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PHYTOCHEMISTRY AND PHARMACOLOGY OF TRADITIONALLY USED TROPICAL MEDICINAL PLANT *BAUHINIA RACEMOSA* LAM

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ABSTRACT

Bauhinia racemesa Lam, a small deciduous tree belonging to the family Caesalpiniaceae, is traditionally used in the indigenous system of medicine Ayurveda, Unani and Sidha for the treatment of several ailments like headache, fever, skin and blood diseases, jaundice, chronic dysentery, diarrhoea, and leucorrhoea, infection of malaria, boil, glandular swelling, tumors and cancer. It is also used to cure scorpion bite, to relief food poisoning in cattle and as contraceptive by women. In order to reveal full pharmacological and therapeutic potentials, the aim of the present review was focused on the assessment of its current medicinal uses, phytochemistry, pharmacology and toxicology. Literature survey on scientific journals, books as well as electronic sources was performed. It showed that this plant is of an immense value because of its various potent pharmacological actions shown by it and several pharmacologically active principles like galactolipids, racemosol, de-*O*-methylracemosol, pacharin, resveratrol which have been isolated from it. It will be definitely useful to explore it for further research to be carried out on this medicinal plant.

INTRODUCTION

Bauhinia racemosa Lam, belonging to the family Caesalpiniaceae is a small deciduous tree used in the indigenous system of medicine [1,2]. Its synonym is *Bauhinia vahlii* Wight & Arn [3]. It is named as Mountain ebony in English, Kachnal/Kanchanara/Sonpatta in Hindi, Gul-e-anehnal in Urdu and Sona/Sonpatta or Apta in Marathi [4]. It is of religious significance. It is being considered to be as valuable as gold for its medicinal values. Therefore, there is a ritual of exchanging Sonpatta (leaf of gold) leaves during Dussehra in India. It teaches to enjoy the joy of giving [5,6]. It is having antifilarial activity, abortifacient, anti-anxiety, anthelmintic, antimicrobial, antihistaminic, anti-inflammatory, analgesic, and antipyretic effects, antimalarial, anti-oxidant,

anticarcinogenic, antitumor, anti-ulcerogenic, hepatoprotective, and various other pharmacological activities. It is traditionally used in for the treatment of various ailments like diarrhoea, dysentery, headache, jaundice, etc.

Flowers are white and appear in axillary or terminal racemes. Flowering takes place in March to June. Fruit is a pod, oblong, compressed, often twisted and dark green. Fruiting takes place through the season. Bark is rough and black. Leaves are orbicular, bifoliate and alternate distichous with entire margins. Their apices are mucronate and bases are chordate (fig. 1).

Bauhinia (Caesalpiniaceae) is mostly present in lowland and drier forest types of northwestern South America, extending to Brazil and Argentina, recorded in cerrado [7]. *B. racemosa* is very common in foothills upto 1000 m in India and Srilanka. It is inhabited in semi-arid region of Rajasthan in India along with various fodder trees like *Prosopis cineraria, Acacia nilotica, Albezia lebbek, Ailanthes excelsa, Azardirachta indica* [8]. It is a tropical dry thorn found in transects in the Nilgiri landscape of Western Ghats in India [9,10].

Mean wood specific gravity (WSG, g cm^{-3}), height range (m) and mean basal area (BA, m^2 ha^{-1}), carbon density (CD, kg-C ha^{-1}), carbon accumulation rate per unit basal area (CA_b, kg-C m^{-2} yr^{-1}) and carbon accumulation rate per unit ground area (CA_a, kg-C ha^{-1} yr^{-1}) of the tree *B. racemosa* on Hathinala site of tropical dry forest were found to be 0.57, 3.4-4.5, 0.08, 430, 523, 41.8 respectively [11]. Density, basal area (m^2 ha^{-1}) and importance value index (IVI) of woody species *B. racemosa* in the valley of the Slopka forest were 10±10, 0.06±0.06 and 1.9 respectively. It's IVI on different aspects of hill slopes (valley, east-facing slope and south-facing slope) in the undisturbed Slopka forest (the average of 30 quadrats of 100 m^2) were 1.96, 2.99 and 3.18 respectively. Density, basal area (cm^2 100 m^{-2}) and IVI in relation to human disturbance in the Sariska Tiger Project (based on 130 quadrats of 100 m^2 each in each of the study site Slopka forest-undisturbed, Kalighati forest-protected and Bharthari forest-partially disturbed) were 0.30, 18.96, 1.63; 0.13, 8.06, 2.92 and 0.07, 1.32, 1.23 respectivrly [12].

It is found in highly disturbed stand of dry deciduous forest of Western Ghats, India too alongwith *Albizia amara* and *Pleiospemium alatum* [13]. It is one of the many new seedlings emerging indicating better regeneration potential in the low lantana cover site of Vindhyan tropical dry deciduous forest of India [14]. Its seeds, in Vindhyan hill tract in the Sonebhadra district of Uttar Pradesh, India have the weight of 0.124 g/seed and are relatively shade-intolerant [15]. It is propagated easily from seed and can grow in poor and even very harsh climatic conditions [5].

