

Review Article

Anti-inflammatory activity of medicinal plants and herbs: A review

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Abstract

Medicinal plants with their ingredients, extract, seeds, oils and fruit are gradually used in the treatment of many diseases. Inflammation is a pathological process characterized by injury or destruction of tissues caused by a variety of cytological and chemical reactions. The medicinal plants

reduce inflammation by blocking the inflammatory process, blocking the arachidonic acid metabolism, blocking enzymes, and blocking the inflammatory cells. Curcuma long, Zingiber officinale, Rosa canina, cassia fistula, salvia officinale, Borago officinale, Rosmarinus officinale, evening primrose, Ribesnigrum, Oleaeuropea, Herpagophytum, Elaeagnusangustifolia are some plants discussed in this study with their anti-inflammatory mechanism. Since the treatment of inflammation is not a single configuration relief, in this review article we tried to introduce to approach multi-dimensional medicinal access to treat inflammation, with the help of anti-inflammatory plants and by modification our life style by exercise and diet.

Key words

Inflammation, Medicinal plants, Chemical constituents, Anti-inflammatory mechanism, Therapeutic activity.

Introduction

Inflammation is a healthy process and defense mechanism of body by which the immune cells of our body protect us from hazardous stimuli such as allergen and injury and maintain tissues homeostasis. The five primary indicators of inflammation are heat or warmth, redness: swelling, pain and loss of function [1]. Although the inflammation is a healing and restoring process but it can be a vast continuum of disorders such as rheumatoid arthritis, hepatitis, gastroenteritis, osteoarthritis, inflammatory bowel disease, multiple sclerosis, cancer, periodontitis and autoimmune disorders [2]. Due to the least side effects and more effectiveness we use herbal plants to overcome these problems. The plants are not only effective in acute and chronic inflammation but also boost immunity. Different parts of different plants are used e.g. flower's extract, root's extract, seeds and whole plant.

Herbal medicine is one of the most important medicines for treating all kinds of diseases. It is best therapy having least side effects and best curative effects. In this review some plants which their anti-inflammatory effect has been thoroughly evaluated in many research articles and review articles which are of experimental based. Curcuma long, Zingiber officinale, Rosa canina, cassia fistula, salvia officinale, Borago officinale, Rosmarinus officinale, evening primrose, Ribesnigrum, Oleaeuropea,

Herpagophytum, Elaeagnusangustifolia these are the plants which have strong anti-inflammatory activity and have been used for the treatment of many inflammatory disorders such as in the treatment of rheumatoid arthritis, uveitis, inflammatory bowel disease, ulcerative colitis, dermatitis, bronchitis, meningitis, sinusitis, periodontitis etc. In inflammatory process various mechanisms are involved. So, inflammation is treated by different kind of action e.g. by acting on inflammatory cells production and by acting on inflammatory enzyme's biosynthesis. As an injury occur, enzymes involved, cell released process will have called inflammation. Most of the plants act on the pathway through which pro-inflammatory cytokines are released and some act on the enzymatic pathway through which cyclooxygenase and lipoxygenase are released and block the production of them. Using plants in treatment of diseases is a natural way of treatment and plants will have called natural anti-inflammatory compounds or treatment will have called natural anti-inflammatory treatment. Some plants are considered as contra-indication in some conditions e.g. in pregnancy which will beman issue and will demands better cautions on the part of physician, but almost there is no evidence about these.

Mechanism of inflammation

Process of inflammation starts when allergen, chemical irritation, infection and injury occur in body chemical mediators released from mast

cells, platelets, neutrophils, macrophages and lymphocytes. These chemical mediators are also called pro-inflammatory factors which released when membrane phospholipid converted to arachidonic acid in the presence of phospholipase A. From arachidonic acid prostaglandins, leukotrienes and cytokines are released in the presence of cyclooxygenase and lipoxygenase. Prostaglandins cause capillary dilation and increases blood flow. Leukotrienes cause degranulation, promote adhesion of neutrophils to vascular endothelial cells and produce superoxide. Cytokines (IL-1, IL-2, IL-3, IL-4, IL-5, IL-6, IL-8, IL-10, IL-12, TNF) inhibit viral replication, inhibit cell proliferation, increase tissue destruction and lytic activity of natural killer cells.

