

Research and Reviews: Journal of Pharmacy and Pharmaceutical Sciences

Potential Anti-Arthritic Agents From Indian Medicinal Plants

Samrat Chauhan¹, Lalit Kishore¹, Navpreet Kaur¹, Randhir Singh¹

¹M.M.College of Pharmacy, Maharishi Markandeshwar University, Mullana, Ambala, Haryana, India-133207

Research Article

Received date: 13/07/2015

Accepted date: 20/08/2015

Published date: 28/08/2015

*For Correspondence

Randhir Singh, M.M. College of Pharmacy,
Maharishi Markandeshwar University, Mullana,
Ambala, Haryana, India-133207; Tel: 91-
9896029234

E-mail: randhirsingh.dahiya@gmail.com

Keywords: Anti-arthritic activity, chemical moieties
medicinal plants.

ABSTRACT

Traditional medicines are used globally for management of rheumatoid arthritis since prehistoric times. This review emphasizes on the Indian medicinal flora and their traditional utilization in the management of rheumatoid arthritis. Peer reviewed articles from the last three decades and the classical textbooks were examined for bibliographic investigation. Plant extract traditionally used for ameliorating arthritic condition have been studied in the present review. 124 plants, traditionally used in the management of arthritis have been recorded. This study reflects the need to explore potential chemical moieties from unexploited plants in arthritic management along with the mechanism of action through which they would act, remain to be studied.

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic, progressive, and systemic inflammatory disorder. It preferentially affects the synovial membranes of joints and eventually leads to bone and cartilage destruction. RA affects 0.5%–1% of the adult population worldwide; the disease targets patients from every ethnic background and predominately females (2- or 3-fold more often than males). Although RA can occur at any age, it is more frequent among individuals in the fourth to sixth decades of life^[1]. As a chronic disease which causes irreversible joint damage, RA exacts high costs from both the patients and society at large. The clinical manifestations of RA can be classified as articular and extra-articular. RA is indicated by fever, asthenia, fatigue, myalgia, and weight loss which appear before or concomitantly with the onset of the articular manifestations like synovial thickening, erythema, warmth and decreased mobility.

Pathophysiology

RA is associated with several genetic and environmental factors that contribute the phenotype in different combinations (**Figure 1**). RA is initiated by immune complexes and complement system, perpetuated by cytokines, and affected by metalloproteinases^[2]. Antigen-activated CD4+ T cells stimulate monocytes, macrophages, and synovial fibroblasts which in turn lead to the production of cytokines interleukin-1, interleukin-6, and TNF α and secretion of matrix metalloproteinases through cell-surface signalling^[3]. In early RA, large amount of neutrophils are present in synovial fluid^[4]. Chronically, hypertrophy and hyperplasia forms projections into the joint capsule. Immune complexes found in the synovial fluid often are IgG/anti-IgG antigen-antibody complex^[5]. In RA bone erosions caused by osteoclasts and proteolytic enzymes causes cartilage dissolution^[6]. Rheumatoid factors (IgM & IgA) are key pathogenic markers^[7].

MATERIAL AND METHODS

In this review, bibliographic investigation was done to retrieve articles available in the worldwide scientific databases viz. SCOPUS, PUBMED, SCIELO, NISCAIR and Google Scholar. Botanical names of plants were verified from International Plant Names Index, 2014 and the plant list, 2014. The inclusion criteria for the selection of plants includes (i) medicinal herbs with reported

animal studies in management of arthritis, (ii) compounds isolated from medicinal plants with attributed potential in relieving arthritis and (iii) we limited studies to those published in the English language.

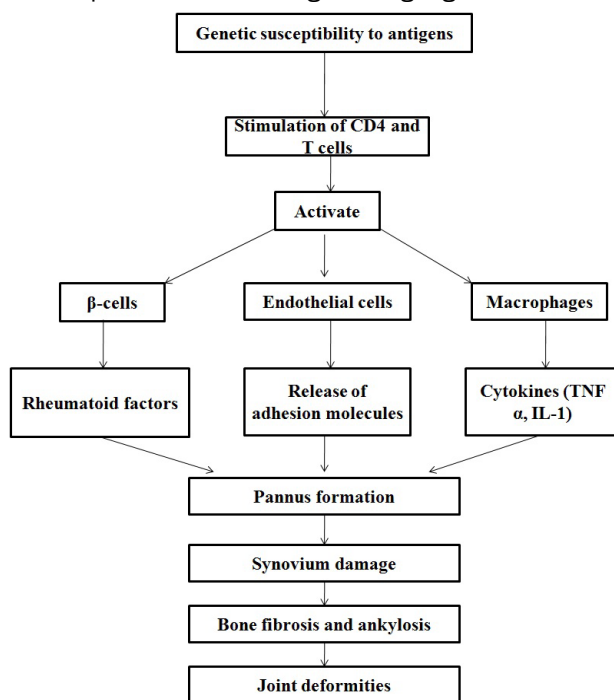


Figure 1. Possible molecular mechanism for arthritis

RESULTS

One hundred and twenty four plants were reviewed from classical text books for their traditional use in rheumatoid arthritis (Table 1).

Table 1. Plants with traditional/folkloric use in arthritis

S.No.	Name	Family	Common name	Part used	Disease	References
1.	<i>Acacia polyantha</i>	Mimosaceae	Svetakhair, kadarah	Heartwood	Rheumatism	AryaVaidyaSala ^[19]
2.	<i>Achillea millefolium</i> Linn.	Compositae	Gandana	Plant	Rheumatism	Kritikar KR ^[8]
3.	<i>Adenantha pavonina</i> Linn.	Mimosaceae	Barigumchi, raktachandana	Leaves	Chronic rheumatism, gout	
4.	<i>Alangium lamarkii</i> Thwaites.	Alangiaceae	Akhaul, akola	Leaves	Rheumatic pains	
5.	<i>Alangium salviifolium</i> Wang	Alangiaceae	Angol, dhera	Roots	Rheumatism	AryaVaidyaSala ^[19]
6.	<i>Alpinia galanga</i> (L.) Willd.	Zingiberaceae	Kulanajn	Rhizomes	Rheumatoid arthritis	
7.	<i>Apium graveolens</i> Linn.	Umbelliferae	Ajmud, boriajmud	Seeds	Rheumatism	Kritikar KR ^[8]
8.	<i>Azima tetraacantha</i> Lam.	Salvadoraceae	Kantagurkamai	Root bark, leaves	Rheumatism	
9.	<i>Bassia latifolia</i> Roxb.	Sapotaceae	Mahua, janglimohva	Bark	Rheumatism	
10.	<i>Bassia longifolia</i> Linn.	Sapotaceae	Mahua, moha	Bark	Rheumatism	
11.	<i>Caesalpinia sappan</i> Linn.	Caesalpinaceae	Bakam, patang, tairi	Wood	Rheumatism	
12.	<i>Carthamus tinctorius</i> Linn.	Compositae	Barre, kussum	Seeds oil	Pain in joints, rheumatism	AryaVaidyaSala ^[20]
13.	<i>Cassia fistula</i> Linn.	Caesalpinaceae	Amaltas, girmala	Leaves and fruits	Rheumatism	
14.	<i>Cassia fistula</i> Linn.	Caesalpinaceae	Amaltas, girmal	Fruits	Rheumatism	
15.	<i>Cichorium intybus</i> Linn.	Compositae	Kasni	Root	Inflammation and pain in joints	AryaVaidyaSala ^[20]
16.	<i>Cinchona officinalis</i> Linn.	Rubiaceae	Kunain	Bark	Arthralgia	
17.	<i>Cirhorium intybus</i> Linn.	Asteraceae	Kasni	Whole plant	Arthralgia	

