International Journal of PharmTech Research
CODEN (USA): IJPRIF ISSN : 0974-4304
Vol. 3, No.2, pp 899-908, April-June 2011

A Review on Anti-Inflammatory Plant Barks

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Abstract: The inflammatory process may be defined as a sequence of events that occurs in response to noxious stimuli, infection or trauma. Non-steroidal anti-inflammatory drugs (NSAIDS) are effective for the treatment of pain, inflammation and fever. The main factor that limits the use of NSAIDs is their gastrointestinal toxicity. Medicinal plants play an important role in the development of potent therapeutic agents. Medicinally important phytoconstituents obtained from plant barks exerted a wide range of pharmacological action on body. In this review an attempt has been made to highlight the work on medicinal plant barks having anti-inflammatory potential. The present paper involves various plant barks along with their chemical constituents and pharmacological profile which focus on the dose administered, bioactive extract involved in anti-inflammatory mechanism. This work stimulates the researchers for further research on the potential use of medicinal plant barks having anti-inflammatory property.
Keywords: Inflammation, plants, bark, medicinal.

Introduction

Inflammation and Non-steroidal anti-inflammatory drugs (NSAIDs)

The inflammatory process may be defined as a sequence of events that occurs in response to noxious stimuli, infection or trauma[1]. The classic signs of inflammation are local redness, swelling, pain, heat and loss of function. The events of inflammation that underline these manifestations are induced and regulated by a large number of chemical mediators, including kinins, eicosanoids, complement proteins, histamine and monokines[2].

NSAIDs are among the most commonly used drugs worldwide. They are prescribed for orthopaedic conditions such as osteoarthritis, soft-tissue injuries and fractures *etc*[3]. NSAIDs are one of the best classes of drug to prevent and treat postoperative pain[4].

The greatest disadvantage in presently available potent synthetic drugs lies in their toxicity and reappearance of symptoms after discontinuation. Therefore, the screening and development of drugs for their anti-inflammatory activity is the need of hour and there are many efforts for finding anti-inflammatory drugs from indigenous medicinal plants[5]. The use of NSAIDs is associated with many side effects, but their unwanted effects on the gastrointestinal tract, the kidney and the cardiovascular system are considered as major issues with the use of these drugs[6].

Plants as natural Anti-inflammatory agents

Unlike modern allopathic drugs which are single active components that target one specific pathway, herbal medicines work in a way that depends on an orchestral approach. A plant contains a multitude of different molecules that act synergistically on targeted elements of the complex cellular pathway[7].

Medicinal plants have been a source of wide variety of biologically active compounds for many centuries and used extensively as crude material or as pure compounds for treating various disease conditions[8]. The widespread use of herbal remedies and healthcare

preparations, as those described in ancient texts such as the Vedas and the Bible, and obtained from commonly used traditional herbs and medicinal plants, has been traced to the occurrence of natural products with medicinal properties[9].

The use of herbal medicine becoming popular due to toxicity and side effects of allopathic medicines. Medicinal plants play an important role in the development of potent therapeutic agents. There are over 1.5 million practitioners of traditional medicinal system using medicinal plants in preventive, promotional and curative applications[10]. India with its biggest repository of medicinal plants in the world may maintain an important position in the production of raw materials either directly for crude drugs or as the bioactive compounds in the formulation of pharmaceuticals and cosmetics *etc*[11]. Ayurveda, literally meaning the "science of life and longevity" in ancient Sanskrit, is the one of the oldest healing system of India, based on lifestyle diet and herbs[12,13]. Natural products with anti-inflammatory activity have long been used as a folk remedy for inflammatory conditions such as fevers, pain, migraine and arthritis. As the inflammatory basis of disease becomes clear, anti-inflammatory food and food products become of greater interest[14]. A brief description of common anti-inflammatory barks from Ayurveda was discussed in table 1.

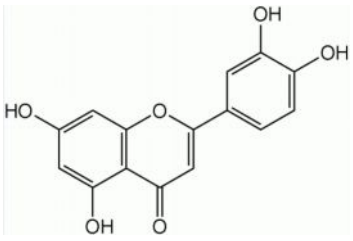
Plant Bark as a potential source of drug

The secondary external tissues lying outside the cambium in stem of root of dicotyledonous plants are known as the bark and is consists of three layers viz. cork (phellem); cork-cambium (phellogen) and secondary cortex (phelloderm)[15]. Medicinally important phytoconstituents obtained from barks exerted a wide range of pharmacological action on body for instance antimalarial activity exerted by barks of *Cinchona*[16], *Spathodea campanulata*[17], *Faidherbia albida*[18], *Vismia laurentii*[19]; cardioprotective activity exerted from barks of *Terminalia arjuna*[20], *Premna serratifolia*[21], *Moringa oleifera*[22]; immunomodulating activity from *Azadirachta indica*[23], *Bauhania variegata*[24] barks; anti-anxiety, hepatoprotective, anti-ulcer, antidiabetic, anti-asthmaic from *Magnolia officinalis*[25], *Calotropis gigantea*[26], *Excoecaria agallocha*[27], *Helicteres isora*[28], *Alianthus excelsa*[29] barks respectively.

