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REVIEW ARTICLE

A Comprehensive Review on Bioactive Compounds of Plant Origin for Anti-arthritic Activities

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ABSTRACT

The aim of the study of this comprehensive review is to find out the major problems caused by arthritis in common people. As arthritis is one of the prevalent chronic disorders, that is causing stiffness, pain, and joint dysfunction including rheumatoid arthritis, septic arthritis, osteoarthritis, and juvenile arthritis. Therefore, there is a basic need of multidimensional approach for its management. For this, various conventional anti-arthritic drugs such as – methotrexate and sulfasalazine have been employed to relieve from arthritic conditions, but these drugs have shown some deleterious effects on human health. This comprehensive review highlights anti-inflammatory potential of bioactive compounds of plant origin for the management of arthritis.

1. INTRODUCTION

Arthritis is one of the most common chronic health problems and a major cause of disability.[1] The term "arthritis" derives from the Greek words "arthron" and "ites" which mean inflammation of the joint. It can be defined as a chronic, inflammatory, and systemic autoimmune disorder characterized by pain, swelling, and rigidity of the synovial joints.[2] Arthritis includes more than 100 different disorders, with osteoarthritis (OA), rheumatoid arthritis (RA), gout, and fibromyalgia being the most common types.[3]

OA is the most frequent form of arthritis.[4] This degenerative disease is characterized by damage to the articular cartilage of the knee, hip, and others lower extremity joints. The estimated risk for knee OA is approximately 47% in women and 40% in men, and its prevalence is projected to increase due to the ageing of the population and the growing occurrence of obesity.[5] RA is a chronic and systemic inflammatory autoimmune disorder, in which joint inflammation leads to cartilage and bone damage, disability, and even to systemic complications and enhanced morbidity and mortality.[6] A number of factors, such as genetic factors, the environment, and autoimmunity, play important role in RA pathogenesis.[7]

All the factors induce the activation of the immune system, which cause auto-antigen presentation with antigen-specific T and B cells activation and aberrant inflammatory cytokines production, this leads to synovitis and cartilage and subchondral bone destruction. Extra-articular organs, such as the skin and the cardiovascular system, can also be involved.[6] The pharmacological management of both these major forms of arthritis is mostly symptomatic and is aimed at reducing pain and inflammation.

This includes the use of non-steroidal and anti-inflammatory drugs and oral glucocorticoids. Current treatment modalities for RA are based on the use of disease-modifying antirheumatic drugs, such as methotrexate, hydroxychloroquine, and sulfasalazine. However, these drugs can cause serious side effects, including gastrointestinal complaints, pneumonitis, and liver function abnormalities. More recently, biological drugs (antibodies or soluble receptors for interleukin [IL]-1, IL-6, and tumor necrosis factor-alpha [TNF-a]) have gained importance in the treatment of OA and RA.

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Immunosuppressive and cytotoxic drugs (e.g., leflunomide, azathioprine, cyclosporine, and cyclophosphamide) may be used as well, but these drugs also cause a number of toxic side effects.[8]

As a consequence, the use of botanicals and nutritional supplements has gained importance, and the number of studies on the potential health benefits of plant extracts in the treatment of arthritis is increasing.[9]

1.1. Aims and Objectives

1. To review the bioactive compounds of plant origin for anti-arthritic activities
2. To describe the use of these bioactive compounds in the management of arthritis.

2. MATERIALS AND METHODS

Most of the published data related to arthritis and anti-arthritic activities have collected from multiple sources/databases including PubMed, PubChem, Google-Scholar, Semantic Scholar, Research Gate, and Chem-Spider. The retrieved literature was critically evaluated and systematically categorized according to bioactive compounds, mechanism of action, and their potential therapeutic role in the treatment of arthritis.

3. REVIEW OF LITERATURE

Girija *et al*.[10] investigated the anti-arthritic activity of ethanolic extract from the leaves of *Commiphora caudate* linn in Complete Freund's Adjuvant induced arthritic rats. The ethanolic extract of *C. caudate* leaves 200 and 400 mg/kg was tested for its anti-arthritic activity. Their investigation concluded that the ethanolic extract of *C. caudate* leaves has potential anti-arthritic activity.

