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Vivek Kumar Patel
Department of Botany, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, India

Devendra Kumar Patel
Department of Botany, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, India

Ranjeet Kumar
Department of Botany, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, India

Ashish Patel
Department of Botany, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, India

Laxmani Verma
Department of Biotechnology, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, India

Leelaparsad
Local Healer, Lamru Forest Region, Korba, Chhattisgarh, India

Corresponding Author:
Vivek Kumar Patel
Department of Botany, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, India

Phytochemical profiling and ethnomedicinal relevance of selected medicinal plants from Korba District, Chhattisgarh, India

Vivek Kumar Patel, Devendra Kumar Patel, Ranjeet Kumar, Ashish Patel, Laxmani Verma and Leelaparsad

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Abstract
The Korba district of Chhattisgarh, India, is rich in plant biodiversity and possesses a strong tradition of ethnomedicinal practices among indigenous communities. The present study aims to evaluate the phytochemical composition and ethnomedicinal relevance of selected medicinal plant species collected from this region. Plant materials were systematically collected, authenticated, shade-dried, and extracted using suitable solvents. Preliminary qualitative phytochemical screening was performed to detect the presence of major bioactive secondary metabolites, including alkaloids, flavonoids, phenolics, tannins, saponins, terpenoids, glycosides, and steroids, following standard protocols. Ethnomedicinal information regarding traditional usage, plant parts employed, and therapeutic applications was documented through literature surveys and interactions with local practitioners. The results revealed a diverse phytochemical profile across the selected plant species, with a predominance of phenolics, flavonoids, and alkaloids, which are known for their antioxidant, antimicrobial, and anti-inflammatory properties. The correlation between traditional knowledge and phytochemical constituents supports the therapeutic potential of these plants. This study provides a scientific basis for the traditional use of medicinal plants in the Korba district and highlights their potential for further pharmacological, toxicological, and drug development studies.

Keywords: Ethnomedicinal plants, bioactive compounds, GC-MS analysis, phytochemistry, traditional knowledge

Introduction
The Lamru Forest area in the Korba district of Chhattisgarh, India, is a portion of a larger landscape that is distinguished by great plant diversity and long-standing traditional plant use by indigenous tribes. It is located within the tropical deciduous forest belt of central India. Many tribal communities, including the Korwa, Gond, Kanwar, Binjhwar, Bhumia, Baiga, and others, depend on the forests of the Korba district, which includes places like Chaiturgarh and Lamru, for their cultural activities, subsistence, and medical requirements. For Korba's forest-dwelling people, medicinal plants are an essential component of the healthcare system. Through traditional preparations including decoctions, pastes, powders, and infusions, these plants are used to treat a variety of illnesses, including fever, digestive disorders, respiratory problems, skin concerns, and musculoskel*et al* symptoms (Shukla, 1970) [4]. The ethnobotanical expertise of tribal healers and elders is strongly linked to this traditional knowledge, which is usually passed down verbally from generation to generation. In terms of ecology, Korba's forests are home to a variety of herbs, shrubs, climbers, and trees that contain bioactive substances crucial to traditional medicine. These plants are classified as tropical dry deciduous. The major threats to biodiversity posed by resource extraction, land-use change, and forest fragmentation. Conservation of this plant diversity is not only essential for maintaining ecological balance but also for local people's cultural and medicinal practices (Ahirwar & Bhoi, 2025) [1].

Combretum nanum (family *Combretaceae*) is an ethnomedicinally significant plant widely used by indigenous and tribal communities for the treatment of various ailments. Traditional knowledge indicates that the leaves, bark, and roots of *C. nanum* are employed in folk medicine to manage gastrointestinal disorders, dysentery, fever, skin infections, wounds, and inflammatory conditions. Decoctions and pastes prepared from different plant parts are commonly applied for their antimicrobial, analgesic, and wound-healing properties.

