

Traditional Herbal Plants That Have Anti-Inflammation And Antioxidant Properties (Review Article)

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ABSTRACT:

Inflammation and oxidative stress are two of the major biological mechanisms involved in the pathogenesis of many acute and chronic diseases. An exaggerated inflammation response can cause tissue injury, pain, and progression of diseases, whereas oxidative stress can be a consequence of a disturbance between the levels of reactive oxygen species and antioxidant mechanisms of defence. The standard medication for the reduction of inflammation and antioxidants has shown efficacy but has a harmful side-effect profile. Medicinal plants have attracted much interest as a safer form of therapy because of their high phytochemical content and vast pharmacological activity. This review highlights some herbal plants that have anti-inflammatory and antioxidant activities. These plants include *Clitoria ternatea*, *Ficus elastica*, *Moringa oleifera*, *Punica granatum*, *Prunus dulcis*, *Salvia rosmarinus*, *Syzygium cumini*, and *Tradescantia pallida*. These plants are sources of active compounds, including flavonoids, phenolic acids, tannins, alkaloids, and terpenoids. The anti-inflammatory activity is primarily exerted through the inhibition of inflammatory enzymes, cytokine release, and regulation of anti-inflammatory pathways, while the antioxidant activity is carried out through free radical scavenging, lipid peroxidation inhibition, metal ion chelation, as well as the stimulation of endogenous antioxidant enzymes. The results demonstrate the potential use of traditional herbal plants to act as natural sources for anti-inflammatory and antioxidant compounds.

Keywords: Anti-inflammation, Antioxidant, Pro-inflammatory cytokines, Reactive oxygen species (ROS), Reactive nitrogen species (RNS), Cyclooxygenase (COX) and LOX pathways.

I. INTRODUCTION

Herbal medicines have continued to be a fundamental part of existing healthcare systems worldwide and continue to receive much attention from the scientific community due to their traditional use, multiple pharmacological properties, and their promise in drug development.¹ Medicinal plants contain various bioactive compounds, including flavonoids, alkaloids, and terpenoids, among others, that have been proven to possess antimicrobial, antioxidant, anti-inflammatory, antidiabetic, and immunomodulatory properties^{2,3} among others, and thus have been extensively used in the treatment of infections, cancers, and diabetes, among others. Unlike many traditional medicines, herbal medicines have been considered safe and more acceptable and have been widely adopted due to their cost-effectiveness and reliance on plants, which have been extensively used by people in developing countries for primary healthcare among the population⁴. Recent review articles underscore that there is an increasing interest in the world regarding herbal medicines, not only due to the reasons of side effects and expense associated with modern medicine, but also because of advances made in the field of phytochemistry, advanced drug delivery systems, and convergence of modern medicine with conventional herbal therapies⁵. Yet, recent studies underscore that there is an increasing emphasis on scientific validation, standardisation, and quality control of herbal products, as there is still a lack of complete evidence regarding the safety and efficacy of various herbal formulations introduced in the market. In such developing situations, herbal medications are turning from traditionally used folk medicine towards evidence-based medicine, thus establishing their importance in health prevention as well as therapeutic sourcing in modern

pharmacology. These herbs have been traditionally used from ancient times in various forms of healthcare practices and are still being unravelled with various therapeutic properties.⁶

Most individuals are familiar with it in tropical regions where it is commonly cultivated, while it has been reported to demonstrate various pharmacological properties, including neuroprotection, improving memory, antidiabetics, and antimicrobial activities, apart from its antioxidant and anti-inflammatory properties.⁷ *Clitoria ternatea* is largely cultivated in tropical regions and has been found to possess neuroprotective, memory-strengthening effects, antidiabetic properties, and antimicrobial properties, besides its antioxidant and anti-inflammatory properties.⁸ *Ficus elastica*, traditionally used as folk medicine, has been reported to display various pharmacological activities, including antimicrobial, wound healing, hepatoprotection, and analgesia, apart from its antioxidant and anti-inflammatory properties.⁹ *Moringa oleifera*, found in the Indian subcontinent, is known for its nutritional value apart from its antidiabetic, antihyperlipidemic, hepatoprotection, antimicrobial, and immunomodulation activities.¹⁰ *Punica granatum* is an ancient, cultivated plant that has been extensively investigated scientifically for its cardio protection, anticancer, antidiabetic, antimicrobial, and gastroprotection, apart from its potent antioxidant and anti-inflammatory effects.¹¹ *Prunus dulcis* has been associated with its lipid-lowering, cardio protection, antidiabetic, and gut responses, apart from its antioxidant and anti-inflammatory activities.¹² *Salvia rosmarinus* has been traditionally valued in Mediterranean cultures, apart from its antimicrobials, neuroprotection, hepatoprotection, and anticancer activities, apart from its antioxidant and anti-inflammatory properties.¹³ *Syzygium cumini*, found as an indigenous plant in the Indian subcontinent, is known for its antidiabetics, gastroprotection, hepatoprotection, and antimicrobials, apart from its antioxidant and anti-inflammatory properties.¹⁴ *Tradescantia pallida* have been reported as an ornamental plant, apart from its wound healing, antimicrobials, and cytoprotecting activities, apart from its antioxidant and anti-inflammatory properties.¹⁵ *Dracaena trifasciata*, commonly used as a house plant, displays antimicrobial, wound healing, and cytotoxic properties in addition to antioxidant and anti-inflammatory properties.¹⁶ Taking all plants together, even though they possess varied biological properties, the

properties of antioxidants and anti-inflammatories are shared.

1.1 Inflammation

Inflammation is defined as the response of vascular tissues to injury and to eliminate the cause of injury, and to start the repair of tissues¹⁷. This is usually a non-specific reaction and occurs because of the blood vessels, immune cells, and mediators, as it has been stated in one of the reviews that the mediators are the chemical substances that take an active part in the immune response¹⁸.

The types of inflammation are based on the duration and clinical presentation. There are three types of inflammation as described below:

Acute Inflammation- Onset of rapid inflammation and usually for a period of minutes to a few days, Characteristics of inflammation appearing like redness, heat, swelling, pain, and loss of function¹; **Sub acute Inflammation-** It is known to be the transition period from acute to chronic inflammation, which may take 2-6 weeks; **Chronic Inflammation-** It persists for a period of months to years and involves different cell types like mononuclear cells, fibroblasts, and plasma cells. The failure to complete the acute inflammation results in *Denovo*, i.e. without previous inflammation²⁰.