Kumbhar *et al*.[11] reported prophylactic effect of hydroalcoholic extract of *Colocasia esculenta* leaves in complete Freund's adjuvant (CFA) and formaldehyde-induced arthritic rats. The extract reduces the paw volume and paw diameter and increases body weight. Serum parameters, such as serum glutamic oxaloacetic transaminase, serum glutamic pyruvic transaminase, and alkaline phosphatase, were also estimated for assessing anti-arthritic activities of phytoconstituents such as alkaloid and flavonoids**.**

Alam *et al*.[12] have reported that Agarwood is the common name of *Aquilaria agallocha* which is found in the Himalayas regions and East India. Moreover, it is cultivated in Bangladesh, Indonesia, and Sri Lanka. It's extraction and essential oils (EOs) contain sesquiterpenes and chromones. Depend on the extraction technique, fatty acids and phenols have also been identified. It has so many biological properties such as antimicrobial, antidiabetic, and antioxidant.

Chaudhary *et al*.[13] have been reported that Deodar is the common name of the plant. It is majorly found in the western Himalaya. Is has been used in the Ayurvedic medicine to treat different diseases such as arthritis and bronchitis.

Suh *et al*.[14] tested the effects of EO isolated from the leaves of *Chamaecyparis obtusa* (Siebold and Zucc.) Endl. (Cupressaceae) on pain related behavior and pro-inflammatory cytokines in rats with carrageenan-induced arthritis. The obtained results demonstrated anti-inflammatory and antinociceptive effects of this EO. The intra-articular application of *C. obtusa* EO inhibited pain-related behavior and expression of pro-inflammatory cytokines TNF alpha and IL-1β in inflamed knee joints in rats.

Biradar *et al*.[15] have observed *in vivo* anti-arthritic potential of the EO from two species of *Cyperus,* namely, *Cyperus esculenthus* (L.) and *Cyperus rotundus* (L.) of family Cyperaceae collected from India. Its extracts were tested using the formaldehyde induced arthritis model in Wistar albino rats. EOs were administered orally at the dose of 500 mg/kg body weight and after 10 days of treatment, they were able to inhibit paw edema by 75.54%.

Uriah *et al*.[16] have reported that *Gaultheria fragrantissima* is an evergreen shrub that is found in the Himalayan region and northeast India, which also possess antioxidant and antibacterial properties. The anti-arthritic activity was evaluated with the egg albumin denaturation method and protein denaturation method using bovine serum albumin as a protein model. At a concentration of 250 μg/mL, the sample induced 49% inhibition of protein denaturation.

Agarwal and Rangari[17] have reported that *in vivo* anti-inflammatory and anti-arthritic activities of the EO of *Strobilanthes ixiocephala* flowering tops. This small straggling shrub is present in India, this plant species belongs to the Acanthaceae family. The plant species was collected in Nashik in India. Moreover, the EO was mainly constituted by the sesquiterpenes alcohols ixiocephala and T-cadinol, the monoterpenoid alcohol isoborneol. Besides the dose-related anti-inflammatory potential demonstrated in both acute and chronic inflammatory models. Carrageenan-induced rat paw edema, and cotton pellet granuloma. It is also called as Ginger and used as spices in all the food items. Countries such as China and Tibet have been using medicines for the treatment of different diseases including RA.

Amalraj *et al*.[18] have reported that *Curcuma longa* belongs to Zingiberaceae and used this drug in the Indian kitchen. They have proved that this medicine is useful in the treatment of OA. It is also known as black curcumin, medicine made from this extraction of this plant species has been used in the management of several diseases like RA, during the times in Ayurveda, Unani, Tibet, and Siddha. Seeds and oil extraction of this plant species possess anti-inflammatory activity.

Mittal and Dixit[19] have reported anti-inflammatory and anti-arthritic activities of *Asparagus racemosus* roots. The hydroalcoholic extract of *A. racemosus* roots (ARHE) *in vivo* 200 and 400 mg/kg were tested for its anti-inflammatory and anti-arthritic activity by Carrageenan-induced paw edema methodology is used to induce inflammation whereas CFA used to induce arthritis. The extract reduces paw volume, joint diameter, arthritic score, and estimate the hematological parameters such as red blood cell (RBC), white blood cell (WBC), and erythrocyte sedimentation rate (ESR) hemoglobin (Hb%) for assessing arthritic activity. Their investigation concluded that the ARHE showed significant anti-inflammatory and anti-arthritic activity.