18.	<i>Citrullus colocynthis</i> (L.) Schrad.	Cucurbitaceae	Badi- indrayan, makkal	Roots	Rheumatalgia	AryaVaidyaSala ^[20]
19.	<i>Commiphora myrrha</i> (nees) Engl.	Burseraceae	Bol, hirabol	Gum	Rheumatoid arthritis	
20.	<i>Commiphora wightii</i> (arn.) Bhandari	Burseraceae	Hill-mango	Leaves	Rheumatalgia	
21.	<i>Corallocarpus epigeous</i> (Rottler) Hook.f.	Cucurbitaceae	Akasgaddah, rakasgaddah	Plant	Rheumatism	Kritikar KR ^[8]
22.	<i>Cordia dichotoma</i> G.Forst.	Boraginaceae	Lasura, lasora	Fruits	Arthralgia	
23.	<i>Cotula anthemoides</i> Lour.	Compositae	Babuna, babunah	Plant oil	Rheumatism	
24.	<i>Dastica cannabina</i> Linn.	Datisceae	Akalbir, bhangjala	Root	Rheumatism	
25.	<i>Delonix elanta</i> (L.) Gamble	Caesalpiniaceae	Tiger bean, sankasura	Plant	Rheumatism	
26.	<i>Dichrosta chyscinerea</i> Linn.	Mimosaceae	Vurtulli, kheri	Roots	Arthralgia	
27.	<i>Dichrosta chyscinerea</i> Wight & Arn.	Mimosaceae	Kheri, vartuli	Root	Rheumatism	
28.	<i>Diospyros candolleana</i> Wight	Ebenaceae	Kari, karikkattai	Bark	Rheumatism	
29.	<i>Diospyros paniculata</i> Dalzell	Ebenaceae	Karivella, karundubarai	Bark	Rheumatism	AryaVaidyaSala ^[20]
30.		Polypodiaceae	Asvakatri, katikapan	Rhizomes	Arthralgia	
31.	<i>Drynaria quercifolia</i> (Linn.)	Compositae	Gokhru, utakanta	Plant	Pain in joints	
32.	<i>Echino psechinatus</i>	Euphorbiaceae	Tidhara	Juice	Rheumatism	Kritikar KR ^[8]
33.	<i>Ephorbia antiquorum</i> Linn.	Myrtaceae	Dugdugia, jamawa	Fruit	Rheumatism	
34.	<i>Eugenia operculata</i> Roxb.	Myrtaceae	Puvala, bhedas	Plant	Rheumatism	
35.	<i>Eugenia spicata</i> Lam.	Euphorbiaceae	Sehund, thuhar	Whole plant	Rheumatism	
36.	<i>Euphorbia ligularia</i> Roxb.	Umbelliferae	Hing, hingra	Stem, leaves	Rheumatism	
37.	<i>Ferula narthex</i> Boiss.	Moraceae	Bat, bargad	Aerial root, bark, leaves, buds, fruits, latex	Antiarthritic	AryaVaidyaSala ^[21] Kritikar KR ^[8] AryaVaidyaSala ^[21] Kritikar KR ^[8]
38.	<i>Ficus benghalensis</i> Linn.	Flacourtiaceae	Paniyala, paniyamalak	Fruits	Rheumatism	
39.	<i>Flacourtia jangomas</i> rausch.	Liliaceae	Kakoli	Bulbs	Rheumatalgia	
40.	<i>Fritillaria roylei</i> Hook. F.	Rutaceae	Girgiti, potali	Whole plant	Rheumatism	
41.	<i>Glycosmis arborea</i> (Roxb.) Dc.	Malvaceae	Kapas, ruyi	Leaves	Rheumatoid arthritis	
42.	<i>Gossypium herbaceum</i> Linn.	Compositae	Mukhatari, mustaru	Root	Rheumatism	
43.	<i>Grangea maderaspatana</i> (L.) Poir.	Boraginaceae	Siriyari, hattasura	Whole plant	Rheumatism	
44.	<i>Heliotropium indicum</i> Linn.	Asclepiadaceae	Anantamul, magrabu	Roots	Arthralgia	
45.	<i>Hemidesmus indicus</i> (Linn.) R.br.	Malpighiaceae	Madhavilata, madhumalati	Bark, leaves, flowers	Rheumatism	
46.	<i>Hiptage benghalensis</i> (Linn.) Kurz	Apocynaceae	Kurci, kuda	Bark, seeds	Rheumatism	
47.	<i>Holarrhena pubescens</i> Wall. ex G. Don	Ulmaceae	Cilbil, kanju	Bark, leaves	Rheumatism	
48.	<i>Holoptela integrifolia</i> (Roxb.) Planch.	Solanaceae	Khurasaniajavayan, khurassanijamani	Leaves, seeds	Rheumatoid arthritis	
49.	<i>Hyoscyamus niger</i> Linn.	Magnoliaceae	Anasphal	Fruits	Rheumarthritis	
50.	<i>Illicium verum</i> Hook. F.	Asteraceae	Pohakarmul, puskarmul	Roots	Arthralgia	
51.	<i>Inula racemosa</i> Hook. F.	Convolvulaceae	Kaladana, jharmaric	Seeds	Arthralgia	
52.	<i>Ipomoea nil</i> (Linn.) Roth	Oleaceae	Chambeli	Root	Rheumatism	
53.	<i>Jasminum grandiflorum</i> Linn.	Oleaceae	Kundphul	Flowers	Rheumatism	
54.	<i>Jasminum multiflorum</i> (Burm.f.) Andr.	Euphorbiaceae	Jungle erand, paharierand	Seeds (oil)	Rheumatism	
55.	<i>Jatropha curcas</i> Linn.	Juglandaceae	Akhor, akhrot	Fruits	Rheumatism	
56.	<i>Juglans regia</i> Linn. Var. <i>Kumaonia</i> dc.	Acanthaceae	Nilinirgundi, udisambhalu	Roots, leaves	Rheumatism	
57.	<i>Justicia gendarussa</i> Burm.f.	Zingiberaceae	Candramula	Rhizomes, root-stock, leaves	Rheumatism	
58.	<i>Kaempferia galanga</i> Linn.	Verbenaceae	Caturang, ghaneri	Fruits	Rheumatism	
59.	<i>Lantana camara</i> Linn. Var. <i>Aculeata</i> (Linn.) Moldenke	Compositae	Bankau	Plant juice	Rheumatism	
60.	<i>Launae apinnatifida</i>	Lythraceae	Mehanti, hena	Leaves	Rheumatalgia	
61.	<i>Lawsonia inermis</i> Linn.	Lamiaceae	Chotahalkusa	Leaves, flowers	Arthralgia	
62.	<i>Leucas aspera</i> (Willd.) Link	Liliaceae	Ksirakakoli	Bulb	Rheumatalgia	
63.	<i>Lilium polyphyllum</i> D. Don	Sapotaceae	Mahva, mohva	Seed (oil)	Rheumatism	
64.	<i>Madhuca longifolia</i> (Koenig) Macbride	Anacardiaceae	Aam, aamb	Roots, bark	Rheumatism	