Role of mediators in Inflammation, the mediators play a vital role in the inflammatory response by their agents. The following are the mediators-Released histamine and serotonin, causing early vasodilation and increased vascular permeability, which contribute to redness, heat, and swelling²⁰. Released bradykinin, which contributes to causing pain, increases vascular permeability²¹. Released eicosanoids from arachidonic acid cause the release of prostaglandins, which further cause fever, pain, and other changes occur by. The Main key actors in the acute phase response are these proinflammatory cytokines, which are produced by cells like leukocytes, macrophages, etc This cytokine regulates the recruitment, activation, and peripheral effects like fever and acute phase response, respectively. Chemokine is a cytokine subset, specialised in immunocytes migration towards sites of inflammation, respectively. ROS is involved in activating phagocytes, which leads to killing pathogens, which can also cause tissue damage if levels become high, respectively. In response to cytokines, acute phase proteins are produced by the liver to these factors. The system comprises some plasma proteins that produce some important proinflammatory mediators, leading to

increased vascular permeability, propagation, and leukocyte chemotaxis, respectively. These pro-resolving molecules are specialised and involved in the resolution phase, acute inflammation phase critical role in arresting immunocytes' recruitment, boosting clearance, involved in tissue repairs in the inflammation phase²².

1.2 Oxidation

Biosynthetic process that entails the loss of electrons from molecules, which is responsible for the production of ROS such as the superoxide anion, hydrogen peroxide, and hydroxyl radical. Essentially, the ROS is generated during the mitochondrial oxidative phosphorylation and participates in signalling and host defences. Inevitably, the excess production of ROS causes oxidative stress²³.

The mechanism of oxidation includes:

Excess ROS Production causes the antioxidant's capacity to neutralise excess ROS, and cellular damage starts.

Lipid peroxidation: ROS attacks the PUFA in the membrane, producing peroxides and aldehydes. Alters membrane fluidity and permeability, resulting in cell dysfunction and death.

Protein Oxidation: Oxidation of amino acids triggers enzyme inactivation, receptor signalling alterations, and protein degradation.

DNA Damage: By Strand Breaks, Mutations, & Base Modifications, ROS activates the DNA Damage Response. Its role in Cancer.

Activation of inflammatory pathways: Oxidative stress stimulates the activation of transcription factors such as NF- κ B and AP-1, leading to the enhancement of inflammatory cytokines, thus relating both oxidation and inflammation. RNS Reactive nitrogen species: Including nitric oxide and peroxy nitrite. High levels of NO react with superoxide, forming peroxynitrite, which is a strong oxidant. Causes endothelial dysfunction and neurotoxicity²⁴.

The connection between inflammation and oxidative stress is that excessive levels of oxidative stress can stimulate inflammatory signalling. For instance, this will be a self-reinforcing and damaging process to cells and tissues. ROS

activates redox-sensitive transcription factors, which regulate inflammatory cytokines, enzymes and chemokines²⁵. Our oxidative stress produces damage-associated molecular patterns recognised by TLRs for nothing but toll-like receptors. The activation of these receptors leads to downstream signalling and inflammation. It is under oxidative stress that our antioxidant mechanisms will be compromised. The weaker our defences, the more continuous levels of ROS will be provided to stimulate inflammatory pathways. As a connection to a disease outlined, let us take cancer, where our oxidative stress and inflammation combine as our ROS stimulates genomic stability and oncogenic signalling, and inflammation provides a boost to tumour growth and angiogenesis²⁶. For this reason, our antioxidants and anti-inflammatories will be more potent combined. The demands for safety and therapeutic action are the reasons why the anti-inflammatory and antioxidant drugs demonstrate limited long-term efficacy and show notable side effects. Certain anti-inflammatory drugs, such as corticosteroids and NSAIDs, exhibit actions such as kidney toxicity, gastric ulcerations, and cardiovascular complications, limiting their long-term treatment. The synthetic antioxidants are clinically futile due to the lack of capacity to interrupt inflammatory and oxidation cycles and poor bioavailability²⁷. Hence, the natural products emerge as the alternatives because they are non-toxic and reduce inflammation and redox imbalances²⁸.

II. PLANT PROFILE

2.1 Clitoria ternatea

Synonyms: Butterfly pea, Blue pea, Asian pigeonwings, Aparajita, Shankhpushpi

Biological source: Clitoria ternatea includes the dried flowers, leaves, roots, and seeds from Clitoria ternatea L. This plant belongs to the Fabaceae family²⁹.

Geographical source: Clitoria ternatea grows in tropical and subtropical regions worldwide. It is commonly found in India, Sri Lanka, Southeast Asia, Malaysia, Indonesia, Thailand, Africa, Australia, and parts of tropical America. In India, it is widely cultivated in plains and gardens for both medicinal and ornamental uses²⁹.



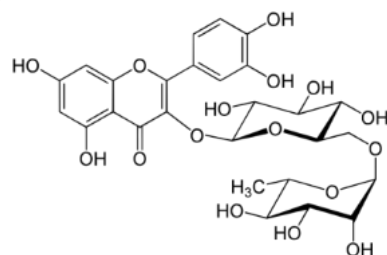
Fig 1 Clitoria ternatea

Phytochemical study of Clitoria ternatea plant:

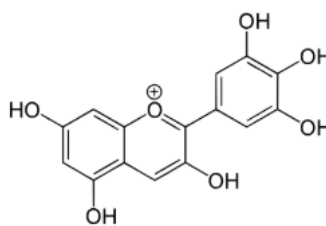
| Phytochemical class | Extraction technique | Identification\ instrument | Anti-inflammatory activity | Antioxidant activity | reference |
|--|---|---|---|----------------------------------|-----------|
| Flavonoids (Quercetin, kaempferol, luteolin) | Solvent extraction using ethanol/methanol | HPLC-High performance liquid chromatography | Inhibition of pro-inflammatory cytokines (TNF- α , IL6); COX suppression | Strong radical scavenging | 30 |
| Alkaloids (clitorin, Aparajitin) | Acid-base extraction with methanol | GS-MS-Gas chromatography mass spectrometry | Modulation of inflammatory mediators | Moderate antioxidant activity | 31 |
| Terpenoids (Triterpenoid, steroidal terpenes) | Soxhlet extraction using chloroform/ Methanol | GC-MS-Gas chromatography mass spectrometry | Reduction of inflammatory and mediator release | Inhibition of lipid peroxidation | 32 |
| Saponins (triterpenoid saponins) | Aqueous or hydroalcoholic extraction | HPLC-high performance liquid chromatography | Inhibition of nitric oxide inflammatory enzyme | Moderate antioxidant activity | 33 |
| Phenolic acid (Gallic acid, caffeic acid, ferulic acid, p coumaric acid) | Methanolic or aqueous extraction | HPLC-high performance liquid chromatography | Reduction of oxidative stress-induced inflammation | High antioxidant potential | 34 |