Marrelli *et al*.[20] have reviewed the role of EOs and bioactive compounds for the control of arthritis. Since, EOs are considered to have various beneficiary properties which include anti-oxidant, anti-diabetic anti-microbial, cancer-preventing, and anti-inflammatory. Examination of the scientific literature allowed the authors to foreground the presence of an increasing number of studies on the potential anti-arthritic properties of EOs and their major constituents. The aim of the review is to inspect the current knowledge on the advantageous effects of EOs for the treatment of arthritic diseases. It provides an overview of the reports on the *in vivo* and *in vitro* effects of EOs.

Gandhi *et al*.[21] have reviewed the advancement in anti-inflammatory medicinal plants and phytochemicals in the management of arthritis.

As RA is known to be an inflammatory disorder due to which certain inflammatory cytokines and periodic inflammation is seen in its progression. The pathophysiology of arthritis involves sequence of processes, including multidimensional approaches for its management. Number of anti-arthritic drugs have given to relieve from arthritis, but there are some major problems caused by the dosing of these drugs on human health. Therefore, there is a need to explore the traditional medicine, medicinal plants and their phytochemicals for the significant examination of anti-inflammatory activities with less deleterious effects on human health. The review encapsulates such potential medicinal plants and bioactive compounds against arthritis on the basis of their potent anti-inflammatory activity.

Rathod *et al*.[22] have reviewed *Citrus limon,* as an abundant source phytochemical for antioxidant activities. *C. limon* is vernacularly known as Kagdi Nimbu. Fruits of this plant contain number of oil glands. The aim of the review was to find out the phytochemicals isolated from different parts of the *C. limon*, which includes stems, peel, roots, leaves, and juice. Qualitative analysis of the plant reveals the presence of various phytochemical compounds.

Babu *et al*.[23] have studied the hesperidin-rich ethanolic extract from waste peels of *Citrus limetta* mitigates RA and related complications. They have explored pharmacological effects of fruit wastes which convert wastes into pharmaceutical agents. Pharmaco-chemical profile of peels' extracts gives details that the ethanolic extract has anti-inflammatory activity and rich in hesperidin content. It has been seen that oral administration of ethanolic extract of fruit against arthritis and other complications reduce the arthritis score and arthritis index in knee and elbow joints against collagen-induced arthritis in rats. Anti-arthritic activity of ethanolic extract also confirmed by the observation of biochemical parameters such as pro-inflammatory cytokines (TNA-α, IL-6, and IL-17A) and C-reactive protein (CRP)-level in blood serum in collagen-induced arthritis rats.

Thakur *et al*.[24] have reviewed evaluation of phytochemicals in the leaf extract of *Clitoria ternatea* willd. through gas chromatography-mass spectrometry (GC-MS) analysis. Most of the parts of this plant possess to have various therapeutic properties. Biochemical tests confirmed the presence of different phytochemicals, namely, resins, tannins, alkaloids, flavonoids, saponins, and glycosides. Approximately 30 compounds reported to be present in leaf extract of *C. ternatea* through GC-MS analysis.

Swathi *et al*.[25] have reported evaluation of anti-inflammatory and anti-arthritic property of ethanolic extract of *C. ternatea*. The aim of the study was to find out the anti-arthritic and anti-inflammatory activities of ethanolic extract of *C. ternatea* roots in mouse models. The efficacy of ethanolic extract of *C. ternatea* in RA was evaluated against CFA-induced arthritic model in Wistar albino rats *Rattus norvegicus*. Anti-arthritic activity of EECT was resolute by systematic scoring of arthritis symptoms and paw edema measurement. Preliminary phytochemical analysis of the extract confirms the presence of phenols, alkaloids, terpenoids, and flavonoids. The anti-arthritic activity was also confirmed from hematological (RBC, WBC, and Hb) and biochemical and anti-oxidant parameters (Superoxide dismutase, catalase, malondialdehyde, and reduced glutathione).

Shirodkar *et al*.[26] have reviewed the potential for the implementation of pea flower (*C. ternatea)* health properties in food matrix. This plant is also known by number of vernacular names including Bell Vein, Blue Pea, Darwin pea, Cordofan Pea, and Asian Pigeon Wings. This paper highlights the anti-arthritic, anti-inflammatory, anti-asthmatic, analgesic, anti-pyretic, anti-diabetic, hypolipidemic, wound healing, antitumor, neuro and cognitive enhancing, anti-oxidant, and anti-bacterial activities.