65.	<i>Mangifera indica</i> Linn.	Compositae	Babuna	Oil	Rheumatism	Kritikar KR [8]
66.	<i>Matricaria chamomilla</i> Linn.	Myrtaceae	Kayaputi	Plant oil	Rheumatism	
67.	<i>Melaleuca leucadendron</i> Linn.	Mimosaceae	Lajjavanti, lajvanti	Whole plant	Rheumatism	Kritikar KR [8] AryaVaidyaSala [22]
68.	<i>Mimosa pudica</i> Linn.	Cucurbitaceae	Karela, kareli	Fruit	Rheumatalgia	
69.	<i>Momordica charantia</i> Linn.	Cucurbitaceae	Gangerua, kathaamala	Root	Rheumatism	
70.	<i>Momordica cochinchinensis</i>	Myrtaceae	Murad, vilayatimehndi	Fruit	Rheumatism	
71.	<i>Myrtus communis</i> Linn.	Oleaceae	Pilacameli	Leaves	Rheumatism	
72.	<i>Myxopyrum serratuluma</i> W.Hill	Ranunculaceae	Needamalli	Whole plant	Rheumatalgia	
73.	<i>Naravelia zeylanica</i> (Linn.)	Acanthaceae	Karvi, kara	Roots	Rheumatalgia	
74.	<i>Nilgirianthus ciliates</i> (Nees) Bremek.	Oleaceae	Har, harsinghar	Leaves	Rheumatism	
75.	<i>Nyctanthes arbor-tristis</i> Linn.	Lamiaceae	Babul, babuyitulsi	Whole plant	Arthralgia, rheumatoid arthritis	
76.	<i>Ocimum basilicum</i> Linn.	Oleaceae	Kahu, kau	Root	Rheumatism	
77.	<i>Olea cuspidata</i> Wall. & G.Don	Convolvulaceae	Nisoth, tarbut	Roots	Arthralgia	
78.	<i>Operculina turpethum</i> (Linn.) Silva manso	Rubiaceae	Bakuchi, somraj	Whole plant	Rheumatism	
79.	<i>Paederia foetida</i> Linn.	Rubiaceae	Kankra, papari	Wood	Rheumatism	
80.	<i>Pavetta indica</i> Linn.	Piperaceae	Pan, tambuli	Whole plant	Rheumatism	
81.	<i>Piper betle</i> Linn.	Piperaceae	Kababcini	Dreid unripe berries	Rheumatism	
82.	<i>Piper cubeba</i> Linn.f.	Piperaceae	Kalimirc, mirc	Fruits	Arthritis	
83.	<i>Piper nigrum</i> Linn.	Plumbaginaceae	Chitra, lalchita	Root	Rheumatic affections	
84.	<i>Plumbago rosea</i> Linn.	Plumbaginaceae	Chita, chitarak	Root	Rheumatism	
85.	<i>Plumbago zeylanica</i> Linn.	Apocynaceae	Chameli, gulachin	Root bark	Rheumatic pain	
86.	<i>Plumieria acutifolia</i>	Verbenaceae	Arni, ageta	Leaves	Rheumatalgia	
87.	<i>Premna corymbosa</i> Rottl.	Rosaceae	Bekkra, bhekal	Shrub oil	Rheumatism	
88.	<i>Prinsepia utilis</i> Royle	Mimosaceae	Chhikura, safedkikara	Bark	Rheumatism	
89.	<i>Prosopis spicigera</i> L.	Myrtaceae	Amrud, amrut	Leaves	Rheumatism	
90.	<i>Psidium guajava</i> Linn.	Fabaceae	Bijasal, vijayasar	Heartwood	Rheumatoid arthritis	
91.	<i>Pterocarpus marsupium</i> Roxb.	Fabaceae	Vidarikand, sural	Roots	Arthritis	
92.	<i>Pueraria tuberosa</i> DC.	Rubiaceae	Arar, mainphal	Fruit	Rheumatism	
93.	<i>Randia dumetorum</i>	Apocynaceae	Sundwar	Roots, stem, leaves, flowers	Chronic rheumatsim	
94.	<i>Rhazya stricta</i>	Ericaceae	Cherailu, chimul	Leaves	Chronic rheumatism	
95.	<i>Rhododendron campanulatum</i>	Euphorbiaceae	Erandi, erand	Leaves	Rheumatoid arthritis, arthralgia	
96.	<i>Ricinus communis</i> Linn.	Rosaceae	Gulab	Flower	Rheumatism	
97.	<i>Rosa alba</i> Linn.	Rubiaceae	Mamjith, majith	Roots	Rheumatoid arthritis	
98.	<i>Rubia cordifolia</i> Linn.	Rutaceae	Pismaram, sadab, satari	Leaves	Rheumatalgia	
99.	<i>Ruta chalepensis</i> Linn.	Salvadoraceae	Bahapilu, jhalawan	Seeds(oil)	Painful rheumatic affections	
100.	<i>Salvadora oleoides</i>	Salvadoraceae	Badapilu, jal	Leaves	Rheumatism	
101.	<i>Salvadora persica</i> Linn.	Rubiaceae	Attuvanni, attuvanji	Bark	Rheumatism	
102.	<i>Sarcocephalus missionis</i>	Compositae	Kot, pachak	Root	Rheumatism	
103.	<i>Saussurae lappa</i>	Sapindaceae	Kusum, kausum	Bark	Arthralgia	
104.	<i>Schleichera oleosa</i> (Lour.) Oken	Anacardiaceae	Bhela, bhilva	Fruits	Antiartirrhic	
105.	<i>Semecarpus anacardium</i> Linn.f.	Fabaceae	Hathya, agast, basna	Root-bark	Arthralgia	
106.	<i>Sesbania grandiflora</i> (Linn.) Poir.	Poaceae	Kamguni,	Grains	Rheumatism	
107.	<i>Setaria italica</i> (Linn.) P.beauv	Malvaceae	Bananiyar, bhyunli	Roots	Arthritis	
108.	<i>Sida cordata</i> (Burm.f.) Borssum	Malvaceae	Janglimedhi	Roots, leaves	Rheumatism, arthritis	
109.	<i>Sida rhombifolia</i> Linn.	Solanaceae	Rengani, kateli, kattay	Whole plant	Rheumatoid arthritis	
110.	<i>Solanum surattense</i> Burm.f.	Compositae	Akarkarha, pokormul	Leaves	Rheumatism	

