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Review Article

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Pharmacological Exploration of Coccinia Grandis (Ivy Gourd) Root: A Comprehensive Investigation into Anti-Inflammatory Potential

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ABSTRACT

This review examines the overall potential activities of Coccinia grandis (L. Voigt), often known as ivy gourd or scarlet gourd, by combining available evidence on its modes of action, phytochemistry, and preclinical efficacy. Chronic inflammation is a key mechanism that underpins many diseases, thus the search for effective, natural anti-inflammatory medicines with fewer side effects remains a top focus. C. grandis has long been utilized in folk medicine systems, notably in South Asia, to treat illnesses such as inflammation, pain, and metabolic abnormalities.

The review assesses phytochemical studies that discover important anti-inflammatory components critically. These include alkaloids, steroids, flavonoids, phenolic chemicals, especially in the leaves, fruits, and roots, and triterpenoids (such as β-amyrin and lupeol). Next, we describe the hypothesized in vivo and in vitro anti-inflammatory processes. Research indicates that the activities of C. grandis extracts and isolated substances include:
-Preventing the synthesis of pro-inflammatory mediators, such as nitric oxide (NO), interleukin-6(IL-6) and tumor necrosis factor (TNF-α)
-Making important enzymes like lipoxygenase (LOX) and cyclooxygenase-2 (COX-2) less active.
-Blocking the signaling pathways that are activated by nuclear factor-kappa B (NF-κB). Strong antioxidant activity, which is inherently associated with the reduction of inflammation.

Finally, the preclinical efficacy in diverse animal models of acute and chronic inflammation, such as carrageenan-induced paw edema, arthritis, and inflammatory bowel disease, is reviewed, revealing consistent and dose-dependent decreases in inflammatory markers and symptoms. This study emphasizes the strong scientific evidence supporting C. grandis' traditional use as an anti-inflammatory agent, as well as its potential as a source for the development of new phytopharmaceuticals. More research, including toxicity assessments and standardized clinical trials, is required to transfer these preclinical discoveries into medicinal applications.

Keywords: Coccinia grandis, Ivy Gourd Root, Anti-inflammatory Activity, GC-MS Analysis, Phytochemical Screening, Lupeol, Stigmasterol, Phytosterols, Ethanolic Extract, Natural Products, Medicinal Plants, NF-κB Pathway.

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Introduction

Inflammation is a necessary and carefully controlled biological response that occurs in vascularized tissues when the body is exposed to damaging stimuli such as pathogenic agents, wounded cells, physical injury, or poisonous substances. Its major job is to protect the body by removing the cause of the injury, preventing future tissue damage, and promoting healing and restoration. Although inflammation is generally good, it can be dangerous if it is severe, poorly controlled, or lasts for an extended period of time. Under these conditions, it aids in the development and progression of a variety of chronic diseases, including rheumatoid arthritis,

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atherosclerosis, inflammatory bowel disease, type 2 diabetes, neurological disorders, and cancer [1.3].

For many years, synthetic medications, particularly nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids, were the primary treatment for inflammatory illnesses. Indomethacin, diclofenac, and aspirin are common NSAIDs, whereas dexamethasone and prednisolone are popular steroidal anti-inflammatory medications. Despite their ability to reduce inflammation and alleviate symptoms, chronic use of these drugs is frequently accompanied with considerable negative effects. Long-term NSAID use can cause gastrointestinal ulcers, bleeding, kidney failure, and increased cardiovascular risk, owing to its impact on cyclooxygenase enzymes. Similarly, long-term corticosteroid medication can lead to immunological suppression, bone loss, metabolic imbalance, and adrenal dysfunction [4-6].

Because of these restrictions, researchers are increasingly looking to natural compounds as promising options for safer anti-inflammatory therapy. Ethnopharmacology and pharmacognosy, which study medicinal plants and ancient therapeutic methods, have emerged as particularly important fields in this pursuit. Ancient medical systems, such as Ayurveda, Unani, and Traditional Chinese Medicine, have a wealth of botanical knowledge that can help with current drug discovery. Plant-based natural chemicals are regarded promising since they have a wide structural variety, can act on various biological targets, and frequently have less side effects than many synthetic medications [7,8].

Botanical Classification, Taxonomy and Naming

Coccinia grandis (L.) Voigt, sometimes known as Ivy Gourd, is a structurally strong and fast-growing perennial climbing vine. It occupies an important place in the botanical landscape since it serves as both a very nutritious food staple and a powerful therapeutic agent in traditional medicine [7].

Taxonomically, the plant belongs to the Cucurbitaceae family (often known as the gourd, melon, or pumpkin family), a varied group of flowering plants recognized for producing biologically active secondary metabolites, particularly cucurbitacins, which are highly oxygenated triterpenes [8].

The formal taxonomic hierarchy of Coccinia grandis is organized as follows:

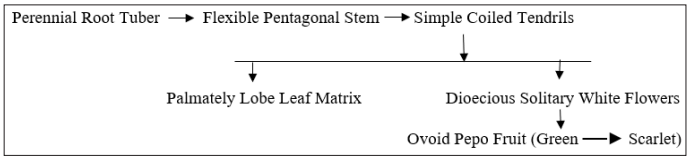
Taxonomical Classification

Kingdom	**Plantae**
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Violales
Family	Cucurbitaceae
Genus	Coccinia Wight & Arn.
Species	Coccinia grandis (L.) Voigt

The most prominent homotypic and heterotypic synonyms encountered across historical literature include: Bryonia grandis L., Coccinia indica Wight & Arn., Coccinia cordifolia Cogn., Cephalandra indica Naudin.