Singh *et al*.[27] have reviewed Chemistry and Pharmacology of *C. ternatea* (Linn.) and isolated active phytoconstituents, which are responsible for various pharmacological activities, including anti-pyretic, anxiolytic, anti-inflammatory, anti-microbial, anti-depressant, hepatoprotective, analgesic, larvicidal, and insecticidal. Flowers of *C. ternatea* have been used for the treatment of snake bite and scorpion sting. Flowers are used to treat chlorosis and intestinal problem. An infusion of flowers is used to promote menstruation. Six fractions of ternatins, namely, A1, A2, B1, B2, D1, and D2 of *C. ternatea* flowers extract were isolated by reverse phase HPLC analysis.[28]

Amorim *et al*.[28] have reviewed anti-inflammatory properties and chemical characterization of EOs of four *Citrus* species. EOs and active principles of citrus species have been used for curing several pathological conditions, including neuroprotective, anxiolytic, anti-inflammatory, anti-microbial, anti-fungal, anti-nociceptive, anti-convulsant, and anti-oxidant agents.

Tag *et al*.[29] have also reviewed therapeutic potential and anti-inflammatory effect of lemon and hot pepper extracts on adjuvant-induced arthritis in mice. As millions of people are being affected by some common diseases like arthritis, and it related disorders including RA. Induction of arthritis was done by injecting CFA subcutaneously at planter surface of hind paw. Then after, extracts of lemon and hot pepper administered subcutaneously at same site two times in a week at the dose of 100 mg/kg. up to 2 weeks, after injecting CFA. At the end of the experiment, ESR, anti-nuclear antibody, arthritic scores, CRP, TNF-α, IL-6, IL-1β, and paw histopathology were examined, respectively.

Bekkouch *et al*.[30] have studied anti-inflammatory activities and phytochemistry of *Zingiber officinale* Roscoe and *C. limon* L. juices. *In vivo* and *in vitro* studies of the juices of both plants were performed on albino rats for reducing inflammation. High-performance liquid chromatography was used to purify juices from *Z. officinale* Roscoe and *C. limon* and bioactive compounds isorhamnetin and hesperidin from Lemon juices and 6-gingerol and 6-gingediol from ginger juice were identified in the purified fractions of the high-performance liquid chromatography.

Dara *et al*.[31] have reported analgesic and anti-inflammatory activities of *C. limon* peel in Wistar *Albino rats*. Citrus fruits reveal the presence of prime chemical components such as ascorbic acid, phenolic compounds, citric acid, and flavonoids. This study shows significant analgesic and anti-inflammatory activities of methanolic, aqueous, and alcoholic extract of *C. limon* in carrageenan-induced and formalin-induced paw edema in Wistar *Albino rats***.**

Vaishnav *et al*.[32] have reviewed formulation and evaluation of anti-microbial gel of flowers of *C. ternatea*. Flower extracts of *C. ternatea* possess number of pharmacological activities such as antidiabetic, diuretic, anti-microbial, hepatoprotective, insecticidal, analgesic, and anti-microbial. Anthocyanins such as ternatin and pentacyclic triterpenoids such as taraxerol and taraxerone are the chief phytoconstituents responsible for anti-microbial activities. The phytochemical analysis test shows the presence of glycosides, flavonoids, saponins, sterols, quinones, terpenoids, tannins, phenols, alkaloids, and carbohydrates.

Mariano[33] has studied anti-oxidant and anti-arthritic activity of peels of *Citrus* fruits. Arthritis is a chronic inflammatory disease

which affects the world's population in such a way that leads to joint deformities and functional disabilities due to the bone and cartilage destruction. During COVID-19 consumption of citrus fruits has increased so much due to its health benefits. Peels of citrus fruits have more bioactive compounds than its juice and pulp. Study reveals the utilization of discarded peels and its conversion to valuable products. They have determined anti-oxidant and anti-arthritic potential of citrus fruits peel's extract. The anti-oxidant activity was evaluated using 2,2-diphenyl-1-picrylhydrazyl, and nitric oxide radical scavenging assay. Anti-arthritic activity was evaluated by protein denaturation and proteinase inhibition assay.