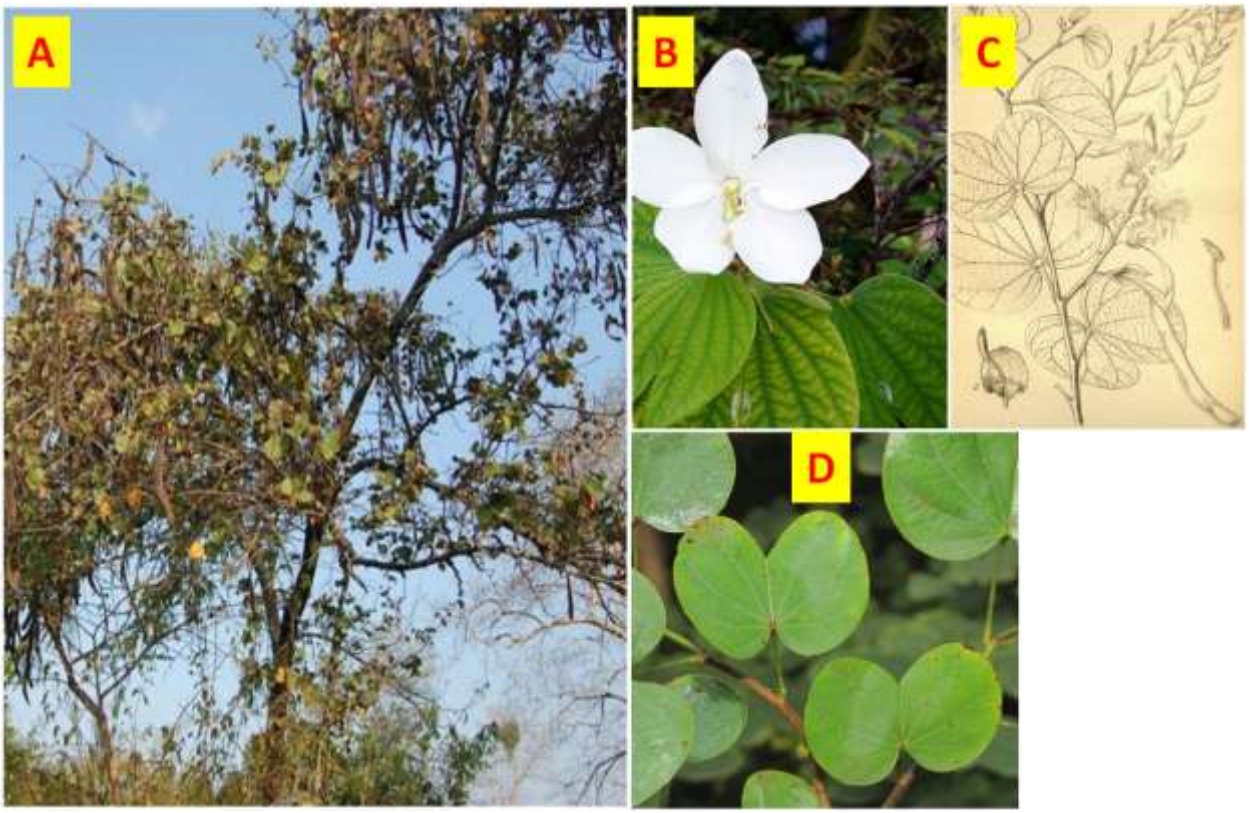


Fig. 1: (A) Whole tree fo *B. racemosa.* (B) Twig with white flower of *B. racemosa.* (C) and (D) Twigs with leaves broader than length.

TRADITIONAL USES

Bauhinia racemosa is one of the plants commonly used by Ayurvedic doctors for the prevention and treatment of cancer [4]. Traditionally, mixture of its bark and *Bridelia retusa* is given orally to women to develop sterility in tribal area of southern Rajasthan and act as contraceptive [16,17]. The folk people and the locales of the Shiwalik Himalaya of Uttarakhand utilize it in the form of different products as ethnomedicine, fodder, food, fibre etc. It is commercially exploited by drug dealers and it come in threatened categories. Therefore, there is an urgent need of its conservation for sustainable development [18]. This is one of the plants eaten by the Rhesus monkey (*Macaca mulatta*) and Hanuman langur (*Presbytis entellus*) in Himachal Pradesh [19].

Its stem bark is kept in house as snake repellent. Leaves are chewed by two people and air is blown in patient's ear, after which a glass of water is given to drink to cure scorpion bite [20]. Pounded bark powder of Kachnal Tree, in 10 g quantity, or decoction with water in 20 ml quantity, is used twice per day for chronic dysentery and diarrhoea in the tribals of Sonaghati of Sonbhadra district, Uttar Pradesh, India [21,22]. It is used in headache also [22].

Whole plant juices either wild or cultivated, administered with vegetable oil orally is used in leucorrhoea by 5% people of Sariska region of Rajasthan [23]. For the treatment of jaundice, Water extracts of its bark, leaves and roots are taken two times daily after meal for 2-4 weeks in the region of Jalgaon, Dhuleand, Nandurbar districts of Maharashtra and also the stem bark of *Woodfordia fructicosa* (L.) Kurz ground with its bark and *Oroxylum indicum* are taken as poultice administered in two spoonfuls banana fruit twice a day for 5-7

days in Adilabad district of Andhra Pradesh [24].

Leaves of *B. racemosa, Aloe vera* and *P. murex* crushed together and mixed with water given to animals three times a day can relief food poisoning in cattle [25].

PHYTOCHEMISTRY

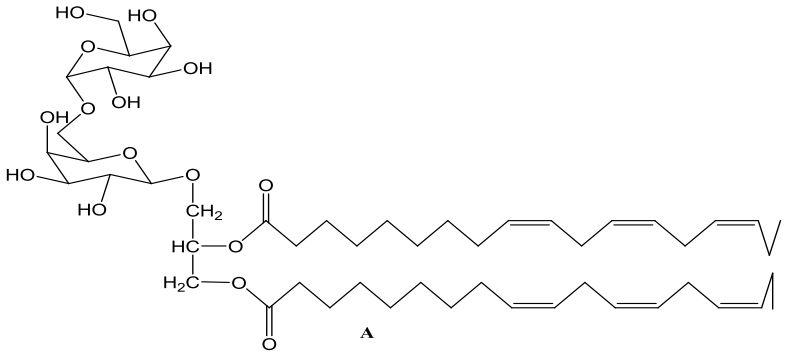
Phytochemical screening of the plant leaves reveals the presence of carbohydrates [26-29], alkaloids [26-29], steroids [26,28,29], glycosides [28,30], tannins [26-30], saponins [27,28,30], phenolic compounds [27,28,30], flavonoids [26,27,28,30,31], protein [27,30], oil and fats [27,28]. Bioassay guided fractionation of ethanolic extract of the leaves led to the isolation of galactolipid and catechin class of the compounds (A-G) (fig. 2) from the most active *n*-butanol fraction [31]. The screening of the heartwood reveals the presence of polycyclic phenolics, racemosol and pacharin [31-33]. The screening of the stem bark reveals the presence of triterpenoids and sterols [31]. Phytochemical screening of the seed reveals the presence of palmitic and stearic acids [34]. It also contains phenolics, flavonoids, saponins, glycosides, tannins and proteins [30].

De-*O*-methylracemosol (fig. 3) was obtained from the column chromatographic separation of a benzene extract of the roots, recrystallized from benzene as brown crystals [35]. Racemosol and de-*O*-methylracemosol were synthesized by Sae-Lao et al (2006) [36]. The key steps involved were the lateral lithiation reaction of *O*-methyl tolulate and the pyran formation via a tandem demethylation-cyclization reaction. The structure of pacharin, previously isolated from the heartwood of *B. racemosa* Lamk has been established as 1,7-dihydroxy-3-methoxy-2-methyl-dibenzo(2,3-6,7)oxepin by a study of its chemical and spectroscopic properties, including X-ray analysis [33,37]. Resveratrol (trans-3,5,4'-trihydroxystilbene), a phytoalexin is obtained from several plants and also from *B. racemosa* [38].