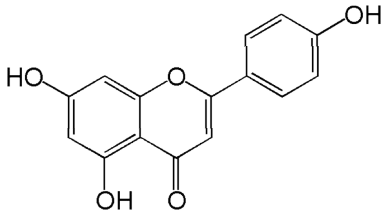
Chemistry of Anti-Inflammatory Barks

Wide ranges of phytoconstituents were responsible for anti-inflammatory activity includes alkaloids, glycosides, tannins, phenolics, anthocyanins, sterols, triterpenoids *etc*. These phytoconstituents present in bark exerted a desired pharmacological effect on body and thus act as natural anti-inflammatory agent. The chemical structures of these agents are shown in figure1 given below[30-75].

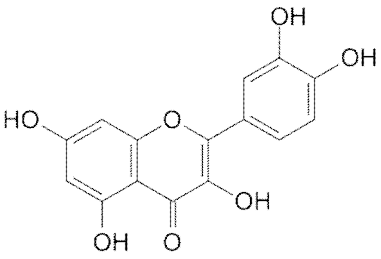
Fig.1: Various Phytoconstituents from bark



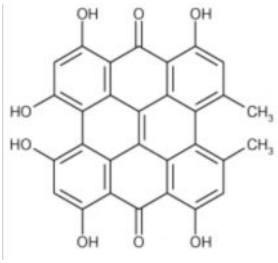
Luteolin



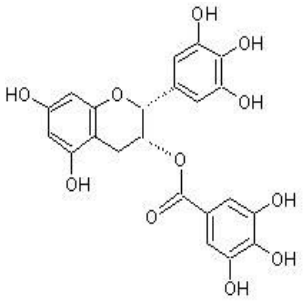
Apigenin



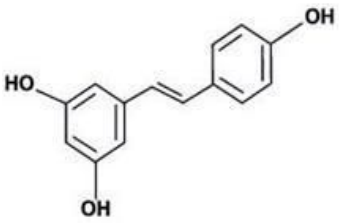
Quercetin



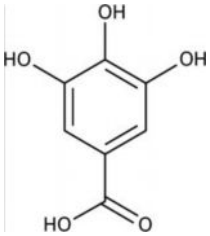
Hypericin



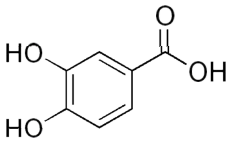
Epigallocatechin



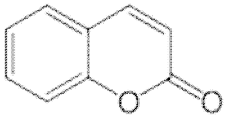
Resveratrol



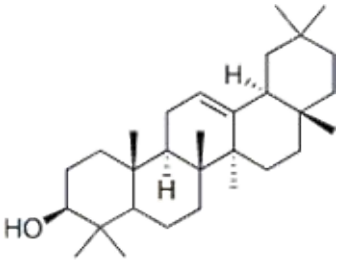
Gallic acid



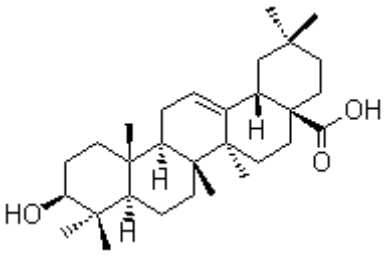
Protocatechuic acid



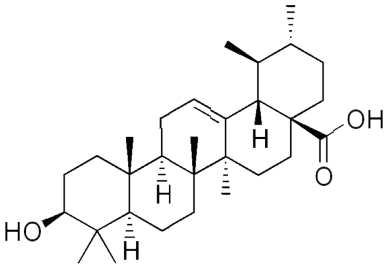
Coumarin



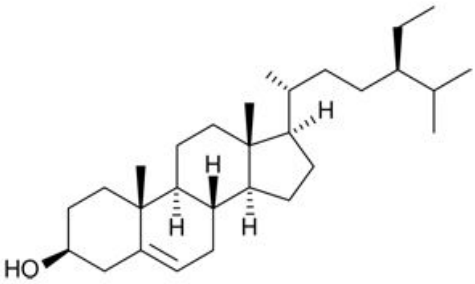
β-amyrin



Oleanolic acid



Ursolic acid



β-sitosterol

Pharmacology of Some Anti-Inflammatory Barks

Natural anti-inflammatory agent's acts by suppressing the various types of inflammatory mediators involved in inflammation process. *Acanthopanax senticosus, Albizia chinensis, Croton zambesicus, Cussonia paniculata, Kalopanax pictus, Khaya grandifoliola, Kigelia Africana, Securidaca longipedunculata, Uncaria tomentosa, Zizyplus rugosa etc* are capable of inhibiting inflammatory process in various pharmacological screening models like Carrageenan induced rats paw edema, acetic acid-induced writhing test, hot plate test, egg albumen-induced edema, histamine-induced rat paw edema, topical edema of the mouse ear[63-75]. Pharmacology of some anti-inflammatory barks was discussed in table 2.