Bhatia *et al*.[34] have studied analgesic and anti-inflammatory activities of leaves extract of *C. ternatea* Linn. on mouse model. *C. ternatea* is a medicinal plant that is used in the treatments of various ailments as a folklore medicine and contains number of bioactive compounds, namely, flavonoids, resins, tannins, triterpenoids, steroids, and anthocyanins. The ultraviolet, nuclear magnetic resonance, and mass spectroscopic data of leaves and flowers of *C. ternatea* have confirmed the presence of flavonoid, glycosides, β-sitosterol, kaempferol-3-monoglucoside, kaempferol-3-rutinoside, kaempferol-3-neohesperiodoside, kaempferol-3-O-rhamnosyl-(1,6)-glucoside, and kaempferol-3-O-rhamnosyl-(1,6)-galactoside. The phytoconstituents studied in the mucilage were alkaloids and anhydrogalacatan, anhydropentosan, and methylpentosan. Other active constituents found in flowers were glycosides, delphinidin, anthocyanins (Ternatin C1, C2, C3, C4, C5, D3, Pre-ternatins A3, Ternatin A1, A2, B1, B2, D1, and D2), malvidin glucoside, delphinidin-3, 5-diglucoside, Delphinidin 3-glucoside, and 3-methyl ether of delphinidin glucoside.

Chandanshive *et al*.[35] have studied *in vitro* anti-arthritic activity of Citrus peel. Studies indicate that extracts of citrus peel help in protecting joint cartilage from degeneration and also helpful in the reduction of inflammatory markers (like cytokines and CRP). Citrus peels are rich in flavonoids (such as *naringin)* and Vitamin C, which help in neutralizing oxidative stress and lower joint inflammation.

Cano *et al*.[36] have studied preliminary phytochemical and thin-layer chromatography analysis of the fruits, leaves, and flowers of *C. limetta* Risso. In Mexico, common name of this particular plant is sweet lime. This fruit is used for anti-hyperglycemic and anti-hypertensive activity. Infusion of fruits and leaves is being used as blood pressure modulator, decreasing cholesterol level and help to reduce inflammation. Phytochemical analysis was performed using different solvents at different polarity as n-butane, ethanol, methanol, and water. Different phytochemical tests were performed for the confirmed presence of phytoconstituents such as Dragendorff's, Mayer's, and Wagner's tests for alkaloids; Shinoda, sodium hydroxide and Pew's tests for flavonoids; Borntrager's test for quinones; Liebermann-Buchard and Salkowski test for sterols; Kedde's test for cardiac glycosides; Baljet's test for sesquiterpene lactones; Benedict's test for tannins; and Foam and leucoanthocyanins test for saponins.

Bhattacharya *et al*.[37] have reviewed that the phytoconstituents such as allicin, ginsenoside, bromelain, chlorogenic acid, hesperidin, madecassocide, kirenol, triptolide, berberine, thymoquinone, curcumin, andrographolide, cryptotanshinone, norisoboldine, and hydroxy napthoquinone have therapeutic potential for anti-arthritic activity. As these phytochemicals inhibit bone erosion in joints, control inflammatory responses and osteoclast differentiation.

List of the compounds and their biological activities present in the Medicinal plants.

4. STRUCTURES OF THE COMPOUNDS

Shown in Table 1 and Figure 1 below

5. DISCUSSION

Arthritis is the medical term for swelling or inflammation of one or more joints, ligaments, and surrounding tissues. RA is an inflammatory autoimmune arthritis that is one of the 100 forms of arthritis. At present, this autoimmune inflammatory arthritis is incurable. Still, treatment is done on an individual basis of symptoms with the primary goal of minimizing joint discomfort and inflammation, improving joint performance, and preventing cartilage damage and distortion. There are many bioactive plant compounds which show promising results in artritus like taraxerol inhibits the production of pro-inflammatory mediators (like cyclooxygenase-2 and inducible nitric oxide synthase) and modulates cell signaling pathways such as nuclear factor-kappa B and mitogen-activated protein kinases. Thymoquinone, reduces clinical score inflammation, serum creatinine, triglyceride, cholesterol, IL-1β, and TNF-α.