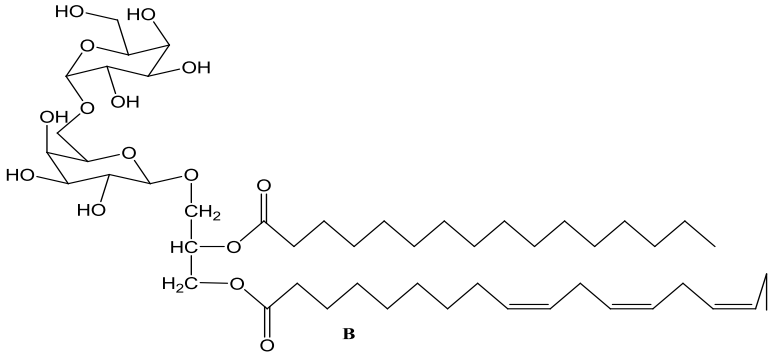
Crude fibre, fat and carbohydrate contents were found to be 1.91%, 15.53% and 36.12% respectively in *B. racemosa* seeds. Its saponification and acid values were found to be 343.72. 5.64 [39]. Crude proteins, crude lipids, ash and nitrogen free extractives constitute 19.84%, 9.52%, 3.31%, and 60.65%, respectively in Ayyanarkoil Forest germplasm of the tribal pulse, *B. racemosa* Lamk; whereas, in Mundanthurai Wildlife Sanctuary germplasm they constitute 19.31%, 8.94%, 3.81% and 61.30% respectively. The caloric values were found to be 407.64 KCal (Ayyanarkoil Forest germplasm) and 402.90 KCal (Mundanthurai Wildlife Sanctuary germplasm). Essential amino acids like isoleucine, tyrosine, phenylalanine and lysine were found to be high in the seed proteins of both the germplasms. The fatty acids, palmitic, oleic and linoleic acids were found to be relatively higher in the seed lipids of both the germplasms. Both the germplasms seemed to be a rich source of calcium, potassium, magnesium, zinc, manganese and iron. Antinutritional substances like total free phenols, tannins, L-DOPA and phytohaemagglutinating activity were also investigated [40].

Dahikar et al. (2011) showed that petroleum ether extract of *B. racemosa* (PEEBR) had only alkaloids and steroids occurring in high concentration [26]. The chloroform extract (CEBR) and ethyl acetate extract (EAEBR) of

B. racemosa had similar photochemical constituents, alkaloids and steroids in higher concentration, carbohydrates, flavonoids, glycosides and saponins. Methanol extract of *B. racemosa* (MEBR) had alkaloids, steroids, flavonoids, saponins and tannins, but no protein. Kumar et al. (2010) found the presence of protein, oil and fats, phenolic compounds, flavonoids, alkaloids, saponins, tannins and carbohydrates as major phytochemical groups in crude MEBR and aqueous extract of *B. racemosa* (AEBR) leaf [27]. Manohar et al. (2011) found the presence of carbohydrates, glycosides, alkaloids, phytosterols, saponins, tannins, phenolics, flavanoids, fixed oils and fats as phytochemicals in crude MEBR and AEBR leaf [28]. Anjaneyulu et al. (1986) reported a new tetracyclic phenol, racemosol from the hexane extract (HEBR) of the heart-wood of *B. racemosa* Lamk [32]. Racemosol was crystallized as deep red prisms from chloroform. It is soluble in alkali giving yellow colour which reverts to the red colour on acidification. Racemosol diacetate and racemosol dimethylether was synthesized by him. Prakash and Khosa (1976) reported octacosane, β-amyrin and β-sitosterol in PEEBR stem bark from column chromatographic resolution over Brockmann alumina [41]. Elution of the column with petroleum ether (60º-80º) furnished octacosane, with benzene β-amyrin and with benzene:chloroform (3:1) β-sitosterol.



A



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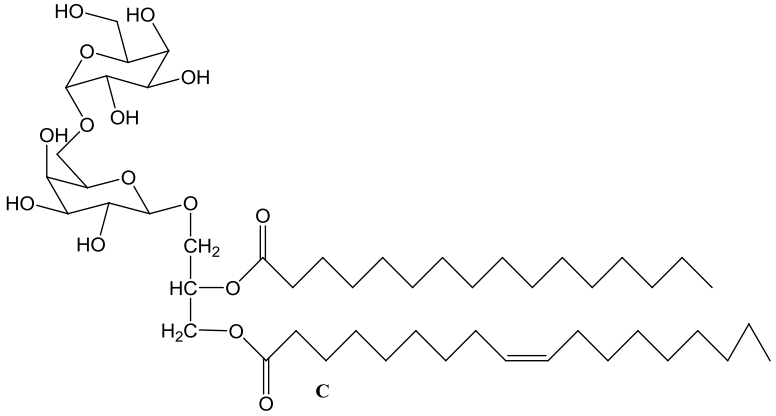

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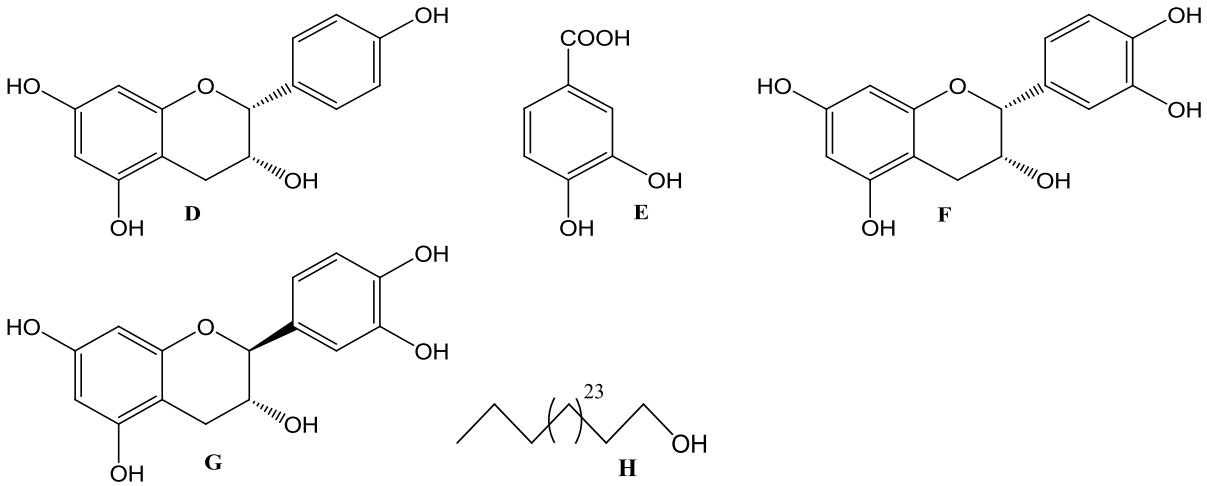

Fig. 2: Isolated phytoconstituents (A-H) from the leaves of *B. racemosa* [Galactolipids: (2*S*)-1,2-di-*O*-linolenoyl-3-*O*-α-galactopyranosyl(1→6)-*O*-β-galactopyranosyl glycerol (A), (2*S*)-1-*O*-linolenoyl-2-*O*-palmitoyl-3-*O*-α-galactopyranosyl(1→6)-*O*-β-galactopyranosyl glycerol (B), (2*S*)-1-*O*-oleoyl-2-*O*-palmitoyl-3-*O*-α-galactopyranosyl(1→6)-*O*-β-galactopyranosyl glycerol (C); Catechins: (−)-epiafzelechin (D), (−)-epicatechin (F), (−)-catechin (G), protocatechuic acid (E); and Long chain fatty acid alcohol: octacosanol (H)].