Because of its widespread distribution and deep integration into local diets and ancient medical systems across continents, the plant is known by a plethora of regional vernacular names:
English: Ivy gourd, scarlet gourd, tindora, baby watermelon, kovai fruit.
Sanskrit: Bimbi, Raktaphaluka (meaning "red-fruited"), Oshthi.
Hindi: Kundru, Tindora, Bimb.
Bengali: Telakucha, Kundri.
Tamil: Kovai, Kovakkai.
Telugu: Donda Kaya, Dondakaya.
Malayalam: Kovalkkai, Koval.
Marathi: Tondli.
Arabic: Kadd, Ghaf.

Features of plants and their morphology Coccinia grandis is a perennial climber that grows rapidly and is dioecious (individual plants are clearly male or female) [9]. It uses unique lateral structures to climb fences, surrounding vegetation, or structural frameworks. In order to avoid misidentification during wild foraging and raw pharmacognostic collecting, it is essential to comprehend its intricate macro-morphology.



Root System: The underground architecture of Coccinia grandis consists of a highly developed, thick, tuberous taproot system. These dense, flesh-like roots function as the plant's primary biological metabolic reservoir. They store water, complex carbohydrates, and concentrated defensive secondary metabolites [10]. This substantial underground mass allows the vine to survive harsh seasonal droughts and rapidly sprout new vegetative shoots once rainfall returns.

Stems and Tendrils: The stems are structurally slender, highly flexible, and distinctly angled (usually pentagonal). In younger growth phases, the stems are bright green and glabrous (smooth) or sparsely hairy, but they become progressively woody, brittle, and covered in a grayish-white bark as the vine grows older. Branching out from the leaf axils are simple, unbranched, spirally coiled tendrils. These structures exhibit intense thigmotropism (touch sensitivity), tightly wrapping around physical supports to lift the dense leaf canopy toward sunlight.

Leaf Structure: The leaves are arranged alternately along the stem on long, flexible petioles. The leaf blades are highly variable in shape (polymorphic), ranging from broadly cordate (heart-shaped) to deeply palmately 5-lobed. The margins are minorly denticulate (toothed), and the upper surface is typically dark

green, studded with small, rough papillae, while the lower surface is lighter green with distinct, radiating palmate veins [12,13].

Floral Morphology: As a dioecious species, cross-pollination between separate male and female vines is required for fruit production. The flowers are large, striking, white, and solitary, emerging directly from the leaf axils:

Male Flowers:- Typically grow solitary or in small, axillary clusters. They feature a campanulate (bell-shaped) five-lobed calyx and a white corolla, housing three distinct, tightly fused stamens with twisted, golden-yellow anthers.
Female Flowers:- Arrive strictly as solitary structures. They visually resemble male flowers but are easily distinguished by a prominent, elongated, inferior green ovary located directly below the white petals. The flower terminates in a short style bearing three deeply split, rough stigmas.

Fruit and Seed Development: The fruit is a smooth, fleshy, ovoid-to-oblong berry-like structure technically classified as a pepo. When immature, the fruit exhibits a smooth, firm, bright green skin decorated with prominent white longitudinal stripes, closely resembling a miniature watermelon. As the fruit undergoes ripening, its biochemical profile shifts drastically: the green chlorophyll degrades completely, revealing a brilliant, glossy, scarlet-red exterior. The inner flesh transforms from a crisp, whitish-green bitter pulp into a soft, mucilaginous, sweet, bright-red matrix enclosing numerous compressed, yellowish-brown, pyriform (pear-shaped) seeds [14,15].

Geographical Distribution, Habitat, and Ecological Profile
Global and Regional Distribution: Coccinia grandis is native to the broad tropical belts of the Old World. Its native distribution spans dynamically across:

The Indian Subcontinent: Found across every state of India, Bangladesh, Pakistan, Sri Lanka, and Nepal, thriving from coastal plains up to lower Himalayan foothills [16].

Southeast Asia: Heavily distributed throughout Thailand, Vietnam, Cambodia, Laos, Myanmar, Malaysia, and Indonesia.

Africa: Widespread across East and West African nations, including Ethiopia, Sudan, Kenya, Uganda, and Somalia.

Due to its adaptability and rapid growth rate, the plant was intentionally introduced to various non-native regions for culinary use. It has since naturalized across parts of northern Australia, several Caribbean islands, Central America, and the United States.

Ecology and Invasive Character: The plant thrives in regions with warm, humid, tropical climates. It prefers rich, well-drained sandy loam soils, though it adapts readily to degraded, nutrient-poor terrains. It is commonly found in disturbed open habitats, forest edges, riverbanks, roadsides, abandoned agricultural fields, and waste areas.

In regions where it has been introduced without its natural biological competitors, such as Hawaii and Guam, Coccinia grandis has shifted from a useful agricultural plant to an aggressive invasive weed. Its rapidly expanding vegetative blanket smothers native shrubs and trees, blocking sunlight and breaking branches under its heavy structural weight. This rapid growth has prompted intensive ecological management and biological control efforts in those areas [17-20.

Ethnopharmacology and Traditional Medical Systems

Centuries before the development of modern chromatography and molecular bioassays, indigenous healers systematically mapped the therapeutic properties of Coccinia grandis. Virtually every structural part of this vine has been deeply integrated into the core texts of ancient medical systems, most notably Ayurveda, Siddha, Unani, and traditional tribal medicine.

Applications in Ayurveda and Siddha: In Ayurvedic medicine, Coccinia grandis is qualitatively classified as possessing a Tikta (bitter) and Madhura (sweet) taste, with a Sheeta (cooling) potency. It is traditionally used to balance aggravated Pitta and Kapha doshas within the human body [21,22].

Management of Madhumeha (Diabetes Mellitus):- The most highly celebrated traditional application of Coccinia grandis is its use as a natural treatment for diabetes. Freshly expressed juice from the leaves or roots was regularly prescribed to patients presenting with polyuria (excessive urination) and glycosuria (sugar in the urine) to safely bring down blood glucose levels.