111.	<i>Spilanthe sacmella</i>	Bignoniaceae	Paraal, paatar, paadrii	Leaves	Rheumatalgia	AryaVaidyaSala [23]
112.	<i>Stereospermum colais</i>	Symplocaceae	Bholiya, sodh	Bark	Arthritis	
113.	<i>Symplocos cochinchinensis</i> (Lour.) Moore	Apocynaceae	Chandni	Roots	Arthralgia	
114.	<i>Tabernaemontan adivaricata</i> (Linn.)	Apiaceae	Aj mud, randhuni	Fruits	Rheumatoid arthritis	
115.	<i>Trachyspermum roxburghianum</i> (DC.) Craib	Zygophyllaceae	Gokharu	Whole plant	Rheumarthritis	
116.	<i>Tribulus terrestris</i> Linn.	Boraginaceae	Andhahuli, chotta-kulpha	Whole plant	Arthralgia	
117.	<i>Trichodesma indicum</i> (Linn.)R.br.	Cucurbitaceae	Indrayanmahakal	Fruit	Rheumatism	Kritikar KR [8]
118.	<i>Trichosanthespa Imata</i>	Valerianaceae	Barhana, chakra	Root	Pain in joints	
119.	<i>Valeriana wallichii</i>	Dipterocarpaceae	Saphed dammar, kahruba	Seeds(oil)	Rheumatism	AryaVaidyaSala [23]
	<i>Vateria indica</i> Linn.	Verbenaceae	Samhalu, saubhalu, nirgandi	Roots	Arthritis	
120.	<i>Vitex negundo</i> Linn.	Verbenaceae	Saphed-samhalu, pani-ki-samhalu	Leaves	Arthralgia	
121.	<i>Vitex trifolia</i> Linn.	Vitaceae	Dakh, drakh	Stem(ash)	Arthralgia	
122.	<i>Vitis vinifera</i> Linn.	Mimosaceae	Jambu	Seeds	Rheumatism	Kritikar KR [8]

Out of 124 traditional plants Forty-four articles were used for citing the proved anti-inflammatory and anti-arthritic activity in laboratory animals (**Table 2**).

Table 2. Description of plants containing various active constituents and their action in anti-arthritic activity

S. No.	Plant name	Family	Parts of plant used	Active constituents	Dose, route of administration	Animal model	Standard	Inference
1.	<i>Alangium salviifolium</i> Wang	Alangiaceae	Stem barks	-	100 mg/kg petroleum ether, ethyl acetate, chloroform, methanol and aq. extract.	Fruends adjuant arthritis model	Indomethacin (100 mg/kg),	Extracts showed potent anti-arthritic activity.
2.	<i>Anethum graveolens</i> L. ^[24]	Apiaceae	Aerial parts	d-carvone, d-limonene, and α -phellandrene, Dillanoside, Kaempferol-3-glucuronide, Vicenin, Myristicin	Aq. extract in sesame oil. (topical)	Formalin-induced inflammation in rats	Diclofenac-gel	Reducing the paw inflammation significantly ($p < 0.001$)
3.	<i>Caesalpinia sappan</i> L.	Leguminosae	Heartwood	-	(1.2, 2.4 and 3.6 g/kg) p.o in olive oil-vehicle. Ethanolic extract	Collagen-induced arthritis (CIA) in rats	-	Significantly attenuates CIA by decreasing the IL-1 β , IL-6, TNF- α and PGE2 levels in serum and COX-2 transcription factor NF- κ B in paw cartilage.
4.	<i>Carthamus tinctorius</i> Linn.	Compositae	Roots	saponin 3beta-O-[beta-D-xylopyranosyl(1 \rightarrow 3)-O-beta-D-galactopyranosyl]-lup-12-ene-28 oic acid-28-O-alpha-L-rhamnopyranosyl ester	Isolated from the methanolic fraction	-	-	Showed anti-inflammatory activity in various color reactions, chemical degradations and spectral analysis.
5.	<i>Commiphora myrrh</i> [25].	-	-	sesquiterpenes, diterpenes, and diterpenic acids	(100, 200 mg/kg)85% ethanol extract.Fractions partitioned with petroleum ether, ethyl acetate, n-butanol, and water.	Formalin-induced inflammation in mice, acetic acid induced writhing test and hot-plate test methods.	dolantin and indomethacin	Ethanol and pet. Ether fractions possess analgesic and anti-inflammatory activities

6.	<i>Delonix elata</i> (L.) Gamble	Leguminosae	Bark	-	250 mg/kg (p.o) 40% hydro-alcoholic extract	Complete freund's adjuvant induced arthritis in rats.	Diclofenac(10 mg/kg)	Significant reduction in paw edema after 12 and 21 days.
7.	<i>Dichrostachys cinerea</i> ^[25]	Mimosoideae	Leaves	saponin	250 mg/kg,	Carrageenan induced paw edema in rats	ketoprofen (10 mg/kg)	The leaves of <i>D. cinerea</i> possess potential anti- inflammatory Property
8.	<i>Inula racemosa Hook.f</i> ^[26] .	Compositae	Roots		Alcoholic extract. <i>i.p</i> & <i>p.o</i>	Egg albumin induced passive cutaneous anaphylaxis (PCA) and mast cell degranulation in albino rats.	Disodium cromoglycate (<i>i.p</i>)	Extract possesses potent anti- allergic activity in rats.
9.	<i>Jatropha curcas</i> L ^[27]	Euphorbiaceae	Leaves		10, 20, 40 80mg/ kg (i.p) Methanolic extract	Egg albumin- induced Rat paw oedema	Piroxicam (0.5mg/kg i.p)	<i>Jatropha curcas</i> Extract caused statistically significant (P < 0.001) inhibition of inflammation Induced by egg albumin in the rats.
10.	<i>Juglans regia</i> L ^[28]	Juglandaceae	Leaves		0.41 g/kg, 1.64 g/kg (aq. extract), 0.292 g/kg, 1.17g/ kg (eth. Extract)	Cotton pellet granuloma Method in mice.	Diclofenac (15 mg/kg)	The Aqueous and ethanolic extracts indicated anti-inflammatory effects.
11.	<i>Madhuca longifolia</i> L ^[29] .	Sapotaceae	Seed		10 and 15 mg/kg. ethanol extract. 1.5 and 3 mg/ kgsaponin mixture.	Acute (carrageenan- induced inflammation), sub-acute (formaldehyde- induced inflammation), and chronic (cotton pellet granuloma) models of inflammation in rats.	Diclofenac sodium.	Results indicated a significant anti- inflammatory activity.
12.	<i>Momordica charantia</i> Linn ^[30] .	Cucurbitaceae.	Fruits	Alkaloids, tannins, glyco- sides, steroids, proteins, and carbohydrates.	250 and 500 mg/ kg, po. ethanolic extracts.	Acetic acid- induced writhing and tail- immersion tests in mice, yeast- induced pyrexia in rats	Aspirin (150 mg/kg, p.o.) Paracetamol (20 mg/kg, ip.)	Extract shows significant analgesic and anti-pyretic activity.
13.	<i>Nyctanthes arbor- tristis</i> Linn ^[31]	Oleaceae	Stem bark		methanolic extracts (250 and 500mg/ kg, p.o.),	Carrageenan- Induced pawedema	Diclofenac (100 mg/kg,	The Extract reduced the rate of edema in carrageenan- induced rat paw edema model.
14.	<i>Paederia foetida</i> ^[32] .		Leaves		butanol fraction of a methanol extract	Cotton pellet granuloma model of inflammation in rat.		Significant inhibition of granulation tissue formation in cotton-pellet implanted rats

