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# Murraya Koeniggi: A Revolution in Ayurveda

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**ABSTRACT**

Plants used from ancient time for various goals like food, shelter, with their therapeutic potential medicinal values this concept known since from ancient time some of them are important constituents of daily dietary food constituents used as home remedies. The aim of preset review is to study about the pharmacognistical, pharmacological aspects of Murraya Koenigii. Pharmacognostic review suggest presence of different phytochemical constituents Koenidine, Koenine, Coumarin glycosides, Carbazole alkaloids with known pharmacological activity such as hepatoprotective activity, Immunomodulatory activity, Hypoglycemic property respectively. Pharmacological review suggests murrayakoenigii have different pharmacological properties like Antifungal, antibacterial, antipyretic, antithrichomonal activities. In view of such valuable pharmacological profile hence this plant is taken for review.

## I. INTRODUCTION

Enormous biodiversity among medicinal plants has always been the well-known aspect of India. Among those Murraya koenigii plant is termed and regarded as medicinally important[1]. Many different forms of Murraya Koenigii are available throughout the country. The active constituents are bismahanine, murrayanine, murrayafoline-A, bi-koeniquinone-A, bismurrayaquinone, mukoenine-A, mukoenine-B, mukoenine-C, murrastifoline, Murrayazoline, murrayacine, murrayazolidine, murrayazoline, mahanimbine, girinimbine, koenioline, xynthyletin, Quinone A and koenigine-Quinone B for therapeutic purpose[2-5].The medicinal plants are mainly use for the therapeutic and prophylactic purpose. For therapeutic properties secondary metabolites like alkaloids, flavonoids, terpenoids, vitamins, tannins etc plays important role as all of these are active constituents. The secondary metabolites of plant physiologically affect body at different stages of body development. The plant Murraya Koenigii belongs to family Rutaceae. It is lagel and widely growing plant throughout spring, summer and monsoon. Geograohically , it grows in tropical regions uptogruhit of 15001655 m from sea - level[6,7]

**SYNONYM**

**Indian: Curry Leaf, Karepaku, Karthaphulli, MithaNeem, Kariveppilei, KurryPatta, Mahanimb.**

**Other Languages: Italian-Fogli de Cari, Spanish- Hoja, German- Curryblatter, English- Curry Leaves.**

**TAXONOMICAL CLASSIFICATON**

- Kingdom - Plantae
- Sub-kingdom - Tracheobionta
- Superdivision -Spermatophyta
- Division - Magnoliophyta
- Class -Magnoliospida
- Subclass - Rosidae
- Order -Sapindales
- Family- Rutaceae
- Genus - Murraya J. Koenig ex L
- Species - Murraya koenigiiL.Spereng.

**DISTRIBUTION**

Geographically , The origin of Murraya koenigii is from India , Pakistan , Srilanka, China and Hainan . However it is also widely cultivated in South-East Aisa and US[9]. The altitude for the cultivation should be atleast 1500-1655 m from sea level[11]. The moist forest of Guangdong , Shainan also shows the plant's presence . Along with South Indian immigrants curry leaves reached Malaysia , South Africa[12,13]. Out of all the 14 species found around the globe that belongs to the genus Murraya , only 2 are known to be found in India which are Murraya Koenigii and Murraya Paniculata.[14,15]

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## PLANT GROWTH

The growth of Curry Leaf plant is throughout the spring, summer and in rain fall. The leaves fall off during its resting period in the winter. The growth is proper in full sun, well-drained soil, which should be the dry side and need fertilizer in the summer.[16,17] The fruiting season was observed from the end of June to the end of August, and the July is considered to be the peak fruiting season. In India, after 15 months harvesting of leaves is mostly started and the collection is done in every 2-3 months.[18] In countries such as Southern California, South Florida, outdoors growth needs protection from freezing. Seeds are fragile so need to be handled with care.[19]

## PLANT DESCRIPTION

### TREE

Murraya koenigii is a small spreading tree/shrub with a strong woody stem . It is semi-decidious and aromatic plant. The colour of the stem is dark green to brownish and the tree is 4-8.7m ( 13-31 feet) tall with trunk's diameter upto 81 cm.[20] The main stem's diameter is about 16cm.[21,22]

### FLOWER

The flowers are small, white , fragrant and funnel shaped . They are regular, stalked, ebracteate, hypogamous, persistent, inferior, green , corolla, polypetalous , androecium , polyandrous , lanceolate , stigma, bright and sticky .The diameter of flower is 1.12 cm when fully opened . The flowers bloom in clusters and each cluster bears approximately 60-90 flowers . There are five petals and their lengths are 5mm. The stamen is in number 10 and it is small in size , dorsifixed and arranged in circle with long superior gynoecium with size 5-6 mm [23]. The curry tree flowers have sweet fragrance. It is bisexual and are self - pollinated and produce black berries in small size having shiny appearance containing a large visible seed.[24]

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**LEAF**

Curry leaves are aromatic in nature having characteristic aroma. They are shiny and smooth with paler undersides.[25] Leaves are pinnate, , having reticulate venation and have ovate lanceolate with an oblique base,[26] with 11-20 leaflets and the size of each leaflet is 0.80–1.55inch long and 0.40–0.75 inch broad. Leaflets are short stalked, alternate, and have 0.6cm long petiole. The leaf margins are irregularly serrate.[23],[26] The yield of a bush is approximately 480 g in three to four pickings.[27]

**STEM & BARK**

The stem of Murraya koenigii is brown to dark green in colour, which has dots on the bark, when the bark was peeled off longitudinally under the exposing the white wood underneath; the girth of the main stem is 16cm up to 6 meters in height and 15 to 40cm in diameter.[28]Microscopy : The microscopically view of Murraya koenigii is as follow:

Leaves: Leaves when they are distilled under pressure yield 20.6% of volatile oils whereas without pressure it yields less than 2% of volatile oils[30,31]. The leaves have obliquely ovate and acute apex. The petiole is about 20-30 cm in length and the leaves have retciulate venation. The base of the leaf is asymmetrical[29].