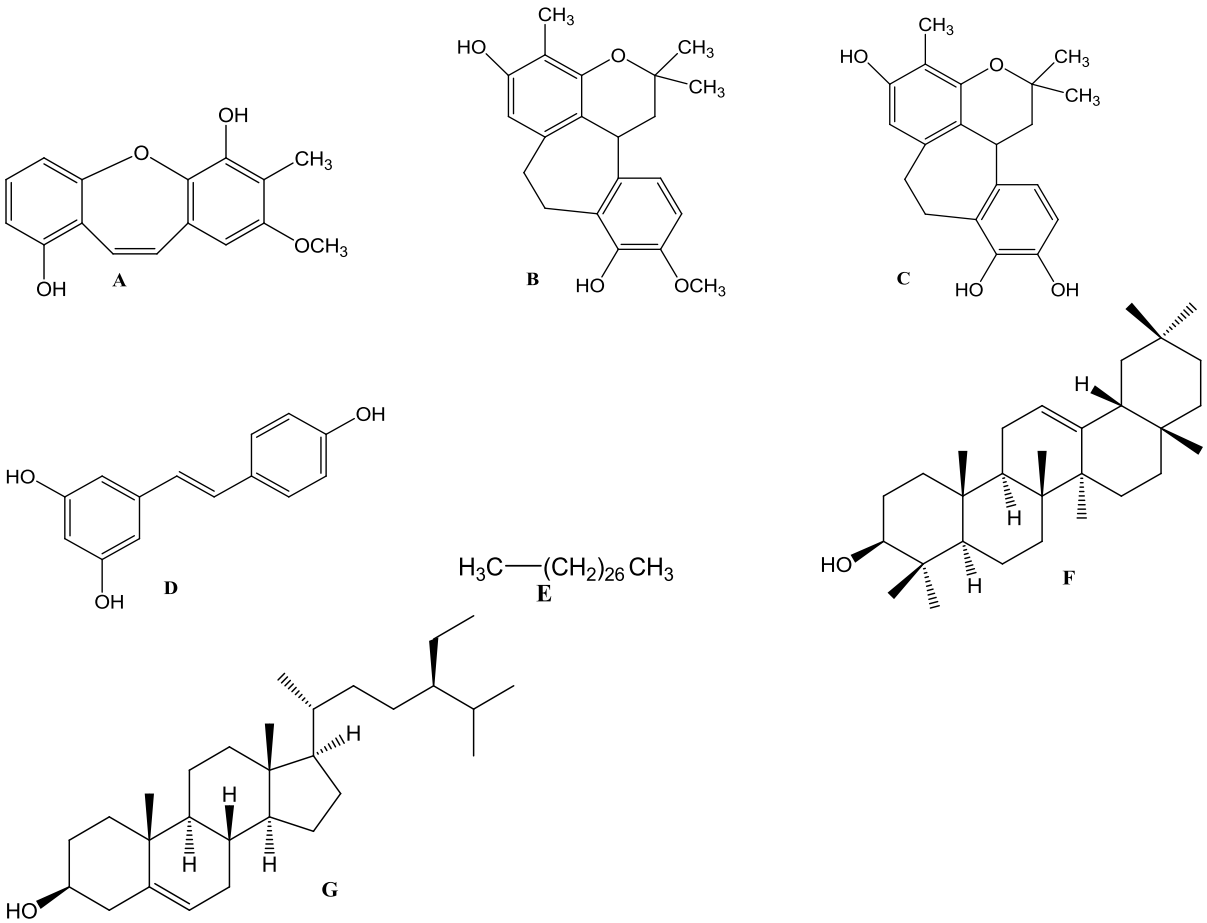

Fig. 3: Other isolated phytoconstituents from *B. racemosa* [pacharin (A), racemosol (B), de-*O*-methylracemosol (C), resveratrol (D), octacosane (E), *β*-amyrin (F), β-sitosterol (G)].

PHARMACOLOGY

Bauhinia racemosa is having antifilarial activity [31], abortifacient [42], anti-anxiety [43], anthelmintic [44], antimicrobial [26,27,28,29,45,46], antihistaminic [47], anti-inflammatory [48], analgesic [48-50], and antipyretic effects [48,51], antimalarial [52], anti-oxidant [46,53,54,55], anticarcinogenic [56], antitumor [54], anti-ulcerogenic [57,58],

hepatoprotective [55,59], and various other pharmacological activities [60].

It does not induce any toxic effects [61]. Its seed mucilage is used as a binder for pharmaceutical dosage forms. It was found to be useful for the preparation of uncoated tablet dosage form in 8% w/w binder concentration [62].

ANTI-ANXIETY EFFECT

The extract MEBR, administered orally (*po*) in two different doses of 150 mg/kg and 300 mg/kg body weight (*bw*) in adult male Swiss albino mice, was able to increase the time spent and the number of arm entries in the open arms of the elevated plus-maze. It also increased the time spent by mice in the illuminated side of the light-dark test, showed significant increase in nose poking and decrease locomotion in hole board test, as well as caused significant reduction in freezing (immobility with rigid body posture) time in comparison with control animals. These effects were comparable to that of the diazepam (2.0 mg/kg *bw*, *po*) indicating that MEBR is an effective anxiolytic agent [43].

ANTIFILARIAL ACTIVITY

The *n*-butanol fraction of ethanolic extract of *B. racemosa* (EEBR) showed promising adulticidal (IC_{50} 5.46 mg/mL) and microfilaricidal (IC_{50} 4.89 mg/ml) activities with Minimum Inhibitory Concentration (MIC) of 15.6 mg/ml. Among the active galactolipids, **1** emerged as the lead molecule which was active on both forms of lymphatic filarial parasite, *Brugia malayi*. It was found to be better than the standard drug ivermectin and diethylcarbamazine (DEC) in terms of dose and efficacy [31].

Anthelmintic activity

AEBR, EEBR and PEEBR whole plant of *B. racemosa* have anthelmintic activity. The crude EEBR significantly demonstrated paralysis and also caused death of earthworm (*Pheretima posthuma*) in dose dependent manner (50, 75 and 100 mg/ml) in *in vitro* study, while AEBR and PEEBR showed weak anthelmintic effect compared to albendazole [44].

ANTIHISTAMINIC ACTIVITY

EEBR leaves inhibited clonidine-induced catalepsy in male Swiss albino mice at a dose of 50 mg/kg *bw*, admistered intraperitoneally *(ip)*. But, there was no effect on haloperidol-induced catalepsy suggesting that the inhibition is through an antihistaminic action and that there is no role of dopamine. It has role in the treatment of asthma [47].