Table 1: **A brief description of common anti-inflammatory barks from Ayurveda**[30-62]

Sr.no.	Botanical/Family name	Ayurvedic name	Chemical constituents	Other biological activities
1	*Oroxylum indicum*, Bignoniaceae	Shyonaaka	Flavones and their glycosides including baicalein and scutellarein; aloe-emodin	Stomachic, spasmolytic carminative
2	*Ailanthus excela,* Simarubaceae	Aralu	Quassinoids (ailanthone derivatives)	Bitter, astringent, febrifuge, antispasmodic, expectorant, anthelminitic
3	*Albizia lebbeck,* Leguminosae	Siris	Flavonoids, triterpenoids, triterpenoid saponins; oleanolic acid, albigenic acid, albigenin and acacic acid	Antiseptic, antibacterial, antiallergic
4	*Azadirachta indica,* Meliaceae	Nimba	Tetranortriterpenoids	Antimicrobial, antifungal, anthelmintic, insecticidal, antiviral, antipyretic
5	*Balanites roxburghii,* Simaroubaceae	Ingudi	Steroidal saponins	Expectorant, bechic, antibacterial, antifungal
6	*Betula alnoides,* Betulaceae	Bhojapatra	Methyl salicylate	Used in supportive therapy of rheumatic ailments
7	*Carallia brachiata,* Rhizophoraceae	Karalli	Alkaloids	Treating oral ulcers, stomatitis
8	*Cassia fistula,* Caesalpiniaceae	Aaragvadha	Anthraquinone glycosides, sennosides A and B, rhein and its glucoside, barbaloin, aloin, formic acid, butyric acid and their ethyl esters	Purgative, febrifugal, astringent
9	*Stachytarpheta jamaicensis*, Verbenaceae	Kariyarthara ni	Friedelin, stigmasterol, ursolic acid, hispidulin, scutellarein, choline, phenolic acids, chlorogenic acid, apigenin	Febrifuge
10	*Bauhinia variegate*, Caesalpiniaceae	Kaanchanaara	Flavonoids, kaempferol-3 galactoside and kaempferol-3-rhamnoglucoside	Used in diarrhoea, dysentery, worm infestation
11	*Garcinia mangostana*, Guttiferae	Mangusta	Anthocyanin glycosides, maclurin and several prenylated and related xanthones	Antileucorrhoeic, astringent, antifungal, antibacterial
12	*Lannea coromandelica,* Anacardiaceae	Jingini	Cluytyl ferulate, lanosterol, epicatechin,leucocyanidin, ellagic acid, quercetin, arabinoside	Stimulant and astringent
13	*Crataeva nurvala,* Capparidaceae	Varuna	Lupeol	Diuretic
14	*Dalbergia sissoo,* Papilionaceae	Shimshapaa	Isoflavone (sissotrin),tannins	Bitter, stimulant
15	*Ficus bengalensis,* Moraceae	Vata	Bengalenoside, flavonoid glycosides, leucocyanidin and leucopelargonidin	Used in diabetes, dysentery and in seminal weakness
16	*Ficus religiosa*,	Ashvattha	β-sitosteryl-D-glucoside,	Astringent, antiseptic,