In the microscopical studies it was observed that stomata were distributed on adaxial surface . The stomata are anomocytic type . The upper epidermis was covered with cuticle and the epidermis has 1-4 layers of collenchymatous cells[32]. The shape of the calcium oxalate is sandy and prismatic crystals[33]. The trichomes are unicellular with obliterated lumen.

Roots:The root exhibits tetrarch to pentarchstele . The phellodermfibres are absent and concentric grains of parenchyma are present[34] .

Powder: It is green in colour and has no distinct odour or taste. The notable identifying features are unicellular trichomes , secretory canal , well developed pericyclic fibres , two layers palisade[35].

**Chemical constituent**

Murraya koenigii is very rich source of organic compounds with different chemical composition such as alkaloids, flavonoids carbohydrates, and sterol is present in the plant extract which is prepared in solvents such as petroleum ether, ethyl acetate, chloroform, ethanol and water.[36-40]

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The essential oil composition of Murraya koenigii was studied and then presence of D-Sabinene, D-αTerpinol, di-α-phellandrene, D-αpinene, caryophyllene and dipentene was determined.

**CHEMICAL CONSTITUENTS IN LEAVES**
The fresh leaves of Murraya Koeniggi consist of :-
2.1-12.5 % Proteins
14.6-18.97% Total sugars
9.7-13.05% Total Ash
1.35-1.82% Acid in Soluble ash
Koenigine , Koenine , Koenidine, Mahanine , were isolated with the help of extract containing acetone .[35] Koenimbidine, Iso-mahanimbine, Murrayacine are isolated from the extract of Hexane mahanimbine . Isomahanimbicine was isolated in the petroleum ether.[41]

**Nutritional Value of Murraya Koeniggi :-**

| Nutrients | Fresh Curry Leaf | Dry Curry Leaf |
|---|---|---|
| Protein | 6g | 12 g |
| Fats | 1 g | 5.4 g |
| Carbohydrates | 18.07 g | 64.31 g |
| Calcium | 830 mg | 2040 mg |
| Iron | 0.93 mg | 12 mg |
| β - carotene | 0.0031 mg | 0.0059 mg |

**As per the data , it is concluded that the dry leaves have more nutrional value than that of fresh leaves.**

**CHEMICAL CONSTITUENTS IN SEEDS AND FRUITS :-**
The seeds of Murraya koenigii consist of furocoumarin lactone, carbazole alkaloids, glycolipids, Phospholipids and terpinenes.
4.4% of Total Lipids are present which mainly consist of
85.4 % Neutral lipids
5.1 % Glycolipids
9.5% Phospholipids

The terpenes present in seeds are as follows :
Terpinene, terpinen-4-ol, linolol,[42]ocimene, limblee, limbolee and simbolee.[43-45]

**The fruits of Murraya Koeniggi comsists of :**
16.8% Total soluble acidsP
9.76% Total sugars
9.58% Reducing sugars
0.17% Non-Reducing sugars
1.97% Proteins
0.0082% Phosphorous
0.811% Potassium
0.166% Calcium
0.00057% Tannins
0.2165 % Magnesium

**CHEMICAL CONSTITUENTS IN STEAM AND BARK**
The Stem and bark of Murraya Koeniggi mainly consist of Carbazole alkaloids , carboxylic acids , coumaringalactoside , glycolipids, phospholipids .

**CHEMICAL CONSTITUENTS IN ROOTS**
The roots of Murraya Koeniggi consists of various types of Bioactive compounds . Benzene and Petroleum ether are used for extraction of chemical constituents present in roots.