Anti-inflammatory mechanism of medicinal plants

Medicinal plants' anti-inflammatory actions encompass a variety of routes and components that assist regulate and modulate the inflammatory response. Here are some examples of common mechanisms:

Inhibition of lipoxygenase

Lipoxygenase is used in production of leukotrienes from arachidonic acid which are pro-inflammatory mediators. Through different parts of plants by inhibiting lipoxygenase inflammation is inhibited [3].

Inhibition of Nos

Many plant's flavonoids inhibit the production of nitric oxides. Nitric oxides are free radicles that involved in formation of inflammation by cytokines activated macrophages. These are also called pro-inflammatory mediators [4, 5].

Inhibition of cyclooxygenase

Many herbal derived compounds inhibit the biosynthesis of prostaglandins by two types of enzymes cyclooxygenase 1 and cyclooxygenase 2 inhibitions. Prostaglandins are inflammatory mediators. Prostaglandins are of 4 types including PGE₂, PGI₂, PGD₂, and PGF₂ [5].

Prostaglandins play role in inflammation by causing classical sign of inflammation which are pain, redness and swelling. Redness and edema is cause by increase blood flow, increasing permeability and vasodilation. Pain occurs due to the effect of prostaglandins on sensory neuron and central site.

Inhibition of phospholipase

From membrane lipid phospholipase, arachidonic acid is released. Arachidonic acid is a precursor of eicosanoid from which prostaglandins are synthesized. The inhibition of phospholipase plays key role in treatment of inflammation [6].

Inhibition of pro-inflammatory cytokines

Some parts of plant inhibit inflammation by inhibiting Pro-inflammatory cytokines. Pro-inflammatory cytokines are signaling molecules, released from immune cells predominantly from T-cells and macrophages. Pro-inflammatory cytokines cause inflammation as IL-1 β , IL-6: involve in regulation of apoptosis in cell and TNF- α : regulate process of apoptosis by effecting in different signals pathway [7, 8, 9].

Modulation of pro-inflammation gene expression

Many plant flavonoids inhibit the modulation of gene expression for isomers of nitric oxides, cyclooxygenase and lipoxygenase that play role in production of prostaglandins, leukotrienes and other inflammatory mediators e.g. cytokines and chemokines by inhibition of protein kinases and transcription factors which are nuclear factor Kappa B, activator protein 1, signal transducers and binding proteins [10].

Anti-inflammatory activity of Medicinal plants

Medicinal plants have traditionally been employed in many traditional medical systems for their anti-inflammatory qualities. These plants have bioactive chemicals that can aid in the relief of inflammation and related symptoms. In the **Table – 1**, some common therapeutic

herbs enlisted with anti-inflammatory properties, parts used and mechanism of action.

Zingiberofficinale

Zingiberofficinale, a native plant of south Asia is an herbaceous perennial obtained from underground stem of rhizome. It is commonly called ginger and belonged to the family Zingibraceae [11]. The surface color of it is purple and it has pungent taste. It is non-toxic and well tolerated even at high dose. Since ancient time it has been used traditionally in Ayurvedic medicine, as a spice, condiment and food preservative. In advanced usage, due to cyclooxygenase activity of its ingredients gingerol, paradol, zingerone and essential oil it is used in treatment of both acute and chronic inflammation. Due to highly propitious nature it is also used as anti-microbial, anti-oxidant, anti-diabetic, anti-carcinogenic. The major active component of ginger is gingerol. Ginger show its strong anti-inflammatory activity by 6-gingerol and 6-paradol through inhibiting cyclooxygenase-1, cyclooxygenase 2, leukotriene and prostaglandins synthesis by suppressing 5-lipoxygenase, prostaglandin synthetase and tumor necrosis factor alpha [12, 13]. It has best curative effect due its dual inhibition of cyclooxygenase and 5-lipoxygenase. It is considered that it also inhibits the induction of genes which are involved in the process of inflammation and it is very efficacious in the inhibition of inflammation without meddling with antigen presenting function of macrophages.