15.	<i>Rubia cordifolia</i> [33].	Rubiaceae	Roots		300 and 600 mg/kg. hydro-alcoholic extract	Indomethacin-induced enterocolitis in rats		Pre-treatment with extract significantly prevented elevated serum LDH levels and restored it to near-normal value.
16.	<i>Semecarpus sanctum</i> Linn [9].	Anacardiaceae	Nut		150 mg/kg	Adjuvant Arthritis in Rats	Indomethacin	The paw swelling was completely suppressed
17.	<i>Vitex Negundo</i> L [34].	Lamiaceae	Leaves		500 and 1000 mg/kg. (p.o)	Carrageenin-induced rat paw oedema	Phenylbutazone (100 mg/kg p.o.)	Extract significantly decreased the rat paw oedema
18.	<i>Alangium lamarckii</i> Thwaites [35].	Cornaceae	Root		Ethanol extract	Carrageenan induced paw oedema	Diclofenac sodium.	Significant percent inhibition of the maximal paw Oedema in 6h
19.	<i>Azima tetracantha</i> Lam [10].	Salvadoraceae	Leaves	Friedelin	hexane extract	Adjuvant-induced arthritis		Friedelin inhibited 54.5% of paw thickness
20.	<i>Chaenomeles speciosa</i> (Sweet) [36].	Rosaceae	Root		30, 60, 120 mg/kg. intragastrically	Collagen-induced arthritis in rats		Inflammatory responses were inhibited, body weight restored and immune organs weight of rats.
21.	<i>Citrullus colocynthis</i> Schrad	Cucurbitaceae	Immature fruit and seed		petroleum ether, chloroform, ethyl acetate, acetone and methanol extract	Carrageenan-induced paw edema assay in rats, the acetic acid writhing test in mice		Study has demonstrated the analgesic and anti-inflammatory activities of <i>C. colocynthis</i> immature fruit and seed extracts.
22.	<i>Drynaria quercifolia</i> [38].	Polypodiaceae	Rhizome	Catechin, coumarins, flavonoids, phenolics, saponin, steroids, tannins, and triterpenes.	Oral administration, ethanolic extract	Carrageenan-induced paw oedema, cotton pellet-induced granuloma in rats and acetic acid-induced writhing, formalin-induced paw licking test in mice	Indomethacin, sodium salicylate and aspirin	Extract significantly inhibited paw oedema and granuloma formation in rats, acute and delayed phases of formalin-induced pain and acetic acid-induced writhing were significantly reduced in mice.
23.	<i>Ferula narthex</i> Boiss [39].	Apiaceae			50, 100 and 200 mg/kg. (i.p.) methanolic extract	Acetic acid-induced writhing model in mice	Diclofenac sodium (10 mg)	Effects of extract justify its Use in folkloric medicines for the management of pain.

24.	<i>Ficus bengalensis</i> Linn ^[11] .	Moraceae	Bark		100, 200 and 300 mg/kg (i.p). methanolic extract	Complete Freund's Adjuvant induced arthritis, Formalin induced arthritis model and the Agar induced arthritis model	Acetyl salicylic acid (ASA) at 10mg/Kg	Dose -dependent anti-rheumatic activity in all the models and possible action was through the central and peripherally mediated.
25.	<i>Grangea maderaspatana</i> (L.) Poir ^[29] .	Compositae	Whole plant		1 and 3 g/kg methanol extract	Acetic acid-induced writhing in mice		Extract significantly attenuated acetic acid-induced writhing in mice by 50 and 80%, respectively. (P<0.001)
26.	<i>Hemidesmus indicus</i> (L.) R. Br. ex Schult ^[12] .	Apocynaceae	Roots		Hydroalcoholic extract (450 mg/kg, p.o.), ethyl acetate (75 mg/kg, p.o.),	Complete Freund's Adjuvant induced arthritis in rats	Methotrexate	Extract showed anti-arthritic activity.
27.	<i>Holarrhena pubescens</i> (Buch.- Ham.) Wall ^[13] .	Apocynaceae	Seeds	Alkaloids, carbohydrate, glycosides, triterpenoids and steroids	Ethanol extract.,100, 200 and 400 mg/kg (p.o)	Carrageenan-induced rat paw edema, Cotton pellet induced granuloma, Freund's Complete adjuvant induced arthritis	Indomethacin (10 mg/kg)	Maximum dose 400 mg/kg of extract inhibited the paw edema 74.07% (p<0.01). Inhibited the granuloma formation 62.63% and inhibited adjuvant induced arthritis 77.95% in rats.
28.	<i>Holoptelea integrifolia</i> , Planch ^[40] .	Urticaceae	Leaves		250 and 500 mg/kg.(p.o)aqueous extract	Carrageenan-induced paw edema test in the male Wistar rats	Indomethacin. (10 mg/kg)	Extract inhibited paw swelling dose-dependently.
29.	<i>Hyoscyamus niger</i> L.	Solanaceae	Seeds	Coumarinolignans, cleomiscosin A	Methanolic extract	Carrageenin-induced paw oedema and cotton pellet granuloma methods		Significant inhibition of inflammatory responses. Cleomiscosin A significantly reduced dry and wet weight of cotton pellet granuloma in mice.
30.	<i>Illicium verum</i> Hook.f ^[41] .	Schisandra-ceae	Essential oil	Anethole [1-methoxy-4-(1-propenyl) benzene]	250 and 500 mg/kg. (p.o)	Croton oil-induced ear edema and carrageenan-induced pleurisy		In the inflammatory exudate there significant reduction in the volume of pleural exudates, no. of migrated leukocytes, levels of nitric oxide (NO) and prostaglandins (PGE2).
31.	<i>Jasminum sambac</i> (L.) ^[30] .	Oleaceae	Leaves		Petroleum ether extract.200 and 400 mg/kg.(p.o)	Carrageenan induced paw edema. Acetic acid induced writhing in mice, tail immersion and hot plate method	Diclofenac sodium (10 mg/kg i.p.), Indomethacin (10 mg/kg, p.o),	Study indicates that the extract exhibit significant Anti-nociceptive and anti-inflammatory activities