Respiratory and Gastrointestinal Relief:- The leaves were formulated into medicated decoctions to alleviate chronic bronchitis, dry coughs, and mucosal inflammation. The green, immature fruits were consumed to soothe burning sensations in the stomach, heal aphthous ulcers (canker sores), and treat acute dysentery [23,24].

Topical Applications:- Fresh leaf pastes or poultices were applied directly to the skin to treat scabies, psoriasis, eczema, ringworm infections, and to accelerate the healing of minor wounds and burns [25].

Applications in Unani and Traditional Tribal Medicine: In the Unani system, the plant is valued for its anti-periodic, antipyretic (fever-reducing), and blood-purifying properties. Tribal communities across India and Bangladesh have long relied on the roots of the plant to treat specific systemic conditions:

The tuberous roots are crushed and boiled into dense concentrated decoctions to treat urinary tract infections (UTIs) and dissolve renal calculi (kidney stones) [26].

Juice extracted from the fresh roots is administered orally to treat hepatomegaly (enlarged liver) and reduce systemic dropsy or localized inflammatory swellings caused by physical trauma.

Nutritional Value and Phytochemical Composition: The multi-targeted therapeutic efficacy of Coccinia grandis is directly tied to its dual nature: it is a highly nutritious food source and a rich factory of secondary metabolites [27].

Proximate Nutritional Profile: The immature green fruits and tender leafy shoots are widely consumed as a vegetable across Asia. They offer an exceptional nutritional profile characterized by low

caloric density, high dietary fiber, and a dense concentration of essential vitamins and minerals:

Nutritional Component Primary Health / Physiological Benefit Beta-Carotene (Provitamin A) Critical for maintaining ocular health, mucosal integrity, and systemic immune surveillance [28]. Ascorbic Acid (Vitamin C) Acts as a potent water-soluble antioxidant, protecting cells from oxidative stress and facilitating collagen synthesis. B-Complex Vitamins (Thiamine, Riboflavin, Niacin) Serve as vital coenzymes in cellular energy production and metabolic pathways. Essential Minerals (Calcium, Iron, Potassium, Phosphorus) Crucial for maintaining skeletal density, hemoglobin synthesis, and electrolyte balance [29].

Qualitative and Quantitative Phytochemical Profiling: When the leaves, fruits, or roots of Coccinia grandis are processed using analytical extraction methods (such as sequential extraction with petroleum ether, n-hexane, chloroform, ethyl acetate, ethanol, and water), a diverse matrix of complex secondary metabolites is recovered.

Comprehensive screenings using Thin-Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC), and Gas Chromatography-Mass Spectrometry (GC-MS) show that the plant synthesizes several major chemical classes:

Triterpenoids and Cucurbitacins:- The Cucurbitaceae family are characterized by cucurbitacins—a group of highly oxygenated, tetracyclic triterpenes known for their intense bitter taste. The roots and fruits of Coccinia grandis contain unique cucurbitacin glycosides and derivatives. These compounds are of immense biomedical interest due to their potent cytotoxic, anti-tumor, and anti-inflammatory properties.

Phytosterols:- The plant is exceptionally rich in steroidal compounds, most notably β-sitosterol, stigmasterol, and taraxerol. These plant sterols are structurally analogous to mammalian cholesterol. When absorbed, they actively modulate cellular membrane fluidity, inhibit cholesterol absorption in the gut, and suppress downstream pro-inflammatory cell signalling.

Flavonoids and Polyphenolic Compounds:- A wide array of polyphenols, including quercetin, kaempferol, and rutin, are densely distributed throughout the leaves and fruits. These substances have extremely reactive hydroxyl groups that function as potent scavengers of free radicals. They neutralize reactive oxygen species (ROS), protect cellular structures from lipid peroxidation, and downregulate the expression of inflammatory enzymes [30,31].

Alkaloids and Glycosides:- Unique alkaloidal fractions (such as cephalandrine and coccinine) have been isolated from the plant's aerial parts and roots. These nitrogenous bases exhibit targeted pharmacological actions on the mammalian central nervous system and metabolic apparatus, contributing directly to the plant's analgesic and hypoglycemic effects.

Modern Pharmacological Evaluation and Therapeutic Potential Over the past few decades, researchers have subjected Coccinia grandis to extensive in vitro and in vivo preclinical testing. This research has successfully validated many of its traditional medical uses and uncovered new therapeutic avenues [32].

Preparation of Coccinia Grandis (L.) extract and Authentication

The plant material (Coccinia grandis) was ethically collected from local area of Mukundapur and taxonomically authenticated authenticated it from Shivpur Botanical Garden, Howrah. Specimen number: TNU/AM-01. The subterranean roots were thoroughly washed with water to eliminate debris, sliced into smaller segments, and shadow-dried at room temperature. The completely dehydrated root material was subsequently crushed to a coarse powder using a mechanical grinder. The pulverized root mass was subjected to extraction to yield the crude extract fractions. The solvents were concentrated under reduced pressure and dried thoroughly to aim for the final solid/semi-solid therapeutic extract residue, which was preserved in a desiccator at low temperature until further pharmacological evaluation.

Figure: Herbarium of Coccinia grandis

GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
BOTANICAL SURVEY OF INDIA
CENTRAL NATIONAL HERBARIUM
HOWRAH – 711 103

No.:CNH/Tech.II/2025/248 Date: 11.05.2026

To,
Mr. Amit Maity
M. Pharm.
School of Pharmacy
The Neotia University
Sarisha, West Bengal

Sub.: Identification of one plant specimen – reg.

Dear Mr. Maity,
Please refer to your letter ref. no. SOP/TNU/2025-26/93 dated 19th December 2025 along with one plant specimen for identification. The specimen has been identified by the concerned expert as:

Sl. No.	Specimen No.	Scientific Name	Family
1.	TNU/AM-01	**Coccinia grandis** (L.) Voigt	Cucurbitaceae

The receipt of ₹ 250/- (Rupees two hundred fifty only) Receipt No. TR-5, C-112337 dated 9.12.2025 is enclosed herewith.
Please collect the specimen within three months from the date of receipt of this letter failing which it will be discarded.