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|--|--|---|---|---|----|
| Tannins (condensed and hydrolysable tannins) | Hot water or aqueous - methanol extraction | UV-VIS-ultraviolet visible spectroscopy | Inhibition of protein denaturation and inflammatory mediators | Strong metal chelating and antioxidant activity | 35 |
| Anthocyanins (terminations) | Acidified or aqueous ethanol extraction | HPLC-PDA: high-performance liquid chromatography with photodiode array detector | Suppression of inflammatory signalling pathways | Very strong antioxidant activity | 36 |

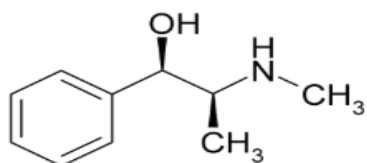
Chemical structures:



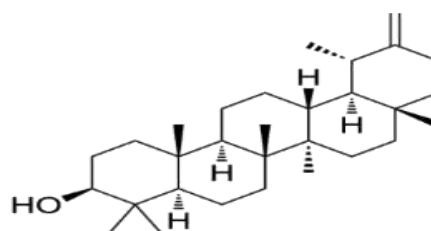
Rutin



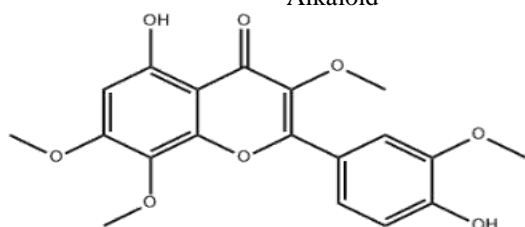
Delphinidin



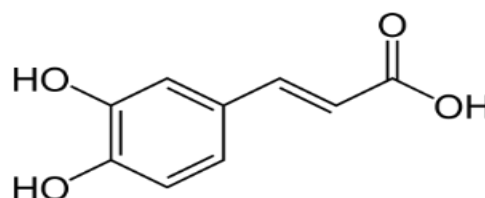
Alkaloid



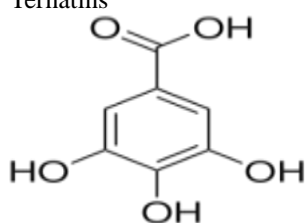
Taraxerol



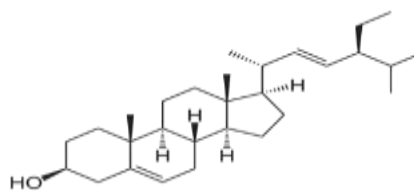
Ternatins



p-Coumaric acids



Tannins



Stigmasterol

Other pharmacological activities: Cognitive enhancing, antidepressant, anxiolytic, antimicrobial (antibacterial, antifungal, antiviral), antidiabetic, hepatoprotective, anti-obesity.

2.2 Ficus elastica

Synonyms: Ficus decora, Ficus robusta, rubber plant/Indian rubber plant

Biological source: Ficus elastica consists of the leaves, bark, and latex obtained from the plant Ficus elastica Roxb. Ex hornem, this plant belongs Moraceae family³⁷.

Geographical source: Ficus elastica is primarily found in Southeast Asian countries such as India, Nepal, Bhutan, Myanmar, Malaysia, and Indonesia. It is widely used as an ornamental plant in warm regions all over the world³⁷.



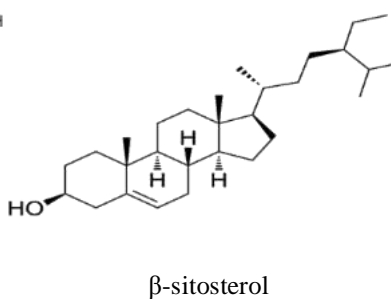
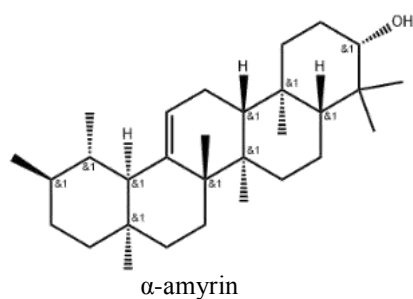
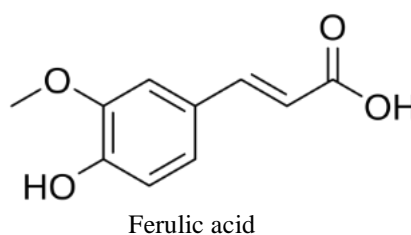
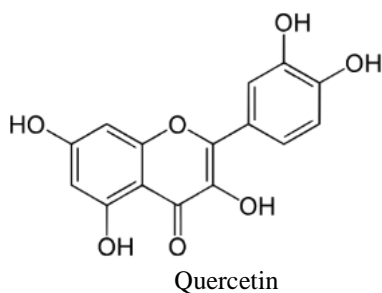
Fig2 Ficus elastica

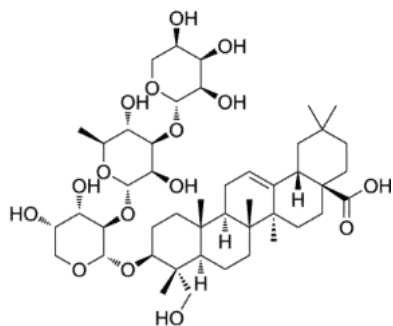
Phytochemical study of Ficus elastica plant:

| Phytochemicals class | Extraction technique | Identification/instruments | Anti-inflammatory activity | Antioxidant activity | reference |
|--|---|--|---|--|-----------|
| Flavonoids (quercetin, kaempferol, rutin) | Solvent extraction using ethanol/methanol | HPLC-high performance liquid chromatography | Inhibition of proinflammatory mediators and cytokines | Strong free radical scavenging (DPPH, ABTS) | 38 |
| Phenolic compounds (Gallic acid, chlorogenic acid, catechol) | Methanolic or aqueous extraction | HPLC- high performance liquid chromatography | Reduction of inflammation associated with oxidative stress | High antioxidant potential | 39 |
| Tannins (Condensed tannins, hydrolysable tannins) | Hot water or aqueous methanol extraction | UV-Vis-ultraviolet visible spectroscopy | Inhibition of protein denaturation and inflammatory enzymes | Strong metal chelating and radical scavenging activity | 39 |

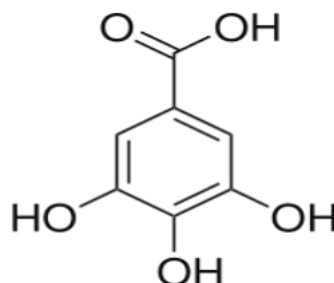
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|---|--|--|--|-------------------------------|-------|
| Alkaloids (Indole alkaloids) | Acid-base extraction with methanol | GC-MS-Gas chromatography mass spectrometry | Modulation of inflammatory mediators | Mild antioxidant activity | 39 |
| Terpenoids (Triterpenoids, steroidal terpenes) | Soxhlet extraction using chloroform/ methanol | GS-MS-Gas chromatography mass spectroscopy | Suppression of inflammatory responses | Moderate Antioxidant activity | 40,41 |
| Saponins (Triterpenoids) | Aqueous hydroalcoholic extraction | HPLC-High performance liquid chromatography | Inhibition of nitric oxide inflammatory pathways | Moderate antioxidant activity | 42 |
| Latex constituents (cis-1,4 polyisoprene, resins) | latex tapping followed by solvent purification | FTIR-Fourier transform infrared spectroscopy | Mild inflammatory action | Limited antioxidant activity | 43 |