	Moraceae		Vitamin K, *n*-octacosanol, methyl oleanolate, lanosterol, stigmasterol, lupen-3-one	alterative, laxative, haemostatic
17	*Helicteres isora,* Sterculiaceae	Aavartani	Diosgenin, cucurbitacin B, iso-cucurbitacin B	Antidiarrhoeal, astringent, antibilious
18	*Machilus macrantha,* Lauraceae	Jyotishmati	Phytosterols, glycosides and alkaloids (machiline)	Antirheumatic, purgative Antiasthmatic
19	*Jatropha curcas,* Euphorbiaceae	Vyaaghraira nd	Curcosones, lathyrane diterpenes	Purgative
20	*Mangifera indica,* Anacardiaceae	Aamra	Gallotannin, phloroglucinol, protocatechuic acid, flavonoids	Astringent, antiscorbutic
21	*Moringa oleifera,* Moringaceae	Shigru	Nitrile glycosides, niazirin and niazirinin	Antipyretic, anthelmintic
22	*Murraya koenigi,* Rutaceae	Surabhini-nimba	Coumarin glucoside, scopolin	Stomachic, antiprotozoal, spasmolytic; promotes appetite and digestion
23	*Boswellia serrata,* Burseraceae	Shallaki	Triterpenes of oleanane, ursane and euphane series	Antiseptic, anti inflammatory, antiatherosclerotic, emmenagogue, analgesic
24	*Pongamia pinnata,* Fabaceae	Naktmaal	Flavonoids and related compounds flavones, furanoflavonoids, chromenochalcones, coumarones, flavone glucosides, sterols, triterpenes and a modified phenylalanine dipeptide	Used for skin diseases-eczema, scabies, leprosy
25	*Pterospermum acerifolium*, Sterculiaceae	Muchakunda	Betulin, lupeol, bauerenol, friedelin and β-sitosterol	Styptic
26	*Sesbania grandiflora,* Papilionaceae	Agastya	Saponins	Astringent, antihistaminic, febrifuge
27	*Xeromphis spinosa,* Rubiaceae	Madana	Saponins	Nervine, calmative, antispasmodic
28	*Wrightia tinctoria,* Apocynaceae	Shveta Kutaja	Cycloartanes, cycloartenone and cycloeucalenol along with α- and β-amyrin, β-sitosterol, ursolic acid, oleanolic acid, terpene, wrightial	Antidysenteric
29	*Vitex leucoxylon,* Verbenaceae	Paaraavatapadi	Flavonoids	Febrifuge, astringent
30	*Sesbania sesban*, Papilionaceae	Jayantikaa	Cholesterol, campesterol, β-sitosterol, cyanidin and delphinidin glucosides	Astringent, emmenagogue

Table 2: **Pharmacology of some anti-inflammatory barks**[63-75]

Sr.no.	Plant/Family name	Extract /compound	Dose (mg/kg)	Anti-inflammatory model	Result of study
1	*Acanthopanax senticosus,* Araliaceae	Liriodendrin	5, 10	Acetic acid-induced writhing test; hot plate test	Liriodendrin significantly inhibited the increase of vascular permeability induced by acetic acid in mice and reduced an acute paw edema induced by carrageenan in rats
2	*Albizia chinensis,* Fabiaceae	Chloroform	200, 400	Carrageenan induced rats paw edema	Extract showed significant decrease in the paw volume when compared to control and positive control
3	*Croton zambesicus,* Euphorbiaceace	Ethanolic	27-81	Carrageenan induced edema in mice; Acetic acid induced writhing in mice	Extract showed significant analgesic and antipyretic activities though with a weak anti-inflammatory activity
4	*Cussonia paniculata,* Araliaceae	Aqueous	50, 100, 200	Carrageenan induced rat paw edema; Histamine-induced rat paw edema	Plant's activity may be mediated by cyclooxygenase I and II inhibition
5	*Kalopanax pictus,* Araliaceae	Aqueous	250µg/ml	Measurement of nitrite concentration; Macrophage culture	Extracts inhibits NO (nitric oxide) synthesis and *i*NOS (inductible nitric oxide synthase) expression in macrophages
6	*Khaya grandifoliola,* Meliaceae	Methanolic	200	Carrageenan induced paw edema	The present study established the anti inflammatory activity of the methanolic extract of *K.grandifoliola* in a number of experimental rats and mice models
7	*Kigelia africana,* Bignoniaceae	Ethanolic	500	Carrageenan induced paw edema	Inhibition of the synthesis of prostaglandins and other inflammatory mediators
8	*Margaritaria discoidea,* Euphorbiaceae	Aqueous	50, 100, 200	Carrageenan induced rat paw edema; Histamine induced rat paw edema	Extract significantly reduced the formation of edema induced by carrageenan and histamine
9	*Mitragyna ciliate*, Rubiaceae	Methanolic	50	Carrageenin induced paw edema; 5-lipoxygenase assay	Extract exhibited no inhibition on 5-lipoxygenase. However, this extract produced about 70% inhibition of carrageenan-induced paw edema
10	*Olax viridis,* Olacaeceae	Hexane, methanolic	200, 400, 800	Egg albumen induced edema	Extract significantly caused edema inhibition
11	*Zizyplus rugosa,* Rhamnaceae	Aqueous	50, 100	Carrageenan induced paw edema	Root bark extracts showed significant anti-inflammatory effect in the acute phase of the inflammation process as

					compared with NSAIDs products
12	*Uncaria tomentosa*, Rubiaceae	Hydroalcoholic	50, 100, 200, 500	Carrageenan induced paw edema model in mice	Inhibitory activity on cyclooxygenase I and II
13	*Securidaca longipedunculata,* Polygalaceae	Methanolic	500	Topical edema of the mouse ear	Extract and fractions inhibited topical edema induced by xylene in the mouse ear

Conclusion

Barks of plants have been a prime source of highly effective conventional drugs. Many studies have been performed to identify anti-inflammatory compounds with desired pharmacological activity and a limited toxicity. This review makes an attempt to give scientific account of use of valuable plant barks as anti-inflammatory source. Also the various secondary metabolites from barks like Coumarins, terpenes, flavonoids, sterols, saponins, glycosides *etc*. have been exerting wide range of anti-inflammatory activity. Thus successful results have been achieved by following an appropriate screening approach.