Yours sincerely
(K. Karthigeyan)
Scientist -'F' & Head of Office

Botanical Survey of India, Central National Herbarium, P.O. – Botanic Garden, Howrah – 711 103, West Bengal, India.

Figure: Authentication Certificate

Qualitative Colorimetric and Precipitating Assays

The table below outlines the standard qualitative chemical assays used to identify the primary classes of secondary metabolites within Coccinia grandis root extracts.

Target Metabolite Class	Analytical Test	Laboratory Procedure	Diagnostic Observation	Expected Distribution
Alkaloids	Mayer's Test	Mix 2 ml of extract with 3 drops of Mayer's reagent	Formation of a creamy white precipitate.	High.
Saponins	Froth Test	Dilute 1 ml of crude extract with 5 ml of distilled water in a testtube and shake vigorously for 15 mins.	Formation of a persistent,stable honeycomb like froth layer that remains for over 15 minutes.	High
Tannins & Phenols	Ferric Chloride Test	Add 3-4 drops of a freshly prepared 5% neutral Ferric Chloride (FeCl3) solutions to 2 ml of the extract.	Development of a deep blue-black or deep-greenish-black color.	High
Steroids & Triterpenoids	Salkowski Test	Dissolve the extract residue in 2 ml of chloroform then carefully add 2 ml of concentrated H2SO4 along the inner wall.	The upper chloroform layer turns vivid red/ reddish-brown while the acid layer shows a green fluorescence	High
Glycosides	Keller-Kiliani Test	Dissolve 2 ml extract in 1 ml glacial acetic acid containing 1 drop of FeCl3 then gently layer 1 ml concentrated H2SO4 down the tubeside.	A reddish-brown ring appears at the interface while the upper layer gradually turns bluish-green.	High

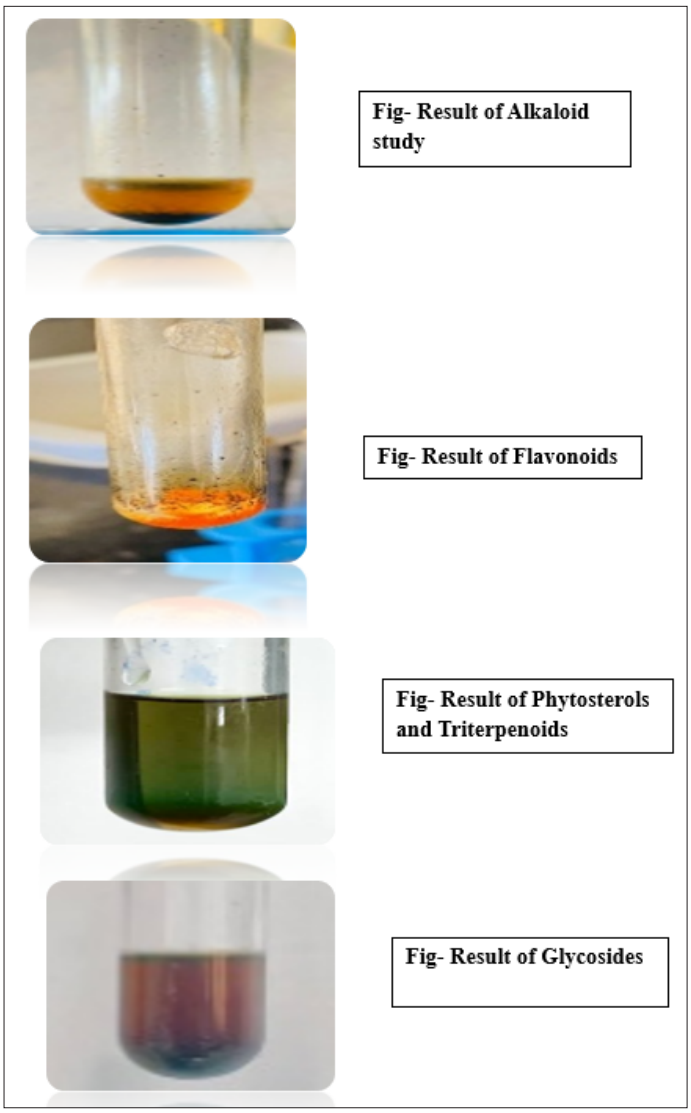
Traditional & Ethnopharmacological Applications of C. grandis root

System of Medicine	Historical Indication & Usage	Validated Phytochemical
Traditional Systems & Folk Remedies	Deeply embedded in ancient texts like Ayurveda, Unani and Siddha as well as indigenous tribal practices. Healer historically relied on the roots to treat broad-spectrum conditions including fevers, internal inflammation, diabetes and skin disorders.	Indigenous practitioners mapped out these multi-targeted healing traits centuries prior to the advent of modern bioassays and analytical chromatograpy.
Ayurvedic Metabolic Therapy	Prescribed as a freshly extracted juice to treat Madhumeha. It was specifically administered to manage clinical symptoms such as glycosuria and polyuria.	Classified qualitatively as having a bitter and sweet taste coupled with a cooling potency. This profile is used to rebalance elevated Pitta and Kapha doshas.
Systemic & Deep-Tissue Infections	Utilized to combat severe, deep-seated bodily infections. Controlled testing shows root extracts offer superior antibacterial strength against stubborn pathogens like Bacillus cereus and Salmonella typhi compared to leaf or fruit extracts.	The root architecture serves as a concentrated reservoir for highly basic alkaloidal compounds. These specialized metabolites directly sabotage bacterial protein synthesis.
Dermatological & Antifungal Care	Crushed root pastes were traditionally applied tropically to soothe persistent skin ailments and superficial ringworm or athlete; s foot infections.	Roots are rich in lipophilic phytosterols and long – chain fatty acids. Thesis elements integrate into the fungal cell wall, stalling hypal tip expansion and disruption ergosterol production to compromise membrane fluidity.