Curcuma longa

Curcuma longa is common spice, is an underground stem rhizome belonged to the family Zingibraceae. Curcuma longa commonly known as "Haldi" in many regions of world. It is widely cultivated in china and India. Powder of curcuma longa is called turmeric used in cooking applications of both vegetarian and non-vegetarian dishes as spice and flavoring agent [14]. In Nepal, its rhizome is used as house-hold remedy [15]. In Ayurvedic medicine its powder is used for the treatment of sinusitis, biliary

diseases, rheumatism, diabetic wounds, anorexia, hepatic disorder, coryza and cough [16].

Curcumin is a coloring principle of turmeric and it was isolated in 19th century from the rhizome of curcuma longa. Curcumin gives yellow color of turmeric powder and it is a main constituent of this plant and it is also responsible for its anti-inflammatory activity. For swelling due to injury and sprain it was widely used in old Hindu medicine [17]. Due to its active polyphenol curcumin has been used in traditional medicine for its therapeutic properties and through different route of administration as an anti-inflammatory remedy to treat in both types of inflammation.

Curcuminoid is a most important secondary metabolite which play strong anti-inflammatory role. It is very effective for the treatment of rheumatoid arthritis. Its play its anti-inflammatory by inhibiting or reducing pro-inflammatory cytokines. Curcumin is used for the treatment of both model of inflammation. One model of inflammation is chronic and prolonged which is a proliferation stage of inflammation and other is acute phase of inflammation which is produced as a result of infection and injury. Srimal and Dhawan in 1973 discovered the pharmacological action of curcumin in inflammation; they stated that it is effective equally in both models. Volatile oils of curcuma longa also play anti-inflammatory activity in the treatment Of rheumatoid arthritis [18].

Elaeagnus angustifolia

Elaeagnus angustifolia is widely distributed from Himalayas to north of Asia and Europe belonging to the family Elaeagnaceae [19]. The fruit and extract of Elaeagnus angustifolia which consist of flavonoids, terpenoids and glycosides have strong anti-inflammatory activity and has been used traditionally for the treatment of both types of inflammation. It is best remedy for asthma, rheumatoid arthritis and dermatitis. It plays its anti-inflammatory activity by alleviating

the pro-inflammatory cytokines. It also has antinociceptive and anti-ulcerogenic activities [20].

Rosmarinus officinale

Rosmarinus officinalis is a most popular perennial herb. It is commonly known rosemary [21]. It has been used therapeutically in many countries due to its anti-inflammatory activity. It is also having anti-bacterial, anti-diabetic and anti-ulcerogenic activity. Essential oil, carsonic acid and diterpenes have anti-inflammatory activity. Essential oil of *Rosmarinus officinalis* plays their anti-inflammatory activity by inhibiting the intracellular adhesion molecule (ICM-1) at transcriptional stage [22]. Carnosic acid also play inhibitory role in the process of inflammation by inhibiting the expression of cytokines. Rosemary diterpenes are highly effective in inhibiting the activation of glial cells which are major inflammatory cells and produce pro-inflammatory cytokines e.g. interleukin 1beta, interleukin-6 and tumor necrosis factor alpha [23].