References

1. Calixto JB, Campos MM, Otuki MF, Santos ARS. ‘‘Anti-inflammatory compounds from plant origion. Part II. Modulation of Pro-inflammatory cytokines, chemokines and adhesion molecules’’. Planta medica 2004; 70:93-103.
2. Percival M. ‘‘Understanding the Natural Management of Pain and Inflammation’’. Clinical nutrition insights 1999; 4:1-5.
3. Boursinos LA, Karachalios T, Poultsides L, Malizos KN. ‘‘Do steroids, conventional non-steroidal anti-inflammatory drugs and selective Cox-2 inhibitors adversely affect fracture healing’’. J Musculoskelet Neuronal Interact 2009; 9(1): 44-52.
4. Luna SPL, Basilio AC, Steagall VMP, Machado LP, Moutinho FQ, Takahira RK, Brandao CVS. ‘‘Evaluation of adverse effects of long-term oral administration of carprofen, etodolac, flunixin meglumine, ketoprofen, and meloxicam in dogs’’. AJVR, 2007; 68(3):258-264.
5. Srinivasan K, Muruganandan S, Lal J, Chandra S, Tandan SK, Ravi Prakash. V. ‘‘Evaluation of anti-inflammatory activity of *Pongamia pinnata* in rats’’. J. Ethnopharmacol. 2001; 78: 151–157.
6. Alexandrina L. Dumitrescu.‘‘Antibiotics and Antiseptics in Periodontal Therapy’’. Berlin/Heidlburg, Springer verlang 2010.
7. Durmowicz AG, Stenmark KR. Mechanisms of Structural Remodeling in Chronic Pulmonary Hypertension**.** Pediatr. Rev. 1999; 20: *e*91-*e*101.
8. Arif T, Bhosale JD, Kumar N, Mandal TK, Bendre RS, Lavekar GS, Dabur R. ‘‘Natural products- antifungal agents derived from plants’’. Journal of Asian Natural Products Research 2009; 11(7): 621-638.
9. Dasilva EJ. ‘‘Medicinal plants: a re-emerging health aid’’. Electronic Journal of Biotechnology 1999; 2(2):57-70.
10. Verma S, Singh SP. ‘‘Current and future status of herbal medicines’’. Veterinary World 2008; 1(11): 347-350.
11. Tiwari S. ‘‘Plants: A Rich Source of Herbal Medicine’’. Journal of Natural Products 2008; 1:27-35.
12. Shah V K, Zalavadiya VI, Sheth NR, Raval MK, Dudhrejiya AV, Golwala DK. ‘‘Standardization and Assessment of Preformulation Parameters of Rasayana Tablet’’. International Journal of Pharmaceutical Sciences and Drug Research 2010; 2(1): 58- 62.
13. Gupta M, Shaw BP. ‘‘Uses of medicinal plants in Panchkarma Ayurvedic therapy’’. Indian Journal of traditional knowledge 2009; 8(3), 372-378.
14. Yuan G, Wahlqvist ML, He G, Yang M, Li D. ‘‘Natural products and anti inflammatory activity’’. Asia Pac J Clin Nutr. 2006; 15 (2): 143-152.
15. Kokate CK, Purohit AP, Gokhale SB. ‘‘Pharmacognosy’’. 29th Edn.Nirali Prakashan, Pune Mumbai 2004.
16. Druilhe P, Brandicourt O, Chongsuphajaisiddhi T, Berthe J. ‘‘Activity of a Combination of Three Cinchona Bark Alkaloids against *Plasmodium falciparum* In Vitro’’. Antimicrobial agents and chemotherapy 1998; 32(2): 250-254.
17. Makindet JM, Amusan OOG, Adesogan EK. ‘‘The antimalarial activity of chromatographic fractions of *Spathodea campanulata* stem bark extracts against *Plasmodium berghei* in mice’’. Phytotherapy Research 1990; 4: 53–56.
18. Oluwakanyinsola SA, Adeniyi TY, Babayi H, Angela NC, Anagbogu RA, Agbakwuru VA. ‘‘Anti-malarial activity of ethanolic stem bark extract of *Faidherbia albida* (Del) a. Chev (Mimosoidae) in mice’’. Archives of Applied Science Research, 2010; 2 (5): 261-268.
19. Noungoue DT, Chaabi M, Ngouela S, Antheaume C, Boyom FF, Gut J, Rosenthal PJ, Lobstein A,