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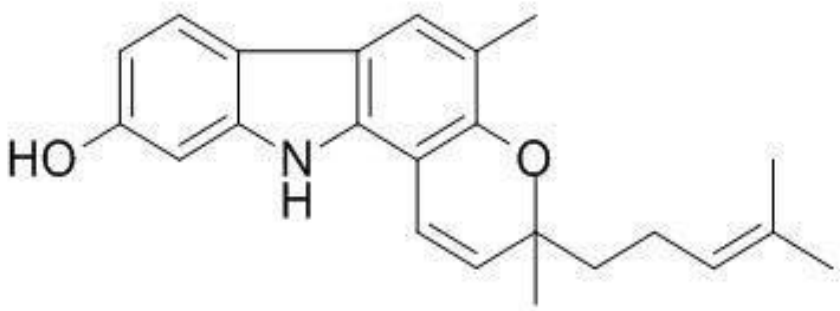
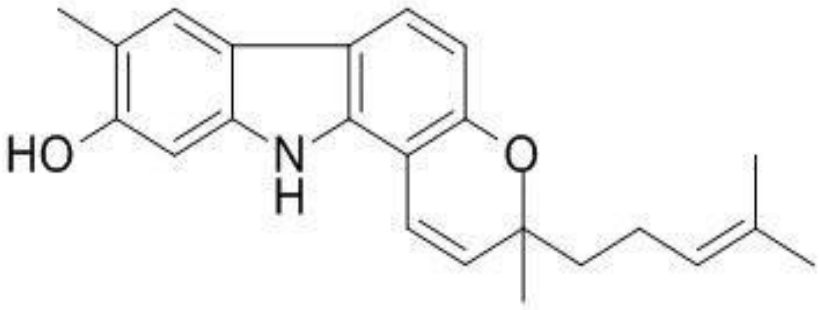
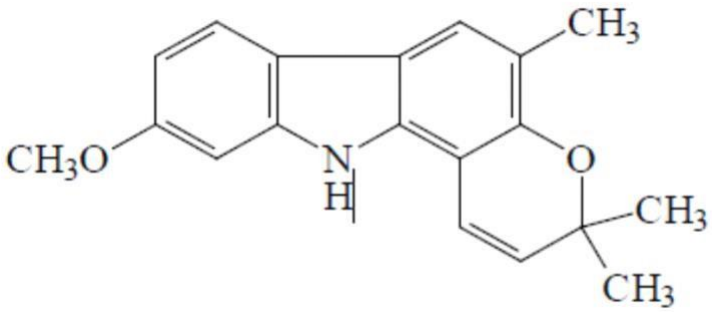



**O - methyl mahanine**




**Iso-mahanine**




**O-methyl murrayanine**

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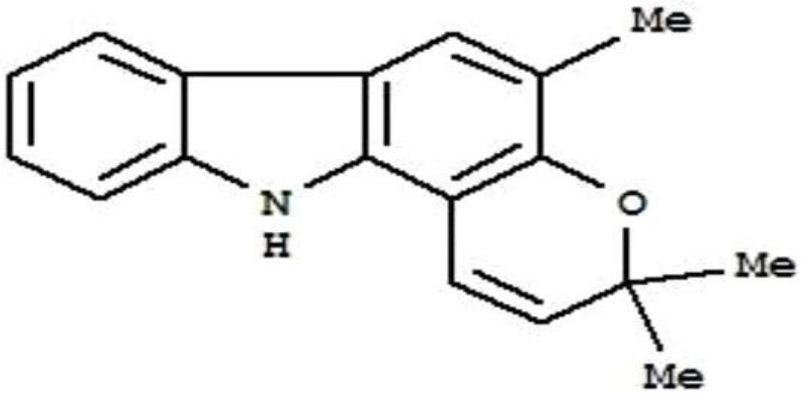
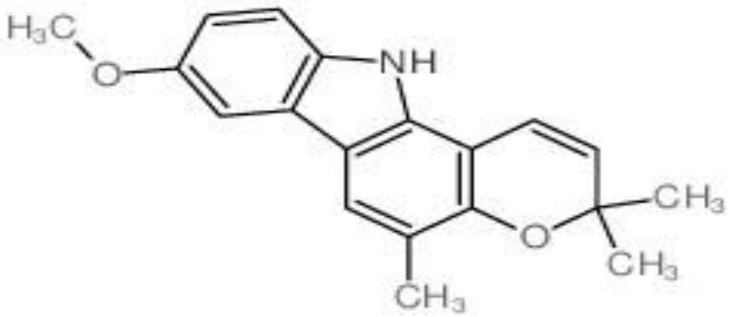
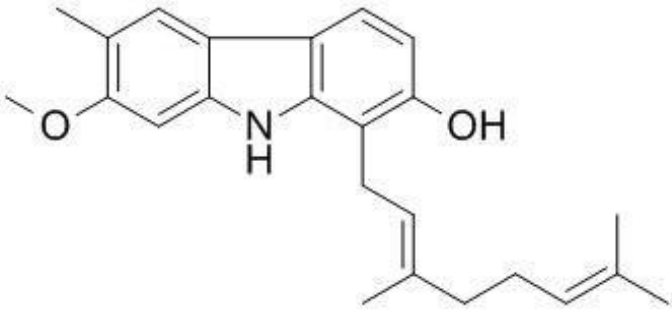



**Grinimbine**




**Koenimbine**



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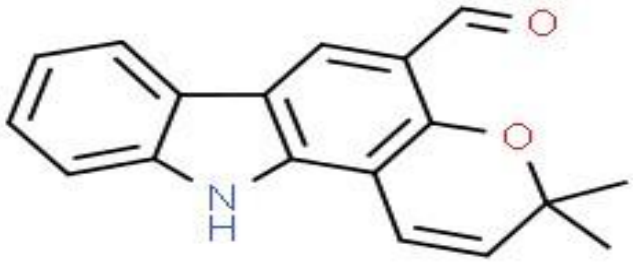
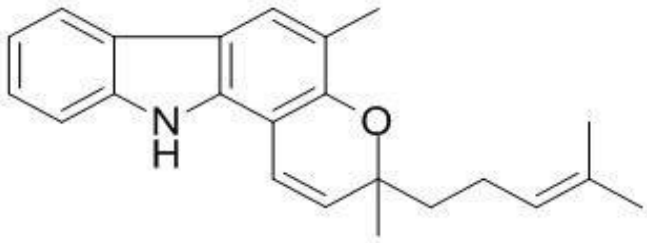
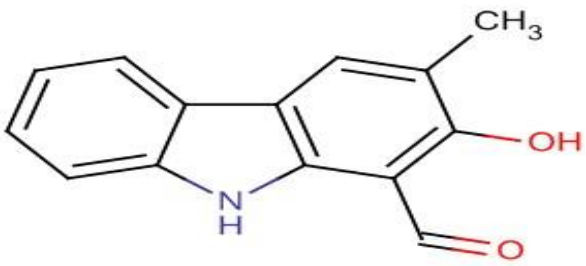
**Murrayanol**




