT) and glutamate oxaloacetate transaminase (GOT) was decreased in the in vivo studies conducted in rats [56]. The ethanol extract and hexane extract were administered and the serum parameters (serum bilirubin, serum alkaline phosphatase, serum aspartate (AST), serum alanine transferase (ALT), hepatic reduced glutathione (GSH) were analysed and these parameters were controlled after the treatment with hexane extract and .hence, it was stated that P.niruri can control the paracetamol induced hepatotoxicity^[27].

Protein isolated from this plant was found to enhance cell viability against tertiary butyl hydroperoxide induced cytotoxicity and cell death; and it protects hepatocytes against thioacetamide induced cytotoxicity. The extract prevents the alterations in GSH levels and it also reduces the lipid peroxidation induced by TAA. By the DPPH assay it was found that the isolated protein has radical scavenging activity. This protein protects the liver from the carbon tetra chloride induced hepatotoxicity and this can be measured by the liver enzymes and reduced levels of antioxidant enzymes^[36, 37, 50].

Alcohol is a toxin in higher doses and when it is associated with poly unsaturated fatty acids (PUFA) induces oxidative stress & hepatotoxicity. This can be efficiently reduced by P.niruri extract analyzed by the antioxidant potentials of liver enzymes and histopathological studies^[38].

Anti cancerous & cellular protective actions

P.niruri has high potential to inhibit the growth and initiation of cancerous cells which were introduced into mouse skin cells with 7, 12 dimethyl benz (a) anthracene (100µg/100ml acetone) and croton oil (1%)^[46] and there is drastic increase in the catalase, reduced glutathione and protein levels in the skin. In albino mice the chemopreventive action of P.niruri with DMBA induces skin papillomagenesis.^[45]

Immune modulatory actions

An arabinogalactan (AG) which was obtained from P.niruri tea preparations was found to have immunological properties and is tested with peritoneal mice macrophages. The glycoside showed the same activity when subjected to acidic and neutral gastric conditions using human gastric fluids and aq.HCL solution^[39].

Anti viral action (Hepatitis B)

The plants of Phyllanthus genus have been used for natural remedy from thousands of years in Asia. (Thyagarajan et al., 1988). P.niruri has been used to inhibit the hepadna virus and it is extensively used to treat jaundice and hepatitis B virus^[78]. The phyllanthus genus plants inhibit duck hepatitis B virus by inhibiting 50 % of DNA polymerase^[4].

Hepatitis B is the most prominent disease in emerging era. Phyllanthus niruri extract can prevent Hepatitis B by binding to the endogenous DNA polymerase and even it can bind to the hepatitis B surface antigen in invitro. Wood chuck hepatitis virus (WHV) was tested against the extract in wood chucks (Marmota monax), it efficiently inhibited the wood chuck hepatitis virus (WHV) and elimination of both surface antigen and DNA polymerase activity was found^[83].

HIV replication inhibition

The prominent human Immuno Virus replication is inhibited by the alkaloidal extract of P.niruri and tested against virus induced MT-4 cells, it suppressed the activity in strains of HIV 1 cells^[43].

The REV (regulation of virion expression) is an HIV protein that regulates the transport of viral RNA to the cytoplasm and its basic domain is RRE (responsive element). The nirurisode isolated from methanol extract of P.niruri shows inhibitory activity against binding the REV protein to RRE RNA^[48].

Lipid lowering activity

The Phyllanthus niruri has the capacity to reduce the serum lipid levels. The extract is fed orally (250 mg/kg b.w) in hyper lipemic rats, results followed by reducing lipid levels [29]. Methanol extract of P.niruri was tested against chlorpyrifos (CPF)- evoked erythrocyte fragility and liperoxidative changes in wister rats and observed lipid peroxidative changes and protection from the chlorpyrifos induced erythrocyte fragility^[67].