ANTI-INFLAMMATORY, ANALGESIC AND ANTIPYRETIC EFFECTS

MEBR possesses potent anti-inflammatory, analgesic and antipyretic activities. In acute phase of inflammation, a maximum inhibition of 44.9, 43.2, 44.8 and 45.9% ($P<0.001$) was noted at the dose of 200 mg/kg *bw* of Wistar albino rats after 3 h of treatment with MEBR in carrageenan, dextran, histamine and serotonin-induced paw oedema, respectively. Administration of MEBR (200 mg/kg *bw*) and indomethacin (10 mg/kg *bw*) significantly ($P<0.05$) decreased the formation of granuloma tissue induced by cotton pellet method at a rate of 50.4 and 56.2%, respectively. The extract also inhibited peritoneal leukocyte migration in mice. The MEBR also produced significant ($P<0.01$) analgesic activity in mice in the models, acetic

acid-induced writhing and hotplate tests. Further, the MEBR potentiated the morphine- and aspirin-induced analgesic action. Treatment with MEBR showed a significant (P<0.01) dose-dependent reduction in yeast-induced hyperpyrexia in rats [48].

AEBR stem bark at the dose of 200 mg/kg *bw* produced significant analgesic activity by 'Tail Immersion Method' in Wistar rats whereas 100mg/kg dose did not produce significant results when compared with control receiving only normal saline (P<0.01). EEBR produced significant results at both the doses (P<0.01) [49].

EEBR stem bark shows marked antipyretic activity in a dose dependent manner in healthy Wistar albino rats with 50% sex ratio where the pyrexia was induced by injecting a suspension of 15% of brewer's yeast and 2% gum acacia in normal saline subcutaneously below the nape of neck in the volume of 1ml/100 gm of animal weight. The temperature was brought back to normal after 4 hrs of post administration of extracts. AEBR in a dose of 200 mg/kg *bw* and EEBR in the doses of 100mg/kg and 200mg/kg *bw* was found to have significant effect and was found significant at 5% level of significance [51].

ANTIMALARIAL ACTIVITY

Racemosol and de-*O*-methylracemosol exhibited cytotoxicity against KB cell line (EC_{50} at 15.0 µg/ml and 5.6 µg/ml, respectively) and BC cell line (EC_{50} at 6.1 µg/ml and 3.6 µg/ml, respectively) exhibiting moderate antimalarial activity against parasite *Plasmodium falciparum (*EC_{50} at 0.9 µg/ml and 2 µg/ml, respectively) [52].

ANTIMICROBIAL ACTIVITY

In an attempt to develop a new pharmaceutical drug from natural origin for prevention of enteric infection, antibacterial activity of various extract of the leaves was carried out by disc diffusion method against certain enteric bacterial pathogens such as *E. coli, S. aureus, Klebsiella pneumonia, Enterobacter aerogenes, P. aeruginosa, Salmonella typhimurium, S. typhi, Staphylococcus epidermidis* and *Proteus vulgaris* and found that MEBR had wide range of antibacterial activity against enteric bacterial pathogens than PEEBR, whereas EAEBR was of slightly higher antibacterial activity than CEBR [26].

MEBR leaves showed significantly higher inhibitory effect compared to AEBR on tested organisms. The MEBR showed a broad spectrum of antimicrobial activity in agar well diffusion method as it inhibited Gram negative bacteria (*E. coli, Micrococcus luteus* and *P. aeruginosa*), Gram positive bacteria (*Bacillus subtilis*) on Mueller hinton agar and fungi (*Candida albicans* and *A. niger*) on Sabouraud dextrose agar. Both the extracts showed maximum relative percentage inhibition against *A. niger*. MIC values determined by modified agar well diffusion method for MEBR varied from 1.5-25 mg/ml [27].

The antimicrobial studies of AEBR and MEBR leaves were carried out by cup-plate agar diffusion method against bacterial pathogens *B. subtilies, S. typhi, S. aureus* (zone of inhibition of MEBR: 6 mm, 6 mm, 7 mm respectively and that of AEBR: 4 mm, 4 mm, 5 mm respectively). It concluded that MEBR was having good antimicrobial activity [28]. MEBR bark had wide range of antimicrobial activity against enteric bacterial pathogens such as *E. coli, S. aureus, B.*

subtilis, P. aeruginosa and fungi *A. niger and C. albicans* than EEBR, whereas EEBR had slightly higher antibacterial activity than AEBR in agar well diffusion method [29].

As compared to HEBR, the MEBR extracts of all the examined sixteen plants of the family Caesalpiniaceae, collected around Karachi, Pakistan, showed stronger growth inhibitions against both bacteria and fungi. HEBR showed antibacterial activity against *Corynebacterium diptheriae*; *Escherichia coli*; *Salmonella typhi; Staphylococcus aureus; Staphylococcus pyogenes* while MEBR against *Bacillus cereus; Shigella sonii; Pseudomonas aeruginosa; S. typhi; Shigella boydii; S. aureus; S. pyogenes*. HEBR also showed antifungal activity against *Trichophyton longifuses; Pseudallescheria boydii; Aspergillus niger; Microsporum canis* while MEBR against *T. longifuses; P. boydii; M. canis; Trichophyton mentagrophytes; Trichophyton simii; Fusarium solani; Macrophomina phaseolina; Trichophyton schoenleinii* [43].

The anti-oxidant activity of the MEBR bark increased in a concentration dependent manner. About 50, 100, 250 and 500 µg/ml MEBR inhibited the peroxidation of a linoleic acid emulsion by 62.43, 67.21, 71.04 and 76.83%, respectively. Similarly, the effect of MEBR on reducing power increased in a concentration-dependent manner. The IC_{50} values were found to be 152.29 µg/ml, 78.34 µg/ml and more than 1000 µg/ml for DPPH radical-scavenging, nitric oxide-radical scavenging and hydroxyl radical-scavenging assays, respectively. MEBR scavenged also the superoxide generated by the PMS/NADH-NBT system. Total phenolic content was also determined and 64.7 µg pyrocatechol phenol equivalent was detected in MEBR (1 mg). MEBR showed broad-spectrum antimicrobial activity determined by disc diffusion against all tested microorganisms; four Gram positive bacteria *S. aureus, Streptococcus pneumonia, M. luteus, S. epidefrmidis*, five Gram negative bacteria *P. aeruginosa, E. coli, S. typhi, Shigella dysenteriae, Vibrio cholerae* and four fungal species *C. albicans, A. niger, Aspergillus flavus,* and *Alternaria solani*. The results obtained indicate that MEBR can be a potential source of natural antioxidant and antimicrobial agents [46].

ANTI-OXIDANT ACTIVITY

AEBR leaves showed good anti-oxidant activity in different systems of assays. IC_{50} values found were 1739, 536, 216 and 797 µg/ml for hydroxyl radical-scavenging, superoxide radical-scavenging, DPPH radical-scavenging and lipid peroxidation preventive activities, respectively. Total antioxidant capacity was found to be 16.5 and 58.1 gallic acid equivalent, GAE and amino acid equivalent, AAE (µg/mg plant material) respectively. Phenol and flavonoid content was found to be 150 GAE and 13 Catechin Equivalent (µg/mg plant material) respectively [53].