Tsamo E. ''Antimalarial Compounds from the Stem bark of *Vismia laurentii*''. Z. Naturforsch 2009; 64 (c): 210 – 214.
20. Halder S, Bharal N, Mediratta PK, Kaur I, Sharma KK. ''Anti-inflammatory, immunomodulatory and antinociceptive activity of *Terminalia arjuna* bark powder in mice and rats''. Indian journal of experimental biology 2009; 47: 577-583.
21. Rajendran R, Basha NS. ''Cardioprotective effect of ethanol extract of stem-bark and stem-wood of *Premna serratifolia* Lin., (Verbenaceae)''. Research J. Pharm. and Tech. 2008; 1(4): 487-491.
22. Gunjal MA, Shah AS, Wakade AS, Juveker AR. ''Protective effect of aqueous extract of *Moringa oleifera* stem bark on serum lipids, marker enzymes and heart antioxidant parameters in isoproterenol induced cardiotoxicity in Wistar rats''. Indian journal of natural product and resources 2010; 1(4): 485-492.
23. Nat JM, Klerx JPAM, Dijk H, Silva KTD, Labadie RP. ''Immunomodulatory activity of an aqueous extract of *Azadirachta indica* stem bark''. Journal of Ethnopharmacology 1987; 19(2): 125-131.
24. Ghaisas MM, Shaikh SA, Deshpande AD. ''Evaluation of the immunomodulatory activity of stem bark of *Bauhinia variegate''*. International Journal of green chemistry 2009; 70-74.
25. Lee YK, Yuk DY, Kim TI, Kim YH, Kim KT, Kim KH, Lee BJ, Nam SY, Hong JT. ''Protective effect of the ethanol extract of *Magnolia officinalis* and 4-*O*-methylhonokiol on scopolamine-induced memory impairment and the inhibition of acetylcholinesterase activity''. Nat Med. 2009; 63(3): 274–282.
26. Deshmukh P, Nandgude T, Rathode MS, Midha A, Jaiswal N. ''Hepatoprotective Activity of *Calotropis* gigantea Root Bark Experimental Liver Damage Induced by D-Galactosamine in Rats''. International Journal of Pharmaceutical Sciences and Nanotechnology 2008; 1(3): 281-286.
27. Thirunavukkarasu P, Ramkumar L, Ramanathan T. ''Anti-ulcer Activity of *Excoecaria agallocha* bark on NSAID-induced Gastric Ulcer in Albino Rats''. Global Journal of Pharmacology 2009; 3(3): 123-126.
28. Kumar G, Banu GS, Murugesan AG. ''Anti-diabetic Activity of *Helicteres isora* L. Bark Extracts on Streptozotocin-induced Diabetic Rats''. International Journal of Pharmaceutical Sciences and Nanotechnology 2009; 1(4): 379-382.
29. Kumar D, Bhujbal SS, Patil PS, Buge PV. ''In vitro and in vivo activities of stem bark of stem bark of *Alianthus excela* in management of asthmas''. International journal of pharmacology 2010; 6(3): 284-289.
30. Khare CP, ''Indian Medicinal Plants'' 1st Edn., Berlin/Heidlburg, Springer verlang 2007.
31. Nadkarni KM, Nadkarni AK. ''Indian Materia Medica'' 3rd Ed., Popular Prakashan, Mumbai, 2005.
32. Kiritikar KR, Basu BD. ''Indian Medicinal Plants''. Vol. 8, International Book Distributors, Dehradun, 1999.
33. Maitreyi Z, Sunita J. ''Anti-inflammatory and analgesic activity of root bark of *Oroxylum indicum*, vent''. Journal of Global Pharma Technology 2010; 2(4):79-87.
34. Patil SB, Reddy UCH, Goudgaon NM. ''Antifungal, anti-inflammatory and analgesic activity of *Ailanthus excelsa* bark''. International Journal of Pharmaceutical Sciences and Research 2010; 1 (12): 119-122.
35. Saha A, Ahmed M.''The analgesic and anti-inflammatory activities of the extract of *Albizia lebbeck* in animal model''. Pak. J. Pharm. Sci. 2009; 22(1): 74-77.
36. Biswas K, Chattopadhyay I, Banerjee R, Bandyopadhyay U. ''Biological activities and medicinal properties of neem (*Azadirachta indica*)''. Current science 2002; 82: 11.
37. Singh V, Patel JR, Gaur K, Tyagi LK, Kori ML. ''*In vitro* Antioxidant Activity and Phytochemical Analysis of Stem Bark of *Balanites roxburghii* Planch''. Advances in Biological Research 2009; 3 (5-6): 242-246.
38. Sur TK, Pandit S, Battacharyya D, Kumar CKA, Lakshmi SM, Chatttopadhyay D, Mandal SC. ''Studies on the anti-inflammatory activity of *Betula alnoides* bark''. Phytotherapy Research 2002; 16: 669–671.
39. Krishnaveni B, Neeharika V, Srikanth AV, Madhava Reddy B. ''Anti-Inflammatory Activity of *Carallia brachiata* Bark''. International Journal of Pharmaceutical Sciences and Nanotechnology 2009; 1(4):375-378.
40. Ilavarasan R, Mallika M, Venkataraman S. ''Anti-inflammatory and antioxidant activities of *Cassia fistula linn* bark extracts''. Afr. J. Trad. CAM 2005; 2 (1): 70-85.
41. Sulaiman MR, Zakaria ZA, Chiong HS, Lai SK, Israf DA. ''Antinociceptive and Anti-Inflammatory Effects of *Stachytarpheta jamaicensis* (L.) Vahl (Verbenaceae) in Experimental Animal Models''. Med Princ Pract 2009; 18: 272-279.
42. Velmurugan C, Balasubramanian V, Devangam SS, Thavasi D. ''Evaluation of anti-inflammatory activity of ethanolic and acetonic extracts of *Bauhinia variegate*''. Int J Pharm Sci Bio 2010; 1(3):138-140.