Dietary phenolic compounds, terpenoids, saponins, flavonoids, carotenoids, and alkaloids have effectively slowed the progression of arthritic disease due to their ability to alter pro-oxidant and pro-inflammatory pathways. In addition to whole herbs and spices and their extract, many isolated phytoconstituents have been discovered to have healing capability in the treatment of RA. These compounds include aconite, brucine, kaempferol, tamaractam, andrographolide, artemisinin, asiaticoside A, bufalin, hecogenin, curcumin, swertiamarin, resveratrol, cardamonin celastrol, lapachol, brazilin, thymoquinone, asperosaponin VI, liquiritin, βelemene, oleanolic acid acetate, ellipticine, hesperidin, and sinomenime. The pharmacological management of both these major forms of arthritis is mostly symptomatic and is aimed at reducing pain and inflammation.

6. CONCLUSION

Plants play a major role in procurement of curable and non-curable diseases, as it has abundant sources of bioactive compounds in the form of the secondary metabolites which are present in whole parts of its body and possess number of medicinal properties. Therefore, they play role as traditional herbal medicine. Arthritis is one of the challenging chronic-inflammatory autoimmune diseases/problems rising now-a-days due to standard way of living especially in women that damages the joints and also affects other organs. That's why it is considered as life style disease. Standard drugs available in the market create some serious effects on the living body so to overcome these effects, ones need to prepare drugs in such a way which is more effective and budget friendly for human welfare. This systematic review will help the researchers to know more about the phytochemicals containing bioactive compounds such as flavonoids, alkaloids, berberine, curcumin, kirenol, kaempferol, clitorin, taraxerol, and adenosine that actively participate for the treatment of arthritis.

More clinical trials can be conducted for the development of reliable and effective anti-arthritic drugs, either alone or in combination with other anti-arthritic agents. From this systematic review, it is concluded that there are number of phytochemicals reported in plants that exhibit anti-arthritic and anti-inflammatory activity. Therefore, this review was aimed to give current scientific knowledge of plant extract of valuable phytochemicals in arthritis and finally through this review, authors have highlighted certain bioactive principles including allicin, ginsenoside, bromelain, chlorogenic acid, hesperidin, madecassocide, kirenol, triptolide, berberine, thymoquinone, curcumin, andrographolide,

cryptotanshinone, norisoboldine, and hydroxy napthoquinone present in herbal plants.

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10. ETHICAL STATEMENT

Ethical approval was not required for this study as it is a review article.

11. CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

12. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

13. DISCLAIMER/VIEW AND OPINIONS

The opinions expressed in this article are solely those of the authors and do not reflect the views of the International Research Journal of Ayurveda and Yoga or its editorial board.

14. AI-USE DECLARATION

The authors declare that no generative AI tools were used to create scientific content, interpret data, or draft any sections of this manuscript. AI-based tools were used solely for minor language and grammar refinements to improve clarity and readability. All scientific content, analysis, and conclusions remain the sole responsibility of the author.

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41. Available from: https://pubchem.ncbi.nlm.nih.gov/#query=kaempferol [Last accessed on 2026 May 13].
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Table 1: Name and pharmacological properties of bioactive compounds

S. No.	Name of the compound	Where it is found	Pharmacological property
1	Taraxerol[38]	*Taraxacum officinale* (Dendelions), Tea plant and in the roots of *Clitoria ternatea*	It inhibits the production of pro-inflammatory mediators (like cyclooxygenase-2 and inducible nitric oxide synthase) and modulates cell signaling pathways such as nuclear factor-kappa B and mitogen-activated protein kinases
2	Taraxerone[39]	*Taraxacum officinale*	It also suppresses the production of pro-inflammatory mediators like nitric oxide. It modulates B-lymphocyte and macrophage activity.
3	β-sitosterol[40]	Rice bran, Wheat germ, Corn oils, Soybeans, and Peanuts.	It suppresses joint damage, reduces the proliferation of destructive synoviocytes, and promotes cartilage repair, making it a promising natural therapeutic agent for both rheumatoid arthritis and osteoarthritis.
4	Kaempferol[41]	Apples, Grapes, Broccoli, Green Tea, and Spinach.	It scavenges free radicals, reduces oxidative stress and lowers inflammation markers.
5	Clitorin[42]	*Clitoria ternatea* (butterfly pea), *Carica papaya* (papaya), and *Acalypha indica*	It has anti-inflammatory, anti-oxidant and immunomodulatory properties.
6	Myricetin 3-glucoside[43]	*Tibouchina paratropica*, *Abelmoschus manihot* (sunset hibiscus), and *Myrica rubra* (Chinese bayberry).	It suppresses the production of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin (IL)-6, and IL-1β.
7	Adenosine[44]	In the seeds of *Clitoria ternatea*	Adenosine signaling decreases the release of pro-inflammatory cytokines (such as TNF-α, IL-1β, and IL-6) while stimulating the production of anti-inflammatory cytokines like IL-10.
8	Curcumin[45]	*Curcuma longa*	It inhibits cell proliferation, interleukin-1β, nuclear factor κβ, and tumor necrosis factor α.
9	Berberine[46]	*Coptidis rhizome*	It suppresses Th 17 cell frequency and interleukin-17 level in blood. It is also used as antitumor and anti-inflammatory agent.
10	Thymoquinone[47]	*Nigella sativa*	It reduces clinical score inflammation, serum creatinine, triglyceride, cholesterol, interleukin-1β, and tumor necrosis factor α.
11	Kirenol	*Siegesbeckiae* species	To suppress the inflammatory pathology in collagen-induced arthritis.