**Murrayacine**




**Mahanimbinine**




**1-Hydroxy-3-methyl carbazole**

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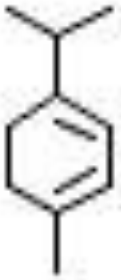
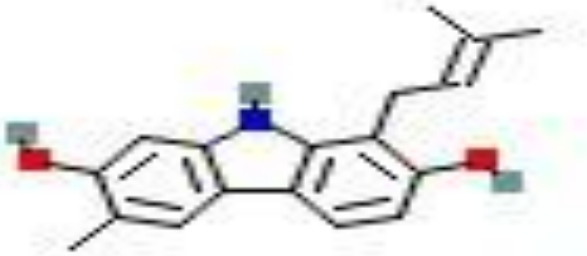
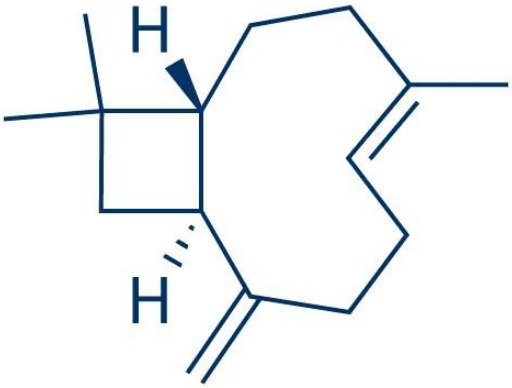


**α-Terpene**



**Euchrestine**




**β-Caryophyllene**

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**CHEMICAL TEST :**

- Test For Alkaloids –

Mayers's Test – The extract of Murraya Koeniggi was treated with Mayers reagent which shows white or cream coloured precipitate indicating presence of Alkaloids.

- Test For Phenolic Compounds-

The acloholic extract of Murraya Koeniggi which shows white precipitate indicating presence of Phenolic compounds.

- Test For Flavonoids –

A filter dipped in ammoniated solution of alcohol is kept on the extract, yellow colour is seen which indicates presence of flavonoids.

- Test For Saponins –

On the addition of Sodium Bicarbonate in the extract honeycomb like frothing is formed which indicates presence of saponins.

- Test For Proteins & Amino Acids-

Following tests are performed for the detection of amino acids and proteins :

- Millons Test
- Biuret Test
- Ninhydrin Test

- Test For Sterols & Terpenes-

The alcoholic extract is shaken with chloroform and few drops of acetic anhydride along with conc$^{n}$ $H_2SO_4$ from side of test tube , forms blue to brick red colour.

**EXTRACTION METHODS FOR CHEMICAL CONSTITUETS**

Murraya Koeniggi can be extracted by using following methods:

- M.koenigii powder is extracted using 100ml of Ethanol and kept on rotary shaker for 24 hours.The speed is maintained at 190-220 rpm for 24 hours. The extract was collected followed by evaporation of solvent to make up the final volume and stored at 400$^{o}$C in air tight bottles.[46]
- The M.koenigii's crude powder was defatted using petroleum ether for about 24h. Post defattation, the extraction was carried out , and Soxhlet apparatus was used in hydromethanolic solution in the ratio 30:70.[47]
- Extractions and separations on the isolates of hexane, chloroform and methanol of the plant sample leads to the isolation and characterizations of carbazole alkaloids. Mainly the extract is prepared from the stem and the bark of M.koeniggi. For a crude Hexane extract the

extract is concentrated to yield a brown yellowish viscous viscous syrup (22.5g - 33g). For the purpose of Chloroform extract the extract is concentrated till a dark brown viscous syrup(14g - 24g).The crude extract are subjected to column chromatography where silica gel is used and eluted with mixture of hexane, ethyl acetate, ethyl acetate/ methanol and methanol which gives about 75 fractions each.[48]

- The essential oil was extracted by hydro-distillation method using Clevenger apparatus. The distilled oil was separated from water by a separating funnel and stored in refrigerator.[49]

**PHARMACOLOGICAL ACTIVITY OF MURRAYA KOENIGGI**

- Hepatoprotective Property

The Hepatoprotective property of Murraya Koeniggi is seen due to combined effect of carbazolealkaaloidsi.e
Mahanimbine, Girinimbine, Isomahanimbine , Murrayazoline, Mahanine, and ascorbic acid. This nature of M.Koeniggi was studied by Gupta et.al.As per this study it was found that M. Koeniggi is an rich source of radical free quenchers which shows hepatocyte membrane stabilizing activity and also helps in reduction of fat metabolism.[50]

- **Anti-Inflammatory Property**

Ethanolic extract of M. koenigii (300 and 400 mg/kg) showed antihistaminic actions. The mast cell stabilization and anti-histaminic effects are responsible of ethanolic extract of M.Koeniggi are responsible for its anti-inflammatory activity.[51]

The crude root extract also shows anti-inflammatory property.