ANTITUMOR AND ANTICARCINOGENIC ACTIVITY

Administration of MEBR bark was able to suppress neoplastic nodule development/hepatocellular lesion formation in *N*-nitrosodiethylamine induced hepatocarcinogenesis in male Wistar albino rats. The extract treatment increased the level of antioxidants vitamin C, vitamin E, reduced glutathione (GSH), superoxide dismutase

(SOD) and catalase (CAT), and dramatically decreased lipid peroxidation levels indicated by low level of malondialdehyde (MDA). MEBR also produced a protective effect by decreasing the levels of serum enzymes (SGOT, SGPT and ALP) and bilirubin, and increasing the protein and uric acid levels. It suggested that MEBR exert chemopreventive effects by suppressing nodule development and decreasing lipid peroxidation and enhancing the levels of antioxidants in NDEA carcinogenesis by reducing the formation of free radicals [56].

The MEBR bark (at the doses of 50, 100, and 200 mg/kg *bw*) showed decrease in transplantable murine tumor volume, packed cell volume and viable cell count, and increase in nonviable cell count and mean survival time thereby increasing life span of Ehrlich Ascites Carcinoma (EAC) tumor bearing mice. Hematological profile (hemoglobin content, red blood cell and white blood cell counts) reverted to more or less normal levels in extract treated mice. The level of lipid peroxidation was decreased and that of GSH, SOD and CAT was increased. Thus, MEBR bark exhibits antitumor effect by modulating lipid peroxidation and augmenting antioxidant defense system in EAC bearing mice. Gupta M *et al* proposed that the additive and synergistic antioxidant activity of phytochemicals such as flavonoids, triterpenoids, steroids, etc, present in MEBR bark are responsible for its potent antitumor activity [54].

ANTI-ULCEROGENIC ACTIVITY

The effects of MEBR (flower buds) on the volume of gastric juice secreted, acid output, peptic activity, mucin activity and curative ratio were recorded in aspirin-induced gastric ulcers in Sprague-Dawley rats. It showed significant decrease in ulcer index [57]. AEBR dried fruit powder (200 mg/kg *bw*) and EEBR (100 mg/kg and 200 mg/kg *bw*) produced antiulcer activity in Wistar albino rats when the treated rats were administered paracetamol at a dose rate of 200 mg/kg *bw* orally after one hour [58]. After 24 hrs, the number of ulcers, ulcer score, percent incidence, ulcer index and healing index were recorded as anti-ulcer parameters.

HEPATOPROTECTIVE ACTIVITY

The MEBR bark at the doses of 50, 100 and 200 mg/kg and silymarin at 25 mg/kg *bw* produced significant ($P<0.05$) hepatoprotective effect by decreasing the activity of serum enzymes (serum transaminases; SGOT, SGPT and ALP), bilirubin and lipid peroxidation and significantly increasing the levels of GSH, SOD, CAT and protein in a dose dependant manner in different groups of Wistar albino rats administered with paracetamol (500 mg/kg, *po* once in a day for 7 days) and carbon tetrachloride (30% CCl_4, 1 ml/kg *bw* in liquid paraffin 3 doses *ip* at 72 h interval). MEBR also showed antioxidant effects on $FeCl_2$-ascorbate induced lipid peroxidation in rat liver homogenate and on superoxide scavenging activity. From these results, it was suggested that MEBR could protect the liver cells from paracetamol and CCl_4-induced liver damages perhaps, by its antioxidative effect on hepatocytes, hence eliminating the deleterious effects of toxic metabolites from paracetamol or CCl_4 [55].

B. racemosa stem bark was found effective as hepatoprotective, through *in vivo* and histopathological studies of paraffin sections of Male Wistar albino rat's liver and

biochemical parameters. The animals treated with EAEBR exhibited significant liver protection against the toxicant as evident by the presence of normal hepatic cords, absence of necrosis and lesser fatty infiltration. The hepatoprotective effect of EAEBR was comparable to that of silymarin, a standard hepatoprotective agent [59].

TOXICOLOGICAL EFFECTS

MEBR bark administered *ip* at the doses of 100 and 200 mg/kg *bw* twice a week for thirteen weeks to Swiss albino mice did not induce any toxic effects. Adverse effect was noted at the dose of 400 mg/kg *bw*. Its administration at the dose of 400 mg/kg *bw* significantly elevated the levels of bilirubin, serum enzymes (SGOT, SGPT and ALP) and altered the level of urea, uric acid, creatinine, cholesterol, glucose and hematological parameters (hemoglobin content, total count of RBC and WBC, differential count of leucocytes such as neutrophil, lymphocyte, monocyte, hematocrit, mean cell volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration and platelet count) [61].

MARKETED FORMULATION

Masanumas2 is a formulation for the second month of pregnancy [63]. Each coated tablet contains- Ashmantak (*Bauhinia racemosa*) bark extract, Black Sesame (*Sesmum indicum*) seed extract, Manjishtha (*Rubia cordifolia*) stem xtract and Shatavari (*Asparagus recemosus*) root extract 60 mg each. Each pack contains 120 tabs. Dose: 2 tablets with lunch and 2 tablets with dinner. Indications: Habitual abortions, repeated abortions, high value pregnancies, high risk pregnancies.

Discussion and Conclusion

The extensive literature survey revealed *B. racemosa* to be a valuable and important medicinal plant used for the treatment of several ailments like headache, fever, skin and blood diseases, jaundice, chronic dysentery, diarrhoea, and leucorrhoea, infection of malaria, boil, glandular swelling, tumors and cancer. It is also used to cure scorpion bite, to relief food poisoning in cattle and as contraceptive by women. Pharmacological studies carried out on the fresh plant materials, crude extracts and isolated active principles of *B. racemosa* provide a support for its numerous traditional uses. Recent studies have been focused on evaluating the abortifacient activity, anthelmintic, anti-anxiety, antimicrobial, antifilarial, anticarcinogenic, anti-inflammatory, analgesic and antipyretic effects, hepatoprotective, antitumor, anti-ulcerogenic, antihistaminic and antimalarial activities. Most of the mentioned pharmacological studies were aimed on validating its traditional uses. The different parts of *B. racemosa* have been employed for the treatment of various ailments. Most of the pharmacological studies that have been carried out on *B. racemosa* were conducted using uncharacterized crude extracts. Thus, it is difficult to reproduce the results of these studies and point the bioactive principles. Hence, there is a need of phytochemical standardization and bioactivity-guided identification of bioactive metabolites. Phytochemical research carried out on *B. racemosa* had led to the isolation of some active principles. However, the vast traditional use and proven pharmacological activities of *B. racemosa* indicates that an immense scope still exists for its phytochemical exploration.