32.	<i>Justicia gendarussa</i> Burm F ^[14] .	Acanthaceae	Leaves		100 mg/kg	Freund's adjuvant-induced and collagen-induced arthritic rat models	Aspirin(360 mg/kg)	Significant anti-arthritic activity that was statistically similar to that of aspirin.
33.	<i>Lawsonia inermis</i> L ^[42] .	Lythraceae	Leaves	Carbohydrates, glycosides, flavonoids, saponins and tannins	Methanolic extract.	Acetic acid induced writhing test in mice	Diclofenac sodium (20 mg/kg)	Results suggest that extract can reduce neurogenic pain stimulus.
34.	<i>Leucas aspera</i> . (Willd.) Link ^[15] .	Lamiaceae			Ethanolic extract. 100 and 200 mg/kg.	Complete Freund's adjuvant induced arthritis	Diclofenac	Extract exhibited significant anti-inflammatory activity (p<0.001). In extract treated arthritic rats histopathological studies showed the complete cartilage regeneration to near normal joint.
35.	<i>Mangifera indica</i> L ^[43] .	Anacardiaceae	Leaves		50, 100, and 200 mg/kg ethanolic extract	Monosodium Urate Crystal-Induced Gouty Arthritis in Rats	Indomethacin (5 mg/kg)	Extract Significantly decrease ankle swelling in arthritic rats
36.	<i>Pavetta indica</i> Linn ^[44] .	Rubiaceae	Leaves		Methanol extract	Carrageenan, histamine and dextran induced paw inflammation in rats. Cotton pellet induced granuloma in mice	Indomethacin	Extract significantly inhibited the inflammatory responses.
37.	<i>Piper cubeba</i> ^[45] .		Fruit		Oral administration (200 mg/kg)	Carrageenan-induced paw edema, arachidonic acid-induced ear edema and formaldehyde-induced arthritis		Acute and sub-acute inflammations were reduced by plant extract.
38.	<i>Piper nigrum</i> Linn ^[46] .	Piperaceae		Piperine	10, 50 or 100µg/ml	IL-β induced expression of inflammatory mediators in human osteoarthritis chondrocyte.		inhibited the production of PGE2, NO, MMP-3, MMP-13, inos and COX-2 induced by IL-1β in human OA chondrocytes.
39.	<i>Plumbago zeylanica</i> ^[47] .	Plumbaginaceae	Leaves	Plumbagin	200 and 400 mg/kg, (p.o.)acetone extract	The carrageenan induced paw oedema,the hot plate and formalin induced model	Diclofenac (100 mg/kg), Morphine (10 mg/kg, i.p.)	Extract significantly reduced inflammation in the rats. (p < 0.01)
40.	<i>Plumeria acutifolia</i> Poir ^[48] .	Apocynaceae	Root bark	Plumerianine	10, 25 50 mg/kg	Cotton pellet granuloma method, carrageenan induced paw edema model.	Indomethacin	Significant inhibition of granuloma and paw edema.

41.	<i>Psidium guajava</i> Linn	Myrtaceae	Leaves		250, 500 mg/ kg p.o., ethanolic extract	Adjuvant- induced arthritis method in rats	Aspirin (100 mg/kg, p.o.)	Shows significant dose-dependent effect.
42.	<i>Randia dumetorum</i> (Retz.) Lamk ^[49] .	Rubiaceae	Fruit		100, 200 mg/kg	Carrageenan induced oedema model in rats.	Indomethacin	Significant inhibition from edema.
43.	<i>Ricinus communis</i> L	<i>Euphorbiaceae</i>	Root	Lupeol, erandone	100 mg/kg p.o methanolic fraction	Carrageenan- induced hind paw oedema model.		produces significant anti- inflammatory activity. (P<0.001)
44.	<i>Sida rhombifolia</i> L. (Narendhi- rakannan ^[26] .	Malvaceae	Stems and roots			Adjuvant induced arthritic rats.		Arthritic symptoms were significantly reduce, especially elevated rate of erythrocyte sedimentation.

A total of 14 plants with potential anti-arthritic activity have been discussed below.

***Alangium salviifolium* wang. (Family: Alangiaceae)**

Alangium salviifolium (AS) is a small deciduous tree or shrub, grows in the wild throughout the hotter parts of India (The wealth of India, 1952). The major chemical constituents of the plant are alangine A and B, alangicine, markindine, lamarckinine and emetine. The root of AS has been used in the Indian system of medicine as an acrid, diuretic, astringent and also as a antidote for several poisons. The fruit of the plant are useful in burning sensation and haemorrhages^[8]. Different extracts of stem bark of AS were found to possess anti-arthritic activity using Freund's adjuvant model in rats.

***Caesalpinia sappan* L. (Family: Leguminosae)**

Caesalpinia sappan (CS) is a traditional medicinal plant grown in Asian countries and it is mainly used for anti-inflammatory activity and it also promotes blood flow. The plant was found to possess anti-arthritic activity in collagen-induced arthritis model in rats. Different doses of ethanolic extract produced significant attenuation in paw swelling, arthritis index, radiographic and histopathological changes were evaluated.

***Delonix Elata* (Family: Leguminosae)**

Delonix elata (DE) (white gold mohur) is used traditionally for joint pains and in flatulence. The paste of leaves and bark is used by local people to reduce inflammation and pain^[9]. Bark of DE was evaluated for the anti-arthritic activity using incomplete Freund's adjuvant induced arthritis model in rats. Hydro-alcoholic (40%) extract (250 mg/kg p.o.) was found have significant inhibiting anti-arthritic activity rat paw edema after 14 and 21 days. The results were also significant when compared with Diclofenac.

***Semecarpus anacardium* Linn. (Family: Anacardiaceae)**

Semecarpus anacardium (SA) commonly called "marking nut" has been used in Indian medicine in the treatment of gout, rheumatic pain and cancer. SA nut extract was evaluated using adjuvant arthritis model. Treatment with SA extract (150 mg/kg) decreased the paw edema in both developing and developed adjuvant arthritis. Results indicated that the SA nut extract is a potential anti-arthritic agent^[9].

***Azima tetraacantha* Lam (Family: Salvodoraceae)**

Azima tetraacantha (AT) is known as Kundali in Ayurvedic medicine and also called uppimullu in kannada^[8]. There are reports that the leaves juice is efficient against toothache and earache. In Indian tribes, leaves paste of AT is used to treat snakebites. Friedelin, a compound isolated from AT. Leaves were investigated for adjuvant-induced arthritis activity in Wistar rats and 54.5% of paw thickness in rats^[10].

***Chaenomeles speciosa*(Sweet) Nakai (Family: Rosaceae)**

Chaenomeles speciosa (CS) also known as mugua, tiegenghaitang, tiejiaoli or zhoupimugua and is distributed in Central, East and Southwest China and is now cultivated worldwide. According to traditional Chinese medicine, the fruit of CS, which is warm in nature and sour in flavor, has the ability to calm the liver, relax the muscles and tendons, harmonize the stomach and eliminate dampness. Roots of CS were investigated for anti-arthritic activity using collagen-induced arthritis model in rats. Doses of 30, 60, 120 mg/kg of extract inhibited the inflammatory response and restored body weight in arthritic rats.

***Ficus bengalensis* Linn (Family: Moraceae)**

Ficus bengalensis (FB) is commonly known as Banyan tree [8] and is used in Ayurveda for diarrhea, dysentery, hypoglycemic, astringent, rheumatism as well as it was applied to gums to lessen inflammation. The bark of FB was investigated for its anti-rheumatic activity using the Complete Freund's Adjuvant induced, formalin induced and Agar induced arthritis models. The extract (100, 200 and 300 mg/kg, *i.p.*) showed significant inhibitory effect on edema especially on secondary immunological arthritis and inhibited Formalin- induced pain [11].

***Hemidesmus indicus* R.Br (Family: Asclepiadaceae)**

Hemidesmus indicus (HI) has been used in Ayurvedic and Unani medicine against blood disorders of blood and inflammation. Hydro-alcoholic extract (450 mg/kg, *p.o.*), ethyl acetate (75 mg/kg, *p.o.*), chloroform (60 mg/kg, *p.o.*) and residual fractions (270 mg/kg, *p.o.*), was evaluated by using Complete Freund's adjuvant arthritis rat models. The study showed significant decrease in paw edema, body weight, arthritic index, erythrocyte sedimentation rate, serum rheumatoid factor, serum C-reactive protein, and serum nitrite level [12].