As compared to chloroform and petroleum ether extract the ethanolic extract with dose of 250mg/kg shows better and significant anti-inflammatory effects in the acute carageen induced paw edema method and the yeast induced hyperexia method, respectively[52]

The alcohol extract of stem bark (1gm/kg body weight) is effective against carrageenan-induced inflammation. By the rapid removal of carbon particles from blood stream , the methanolic extract of M. Koeniggi leads to increase in phagocytic index. The extract is also responsible

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for the increased antibody titre against ovalbumin and helps in protection towards cyclophosphamide-induced myelosuppression in albino mice.[53]

- **Anti-Fungal Property**

Murrayanimbine, Girinimbine and Mahanimbine are isolated from the stem/bark of M. Koeniggi which shows anti-fungal activity against the human pathogenic fungi.[46] . 1- formyl-3 methoxy-6- methyl carbazole and 6,7-dimethoxy-1-hydroxy-3- methyl carbazole possess antibacterial and anti fungal property and this effect was studied by Chaudhury.et.al. [54] The essential oil and aqueous extract of leaf were found to be active against Staphylococcus epidermidis, S. aureus and streptococcus species. Crude extract and chloroform soluble fraction , petroleum ether soluble fraction shows antibacterial activity against all the tested bacteria [55-57]. The crude extract of roots of M. koenigii posses strong antibacterial activity[58]. The extract containing murrayanol , isomahanine is used as microbicide in most of industries due to its high safety, strong activity, less odour and without coloring effect[59].

- **Anticancer Property**

Mahanimbine , Girinimbine , Mahanine present in M. Koeniggi are responsible for the anticancer activity which which increases the death of carcinogenic cells i.e the protease inhibitor reaspectively.[61]

Koenoline isolated from the roots and bark of M.koeniggi exhibits cytotoxic activity against the KB cell culture system[62]. 9- formyl-3 methyl carbazole exhibits weak cytotoxic activity against both mouse melanoma B-16 and adriamycin resistant P-388 mouse leukemia cell lines[51]. Yihet.al investigated the in-vitro antitumour promoting activity and antioxidant properties of Girinimbine isolated from the stem and bark of M.koeniggi. It was determined by measuring the percent inhibition of induced early antigen (EA) of EBV on the surface of Raji cells.[63] The extracts of M.koenigii have been tested in male Swiss albino mice in vitro (short term incubation technique) and in vivo (Dalton ascitic lymphoma DAL) anticancer models. DAL cells were injected intraperitoneally (106 cells) to the mice with a dose of 150mg/kg[64].

- **Immunomodulatory Property**

The methanolic extract of M. Koeniggi shows the effect of increase in the phagocytic index by the removal of carbon particles present in the blood stream. It also increases the antibody titre against ovalbumin and protection towards cyclophosphamide-induced myelosuppression in albino mice[65].The oral administration of the aqueous extract of leaves at doses of 250-500 mg/kg and enhances the delayed-type hypersensitivity reaction induced by ovalbumin.[66]

- **Antipyretic Property**

The ethanolic extract of M. koenigii posses the antipyretic activity tested in rats using yeast-induced pyrexia. A single dose of 300 mg/kg produces significant antipyretic activity ($P<0.01$) in albino rats as compared with the standard drug paracetamol[67].

- **Hypoglycemic Property**

An significant hypoglycaemic action of Murraya koenigii has been reported. Feeding of diet containing various doses of curry leaves (5-15%) to normal rats for 7 days along with mild diabetic rats (having blood glucose levels >175 mg/dl induced by alloxan 35 mg/kg i.p.) and moderate diabetic rats (having blood glucose levels >250 mg/dl induced by STZ 60 mg/kg i.p.) for 5 weeks showed different hypoglycemic and antihyperglycemic effect due to the effect of M. Koeniggi.

The reduction in the blood sugar levels was found to be more in the moderate diabetic rats as compared to the normal rats.[68] The oral administration of ethanolic extract of M.koenigii with a dose of 200 mg/kg/day for about 30 days majorly decreases the levels of blood glucose, glycosylated hemoglobin, urea, uric acid and creatinine in diabetic treated animals. It is found that M. koenigii possesses significant hypoglycemic property in STZ-induced diabetic rats. The Murraya koenigii extract appeared to be more effective than glibenclamide,which is an antidiabetic drug.[69] According to a study it is found that the effect of daily oral administration of aqueous extract (600 mg/kg) and methanol extract (200 mg/kg) of M. koenigii leaves for a period of eight weeks maitains blood glucose and plasma insulin level in alloxan-induced diabetic rats. The blood glucose levels of diabetic rats treated with aqueous and methanol extracts of Murraya koenigii shows reduction in its levels as compared to diabetic control groups.[70]

A single oral administration of various dose levels (200, 300 and 400 mg/kg) of aqueous extract leds to lowering of blood glucose level in normal as 00 mg/kg.[71]

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- **Antitrichomonal Property**

The Carbazole alkaloids and its derivatives from M. koenigiileaves shows antitrichomonal activity against the Trichomonasgallinae. Girinimbine and girinimbilol with IC50 values of 1.08 and 1.20 mg/mL were found to be most active. The activity of girinimbilol and mahanimbilol have been enhanced by acetylation to 0.60 and 1.08 mg/ml[72]

## II. CONCLUSION:

Murraya Koeniggi is a green leafy plant that belongs to family Rutaceae. The plant posses various pharmacological activities such as Hepatoprotective , Anti-inflammatory , Antifungal, Anticancer, Antipyretic, Anthelmintic , Antitrichomonal, Antiulcer, Immunomodulatory, Hypoglycemic and with many other phagocytic activities. The chemical composition of the Murraya koenigii consists of essential oil alkaloids, terpenoids , flavonoids, carbohydrates.It mainly consist of Koenigine, Koenine, Koenidine, Murrayacine, Mahanine, Murryazoline .