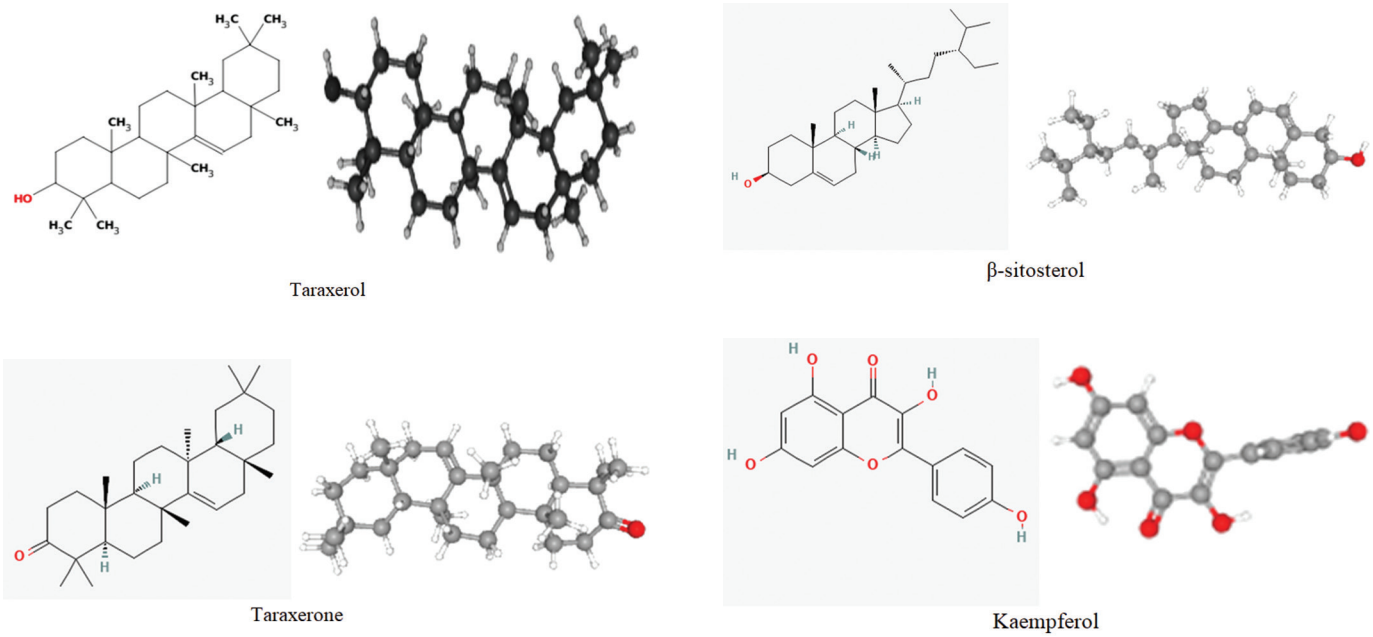
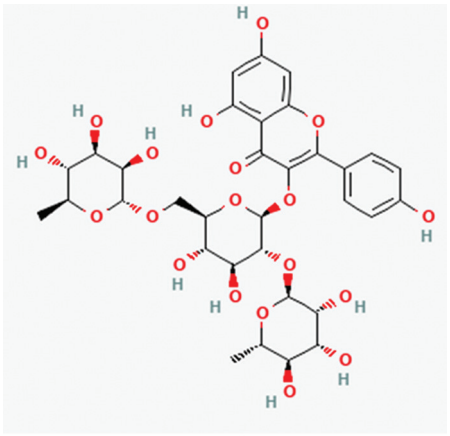