Medicinal value of Coccinia grandis by plant part

Plant part	Traditional uses	Reported pharmacological activities	Key bioactive types

Leaves	Diabetes, wounds, fever, cough, skin disorders	Antidiabetic,anti inflammatory, antioxidant, wound healing, analgesic	Flavonoids, phenolics, tannins, triterpenoids
Fruits	Antidiabetic, digestive aid, cough; general tonic	Hypoglycemic,antioxidant, hepatoprotective, antimicrobial	Cucurbitane, triterpenoids, phenolics
Roots	Jaundice, ulcers, fever, pain relief	Anti inflammatory,hepatoprotective, analgesic	Alkaloids,saponins, flavonoids
Stem	Wound healing, urinary complaints, fever	Antimicrobial, anti inflammatory, diuretic (reported traditionally)	Saponins, glycosides
Seeds	Digestive aid, Anthelmentic	Antimicrobial, larvicidal, antioxidant	Oils, fatty acids and phenolics



Figures of some Test

Metabolite profiling using GC-MS analysis

A 100 µl of ethanolic plant extract was dissolved in 1 ml of methanol solvent. The solution was stirred vigorously using vortex stirrer for 10 secs and filtered using 0.2-micron membrane filter. Then, the clear extract was used for GC-MS analysis. GC-MS analysis of plant seed ethanol extract was performed. This investigation was carried out to determine the possible chemical compound from natural plant. The identity of the components in the extracts was assigned by the comparison of their retention indices and mass spectra fragmentation patterns with NIST. WILEY and PESTE library sources were used for matching the identified components from the plant material. GC-MS analysis was performed using Agilent Technologies7890 Gas Chromatograph with Auto Sampler and 5975 Mass Selective Detector and Chemstation data system, following procedures performed by John Bwire Ochola (Ochola et al., 2022) and modified by the BALITRO (Spice and Medicinal Plants Research Center) library. Methanol plant extract is filtered through a five µl syringe filter in split mode (8:1). Helium gas is used as a carrier at a rate of 1.2mL/min. The injector temperature is 250 °C, then the analytes are separated on the silica capillary column (30m×0. 20mmI.D×0.11mmfilmthickness). The initial oven temperature is set at 80 °C, which is raised to 150°C at a rate of 3 °C/min. One minute later, the oven temperature is raised to 280 °C at a rate of 20 °C/min. Once the oven temperature reaches 280 °C, it is maintained for 26 minutes. Determination of the mass spectrum using an ionization energy of 70 [33-38].

GC-MS serves as a chemical "fingerprint" detector. It vaporizes the extract, isolates its individual chemical ingredients based on their volatility (Retention Time/R.Time), and fragments them before matching their mass spectrum to a standardized library (NIST20) for identification [39].

Here's how this unique chemical profile supports and explains anti-inflammatory activity:

Key Phytochemicals Driving the Anti-Inflammatory Activity Looking closely at the Peak Report TIC, the sample contains several heavy-hitting bioactive compounds known for their ability to suppress the inflammatory cascade:

1. The Sterols and Triterpenoids (The Late-Phase Inhibitors) –

- Stigmasterol (Peak 44, Area 0.49%) and Campesterol (Peak 42, Area 0.19%) are key plant sterols. Phytosterols are well-known for inhibiting the expression of pro-inflammatory mediators. They function at the cellular level to lower nitric oxide (NO) production while also inhibiting inducible nitric oxide synthase (iNOS) and COX-2.
- Lupeol (Peak 64, Area 0.34%): Lupeol is a highly potent anti-inflammatory triterpene. It successfully targets the NF-κB pathway, which is the main molecular "switch" for inflammation. Lupeol inhibits NF-κB, reducing the release of IL-6, and TNF-α.
- γ-Sitosterol (Peak 48, Area 0.57%) & γ-Sitostenone

(Peak 59, Area 1.17%): These chemicals help to stabilize lysosomal membranes, reducing the release of hydrolytic enzymes that cause localized tissue damage during chronic or acute swelling.

2. Diterpenes and Fatty Acid Esters (Tissue Protection & COX Inhibition) Phytol (Peak 18, Area 3.73%): A branched-chain diterpene alcohol. Phytol has been examined in carrageenan-induced models, where it efficiently inhibits prostaglandin synthesis and reduces neutrophil migration to the injury site [40].

3. Hexadecanoic acid, ethyl ester (Peak 17, Area 0.32%) & Linoleic acid ethyl ester (Peak 19, Area 0.07%): Fatty acid esters that have anti-inflammatory properties via interfering with arachidonic acid pathways, starving COX enzymes of the raw materials required to produce pro-inflammatory prostaglandins [41].

4. Antioxidant Synergists Vitamin E / α-Tocopherol variants (Peaks 35, 36, 39, 40, 41): Chronic and acute inflammation produce large levels of reactive oxygen species (ROS) and free radicals, exacerbating tissue edema. The heavy presence of Tocopherols (Vitamin E) serves as a powerful free-radical scavenging system, reducing oxidative stress and quenching the inflammation amplified by cellular oxidation [42].