***Holarrhena pubescens* (Buch.- Ham.) Wall. (Family: Apocynaceae)**

Holarrhena pubescens (HP) is an Indian traditional medicinal plant, is commonly known as 'kurchi' in India (Kirtikar & Basu, 2006; Nadkarni, 2009). Ethanolic extract of dried seeds of HP were investigated for their anti-inflammatory and anti-arthritic activity. HP (400 mg/kg *p.o.*) extract showed maximum (74.07 %) inhibition of carrageenan-induced rat paw edema, 62.63% inhibition of granuloma formation and 77.95% inhibition of adjuvant induced arthritic edema in rats when compared with Indomethacin [13].

***Justicia gendarussa* Burm F. (Family: Acanthaceae)**

Justicia gendarussa (JG) is used in Indian and Chinese traditional medicine, the leaves of the plant is recommended to treat ailments such as rheumatism, arthritis, headache, earache, respiratory disorders, and digestive trouble. The anti-arthritic potential JG was evaluated using Freund's adjuvant-induced and collagen-induced arthritic rat models. The animals were treated with dose of 100 mg/kg of ethanolic extract of JG and with standard drug aspirin (360 mg/kg) showed significant anti-arthritic activity [14].

***Leucas aspera* (Family: Labiatae)**

Leucas aspera (LA) is traditionally used for analgesic, antipyretic, antirheumatic, anti-inflammatory and antibacterial treatment and its paste is applied topically to inflamed areas. The chronic anti-inflammatory activity of ethanolic extract of LA was investigated using complete Freund's adjuvant arthritis model. A dose of 100 and 200 mg/kg exhibited significant anti-inflammatory activity ($p < 0.001$). After the treatment, histopathological studies confirmed complete cartilage regeneration and near normal joint [15].

***Mangifera indica* L. (Family: Anacardiaceae)**

Mangifera indica (MI) is the largest fruit-tree, has been recently reported for inhibiting lipid peroxidation, antifungal activity and anti-ulcerogenic action. Therapeutic effects of the ethanol extract from MI were investigated using monosodium urate crystals-induced gouty arthritis model in rats. Oral administration of ethanolic extract (100 and 200 mg/kg, *p.o.* for 9 days) significantly ameliorated the abnormalities in ankle swelling, synovial TNF- α , IL-1 β mRNA and protein levels indicating the beneficial effect of MI in gouty arthritis .

***Psidium guajava* Linn. (Family: Myrtaceae)**

Psidium guajava (PG), commonly known as Guava, is used in the traditional medicine for the treatment of wounds, ulcers, bowels, and cholera (Begum et al, 2002). Leaves of PG were evaluated for adjuvant-induced arthritis in rats. Dose of 250 and 500 mg/kg *p.o.* of ethanolic extract of PG produced significant dose-dependent anti-arthritic activity in complete Freund's adjuvant-induced arthritis model.

***Sida rhombifolia* (Family: Malvaceae)**

Sida rhombifolia (SR) has been used from prehistoric times for the treatment of gout in Indonesia. Effect of SR stem and root extracts using adjuvant induced arthritis model in experimental rats were evaluated. Extract was found to normalize the altered levels of hematological parameters. The elevated rate of erythrocyte sedimentation was also significantly reduced [16].

DISCUSSION AND CONCLUSION

Appropriate management of arthritis can reduce pain and help to overcome functional limitations to a greater extent. Medication, physical or occupational therapy, patient education, weight loss, and surgery may be included in treatment and management of arthritis [17]. Though conventional treatment of rheumatoid arthritis is improving, treatment still remains unsatisfactory as remission is rare. Therefore, search remains on going for effective alternative and additional therapies for this

disease. A number of inexpensive herbal medicines have been reported in literature to be useful in rheumatoid arthritis due to their anti-inflammatory and immunosuppressive potential. The literature of Ayurveda describes various plants, to be used as whole, in part or as extracts for treating painful and inflammatory conditions like arthritis. *Matricaria chamomilla* Linn., *Cichorium intybus* Linn., *Rhododendron campanulatum*, *Plumbago rosea* Linn., *Salvadora oleoides*, *Acacia polyantha* is being used traditionally to ameliorate painful inflammatory conditions but have not been yet explored experimentally in the treatment of arthritis. Although plant extracts or individual compounds derived from plants exhibit high potential but the underlying molecular mechanism has not been sufficiently elucidated. There is a need to identify the active principals of these medicines as potential chemotherapeutic agents and monitor the safety of these active constituents ^[18]. Thus, we need a scientific approach towards phytotherapeutics to deliver the components in a sustained manner by formulating novel drug delivery systems so as to increase patient compliance and minimize the need for repeated administration.

REFERENCES

1. Silman AJ and Pearson JE. Epidemiology and genetics of rheumatoid arthritis. *Arthritis Res.* 2002;4:265-72.
2. Gerald Weismann. The Pathogenesis of Rheumatoid Arthritis. *Bulletin of the NYU Hospital for Joint Diseases* 2006;6:12-15.
3. Isler P, et al. Cell surface glycoproteins expressed on activated human T cells induce production of interleukin-1 beta by monocytic cells: a possible role of CD69. *Eur Cytokine Netw.* 1993;4:15-23.
4. Harris ED Jr. Mechanisms of disease: rheumatoid arthritis pathophysiology and implications for therapy. *N Engl J Med.* 1990;322:1277-1289.
5. Paget SA and Gibofsky A. Immunopathogenesis of rheumatoid arthritis. *Am J Med.* 1979;67:961-970.
6. Nepom GT, et al. HLA genes associated with rheumatoid arthritis: Identification of susceptibility alleles using specific oligonucleotide probes. *Arthritis Rheum.* 1989;32:15-21.
7. Van der Linden MP, et al. Value of anti-modified citrullinated vimentin and third-generation anti-cyclic citrullinated peptide compared with second-generation anti-cyclic citrullinated peptide and rheumatoid factor in predicting disease outcome in undifferentiated arthritis and rheumatoid arthritis. *Arthritis Rheum.* 2009;60:2232-2241.
8. Kritkar KR and Basu BD. In: Indian medicinal plants. Vol 2. 2nd edn. Allahabad: Publ. Lalit Mohan Basu; 1991.
9. Vanu Ramkumar Ramprasath, et al. Anti-inflammatory effect of semecarpus anacardium linn. Nut extract in Acute and chronic inflammatory conditions. *Biol. Pharm. Bull.* 2004;27:2028-2031
10. Antonisamy P, et al. Anti-inflammatory, analgesic and antipyretic effects of friedelin isolated from *azima tetraacantha* lam. In mouse and rat models. *J Pharm Pharmacol.* 2011;63:1070-1077.
11. Manocha N, et al. Evaluation of anti-rheumatic activity of extract of stem bark of *ficus bengalensis* *Journal of Global Pharma Technology.* 2011;3:31-37.
12. Mehta A, et al. Anti-arthritis activity of roots of *hemidesmus indicus* r.br. (anantmul) in rats. *Asian Pac J Trop Med.* 2012;5:130-5.
13. Saha S and Subrahmanyam EVS. Evaluation of anti-inflammatory activity of ethanolic extract of seeds of *holarrhena pubescens* (buch.- ham.) *Wall Int J Pharm Pharm Sci.* 5:915-919
14. Jaijesh Paval, et al. Anti-arthritic potential of the plant *justicia gendarussa* burm f. *Clinics* 2009;64:357-60
15. Kripa KG, et al. Modulation of inflammatory markers by the ethanolic extract of *leucas aspera* in adjuvant arthritis. *J Ethnopharmacol.* 2011;134:1024-7.
16. Narendhirakannan and Limmy TP. Anti-inflammatory and anti-oxidant properties of *sida rhombifolia* stems and roots in adjuvant induced arthritic rats. *Immunopharmacol immunotoxicol.* 2012;34:326-36
17. Fantini F. New drugs and treatment strategies for rheumatoid arthritis. *Recenti Prog Med.* 2003;94:361-79.
18. Gogtay NJ, et al. The use and safety of non-allopathic Indian medicines. *Drug Saf.* 2002;25:1005-19.
19. AryaVaidyaSala. Indian medicinal plants, A compendium of 500 species. Vol-1. Universities press (India) private limited. 2010;30-101.
20. AryaVaidyaSala. Indian medicinal plants, A compendium of 500 species. Vol-2. Universities press (India) private limited. 2010;11-389.
21. AryaVaidyaSala. Indian medicinal plants, A compendium of 500 species. Vol-3. Universities press (India) private limited. 2010;1-390.
22. AryaVaidyaSala. Indian medicinal plants, A compendium of 500 species. Vol-4. Universities press (India) private limited. 2010;6-395.
23. AryaVaidyaSala. Indian medicinal plants, A compendium of 500 species. Vol-5. Universities press (India) private limited. 2010;1-403.