The outcome of such phytochemical studies may further expand its existing therapeutic potential. The outcome of the future research will provide a convincing support for the future clinical use of *B. racemosa* in modern medicine.

REFERENCES

1. Gamble JS. Flora of presidency of Madras. Bot Surv India (I); 1967.
2. Chopra RN, Chopra IC, Nayar SL. Glossary of lndian Medicinal Plants. CSIR, New Delhi; 1956.
3. Bandyopadhyay S. Comments on the type of *Bauhinia vahlii* Wight & Arn. (Leguminosae: Caesalpinioideae). Candollea 2008;63:35-7.
4. Garodia P, Ichikawa H, Malani N, Sethi G, Aggarwal BB. From ancient medicine to modern medicine: Ayurvedic concepts of health and their role in inflammation and cancer. J Soc Integr Oncol 2007;5:1-16.
5. Phalak, Prashant P. "The Real Gold". 2012 http://giftingtrees.blogspot.in/2010/10/real-gold.html.
6. Pawar S, Patil DA. *Ethnobotany of Jalgaon district, Maharashtra*. Daya Publishing House: Delhi; 2008, p. 450.
7. Marchant R, Almeida L, Behling H, Berrio JC. Distribution and ecology of parent taxa of pollen lodged within the Latin American Pollen Database. Rev Palaeobot Palynol 2002;121:1-75.
8. Bhatta R, Vaithiyanathan S, Singh NP, Shinde AK, Verma DL. Effect of feeding tree leaves as supplements on the nutrient digestion and rumen fermentation pattern in sheep grazing on semi-arid range of India-I. Small Ruminant Res 2005;60:273-80.
9. Kodandapani N, Cochrane MA, Sukumar R. A comparative analysis of spatial, temporal and ecological characteristics of forest fires in seasonally dry tropical ecosystems in the Western Ghats, India. Forest Ecol Manage 2008;256:607-17.
10. Rao KS. Himalayan ecology. Envis Bulletin 2001;9:1-94.
11. Chaturvedi RK, Raghubanshi AS, Singh JS. Carbon density and accumulation in woody species of tropical dry forest in India. Forest Ecol Manage 2011;262:1576-88.
12. Yadav AS, Gupta SK. Effect of micro-environment and human disturbance on the diversity of woody species in the Sariska tiger project in India. Forest Ecol Manage 2006;225:178-89.
13. Anitha K, Joseph S, Ramasamy EV, Prasad SN. Changes in structural attributes of plant communities along disturbance gradients in a dry deciduous forest of western Ghats, India. Environ Monit Assess 2009;155:393-405.
14. Sharma GP, Raghubanshi AS. Tree population structure, regeneration and expected future composition at different levels of *Lantana camara* L invasion in the Vindhyan tropical dry deciduous forest of India. Lyonia 2006;11:27-39.
15. Khurana E, Sagar R, Singh JS. Seed size: a key trait determining species distribution and diversity of dry tropical forest in northern India. Acta Oecol 2006;29:196-204.
16. Jain A, Katewa SS, Chaudhary BL, Galav PK. Folk herbal medicines used in

birth control and sexual diseases by tribals of southern Rajasthan, India. J Ethnopharmacol 2004;90:171-7.

17. Jain A, Katewa SS, Galav PK, Sharma P. Medicinal plant diversity of Sitamata wildlife sanctuary, Rajasthan, India. J Ethnopharmacol 2005;102:143-57.
18. Sharma J, Gaur RD, Painuli RM. Conservation status and diversity of some important plants in the Shiwalik Himalaya of Uttarakhand, India. Int J Med. Arom Plants 2011;1:75-82.
19. Pirta RS, Gadgil M, Kharshikar AV. Management of the Rhesus monkey *Macaca mulatta* and Hanuman langur *Presbytis entellus* in Himachal Pradesh, India. Biol Cons 1997;79:97-106.
20. Jagtap SD, Deokule SS, Bhosle SV. Some unique ethnomedicinal uses of plants used by the Korku tribe of Amravati district of Maharashtra, India. J Ethnopharmacol 2006;107:463-9.
21. Singh AK, Raghubanshi AS, Singh JS. Medical ethnobotany of the tribals of Sonaghati of Sonbhadra district, Uttar Pradesh, India. J Ethnopharmacol 2002;81:31-41.
22. Reddy PRK, Reddy SJ. Elemental concentrations in medicinally important leafy materials. Chemosphere 1997; 34:2193-212.
23. Upadhyay B, Singh KP, Kumar A. Ethno-veterinary uses and informants consensus factor of medicinal plants of Sariska region, Rajasthan, India. J Ethnopharmacol 2011;133:14-25.
24. Sharma J, Gairola S, Gaur RD, Painuli RM. The treatment of jaundice with medicinal plants in indigenous communities of the sub-Himalayan region of Uttarakhand, India. J Ethnopharmacol 2012;143:262-91.
25. Patel DK, Laloo D, Kumar R, Hemalatha S. *Pedalium murex* Linn.: An overview of its phytopharmacological aspects. Asian Pac J Trop Med 2011;4:748-55.
26. Dahikar SB, Bhutada SA, Tambekar DH, Vibhute SK, Kasture SB. *In vitro* antibacterial efficacy of solvent extracts of leaves of *Bauhinia racemosa* Lam. (Caesalpiniaceae) against enteric bacterial pathogens. Int J Pharm Sci Drug Res 2011;3:32-4.
27. Kumar G, Karthik L, Rao KVB. Phytochemical composition and *in vitro* antimicrobial activity of *Bauhinia racemosa* Lamk (Caesalpiniaceae). Int J Pharm Sci Res 2010;1:51-8.
28. Manohar P, Rajesham VV, Ramesh M, Kumar SK, Kumari JP. Pharmacognostical, phytochemical and antimicrobial activity of *Bauhinia racemosa* leaves. J Pharm Biol 2011;1:10-4.
29. Chavan RT, Kadam AS. Preliminary phytochemistry and antimicrobial activity of bark of *Bauhinia racemosa* Lamk. Curr Bot 2012;3:31-3.
30. Sharanabasappa GK, Santosh MK, Shaila D, Seetharam YN, Sanjeevarao I. Phytochemical studies on *Bauhinia racemosa* Lam, *Bauhinia purpurea* Linn and *Hardwickia binata* Roxb. E-J Chem 2007;4:21-31.
31. Sashidhara KV, Singh SP, Misra S, Gupta J, Misra-Bhattacharya S. Galactolipids from *Bauhinia racemosa* as a new class of antifilarial agents against human lymphatic filarial

parasite, *Brugia malayi*. Eur J Med Chem 2012;50:230-5.