Peak Report TIC

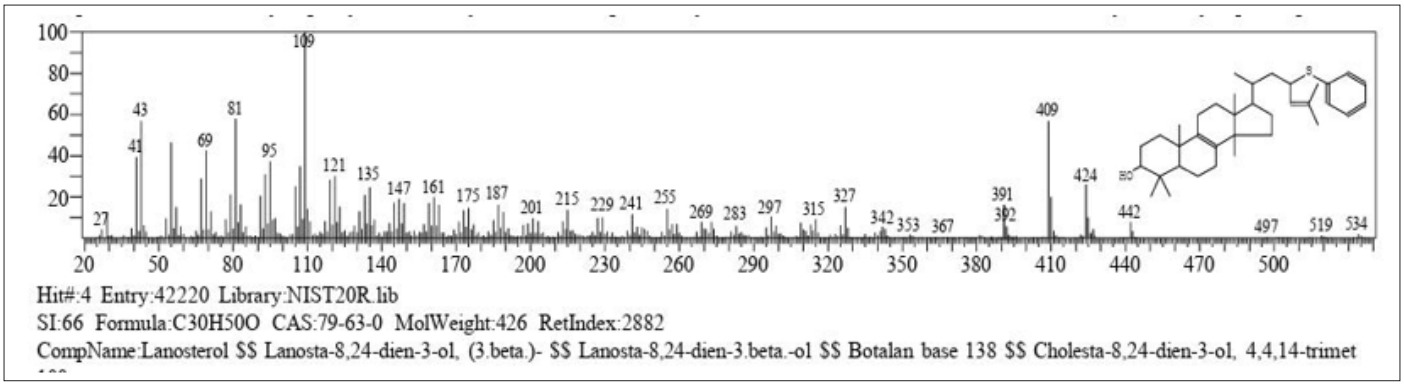
Peak#	R.Time	F.Time	Area	Area%	Height	Name
1	1.570	1.610	765806	0.17	192231	2-Chloroethyl methyl sulfoxide
2	1.702	1.750	56508365	12.47	15039100	Dimethyl ether
3	1.777	2.105	167707467	37.01	30725190	Methylene chloride
4	2.185	2.485	85134225	18.79	21445609	Pentanoic acid, 3-methyl-4-oxo-
5	2.518	2.660	6469049	1.43	2535663	Cyclohexane
6	3.304	3.385	232990	0.05	124660	Ethane, 1,1-diethoxy-
7	3.494	3.645	416092	0.09	113878	1H-Pyrrole, 1-methyl-
8	26.550	26.635	216219	0.05	52007	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-, (R)-
9	28.198	28.255	228201	0.05	77263	1H-Cycloprop[e]azulen-7-ol, decahydro-1,1,7-trimethyl-4-methylene-, [1ar-(1
10	31.660	31.720	281513	0.06	125572	Loliolide
11	32.138	32.225	526384	0.12	240819	Loliolide
12	32.434	32.475	300831	0.07	135475	3-Butylindolizidine
13	32.999	33.045	1905474	0.42	1051883	Neophytadiene
14	33.074	33.110	211544	0.05	136462	2-Pentadecanone, 6,10,14-trimethyl-
15	33.325	33.415	565363	0.12	271110	3,7,11,15-Tetramethyl-2-hexadecen-1-ol
16	33.563	33.625	673422	0.15	373348	Neophytadiene
17	35.001	35.080	1439174	0.32	664936	Hexadecanoic acid, ethyl ester
18	36.826	36.960	16903144	3.73	5694807	Phytol
19	37.712	37.760	320405	0.07	123174	Linoleic acid ethyl ester
20	37.839	37.945	2119373	0.47	669271	E,E,Z-1,3,12-Nonadecatriene-5,14-diol
21	38.129	38.300	2227236	0.49	629863	Spiro[4.5]decan-7-one, 1,8-dimethyl-8,9-epoxy-4-isopropyl-
22	40.726	40.780	261180	0.06	72959	5,6,6-Trimethyl-5-(3-oxobut-1-enyl)-1-oxaspiro[2.5]octan-4-one
23	40.917	40.985	243400	0.05	91136	9-Octadecenal, (Z)-
24	41.082	41.165	285187	0.06	69451	1-Heptadec-1-ynyl-cyclopentanol
25	41.679	41.745	477594	0.11	158059	Epoxylathyrol
26	42.023	42.140	1811325	0.40	503489	2H-Bisoxireno[2,3:8,8a]azuleno[4,5-b]furan-7(3aH)-one, octahydro-3a,8c-dim
27	42.633	42.695	3474773	0.77	895208	Cyclobuta[1,2:3,4]dicyclooctene-1,7(2H,6bH)-dione, dodecahydro-, (6a.alpha
28	42.726	42.860	1302206	0.29	292700	6-Hydroxyeurycomalactone
29	43.009	43.130	1804665	0.40	335788	(11.xi.)-4,7-Dihydroxy-12,13-epoxytrichothec-9-en-8-one
30	43.590	43.635	45176038	9.97	6508585	Anstolene epoxide
31	43.863	43.920	260292	0.06	121310	Nonacosanal
32	44.141	44.200	259589	0.06	103213	4-Hydroxy-6,9-dimethyl-3-methylidene-4,5,6,6a,7,9b-hexahydro-3aH-azuleno
33	44.402	44.500	7337244	1.62	2511186	Azuleno[4,5-b]furan-2,9-dione, 9a-[(acetyloxy)methyl]decahydro-6-methyl-3-
34	46.533	46.615	243260	0.05	62163	cis-11-Eicosenamide
35	47.278	47.440	1034386	0.23	137199	.alpha.-Tocospiro A