43. Chomnawang MT, Surassmo S, Nukoolkarn VS, Gritsanapan W. ''Effect of *Garcinia mangostana* on inflammation caused by Propionibacterium acnes''. Fitoterapia 2007; 78: 401–408.
44. Singh S. and Singh GB. ''Anti-inflammatory activity of *Lannea coromandelica* bark extract in rats''. Phytotherapy Research1994; 8: 311–313.
45. Geetha T, Varalakshmi P. ''Anticomplement activity of triterpenes from *Crataeva nurvala* stem bark in adjuvant arthritis in rats''. General Pharmacology 1999; 32(4): 495-497.
46. Asif M, Kumar A. ''Anti-inflammatory activity of ethanolic extract of *Dalbergia sissoo (roxb.)* bark''. Malaysian Journal of Pharmaceutical Sciences 2009; 7(1): 39-50.
47. Patil VV, Patil VR. ''A comparative evaluation of anti-inflammatory activity of the bark of *Ficus bengalensis* in plants of different age''. Journal of Basic and Clinical Pharmacy 2010; 1(2): 108-113.
48. Verma M, Chaudhary S, Garg VK, Tyagi S. ''Anti-inflammatory and analgesic activity of methanolic extract of stem bark of *Ficus religiosa*''. International journal of Pharma professional research 2010; 1(2): 145-147.
49. Jain PS, Patil RR, Haswani NG. ''Anti-inflammatory activity of *Helicteres isora* linn. Stem bark extracts in rats. Asian'' Journal of Pharmaceutical and Clinical Research 2009; 2(4): 63-65.
50. Tatiya AU, Hatapakki BC. ''Anti-inflammatory activity of bark of *Machilus macrantha*''. International journal of pharmaceutical sciences 2003; 532-533.
51. Igbinosa OO, Igbinosa EO, Aiyegoro OA. ''Antimicrobial activity and phytochemical screening of stem bark extracts from *Jatropha curcas* (Linn)''. African Journal of Pharmacy and Pharmacology 2009; 3(2): 058-062.
52. Wauthoz N, Balde A, Balde ES, Damme MV, Duez P. ''Ethnopharmacology of *Mangifera indica* L. Bark and Pharmacological Studies of its Main C Glucosylxanthone, Mangiferin''. International Journal of Biomedical and Pharmaceutical Sciences 2007; 1(2): 112-119.
53. Chandrashekar KS, Thakur A, Prasanna KS. ''Anti-inflammatory activity of *Moringa oleifera* stem bark extracts against carrageenen induced rat paw edema.'' J. Chem. Pharm. Res. 2010; 2(3): 179-181.
54. Muthumani P, Venkatraman S, Ramseshu KV, Meera R, Devi P. '' Pharmacological studies of anticancer, anti inflammatory activities of *Murraya koenigii* (Linn) Spreng in experimental animals''. Journal of pharmaceutical sciences and research 2009; 1(3): 137-141.
55. Sharma A, Bhatia S, Kharya MD, Gajbhiye V, Ganesh N. ''Anti-inflammatory and analgesic activity of different fractions of *Boswellia serrata.''* International Journal of Phytomedicine 2010; 2: 94-99.
56. Smitha NG, Asif KA, Mukesh SS, Geetanjali SS. ''Anti-inflammatory activity of *Pongamia pinnata* stem bark in rats''. Journal of Pharmacy Research 2010; 3(4), 828-830
57. Kumar MA, Jitendra J. ''Anti inflammatory and analgesic activity of bark extract of *Pterospermum acerifolium''.* International Journal of Current Pharmaceutical Research 2009; 1(1): 32-37.
58. Tamboli SA. ''Anti-inflammatory activity of *Sesbania grandiflora*''. Indian drugs 1996; 33(10)504-506.
59. Das BN, Saha A, Ahmed M. ''Anti-inflammatory activity of bark of *Xeromphis spinosa*''. A journal of the Bangladesh Pharmacological Society 2009; 4: 76-78.
60. Tharkar PR, Tatiya AU, Surana SJ, Bhajipale NS. ''Anti-inflammatory Study of *Wrightia tinctoria* R.Br Stem Bark in Experimental Animal Models''. International Journal of PharmTech Research 2010; 1(4): 2434-2437.
61. Krishnaraju AV, Rao CBM, Sundararaju D. ''Anti-Inflammatory Activity of *Vitex leucoxylon* L. Bark Extracts against Freund's Complete Adjuvant Induced Arthritis in Sprague Dawley Rat''. American Journal of Infectious Diseases 2009; 5 (2): 68-73.
62. Patil RB, Nanjwade BK, Manvi FV. ''Effect of *Sesbania grandiflora* and *Sesbania sesban* bark on carrageenan induced acute inflammation and adjuvant-induced arthritis in rats''. Pharma science monitor: An international journal of pharmaceutical sciences 2010; 1(1): 75-89.
63. Jung HJ, Park HJ, Kim RG, Shin KM, Ha J, Choi JW, Kim HJ, Lee YS, Lee KT. ''In vivo anti-inflammatory and antinociceptive effects of liriodendrin isolated from the stem bark of *Acanthopanax senticosus*''. Planta Med. 2003; 69(7):610-6.
64. Perumal GN, Shankar RB, Malini S, Soumya V, Janardhanan S, Palanivel V, Kumar SKL. ''Anti-inflammatory and ulcer prtotective activities of chloroform extract of *Albizzia chinensis* bark and its phytochemical studies''. Der Pharmacia Sinica, 2010, 1 (1): 95-103.
65. Okokon JE, Nwafor PA. ''Anti-inflammatory, analgesic and antipyretic activities of ethanolic root extract of *Croton zambesicus''.* Pak. J. Pharm. Sci., 2010; 23(4): 385-392.
66. Adedapo AA, Sofidiya MO, Maphosa V, Moyo B, Masika PJ, Afolayan AJ. ''Anti-inflammatory and