Chemical structures:

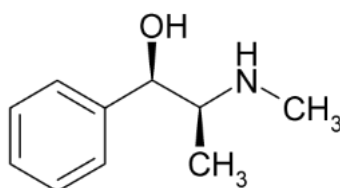




Tannins



Saponin



Alkaloid

Other pharmacological activities include antimicrobial (antibacterial, antifungal), anti-diabetic, hepatoprotective, wound healing, anti-cancer, anti-obesity, analgesic, cognitive support, and antiulcer.

2.3 Moringa oleifera

Synonyms: drumstick tree, miracle tree

Biological source: Moringa oleifera involves the use of the leaves, seeds, flowers, bark, and root of Moringa oleifera. This plant belongs to the Moringaceae family⁴⁴.

Geographical source: Moringa oleifera is found in the Indian Subcontinent, while it is commonly cultivated in the tropical and subtropical regions of Asia, Africa, and the Americas⁴⁵.



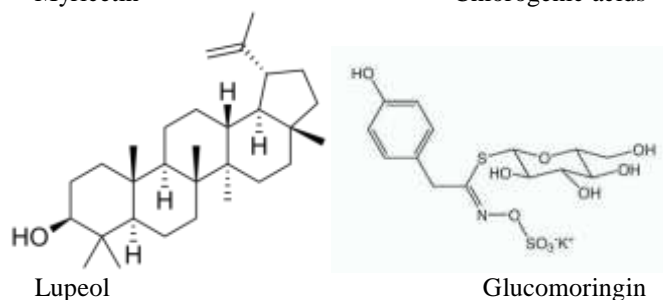
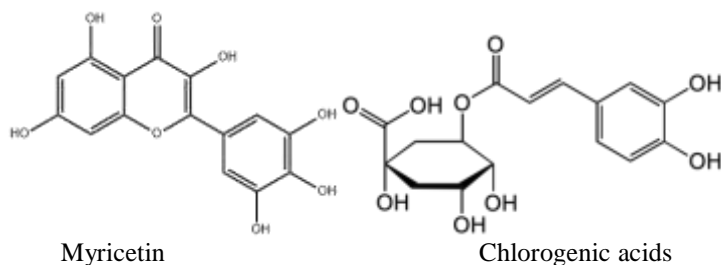
Fig 3 Moringa oleifera

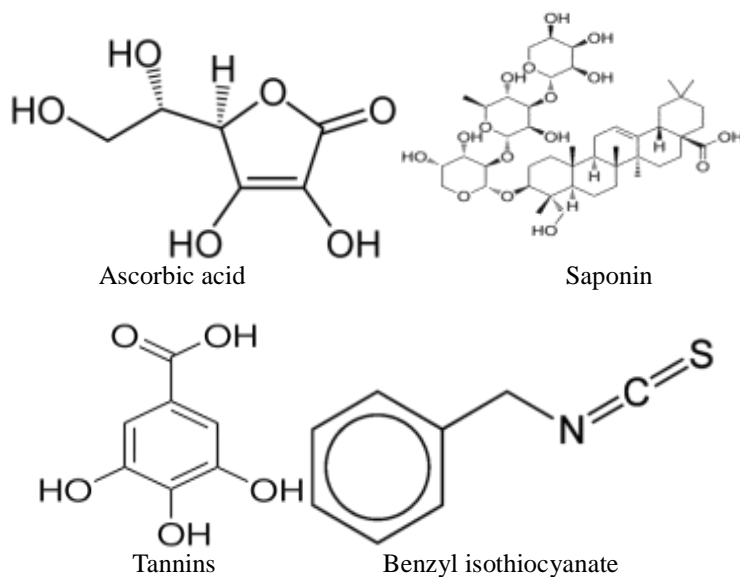
Phytochemical study of Moringa oleifera plant:

| Phytochemical class | Extraction technique | Identification/instruments | Anti-inflammatory Activity | Antioxidant activity | References |
|---------------------|----------------------|----------------------------|----------------------------|----------------------|------------|
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|---|--|--|--|-------------------------------------|--------|
| Flavonoids (Quercetin, kaempferol) | Ethanollic / methanolic solvent extraction | HPLC-High performance liquid chromatography | Inhibits pro- inflammatory cytokines and mediators | Strong free radical scavenging | 46,47 |
| Phenolic acids (Gallic chlorogenic acid) | Methanol acidic extraction | HPLC- highperformance liquid chromatography | Reduction inflammation associated with oxidative stress | High antioxidant of capacity | 48,49 |
| Alkaloids (moringine) | Acid-base extraction | GC-MS-Gas chromatography Mass spectrometry | Modulates inflammatory response | Moderate antioxidant activity | 50 |
| Saponins (Triterpenoid saponins) | Aqueous extraction | HPLC- Highperformance liquid chromatography | Suppresses nitric oxide production | Moderate antioxidant activity | 51, 52 |
| Tannins (Condensed tannins) | Aqueous- Methanol extraction | UV-Vis- Ultraviolet- visible spectroscopy | Prevents protein denaturation | Strong antioxidant activity | 53,54 |

Chemical structures:





Other pharmacological activities: antimicrobial (antibacterial, antifungal, antiviral), anti-diabetic, cardioprotective, neuroprotective, hepatoprotective, anti-cancer, anti-obesity, wound healing, antiulcer, immunomodulatory.

2.4 Punica granatum

Synonyms: Pomegranate

Biological source: Punica granatum involves the fruits, skin (fruit rind), seeds, and flowers derived from the plant Punica granatum L., this plant belongs to the Lythraceae family.

Geographical source: It is originally from the Middle East and South Asia, commonly found in India, Mediterranean regions such as Asia, Africa, and America⁵⁵.