Borago officinalis

Borago officinalis is also called star flower. It is an annual herb and flowering plant. It belongs to family Boraginaceae [24]. It is very effective for the treatment of arthritis, dermatitis and bronchitis due to its anti-inflammatory activity. Borago oil, methanol extract and alkaloids are major compounds that have anti-inflammatory and powerful amoebicidal activity. Oil has strong anti-inflammatory activity which is derived from the seed of this plant. Oil contains omega 6-fatty acid gamma linoleic acid (GLA) [25]. Gamma linoleic acid inhibits the production of prostaglandins and leukotrienes which are formed from arachidonic acid and are called pro-inflammatory mediators. It also inhibits the cyclooxygenase 2 which is an enzyme of inflammatory process. Gamma linoleic acid also inhibits the inflammatory process by suppressing tumor necrosis factor alpha. Tumor necrosis factor alpha is a protein of inflammatory process.

It as contraindication in pregnancy, it can lead to miscarriage [26].

Ribes nigrum

Ribes nigrum is commonly called black current. It is a woody shrub and native to temperate climate. It is a member of Grossulariaceae family [27]. It is commonly cultivated. It has been used traditionally in herbal medicine in inflammatory conditions due to its powerful anti-inflammatory activity. It also has anti-bacterial, anti-viral, anti-septic, anti-toxic and anti-oxidant activities. Its fruit is a rich source of vitamin C. it contains polyphenol phytochemicals and flavonoids which have best therapeutic effect in inflammatory diseases. It plays its anti-inflammatory activity by inhibiting the synthesis of leukotrienes, tumor necrosis factor alpha and NFkB. It is a rich source of 3-O-glucoside, polyunsaturated fatty acids, gamma linoleic acid and alpha linoleic acid. Oil also has effect on immune system and inhibits biosynthesis of PGE2 [28].

Salvia officinale

Salvia officinale is commonly called as sage or garden sage. It is a perennial shrub. it has woody stem. It belonged to family Lamiaceae [29]. Its leaves are of greyish color and flowers are bluish or of purple color. It has been used for therapeutic purposes since many years. It has strong anti-inflammatory and anti-oxidant activity. It has different therapeutic effects due to many activities. It also has anti-microbial, anti-diabetic, anti-cancer and anti-nociceptive activities. Flavonoids, Carnosol, Carnosic acid and ursolic acid are main ingredients which has strong anti-inflammatory potential [30]. The inflammation is inhibited by inhibiting the production of PGE2, biosynthesis of prostaglandins and suppressing the production of leukotrienes, histamine and cytokines. It also has immunomodulatory activity [31].

Cassia fistula

Cassia fistula is commonly called golden rain tree or canafistula. It is flowering and ornamental

plant. It is a member of fabaceae family. It is widely distributed from India to Myanmar, Thailand to Sri Lanka and southern Pakistan. It is used in herbal medicine due to its therapeutic potential. It has anti-inflammatory, immunomodulatory, anti-hyperglycemic, anti-bacterial, anti-fungal and hepatoprotective activities. It inhibits inflammation by suppressing the expression of pro-inflammatory mediators through blocking the NF- κ B and tumor necrosis factor alpha. It also inhibits the biosynthesis of cyclooxygenase-2.

Herpagophytum

Herpagophytum is commonly called devil's claw. It is called devil's claw due to the eccentric presence of hook fruit. It is a member of Pedaliaceae family [32]. It is used pharmaceutically for the treatment of inflammatory and degenerative diseases. The incipient studied on devil's claw's anti-inflammatory activity was directed in 1970. It is very effective for the treatment of osteoarthritis. The main anti-inflammatory ingredient is herpagoside. Its extract plays anti-inflammatory activity by acting on expression and release of pro-inflammatory mediators [33]. It also acts on intracellular signaling pathway which is tangled in inflammation. Herpagoside suppresses the biosynthesis of leukotriene. It also affects tumor necrosis factor alpha and cytokines and inhibits them. It has a direct effect on cyclooxygenase-2 enzyme and through acting on it, herpagoside inhibits the production of iNOs and other inflammatory mediators [34, 35]. It is used as anti-nociceptive for the treatment of musculoskeletal pain e.g. in non-specific back pain, arthrosis of knee and hip, muscle soreness and in orthopedic complaints. It is the best therapeutic treatment for arthritis because it inhibits human elastase and neutrophil elastase. Both human elastase and neutrophil elastase are confederated with arthritis.