32. Anjaneyulu ASR, Reddy AVR, Reddy DSK. Racemosol: a novel tetracyclic phenol from *Bauhinia racemosa* Lamk. Tetrahedron 1986;42:2417-20.
33. Anjaneyulu ASR, Reddy AVR, Reddy DSK. Pacharin: a new dibenzo(2,3-6,7)oxepin derivative from *Bauhinia racemosa* Lamk. Tetrahedron 1984;40:4245-52.
34. Mohan VR, Janardhanan K. Chemical analysis and nutritional assessment of lesser known pulses of the genus, *Mucuna*. Food Chem 1995;52:275-80.
35. Prabhakar P, Gandhidasan R, Raman PV, Krishnasamy NR, Nanduri S. De-*O*-methylracemosol: a tetracyclic 2,2-dimethylchroman from the roots of *Bauhinia racemosa*. Phytochem 1994;36:817-8.
36. Sae-Lao P, Kittakoop P, Rajviroongit S. Total synthesis of racemosol and de-*O*-methylracemosol, potent cyclooxygenase (COX) inhibitors and antimalarial agents. Tetrahedron Lett 2006;47:345-8.
37. Reddy MVB, Reddy MK, Gunasekar D, Caux C, Bodo B. A flavanone and a dihydrodibenzoxepin from *Bauhinia variegata*. Phytochem 2003;64:879-82.
38. Aggarwal BB, Bhardwaj A, Aggarwal RS, Seeram NP, Shishodia S, Takada Y. Role of resveratrol in prevention and therapy of cancer: preclinical and clinical studies. Anticancer Res 2004;24:2783-840.
39. Amoo IA, Moza L. Extraction and physico-chemical properties of oil of *Bauhinia racemosa* seeds. Riv Ital Sostanze Gr 1999;76:399-400.
40. Mohan VR, Janardhanan K. Chemical and nutritional evaluation of two germplasms of the tribal pulse, *Bauhinia racemosa* Lamk. Plant Food Hum Nutr 1994;46:367-74.
41. Prakash A, Khosa RL. Chemical studies on *Bauhinia racemosa*. Current Sci 1976;45: 705.
42. Kumar D, Kumar A, Prakash O. Potential antifertility agents from plants: A comprehensive review. J Ethnopharmacol 2012;140:1-32.
43. Davey MS, Clement AW, Bharathi SRSA, Farook M. Antianxiety effect of methanolic extract of *Bauhinia racemosa* (Lamk) stem bark in mice. Int J Pharm Bio Sci 2011;2:217-24.
44. Kumar T, Alexander A, Ajazuddin, Dewangan D, Khan J, Sharma M. Investigation of *in vitro* anthelmintic activity of *Bauhinia racemosa* Linn. J Appl Pharm Sci 2011;1:73-5.
45. Ali MS, Azhar I, Amtul Z, Ahmad VU, Usmanghani K. Antimicrobial screening of some Caesalpiniaceae. Fitoterapia 1999;70:299-304.
46. Kumar RS, Sivakumar T, Sunderam RS, Gupta M, Mazumdar UK, Gomathi P, et al. Antioxidant and antimicrobial activities of *Bauhinia racemosa* L. stem bark. Braz J Med Biol Res 2005;38:1015-24.
47. Nirmal SA, Laware RB, Rathi RA, Dhasade VV, Kuchekar BS. Antihistaminic effect of *Bauhinia racemosa* leaves. J Young Pharm 2011;3:129-31.

48. Gupta M, Mazumder UK, Kumar RS, Gomathi P, Rajeshwar Y, Kakoti BB, et al. Anti-inflammatory, analgesic and antipyretic effects of methanol extract from *Bauhinia racemosa* stem bark in animal models. J Ethnopharmacol 2005;98:267-73.
49. Borikar VI, Jangde CR, Rekhe DS, Philip P. Study of analgesic activity of *Bauhinia racemosa* Lam in rats. Vet World 2009;2:135-6.
50. Arrau S, Delporte C, Cartagena C, Rodriguez-Diaz M, Gonzalez P, Silva X, et al. Antinociceptive activity of *Quillaja saponaria* Mol. saponin extract, quillaic acid and derivatives in mice. J Ethnopharmacol 2011;133:164-7.
51. Borikar VI, Jangde CR, Philip P, Rekhe DS, Atole SK. Study of antipyretic activity of *Bauhinia racemosa* Lam in rats. Vet World 2009;2:217-8.
52. Kittakoop P, Kirtikara K, Tanticharoen M, Thebtaranonth Y. Antimalarial preracemosols A and B, possible biogenetic precursors of racemosol from *Bauhinia malabarica* Roxb. Phytochem 2000;55:349-52.
53. Dasgupta N, De B. Antioxidant activity of some leafy vegetables of India: A comparative study. Food Chem 2007;101:471-4.
54. Gupta M, Mazumder UK, Kumar RS, Kumar TS. Antitumor activity and antioxident role of *Bauhinia racemosa* against Ehrlich Ascites carcinoma in Swiss albino mice. Acta Pharmacol Sin 2004;25:1070-6.
55. Gupta M, Mazumder UK, Kumar TS, Gomathi P, Kumar RS.. Antioxidant and hepatoprotective effects of *Bauhinia racemosa* against paracetamol and carbon tetrachloride induced liver damage in rats. Int J Pharmacol Ther 2004;3:12-20.
56. Kumar RS, Sunderam RS, Sivakumar T, Sivakumar P, Sureshkumar R, Kanagasabi R, et al. Effect of *Bauhinia racemosa* stem bark on N-nitrosodiethylamine-induced hepatocarcinogenesis in rats. Am J Chin Med 2007;35:103-14.
57. Akhtar AH, Ahmad KU. Anti-ulcerogenic evaluation of the methanolic extracts of some indigenous medicinal plants of Pakistan in aspirin-ulcerated rats. J Ethnopharmacol 1995;46:1-6.
58. Borikar VI, Jangde CR, Philip P, Rekhe DS. Study of antiulcer activity of *Bauhinia racemosa* Lam in rats. Vet World 2009;2:215-6.
59. Subraya KC, Dananjaya, Subraya KP. Hepatoprotective activity of *Bauhinia racemosa* Linn. Int Res J Pharm 2011;2:218-20.
60. Almeida ER, Guedes MC, Albuquerque JFC, Xavier H. Hypoglycemic effect of *Bauhinia cheilandra* in rats. Fitoterapia 2006;77:276-8.
61. Kumar RS, Gupta M, Mazumdar UK, Rajeshwar Y, Kumar TS, Gomathi P, Roy R. Effects of methanol extracts of *Caesalpinia bonducella* and *Bauhinia racemosa* on hematology and hepatorenal function in mice. J Toxicol Sci 2005;30:265-74.
62. Gangurde AB, Boraste SS. Preliminary evaluation of *Bauhinia racemosa* Lam caesalpinaceae seed mucilage as tablet binder. Int J Pharm 2012;2:80-3.

63. Sharir Sthan No. 2-54. *Masanumas2, Ayurvedic system of medicine*. Vatsal Ayurvedic Products (P) Ltd, Ashtanghruday (Vagbhat).