## REFRENCES:

[1]. Singh S, More PK, Mohan SM. Floral composition and taxonomy of mangroves of Andaman and Nicobar Islands. Indian Journal of Scientific Research. 2014;43(6):1037–1050
[2]. Curry leaf-and its uses. CounSci& Indus Res. 1962;6:125–127.
[3]. Anwer F, Masaldan AS, Kapil RS, et al. Synthesis of Murrayacine; oxidation with DDQ of the activated aromatic methyl group of the alkaloids of Murraya koenigiiSpreng. Indian J Chem. 1973;11:1314– 1315.
[4]. Priyanka Gupta, AlokNahata, Vinod K. et al. An update on MurayyaKoenigii: a multifunctional Ayurvedic herb. Journal of Chinese integrative medicine. 2012;9(8):824–833.
[5]. Raghunathan K, Mitra R. Pharmacognosy of indigenous drugs. Central Council for Research in Ayurveda and Siddha. 1985;1:433.
[6]. Gupta S, Prakash J. Studies on Indian green leafy vegetables for their antioxidant activity. Plant Foods Hum Nutr. 2009;64(1):39–45.
[7]. Jain V, Momin M, Laddha K. Murraya Koenigii: An updated review. International Journal of Ayurvedic and Herbal Medicine. 2012;2(4):607– 627.
[8]. Henry AB, Trimen. A hand-book to the flora of Ceylon. Dulau& Co; 2015. p. 1–1893.
[9]. Khosa RL, Prasad S. Pharmacognostical studies of leaf of Murraya koenigii and Murraya paniculata. J Res Indian Med. 197 ;7(3):78.
[10]. Khosa RL, Prasad S. Pharmacognosy of roots of Murraya koenigii and Murraya paniculata. J Res Indian Med. 1974;9(3):105.
[11]. Khosa RL, Sen SP, Dixit SN. Studies on Murraya paniculata. Indian J Pharm. 1970;32(3):65–66.
[12]. Garg SC. Antifungal activity of some essential oils. Indian J Pharm. 1974;36:46.
[13]. Handral HK, Pandith A, Shruthi SD. A review on Murraya koenigii: Multipotential medicinal plant. Asian Journal of Pharmaceutical and Clinical Research. 2012;5(4):5–14.
[14]. Ajay S. Asian journal of pharmacy and life science. 2011;1:4423.
[15]. Dineshkumar B, Mitra A, Mahadevappa M. Antidiabetic and hypolipidemic effects of mahanimbine
[16]. (carbazole alkaloid) from murrayakoenigii (rutaceae) leaves. International Journal of Phytomedicine. 27. 2012;2:22
[17]. Kureel SP, Kapil RS, Popli SP. Two Novel Alkaloids Form Murraya 24. Koenigii: mahnimbicine and bicyclomahanimbicine. ChemInd (London) 1970;29:958.
[18]. Rastogi RP, Mehrotra BN. Compendium of Indian medicinal plants. National institute of science Communication (New Delhi). 1980-1984;4:486–489.
[19]. Sindhu RK, Arora S. Phytochemical and pharmacognostical studies on Murraya koenigii (L.) Spreng roots. Drug Invention Today. 27. 2012;4(1):325–333.
[20]. Adeleke CA, Tiwalade AO, Anthony AE, et al. 2", 3" Epoxyindicolactone from Murraya koenigii. Nigerian Journal of Natural Product and Medicine. 1997;1(1):21–24
[21]. Dutta NL, Quasim C, Wadia MS. Constituents of Murraya koenigii: structure of curryangin. Indian T Chem. 1969;7:1061–1062.
[22]. Ganesan P, Phaiphan A, Murugan Y, et al. Comparative study of bioactive compounds in curry and coriander leaves: An update. Journal of Chemical and Pharmaceutical Research. 2013;5(11):590– 594.