Oleauropea

Oleauropea meaning European olive is commonly called olive. It is a plant of primeval

world. It is a small tree. It belongs to the family Oleaceae [36]. It has both agricultural and pharmacological importance. It is one of the common plants of ancient world. It is widely cultivated in different places and in many countries. It has strong anti-inflammatory and anti-nociceptive activities. It also has anti-atherogenic, anti-cancer, anti-anti-microbial, anti-viral and immunomodulatory activities. It has been used for the treatment of different kinds of diseases since many years. Olive oil's bioactive phenolic compounds have a broad effect in inhibition of inflammation [37]. Fruit of Oleauropea have been used for centuries as therapeutically for the treatment of many inflammatory diseases such as for the treatment of rheumatoid arthritis, hemorrhoids and as a vasodilator. It plays its anti-inflammatory activity by inhibiting the production of pro-inflammatory cytokines.

Evening primrose

Oenothera biennis is commonly called evening primrose. It is an herbaceous flowering plant [38]. It is also called sun cups and sun drops. It is indigenous to America. It belongs to the Onagraceae family. It is a biennial plant. It is very common in subtropical regions. Polyunsaturated omega-6 fatty acids are main anti-inflammatory ingredients. It is a very effective treatment for inflammation and pain due to its anti-inflammatory and anti-nociceptive activities. It has been used for the treatment of rheumatoid arthritis and decrease muscle pain. Gamma linoleic acid (GLA) and linoleic acid (LA) are the types of polyunsaturated omega-6 fatty acids. Gamma linoleic acid (GLA) is involved in the inhibition of inflammation by directly acting on and suppressing inflammatory cells. Gamma linoleic acid (GLA) improves the existence of inflammation by impairing the genesis of interleukin-1 beta which is a cytokine that is responsible for the production of inflammatory disorders. Gamma linoleic acid also affects receptor functioning and enzymatic functioning [39, 40].

Rosa canina

Rosa canina is commonly called dog rose and belongs to Rosaceae family [41]. It is a deciduous shrub. It is aboriginated to Europe, northern Africa and western Asia. It is normally ranging from 1-5 meters. It is climbing wild rose. Its flowers are of pale pink color. It has pinnate leaves which have 5-7 leaflets. Its flowers have five petals. Its fruit is called rose hip. Its fruit have been used medicinally for centuries. It has strong anti-inflammatory activity. It also has anti-nociceptive and anti-oxidant activities. Its fruit is a richest source of galactolipids and 3-O-beta-D-galactopyranosyl glycerol, linoleic acid, alpha linoleic acid and gamma linoleic acid which are main anti-inflammatory ingredients. These ingredients inhibit the mechanism of inflammation by suppressing the inflammatory mediators. They also effect on enzymatic pathway and inhibit the production of enzymes involved in inflammation e.g. cyclooxygenases and lipoxygenases [42].

Conclusion

The goal of this research was to look at scientific studies on the anti-inflammatory properties of several medicinal herbs. Inflammation is a complex process that is required for host defense, but excessive production of inflammatory mediators can lead to chronic illnesses. This review focuses on the ability of plant extracts to produce anti-inflammatory actions by targeting different phases of the inflammation process. These extracts have been found to block the synthesis of cytokines and eicosanoids, limiting the inflammatory cascade and alleviating symptoms such as flare, irritation, and excessive exfoliation. Plant research with anti-inflammatory qualities is a new area of study in modern biomedicine. However, more research into plants with anti-inflammatory properties is still needed. Their useful insights could help to reveal the therapeutic potential of plants that haven't been properly investigated in this context. Continued study in this field has the potential to broaden our understanding of natural anti-inflammatory drugs and their uses in medicine.

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