24. Mohsen Naseri, et al. The study of anti-inflammatory activity of oil-based dill (*anethum graveolens* L.) Extract used topically in formalin-induced inflammation male rat paw. *Iranian Journal of Pharmaceutical Research*. 2012;11:1169-1174.
25. Hassan H, et al. Anti-inflammatory activity of crude saponin extracts from five nigerian medicinal plants. *Afr J Tradit Complement Altern Med*. 2012;9:250-255.
26. Srivastava P, et al. New anti-inflammatory triterpene from the root of *ricinuscommunis*. *Nat Prod Res*. 2014;28:306-11.
27. Uche FI and Aprioku JS. The phytochemical constituents, analgesic and anti-inflammatory effects of methanol extract of *jatropha curcas* leaves in mice and wister albino rats. *J. Appl. Sci. Environ. Manage*. 2008;12:99-102.
28. H Hosseinzadeh, et al. Antinociceptive, anti-inflammatory and acute toxicity effects of *juglans regia*. Leaves in mice. *Iran Red Crescent Med J*. 2011;13:27-33
29. Ramchandra D, et al. Anti-inflammatory activity of *Madhuca longifolia* seed saponin mixture. 2009; 47: 592-597.
30. Jitendra Bhangale, et al. Preliminary studies on anti-inflammatory and analgesic activities of *jasminum sambac* (L.) Aiton in experimental animal models. *Am. J. Pharmtech res*. 2012;2:1.
31. Bibhuti Bhusan, et al. Analgesic and anti-inflammatory activities of the methanolic stem bark extract of *nyctanthes arbor-tristis* linn. *Biomed Research International* 2013;8:262-295.
32. De B, et al. Investigation of the anti-inflammatory effects of *paederiafoetida subrata*. *Journal of Ethnopharmacology*. 1994;43:31-38
33. Kritikar Pawar AT, et al. Protective effect of hydroalcoholic root extract of *rubia cordifolia* in indomethacin-induced enterocolitis in rats. *Indian J Pharm Sci*. 2011;73:250-3.
34. Telang RS. Studies on analgesic and anti-inflammatory activities of *Cedrus deodara* (Roxb.) Loud. wood oil.1999;65:21-7.
35. Ahad, et al. Phytochemical and anti-inflammatory evaluation of *alangiumlamarckii* root extract. *der pharmacia sinica*. 2011;2:119-129.
36. Qun Chen and Wei Wei. Effects and mechanisms of glucosides of *chaenomeles speciosa* on collagen-induced arthritis in rats. *International Immunopharmacology* 2003;3:593-608
37. Marzouk B, et al. Anti-inflammatory and analgesic activities tunisian *citrullus colocynthis* schrad.immature fruit and seed organic extracts. *Eur Rev Med Pharmacol Sci*. 2011;15:665-72.
38. Anuja GI, et al. Anti-inflammatory and analgesic properties of *drynaria quercifolia* (L.) *J Ethnopharmacol*. 2010;132:456-60.
39. Shumaila Bashir, et al. Screening of *ferula narthex boiss* crude methanolic extract for analgesic, gastrointestinal motility and insecticidal activity. *Middle-East Journal of Scientific Research* 2013;14:471-475.
40. Shrinivas Sharma, et al. Studies on anti-inflammatory effect of aqueous extract of leaves of *holoptelea integrifolia*, planch in rats. *Indian J Pharmacol*. 2009;41:87-88.
41. Domiciano TP, et al. Inhibitory effect of anethole in nonimmune acute inflammation. *Naunynschmiedebergs Arch Pharmacol*. 2013;386:331-8.
42. Imam H, et al. Alpha amylase enzyme inhibitory and anti-inflammatory effect of *lawsonia inermis*. *Pak J Biol Sci*. 2013;16:1796-800.
43. Yan Jiang, et al. Effects of extract from *mangifera indica* leaf onmonosodium urate crystal-induced gouty arthritis in rats. *Evidence-based complementary and alternative medicine*. 2012;967573: 6 pages.
44. Mandal SC, et al. Evaluation of anti-inflammatory potential of *pavetta indica* linn.leaf extract (family: rubiaceae) in rats. *Phytother res*. 2003;17:817-20.
45. Choi EM and Hwang JK. Investigations of anti-inflammatory and antinociceptive activities of *piper cubeba*, *physalisangulata* and *rosa hybrida*. *J ethnopharmacol*. 2003;89:171-5.
46. Ying X, et al. Piperine inhibits $il-\beta$ induced expression of inflammatory mediators in human osteoarthritis chondrocyte. *Int Immunopharmacol*. 2013;17:293-9.
47. Sheeja E, et al. Bioassay-guided isolation of anti-inflammatory and antinociceptive compound from *plumbago zeylanica* leaf. *Pharm biol*. 2010;48:381-387.
48. A Vijayalakshmi, et al. Anti-anaphylactic and anti-inflammatory activities of a bioactive alkaloid from the root bark of *plumeria acutifolia* poir. *Asian Pac J Trop Biomed* 2011;1:401-405.
49. Mahavir H, et al. Bronchorelaxant, mast cell stabilizing, anti-inflammatory and antioxidant activity of *randia dumetorum* (retz.) Lamk. Extracts. *Acta Poloniae Pharmaceutica Drug Research*. 2012;69:465-474.