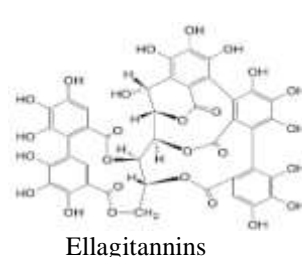
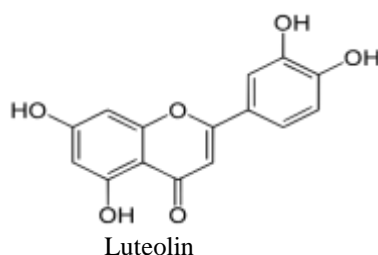
Fig 4 Prunus granatum

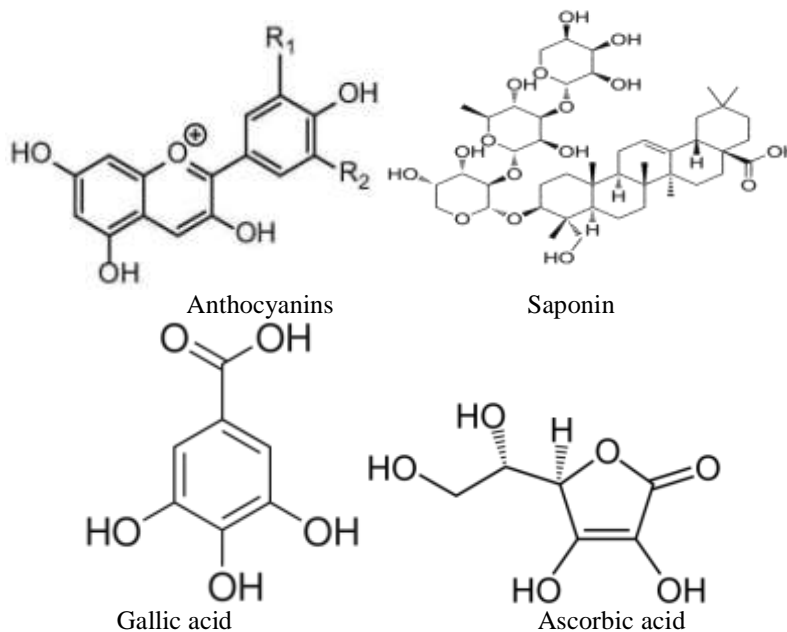
Phytochemical study of Prunus granatum plant:

Table 4 Phytochemical study of Prunus granatum plant

| Phytochemical class | Extraction technique | Identification/instrument | Anti-inflammatory activity | Antioxidant activity | References |
|---|---------------------------------|---|---|-------------------------------------|------------|
| Polyphenols (Punicalagin, ellagic acid) | Methanolic solvent extraction | HPLC-highperformance liquid chromatography | Inhibits cyclooxygenase enzymes and proinflammatory cytokines | Very strong free radical scavenging | 56,57 |
| Flavonoids (Quercetin, Kaempferol) | Ethanollic extraction | HPLC-PDA-highperformance liquid chromatography with photodiode array detector | Suppresses inflammatory signalling pathways | Strong Antioxidant activity | 58,59 |
| Anthocyanins (Delphinidin, cyanidin, pelargonidin) | Acidified Ethanollic extraction | HPLC-PDA-highperformance liquid chromatography with photodiode array detector | Reduces inflammatory mediator release | Very strong antioxidant activity | 60,61 |
| Tannins (Hydrolysable tannins-punicalin, punicalagin) | Aqueous extraction | UV-VIS-Ultraviolet-visible spectroscopy | Antioedematous and anti-inflammatory activity | Strong metalchelating activity | 62,63 |
| Phenolic acids (Gallic acid, ellagic acid) | Methanolic Extraction | HPLC-High performance liquid chromatography | Attenuates oxidative stress induced inflammation | High antioxidant potential | 64 |

Chemical structures





Other pharmacological activities: antimicrobial (antibacterial, antifungal, antiviral), anti-diabetic, cardioprotective, cognitive enhancing, hepatoprotective, anti-cancer, anti-obesity, skin protective, anti-ulcer, immunomodulatory.

Biological source: Prunus dulcis consists of the seeds (kernels) obtained from the plant Prunus dulcis (Mill.) D.A. Webb, this plant belongs to the Rosaceae family.

Geographical source: It is indigenous to the Middle East and South Asia, the Mediterranean, the Indian subcontinent, Europe, and the United States of America⁶⁵.

2.5 Prunus dulcis

Synonyms: Almond, Sweet almond



Fig 5 Prunus dulcis

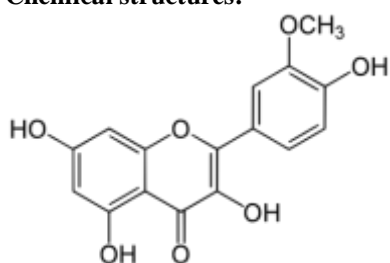
Phytochemical study of Prunus dulcis plant:

Table 5 Phytochemical study of Prunus dulcis plant

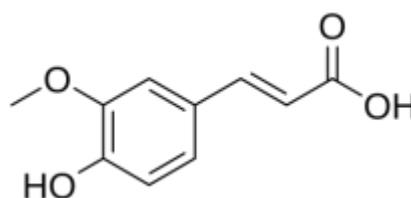
| Phytochemical class | Extraction technique | Identification/instrument | Anti-inflammatory activity | Antioxidant activity | References |
|---------------------|----------------------|---------------------------|----------------------------|----------------------|------------|
| | | | | | |

| | | | | | |
|---|-------------------------|--|--|--------------------------------------|----|
| Flavonoids (Quercetin, kaempferol) | Ethanol extraction | HPLC-High performance liquid chromatograph y | Inhibits Inflammatory mediatory release | Strong free radical scavenging | 66 |
| Phenolic acid (gallic acid, caffeic acid) | Methanol extraction | HPLC-High performance liquid chromatograph y | Reduction oxidative stress- induced inflammation on | High antioxidant potential | 67 |
| Tannins (Condensed tannins) | Aqueous extraction | UV-VIS- Ultraviolet- visible spectroscopy | Antiinflammatory by protein stabilization | Moderate antioxidant activity | 68 |
| Terpenoids (triterpenes) | Soxhlet extraction | GC-MS-Gas chromatograph y Mass spectrometry | Suppresses inflammatory enzyme activity | Indirect antioxidant effect | 69 |
| Alkaloids (Trace alkaloids) | Acid base extraction | TLC-thin layer chromatograph y | Mild antiinflam matory action | Supports Antioxidant defence | 70 |

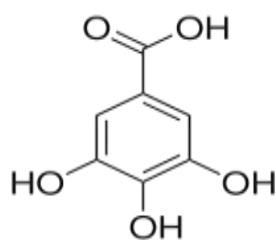
Chemical structures:



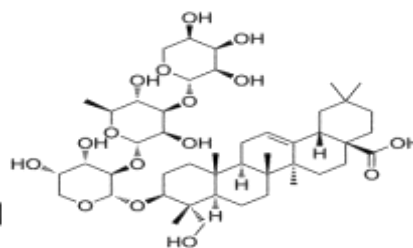
Isorhamnetin



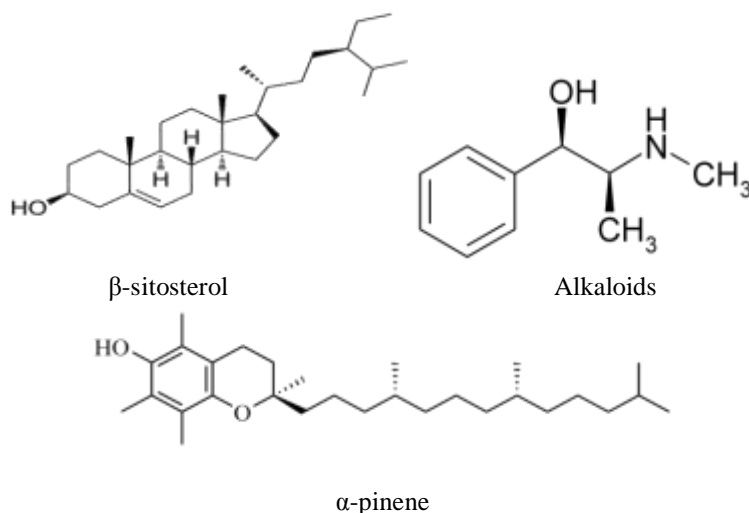
Ferulic acid



Tannins



Saponin



Other pharmacological activities: cardioprotective, cognitive enhancing, anti-diabetic, hepatoprotective, anti-obesity, skin protective, anti-cancer, wound healing, and anti-ulcer.

Biological source: Salvia rosmarinus consists of the leaves and flowering tops obtained from the plant Salvia rosmarinus Spenn., this plant belongs to the Lamiaceae family.

Geographical source: It is found originally in the Mediterranean and is grown worldwide in tropical to subtropical regions⁷¹.

2.6 Salvia rosmarinus
Synonyms: Rosemary



Fig6 Salvia rosmarinus

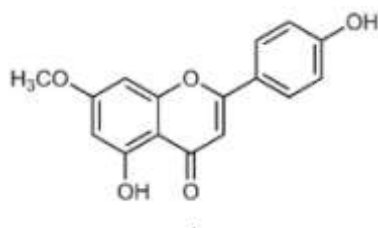
Phytochemical study of Salvia rosmarinus plant:

Table 6 Phytochemical study of Salvia Rosmarinus plant

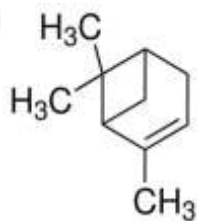
| Phytochemical class | Extraction technique | Identification/ instrument | Anti-inflammatory activity | Antioxidant activity | References |
|---|----------------------|---|--|-------------------------------------|------------|
| Phenolic diterpenes (carnosic acid, carnosol) | Ethanol extraction | HPLC-High performance liquid chromatography | Inhibit cyclooxygenase (COX) and lipoxygenase (LOX) pathways | Very strong free-radical scavenging | 72 |

| | | | | | |
|---|----------------------------|--|---|-------------------------------|-------|
| Phenolic acid (Rosmarinic acid, caffeic acid) | Methanolic extraction | HPLC-High performance liquid chromatography | Suppresses inflammatory mediators | Strong antioxidant activity | 73 |
| Flavonoids (Luteolin, apigenin) | Hydro-alcoholic extraction | HPLC-PDA-high performance liquid chromatography with a photodiode array detector | Reduces cytokine production | Effective radical scavenger | 74 |
| Terpenoids (Essential oils- 1,8Cineole, camphor) | Steam distillation | GC-MS-Gas chromatography - Mass spectrometry | Reduces the Inflammatory enzyme activity | Moderate antioxidant effect | 75,76 |
| Tannins (Condensed tannins) | Aqueous extraction | UV-VIS- Ultraviolet- visible spectroscopy | Protein – stabilizing antiinflammatory action | Moderate antioxidant activity | 77 |

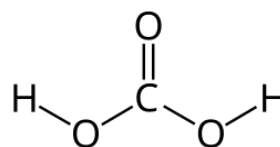
Chemical structures:



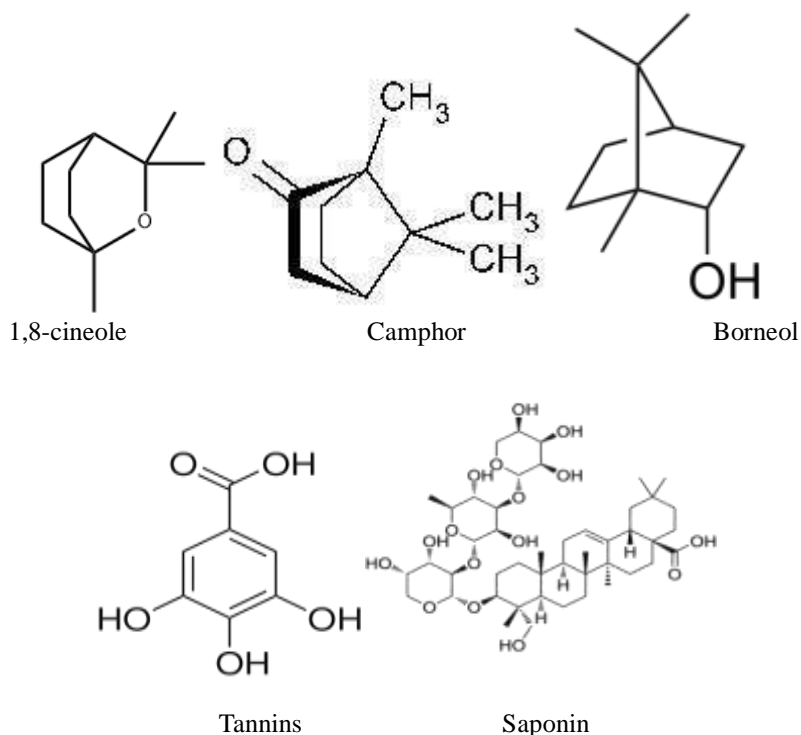
Genkwanin



Carbonic acid



α -pinene



Other pharmacological activities: cognitive enhancing, antimicrobial (antibacterial, antifungal, antiviral), anti-diabetic, cardioprotective, hepatoprotective, anti-cancer, anti-obesity, wound healing, anti-ulcer, analgesic.

2.7 *Syzygiumcumini*

Synonyms: jamun, java plum, black plum

Biological source: *Syzygium cumini* includes seeds, fruits, bark, and leaves of the plant *Syzygium cumini* (L.) skeels. This plant belongs to the Myrtaceae family.

Geographical source: It is found in the Indian subcontinent and Southeast Asia and is widespread in the tropics of Asia, Africa, and Australia⁷⁸.