Peak#	R.Time	F.Time	Area	Area%	Height	Name
36	47.557	47.735	797103	0.18	137871	.alpha.-Tocospiro B
37	48.334	48.445	258239	0.06	50441	14-Deoxyandrographolide
38	49.679	49.755	754490	0.17	209193	Senkyunone
39	50.515	50.610	294598	0.07	66591	.gamma.-Tocopherol
40	51.921	52.000	1116898	0.25	327558	Vitamin E
41	52.074	52.160	463881	0.10	108701	.alpha.-Tocopherol-.beta.-D-mannoside
42	53.392	53.470	866431	0.19	198447	Campesterol
43	53.631	53.680	2253257	0.50	734855	Lanosta-8,24-dien-3-one
44	53.730	53.825	2217002	0.49	635947	Stigmasterol
45	54.009	54.115	8467194	1.87	2633322	Lanosterol
46	54.171	54.270	953966	0.21	301855	Lanosta-8,24-dien-3-one
47	54.393	54.425	453533	0.10	144418	Lup-20(29)-en-3-one
48	54.491	54.520	2564964	0.57	751667	.gamma.-Sitosterol
49	54.542	54.590	1889128	0.42	595860	Lanosterol
50	54.635	54.700	1263079	0.28	333596	Olean-12-en-3-ol, acetate, (3.beta.)-
51	55.015	55.095	2839179	0.63	527168	4-Campestene-3-one
52	55.144	55.185	357628	0.08	92493	D:C-Friedours-7-en-3-one
53	55.269	55.320	3063387	0.68	794709	Lup-20(29)-en-3-one
54	55.353	55.420	1185934	0.26	378232	4,22-Stigmastadiene-3-one
55	55.684	55.730	469513	0.10	145487	Lup-20(29)-en-3-ol, acetate, (3.beta.)-
56	55.772	55.820	559903	0.12	225020	Glutinol
57	55.868	55.935	681384	0.15	203198	Glutinol
58	56.038	56.105	538638	0.12	160340	Acetyl betulinaldehyde
59	56.243	56.375	5284708	1.17	1338186	.gamma.-Sitostenone
60	56.706	56.820	457902	0.10	113756	9,19-Cyclolanostan-3-ol, acetate, (3.beta.)-
61	57.261	57.420	395712	0.09	49761	
62	57.717	57.815	1599303	0.35	298014	Friedelan-3-one
63	58.814	58.950	1558926	0.34	185085	Stigmastane-3,6-dione, (5.alpha.)-
64	59.337	59.420	425380	0.09	93851	Lupeol
			453154676	100.00	104120389	

Figure: Name of different compound obtained from GC-MS analysis

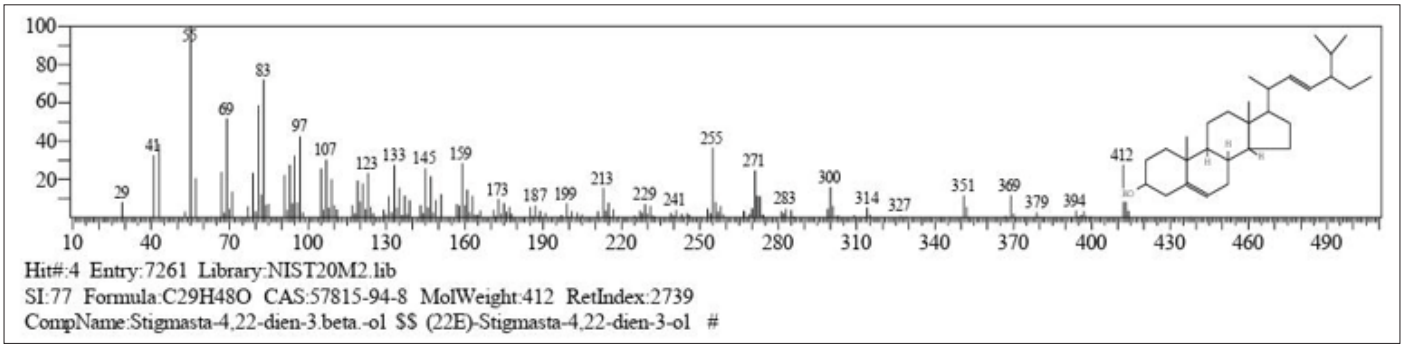
Lupeol

Lupeol is a pentacyclic triterpenoid that is lupine in which the hydrogen at the 3-beta position is substituted by a hydroxy group. It occurs in the skin of lupin seeds as well as in the latex of fig trees and of rubber plants. It possesses a wide spectrum of pharmacological properties most notably potent anti-inflammatory, antioxidant and anti-arthritic activities



Stigmasterol

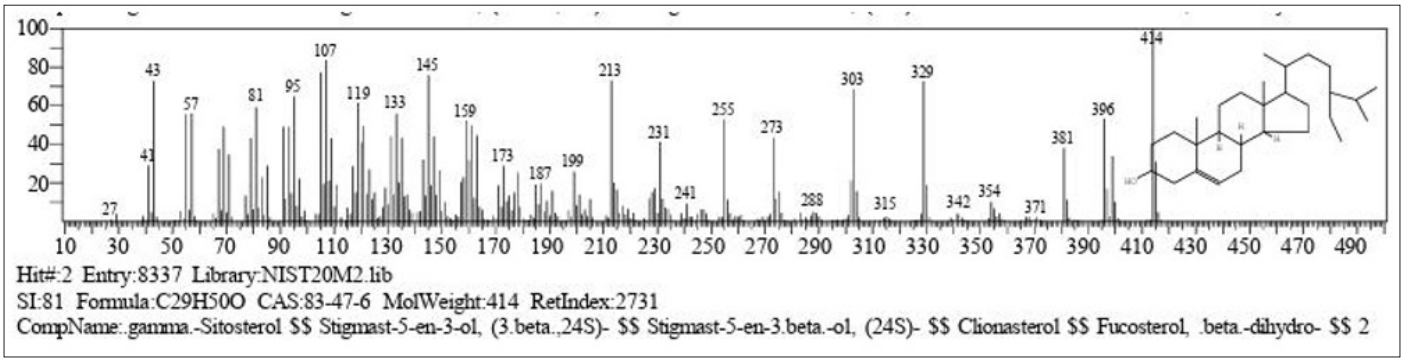
Stigmasterol is a 3 beta-sterol that consists of 3 beta-hydroxystigmastane having double bonds at the 5-6 and 22,23 – positions. It is an abundant plant-derived sterol that is structurally closed to cholesterol.It is frequently identified in the roots of Coccinia grandis during phtochemical screenings [43-45].