[23]. Nagappan T, Ramasamy P, Effendy M, et al. Biological Activity of Carbazole Alkaloids and Essential Oil of Murraya koenigii Against Antibiotic Resistant Microbes and Cancer Cell Lines. Molecules. 2011;16(11):9651–9664.
[24]. Prakash V, Natarajan CP. Studies on Curry Leaf. Food Sci and Technol. 1974;11(6):284–286.
[25]. Narasimha NS, Paradkar MV, Chitguppi VP, et al. Alkaloids of Murraya koenigii: Structures Of Mahanimbine, Koenimbine, (-) Mahanine, Koenine, Koenigine, Koenidine And (+)- Isomahanimbine. Indian Jour Chem. 1975;13(10):993–999.
[26]. Gahlawat DK, Jakhar S, Dahiya P. Murraya koenigii (L.) Spreng: An ethnobotanical, phytochemical and pharmacological review. Journal of Pharmacognosy and Phytochemistry. 2014;3(3):109–119.
[27]. Leela KS, Natarajan AV, Devi K, et al. Chemical composition of aqueous leaf extract of Murraya koenigii. International Journal of Pharmaceutical & Biological Archives. 2013;4(3):493–497
[28]. Roy MK, Thalang VN, Trakoontivakorn G, et al. Mechanism of mahenine induced apoptosis in human leukemia cell (HL-60). BiochemPharmacol. 2004;67(1):41–51
[29]. SastriBN.The Wealth of India, A dictionary of indian raw material and industrial products. Council of Scientific and Industrial Research (New Delhi). 1949;6:446–447
[30]. Darvekar VM, Patil VR, Choudhari AB. Anti-inflammatory activity of Murraya koeniggiSpreng on experimental animals. Journal of Natural Product and Plant Resourse. 2011;1(1):65–69.
[31]. Muthumani P, Venkatraman S, Ramseshu K, et al. Pharmacological studies of anticancer, anti inflammatory activities of Murraya koenigii (Linn) Spreng in experimental animals. Journal of Pharmaceutical Sciences and Research. 2009;1:137.
[32]. Debosree G, Syed BF,Elina M, et al. Protective effect of aqueous leaf extract of murrayakoenigii against lead induced oxidative tress in rat liver, heart and kidney: a dose response study. Asian J Pharm Clin. 2012;5:54–59.
[33]. Mohan S, Abdelwahab SI, Cheah SC, et al. Apoptosis effect of girinimbine isolated from Murraya koenigii on lung cancer cells in vitro. Evidence-Based Complementary and Alternative Medicine. 2013;2013(2013):1–12.
[34]. Kumar VS, Sharma A, Tiwari R, et al. Journal of Medicinal and Aromatic Plant Sciences. 1999;21:1139.
[35]. Ito C, Itoigawa M, Nakao K, et al. Induction of apoptosis by carbazole alkaloids isolated from Murraya koenigii. Phytomedicine. 2006;13(5):359–365.
[36]. Ito C, Itoigawa M, Nakao K, et al. Induction of apoptosis by carbazole alkaloids isolated from Murraya koenigii. Phytomedicine. 2006;13(5):359–365.
[37]. Prabhu KA, Tamilanban T. Investigation of anti-diabetic activity of stem of Murraya koenigii.
[38]. International Journal of Research in Pharmacology and Pharmacotherapeutics. 2012;1(2):165–168.
[39]. Sathaye S, Bagul Y, Gupta S, et al. Experimental and toxicologic pathology : official journal of the gesellschaft fur toxikologischepathologie. Experimental and Toxicologic Pathology. 2011;63(6):587–591.
[40]. Nagappan T, Segaran TC, Wahid MEA, et al. Efficacy of carbazole alkaloids, essential oil and extract of Murraya koenigii in enhancing subcutaneous wound healing in rats. Molecules. 2012;17(2):14449– 14463.
[41]. Gupta V, Sharma M. Protective effect of Murraya koenigii on lipid peroxide formation in isolated rat liver homogenate. Int J Pharma Bio Sci. 2010;1(3):1–6.
[42]. Bandyopadhyaya S, Roy KC, Roy M, et al. Herbal composition of blend of active components prepared form Murraya koenigii And piper betle useful for blocking of 5-Lipooxygenase Activity. USA: US Pat ApplPubl; 2012. p.1–86
[43]. Sathaye .S, Amin PD,MehtaVB,et al. HepatoprotectiveActtivity of Murraya Koenigiiagaint ethanol induced liver toxicity model in experimental animals. internationationl Journal of Pharma and Bio Sciences . 2012;1(2):65-69.
[44]. Kesari AN, Kesari S, Singh SK, et al. Studies on the glycemic and lipidemic effect of Murraya koenigii in experimental animals. J Ethnopharmacol; 2017;112(2):305–311.
[45]. Syam S, Abdul AB, Sukari MA, et al. The growth suppressing effects of girinimbine on HepG2 involve induction of apoptosis and