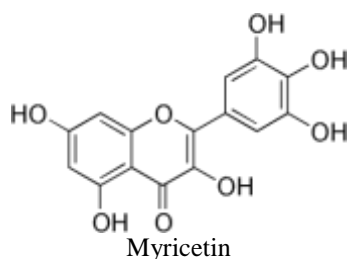
Fig7 *Syzygium cumini*







Phytochemical study of Syzygium cumini plant:

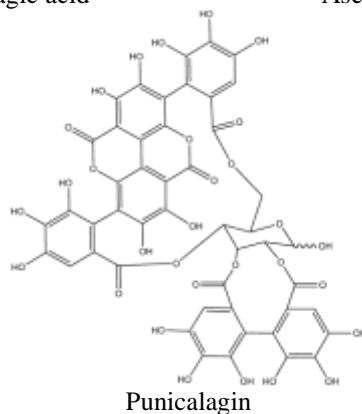
Table 7 Phytochemical study of Syzygium cumini plant

| Phytochemical class | Extraction technique | Identification/instrument | Anti-inflammatory activity | Antioxidant activity | References |
|--|--------------------------------|--|--|---|------------|
| Anthocyanins (delphinidin, cyanidin, malvidin) | Acidified ethanolic extraction | HPLC-PDA-high-performance liquid chromatography with photodiode array detector | Inhibits inflammatory mediator release | Very strong free radical scavenging. | 79 |
| Flavonoids (quercetin, myricetin) | Ethanolic extraction | HPLC-High performance liquid chromatography | Suppresses cytokine production | Strong antioxidant activity | 80 |
| Phenolic acids (gallic acid, ellagic acid) | Methanolic extraction | HPLC-High performance liquid chromatography | Reduces oxidative stress-induced inflammatory effect | High antioxidant potential | 81 |
| Tannins (hydrolysable tannins) | Aqueous extraction | UV-VIS-Ultraviolet-visible spectroscopy | Protein – stabilising antiinflammatory action | Moderate to strong antioxidant activity | 82 |
| Terpenoids (triterpenes) | Soxhlet extraction | GC-MS-Gas chromatography Mass spectrometry | Inhibits inflammatory enzymes | Support antioxidant defence | 83 |

Chemical structures:



| | | |
|---|---|---|
|  |  |  |
| Saponin | Anthocyanins | Luteolin |
|  |  |  |
| Gallic acid, | Ellagic acid | Ascorbic acid |



Other pharmacological activities: anti-diabetic, cardioprotective, cognitive enhancing, hepatoprotective, anti-cancer, anti-obesity, antimicrobial (antibacterial, antifungal, antiviral), wound healing, anti-ulcer.

2.8 *Tradescantia pallida*

Synonyms: purple heart plant, purple queen

Biological source: *Tradescantia pallida* consists of the leaves and aerial parts obtained from the plant *Tradescantia pallida* (Rose) D.R.Hunt. This plant belongs to the Commelinaceae family.

Geographical source: It is originally from Mexico and Central America and is grown as an ornamental and medicinal plant all over the world⁸⁴.



Fig8 Tradescantia pallida

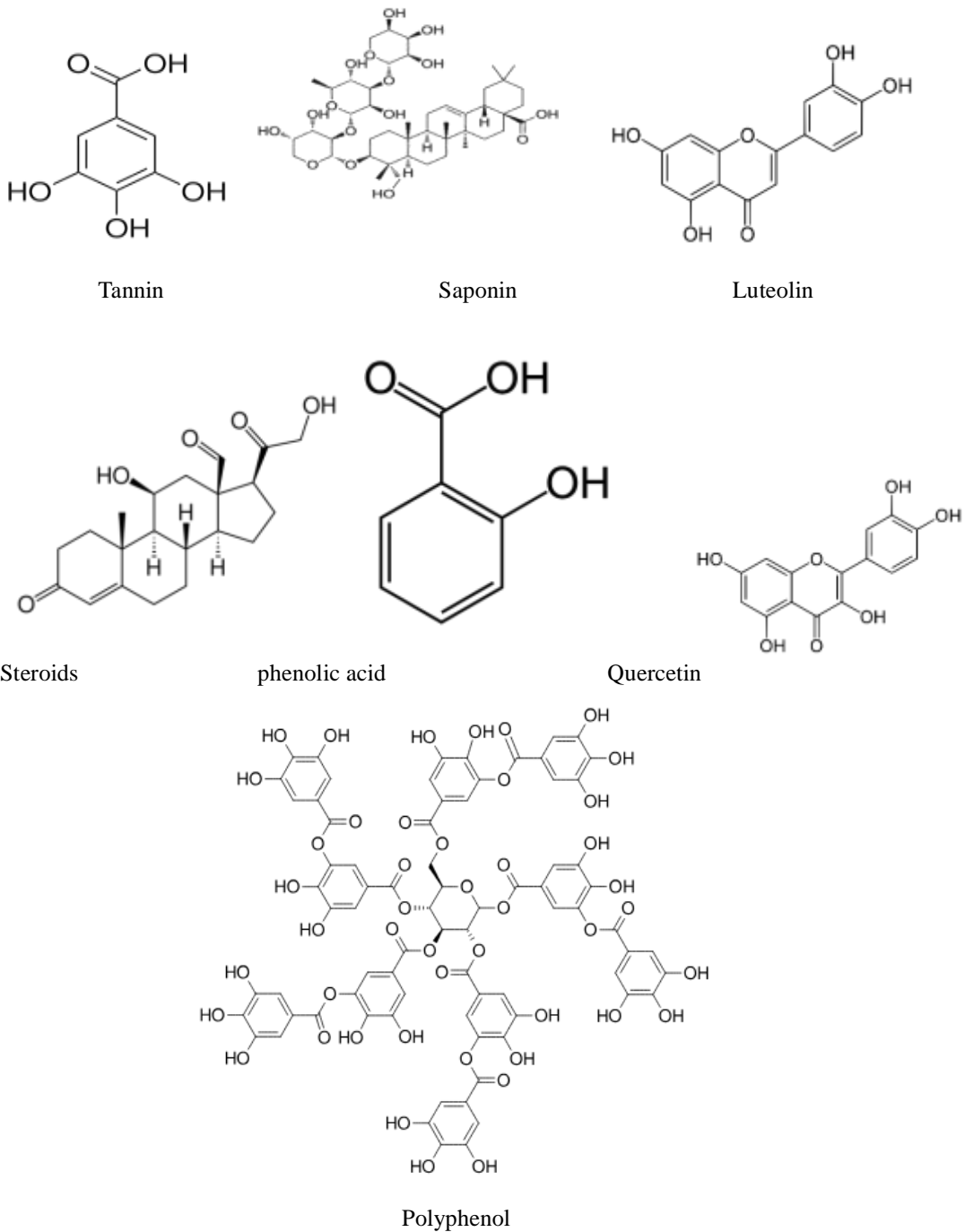
Phytochemical study of Tradescantia pallida plant:

Table 8 Phytochemical study of Tradescantia pallida plant

| Phytochemical class | Extraction technique | Identification/ instrument | Anti- inflammatory activity | Antioxidant activity | References |
|--|---------------------------------|--|---|-------------------------------------|------------|
| Anthocyanin s (Cyanidin3glucoside, delphinidin derivatives) | Acidified Ethanollic extraction | HPLC-PDA- highperformance liquid chromatography with photodiode array detector | Reduce inflammatory mediator release. | Very strong free radical scavenging | 85 |
| Flavonoids (Quercetin, luteolin) | Hydro- alcoholic extraction | HPLC-High performance liquid chromatography | Suppresses proinflammatory cytokines | Strong antioxidant activity | 86 |
| Phenolic compound (Chlorogenic acid, caffeic acid) | Methanol ic extraction | HPLC-High performance liquid chromatography | Attenuates oxidative stressinduced inflammation | High antioxidant potential | 87 |
| Tannins (condensed tannins) | Aqueous extraction | UV-VIS- Ultraviolet- visible spectroscopy | Protein stabilizing antiinflammatory effect | Moderate antioxidant activity | 88 |
| Saponins (steroidal) | Soxhlet | TLC- thin | Mild | Support | 89 |

| | | | | | |
|-----------|------------|----------------------|-------------------------|---------------------|--|
| saponins) | extraction | layer chromatography | antiinflammatory action | antioxidant defence | |
|-----------|------------|----------------------|-------------------------|---------------------|--|

Chemical structures:



2.9 Dracaena trifasciata

Synonyms: Snake plant, mother-in-law’s tongue

Biological source: Dracaena trifasciata consists of the leaves obtained from the plants Dracaena trifasciata (Prain) Madd., this plant belongs to the Asparagaceae family.

Geographical source: It is originally found in tropical West Africa, but it has been widely

cultivated as an ornamental plant in tropical, subtropical, and other parts of the world, including Africa and Asia. It is originally found in tropical West Africa, but it has been widely cultivated as an ornamental plant in tropical, subtropical, and other parts of the world, including Africa and Asia⁹⁰.



Fig 9

Dracaena trifasciata

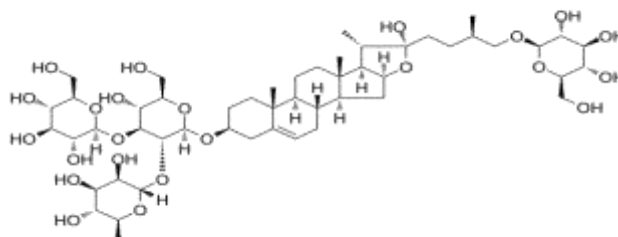
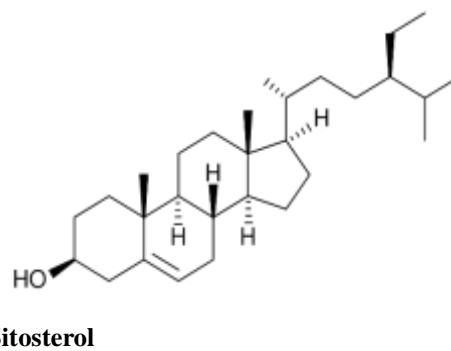
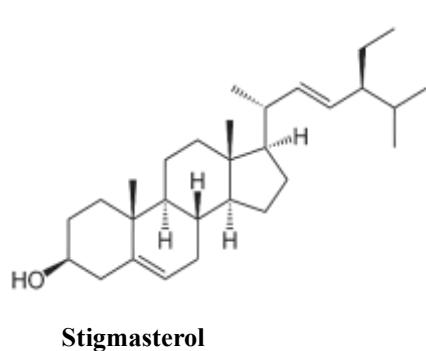
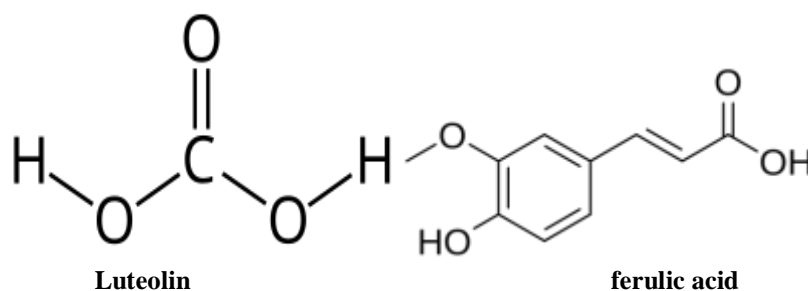
Phytoconstituents:

Table 9 Phytochemical study of Dracaena trifasciata plant

| Phytochemical class | Extraction technique | Identification/instrument | Anti-inflammatory activity | Antioxidant activity | References |
|---|-----------------------|---|--|--------------------------------|------------|
| Flavonoids (quercetin, kaempferol) | Ethanol extraction | HPLC-High performance liquid chromatography | Inhibits inflammatory mediator release | Strong free radical scavenging | 91 |
| Phenolic compound (Gallic acid, ferulic acid) | Methanolic extraction | HPLC-High performance liquid chromatography | Reduction of oxidative stress induced inflammation | High antioxidant potential | 92 |
| Saponins (Steroidal saponins) | Aqueous extraction | TLC- thin layer chromatography | Suppresses inflammatory enzyme activity | Moderate antioxidant activity | 93 |
| Alkaloids (Trace alkaloids) | Acid-base extraction | TLC- thin layer chromatography | Mild antiinflammatory effect | Supports Antioxidant defence | 94 |

| | | | | | |
|-----------------------------------|-----------------------|---|---|-------------------------------------|----|
| | | | | | |
| Tannins (Condensed tannins) | Aqueous extraction | UV-VIS- Ultraviolet- visible spectroscopy | Protein stabilization and antiinflammatory action | Moderate antioxidant activity | 95 |

Chemical structure:



Steroidal saponins

Other Pharmacological Activities: Antimicrobial activity, wound healing activity, antidiabetic activity, analgesic activity, antipyretic activity, anti-ulcer activity, hepatoprotective activity,

antiasthmatic activity, cytoprotective activity, air-purifying property.

III. CONCLUSION

Inflammation and oxidative stress are two independent factors that play a crucial part in the development and progression of various diseases. Proper control of these factors is equally important to maintain the sanctity of cells and thwart complications arising from chronic diseases. Medicinal herbs are a rich source of bioactive compounds that inherently possess impressive antioxidant and anti-inflammatory properties. This herbal drug under scrutiny proves its anti-inflammatory activity by inhibiting the key enzymes involved. These herbal plants are endowed with multiple Phytoconstituents that make it possible to exert a wide-spectrum activity with minimal side effects, as seen with allopathic medicines. These herbal plants are ideal natural sources to counter inflammation and oxidative stress.

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