γ-Sitosterol

γ-Sitosterol is a prominent plant sterol and an epimer of the well-known β-sitosterol

Frequently identified as a major bioactive constituent in the roots of Coccinia grandis. It is a member of the class of phytosterols that is a poriferast- 5- ene carrying a beta-hydroxy substituent at position 3 [46].



Procedure

A 100 µl of ethanolic plant extract was dissolved in 1 ml of methanol solvent. The solution was stirred vigorously using vortex stirrer for 10 secs and filtered using 0.2-micron membrane filter. Then, the clear extract was used for GC-MS analysis. GC-MS analysis of plant seed ethanol extract was performed. This investigation was carried out to determine the possible chemical compound from natural plant. The identity of the components in the extracts was assigned by the comparison of their retention indices and mass spectra fragmentation patterns with NIST. WILEY and PESTE library sources were used for matching the identified components from the plant material [47-50].

GC-MS analysis was performed using Agilent Technologies7890 Gas Chromatograph with Auto Sampler and 5975 Mass Selective Detector and Chemstation data system, following procedures performed by John Bwire Ochola (Ochola et al., 2022) and modified by the BALITRO (Spice and Medicinal Plants Research Center) library. Methanol plant extract is filtered through a five µl syringe filter in split mode (8:1). Helium gas is used as a carrier at a rate of 1.2mL/min. The injector temperature is 250 °C, then the analytes are separated on the silica capillary column (30m×0. 20mmI.D×0.11mmfilmthickness). The initial oven temperature is set at 80 °C, which is raised to 150°C at a rate of 3 °C/min. One minute later, the oven temperature is raised to 280 °C at a rate of 20 °C/min. Once the oven temperature reaches 280 °C, it is maintained for 26 minutes. Determination of the mass spectrum using an ionization energy of 70 [51-54].

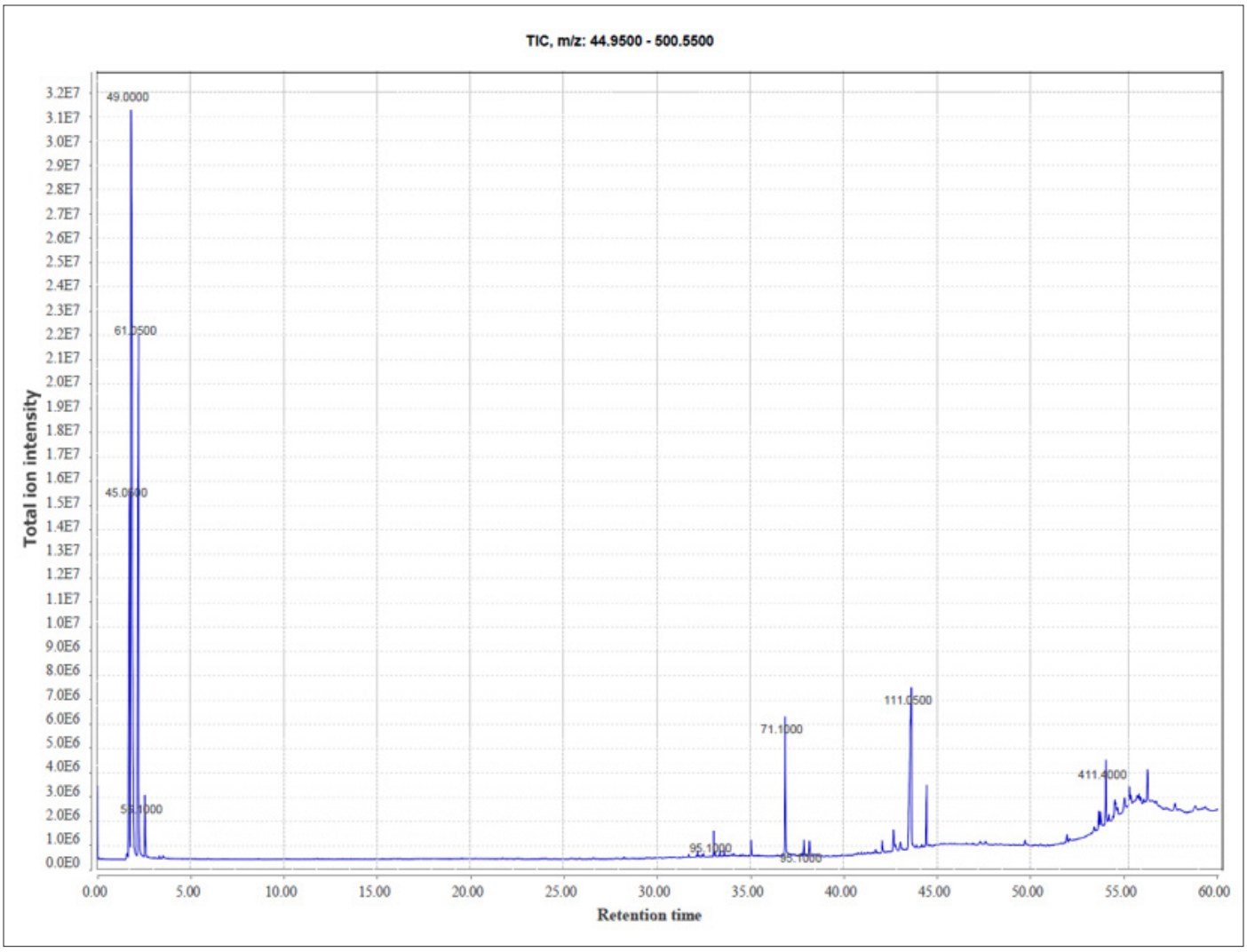


Figure: GC-MS Analysis of Cocinia Grandis

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