Anti fertility activity

The anti fertility activity of Phyllanthus niruri was tested on male albino rats; it shows a significant decrease in fructose levels of seminal fluids, sperm count, sperm motility and viability. It shows anti fertility activity by decreasing the testosterone levels of the treated rats.^[82]

Anti-microbial activity

The extracts of P.niruri and Piper beetle were tested against food borne & spoilage micro organisms. The ethanolic extracts of dried P.niruri inhibited the growth of micro organisms^[16].

The antimicrobial activity of fermented P.niruri by using lactobacillus isolated from the surface of the plant was enhanced. The antimicrobial activity was enhanced 80-170% when compared to the crude extract. The potency was increased by 49% when the extract was fermented with lactobacillus^[81].

The methanol extract of P. niruri is strong against Bacillus pumillus, Bacillus cereus, E. coli and Vibrio cholera at conc of 750µg/ml/disc. It is tested against standard drug chloramphenicol at conc 10µg/ml/disc shows potential source of antimicrobial agent^[88].

The phyllanthus niruri extract of alkaloids were tested on rabbits infected with E.Coli. The results examined were found to have increased concentration of WBC, neutrophils and decreased hemoglobin, lymphocytes more over there are no changes in enzyme concentration^[5].

Anti malarial activity

Malaria is one of the most prominent health problems in the tropical and subtropical countries. The herbal plants show antagonistic properties against malaria. P.niruri and Mimosa pudica showed antiplasmodial activity, when fed with the ethanol extract in albino mice^[40]. P.niruri's ethanolic extract of one month old invitro grown callus showed higher antiplasmodial activity than extract prepared from fresh apical stem extract^[49].

Anti ulcer activity

The acidic heteroxylyan and another polysaccharide showed anti-ulcer activity. These compounds reduced the gastric lesions induced by 65% and 78% ethanol. P. niruri proved to be efficient against peptic ulcers^[69].

Nematocidal activity

The two prenylated flavones isolated from the hexane extract of P.niruri. showed Nematocidal activity against two nematocides, Meloidogyne incognita and Rotylenchulus reniformis. The two compounds showed moderate Nematocidal activity against nematodes^[68].

Antinociceptive activity

The analgesic activity of P.niruri is demonstrated against formalin induced nociception in mice. The hydro alcoholic extract of P.niruri is given orally

(25-200mg/kg) or intra peritoneally (1-30mg/kg) which caused dose related inhibition of capsaicin induced pain [17, 57, 59].

The phyllanthus genus is having high potential level anti analgesic plants and isolated hydroalcoholic extracts of four new species of phyllanthus showed significant inhibition of acetic acid induced abdominal constrictions [6, 58, 59].

Toxicology

Phyllanthus niruri is low toxic, and it showed toxicity to batrachians and fishes when extract is alcohol and water based. It is very less toxic to mammals.

CONCLUSIONS

Phyllanthus niruri Linn. belongs to Euphorbiaceae family and it is a small herb having wide range of medicinal properties, and it is used widely across the world. Phyllanthus niruri plant extract is used as a medicine and is recommended for Bronchitis, Anaemia, Leprosy, Asthma, Urinary disorders etc. Phyllanthus niruri has several bioactive molecules such as lignans, phyllanthin, hypophyllanthin, flavonoids, glycosides, tannins, alkaloids, ellagitannins, triterpenes, phenyl propanoids, steroids, ricinolic acid, niruriside & phyltetralin. Phyllanthus niruri is used as a folk medicine for treating kidney stones, gallbladder stones, liver related diseases such as liver cancer & jaundice, apart from these it is also administered for diuretic, hypoglycemic and hypertension cases and it also shows anti inflammatory, anti tumor, antinociceptive and anti oxidant properties. By the above applications, Phyllanthus niruri has been marketed by prominent companies. The market product of Phyllanthus niruri is recommended in daily used medicines like chyawanprash which were produced by many remarkable companies. Phyllanthus niruri powder is also available for general use.

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