cell cycle arrest. Molecules. 2011;16(8):7155–7170.
[46]. Shivashankara AR, Azmidah A, Haniadka R, et al. Dietary agents in the prevention of alcoholinducedhepatotoxicty: Preclinical observations. Food Funct. 2012;3(2):101–109.
[47]. Sathaye S, Bagul Y, Gupta S, et al. Hepatoprotective effects of aqueous leaf extract and crude isolates of Murraya koenigii against in vitro ethanol-induced hepatotoxicity model. ExpToxicolPathol. 2011;63(6):587–591
[48]. Das, KC, Chakraborty DP, Bose PK, Antifungal Activity Of Some Constituents Of Murraya koenigii, Experimentia,1965; 21(6): 340.
[49]. Chihiro I, Thoyama Y, Omura M, Kajiura I, Furukawa H, Alkaloid Constituents Of Murraya koenigii. Isolation And Structure Elucidation Of Novel Binary Carbazolequinones And Carbazole Alkaloids, Chem. Pharm. Bull.1993;41(12):2096-2100.
[50]. Kaur G, Daftardar S, Kalyani, Barve H. Modifying anti-inflammatory effect of diclofenac with Murraya koenigii. Recent Patents on Inflammation and Allergy Drug Discovery. 2013;8(1):77–81.
[51]. Vasudevan M, Parle M, Sengottuvelu S, et al. Nootropic Potential of Murraya koenigii leaves in Rats. Oriental Pharmacy and Experimental Medicine. 2008;8(4):365–373.
[52]. Gupta RS, Singh D, Protective nature of Murraya Koenigii leaves against hepatosupression through antioxidant status in experimental rats. Pharmacologyonline, 2007; 1: 232-242.
[53]. Parmar S, Gangwal A, Sheth N. Mast cell membrane stabilization and anti-histaminic actions possible mechanism of action of anti-inflammatory action of Murraya koenigii. J Curr Pharm Res 2010; 2(1):21-25.
[54]. Darvekar VM, Patil VR, Choudhari AB. Anti-inflammatory activity of Murraya koenigiSpreng on experimental animals. J Nat Prod Plant Resour, 2011; 1(1):65-69.
[55]. Mathur A, Prasad GBKS, Dua VK. Anti-inflammatory activity of leaves extracts of Murraya koenigii L. Int J Pharma Bio Sci, 2011; 2(1):541-544.
[56]. Chowdhury BK. Jha S., Bhattacharya P, Mukherjee J, Two New Carbazole Alkaloids Form Murraya koenigii, Indian Jour. Chem. 2001;Sect B, 40 B (6): 490-494.
[57]. Shimomura Kenji, Hattori Fumihiro, Skin Composition Containing ConchiolinHydrolyzates And Plant Extracts: Jpn. KokaiTokkyoKoho JP 2001, 316, 239 (Cl. A 61k7/48). 13 Nov 2001,Appl. 2000/136, 952, 10 May 2000, 14 Pp (Japan).
[58]. Srivastava Sanajy, Singh RP., Anti Fungal Activity Of Essential Oil Of Murraya koenigiiSpreng, Indian Perfumer, 2001; 45(1): 49-51.
[59]. Akerel O, Ayinde BA., Antibacterial Activity Of The Volatile Oil And Aqueous Extract Of Murraya koenigii Leaves, Niger. J. Nat. Prod. Med.,1998; 2:44-45.
[60]. M.K. Vinuthan, V. Girish Kumar, J.P. Ravindra and K. Narayana.Effect of extracts of Murraya koenigii leaves on the levels of blood glucose and plasma insulin in alloxan-induced diabetic rats. Indian J. Physiol. Pharmacol. 48(3): 348-352(2004).
[61]. Tanaka Rin, Morishima Midori Shibuya Koji, Maedo Nobuko, Shimoda Shinji, Tanaka Shu,
[62]. Kawasaki Kenzo, Effect Of Murraya Extract On Experimental Carries, ShikaYakubutsu Ryoho,1998; 17(3):161-166.
[63]. Khuntia TK, Panda DS. Evaluation of antibacterial, antifungal and anthelmintic activity of Murraya 30. koenigiiSpreng. Pharma SciMonit 2011; 2(2):105-110.
[64]. BandyopadhyayaSantu, Roy Keshab Chandra, Roy Mitali, Pal Bikash Chandra, BhandraRanjan,
[65]. Das Krishna, Bhattacharya Samir (India), Herbal Composition Of Blend Of Active Components
[66]. Prepared Form Murraya koenigii And Piper betle Useful For Blocking Of 5-Lipooxygenase Activity, US Pat. Appl. Publ. US 2002, 86, 068, (Cl. 424-734: A61k35/78) 4 Jul. 2002, US Appl.925, 415, 10 Aug 2001; 12 Pp Cont In Part Of U.S. Ser. No 925, 415.
[67]. S.YihYihKok , Lim Yang Mooi , Kartini Ahmad , MohdAspollahSukariet.al , AntiTumour Promoting Activity and Antioxidant Properties of Girinimbine Isolated from the Stem Bark of Murraya koenigii Molecules 2012(4): 4651-4660.
[68]. Nutan MTH, Hasnat A, Rashid MA, Antibacterial And Cytotoxic Activities Of

Murraya koenigii, Fitoterapia,1998; 69(2):173-175

[69]. Mathur A, Prasad GBKS, Dua VK. Anti-inflammatory activity of leaves extracts of Murraya koenigii L. Int J Pharma Bio Sci, 2011; 2(1):541-544

[70]. Shah AS, Juvekar AR. Immunostimulatory activity of aqueous extract of Murraya koenigii(Linn.) Spreng. leaves. Indian J Nat Pro Resour, 2010; 1(2) 450-455.

[71]. Patel VR, Patel MG, Patel RK. Anti-pyretic activity of the ethanolic extract of the powdered leaves of Murraya koenigii (L.) Spreng. J Pharm Res, 2009; 2(4):731-732.

[72]. S. Yadav, V. Vats, Y. Dhunnoo and J.K. Grover. Hypoglycemic and antihyperglycemic activity of Murraya koenigii leaves in diabetic rats.Ethnopharmacol. 82(2-3): 111-116(2002).

[73]. P. Arulselvon, G.P. Senthilkumar, D. Sathish Kumar and S. Subramanian. Anti-diabetic effect of

[74]. Murraya koenigii leaves on streptozotocin induced diabetic rats.Pharmazine. 61(10): 874-877(2006).

[75]. M.K. Vinuthan, V. Girish Kumar, J.P. Ravindra and K. Narayana.Effect of extracts of Murraya koenigii leaves on the levels of blood glucose and plasma insulin in alloxan-induced diabetic rats. Indian J. Physiol. Pharmacol. 48(3): 348-352(2004).

[76]. A.N. Kesari, R.K.Gupta and G. Watal. Hypoglycemic effects of Murraya koenigii on normal and alloxan-diabetic rabbits. J. Ethnopharmacol. 97(2): 247-251(2005).

[77]. Adebajo AC, Ayoola OF, Iwalewa EO, Akindahunsi AA, Omisore NO, Adewunmi CO et.al, Antitrichomonal, biochemical and toxicological activities of methanolic extract and some carbazole alkaloids isolated from the leaves of Murraya koenigii growing in Nigeria. Phytomedicine, 2006;13(4):246-254.