Figure 1: Sturcture of compounds *(Continued)*



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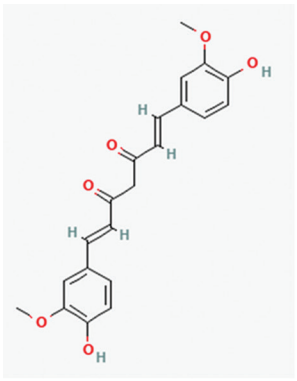
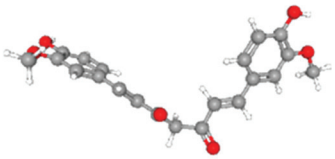
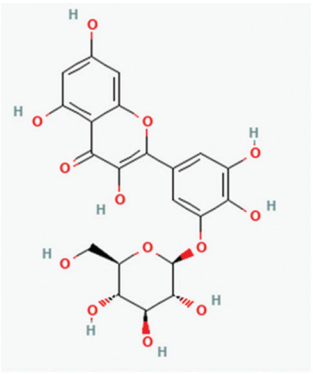
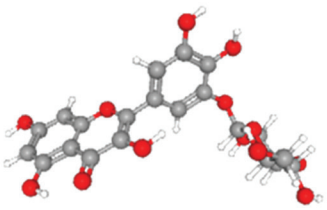


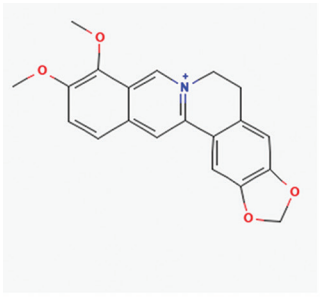


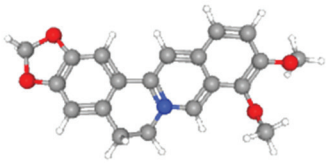
Curcumin



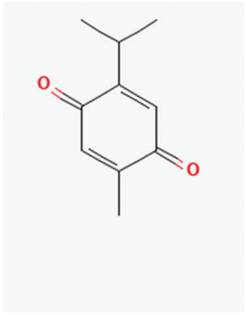


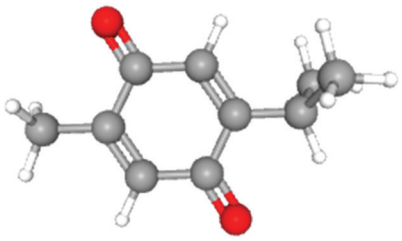
Myricetin 3-glucoside



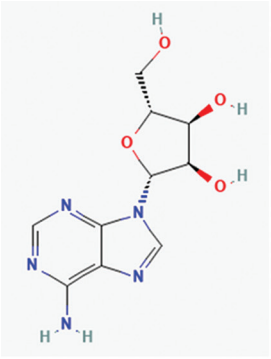


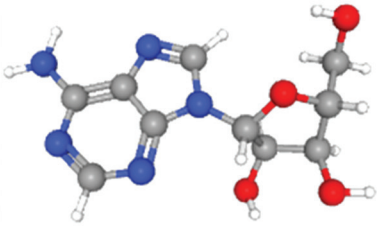
Berberine



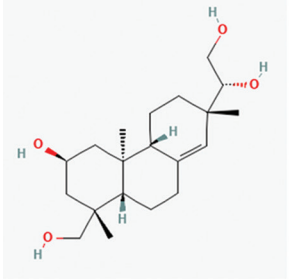


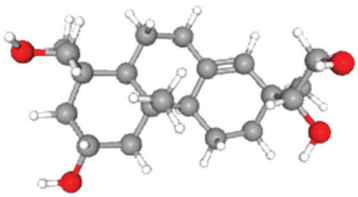
Thymoquinone





Adenosine





Kirenol

Figure 1: Sturcture of compounds