analgesic activities of the aqueous extract of *Cussonia paniculata* stem Bark''. Rec. Nat. Prod. 2008; 2:2 46-53.

67. Bang SY, Park GY, Park SY, Kim JH, Lee YK, Lee SJ, Kim YH. ''The Stem Bark of *Kalopanax pictus* Exhibits Anti-inflammatory Effect through Heme Oxygenase-1 Induction and NF-κB Suppression''. Immune network 2010; 10(6): 212-218.
68. Falodun A, Poh CF, Adelusi SA, Emmanuel O. ''Phytochemical and anti inflammatory evaluation of *Khaya grandifoliola* stem bark extract''. International Journal of PharmTech Research 2009; 1(4): 1061-1064.
69. Owolabi OJ, Omogbai KIE. ''Analgesic and anti-inflammatory activities of the ethanolic stem bark extract of *Kigelia Africana* (Bignoniaceae*)''*. African Journal of Biotechnology 2007; 6(5): 582-585.
70. Adedapo AA, Sofidiya MO, Afolayan AJ. ''Anti-inflammatory and analgesic activities of the aqueous extracts of *Margaritaria discoidea* (Euphorbiaceae) stem bark in experimental animal models''. Int. J. Trop. Biol. 2009; 57(4): 1193-1200.
71. Dongmo AB, Kamanyi A, Dzikouk G, Nkeh BCA, Tan PV, Nguelefack N, Nole T, Bopelet M, Wagner H. ''Anti-inflammatory and analgesic properties of the stem bark extract of *Mitragyna ciliata* (Rubiaceae) Aubrev. and Pellegr''. Journal of Ethnopharmacology 2003; 84:17-21.
72. Ajali U, Okoye FBC. ''Antimicrobial and anti-inflammatory activities of *Olax viridis* root bark extracts and fractions''. International Journal of Applied Research in Natural Products 2009; 2(1): 27-32.
73. Yadav A, Singh P. ''Analgesic and anti-inflammatory activities of *Zizyphus rugosa* root barks''. J. Chem. Pharm. Res. 2010, 2(3):255-259.
74. Aguilar AL, Rojas P, Marcelo A, Plaza A, Bauer R, Reininger E, Klaas CA, Merfort I. ''Anti-inflammatory activity of two different extracts of *Uncaria tomentosa* (Rubiaceae)''. Journal of Ethnopharmacology 2002; 81: 271-276.
75. Okoli CO, Akah PA, Ezugworie U. ''Anti-inflammatory activity of extracts of root bark of *Securidaca longipedunculata* Fres (Polygalaceae)''. Afr. J. Trad. CAM 2005; 2 (3): 54 – 63.

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