Ethnobotanical surveys suggest that the plant plays an important role in primary healthcare systems, particularly in rural and forest-dominated regions (Parusnath *et al*., 2023) [3].
Phytochemical investigations of *Combretum* species, including *C. nanum*, have revealed a diverse array of bioactive secondary metabolites such as flavonoids, phenolic compounds, tannins, triterpenoids, saponins, glycosides, and steroids. These phytoconstituents are known to exhibit antioxidant, antimicrobial, anti-inflammatory, and m*et al*-chelating activities, which validate the plant's traditional therapeutic applications. The abundance of phenolics and flavonoids, in particular, contributes to its free radical scavenging potential and protective effects against oxidative stress. The ethnobotanical relevance coupled with its rich phytochemical profile highlights *Combretum nanum* as a valuable medicinal plant with significant potential for further pharmacological evaluation and development of natural therapeutic agents (Coulidiati, 2023) [2].
Cynanchum viminale (family *Apocynaceae*, formerly *Asclepiadaceae*), commonly known as Somlata, is an important ethnomedicinal plant widely used in traditional Indian medicine, particularly by tribal communities in dry and semi-arid regions. The plant is traditionally employed for the treatment of rheumatism, joint pain, gastric disorders, asthma, skin diseases, and inflammation, and its latex is used externally for wound healing and relief from swelling. Ethnobotanical records also indicate its use as a tonic and in the management of chronic ailments. Phytochemical investigations of *S. acidum* have revealed the presence of diverse bioactive compounds, including alkaloids, flavonoids, phenolics, tannins, triterpenoids, sterols, saponins, and glycosides. These phytoconstituents are associated with antioxidant, anti-inflammatory, antimicrobial, and analgesic activities, providing scientific validation for its traditional therapeutic applications. The rich ethnomedicinal importance combined with its phytochemical diversity highlights *Cynanchum viminale* as a promising medicinal plant for further pharmacological and bioactivity-guided studies (Tripathy & Mishra, 2025) [41].
Nature has provided several remarkable things for human beings over the years, including the tools for the first attempts at therapeutic intervention. Ancient civilization depended on plant extracts for the treatment of various ailments. Today, plant materials remain an important resource for combating illnesses, including infectious diseases and many of these plants have been investigated for novel drugs or used as templates for the development of new therapeutic agents, food additives, agrochemicals and industrial chemicals. Plant-based natural constituents can be derived from different parts of the plant like bark, leaves, flowers, roots, fruits, seeds, etc. The phytochemical is a natural bioactive compound found in plants, such as vegetables, fruits, medicinal plants, flowers, leaves and roots that work with nutrients and fibres to act as a defences system against disease or more accurately, to protect against disease. Phytochemicals are divided into two groups, which are primary and secondary constituents; according to their functions in plant metabolism. Primary constituents comprise common sugars, amino acids, proteins and chlorophyll while secondary constituents consist of alkaloids, terpenoids and phenolic compounds and many more such as flavonoids and tannins (Asfaw *et al*., 2023) [6]. The beneficial medicinal effects of plant materials typically result from the combinations of secondary products present in the plant. But among the large diversity of plant species, only a small percentage has been investigated phytochemicals. So, the systematic screening of plant species to discover new bioactive compounds can help us to cure many fungal and bacterial diseases of economically important crops (Othman *et al*., 2010) [9]. The plant chemicals have been found to possess biological activity against several pests and pathogens. These are superior to synthetic pesticides in several ways like low mammalian toxicity, target specificity and biodegradability (Kumar *et al*., 2022a) [7].
Numerous antibacterial, antifungal, qualities have been demonstrated by bioactive substances. Many of the herbal remedies used in Ayurveda and other alternative traditional medicine systems are still ineffective when used for the general health of the public for a variety of reasons, including secondary metabolites with multiple characteristics. Humans have long used medicinal herbs in widespread practice. Since 80% of people worldwide rely on traditional medicine, the World Health Organization has acknowledged the significant role that medicinal plants play in healthcare. Additionally, it has been noted that distinct plant sections have been shown to contain distinct secondary metabolites and antibacterial qualities, making it difficult to determine which component should be employed as a medicinal agent (World Health Organization 2020).
Plants have long been a useful source of natural products that keep humans alive. Plant extracts have already been utilized by researchers for a variety of antiviral, antibacterial, and antifungal purposes. (Dubale *et al*. (2023) [8]. Plant waste products, including stem or bark, have also been found to contain bioactive chemicals. Phytochemicals have identified the active ingredient in medicinal plants that has demonstrated efficacy against a wide range of microorganisms, including gram-positive and gram-negative bacteria. The kingdom of plants is a treasure trove of possible medications, and the value of medicinal plants has gained attention in recent years. Plant-based medications are widely accessible, reasonably priced, effective, safe, and seldom cause adverse effects. The most obvious option for analysing the current hunt for novel, therapeutically effective medications, such as antibacterial and anticancer treatments, is to look at the plants that have been chosen for medical usage throughout thousands of years. (Hada and Sharma 2014) [7].

Materials and Methods

Collection of Medicinal Plant Material

Medicinal plant Sample No. 1 and Sample No. 2 were collected from the Lamru forest road side and Nakiya waterfall Korba district, Chhattisgarh, India. The plant samples were in a flowering condition during the collection period. Plants species were identified at Botanical survey of India (BSI) Central regional Centre, Allahabad University Prayagraj (UP).

Table 1: Location of collected plant samples

Plant Sample No.	Location	Longitude	Latitude
1	Lemru forest korba, Chhatisgarh, India	82.8096	22.4813
2	Lemru forest Nakiya water fall, korba, Chhatisgarh, India	82.8123	22.4849

Preparation of plant extract: The collected plant samples were thoroughly washed under running tap water to remove adhering debris and then shade-dried for approximately three weeks until a constant weight was achieved. The dried plant materials were mechanically ground using a mortar and pestle and further powdered using a laboratory blender (Remi). The powdered samples were stored separately in airtight containers until further use (Dubale *et al*., 2023) [8].

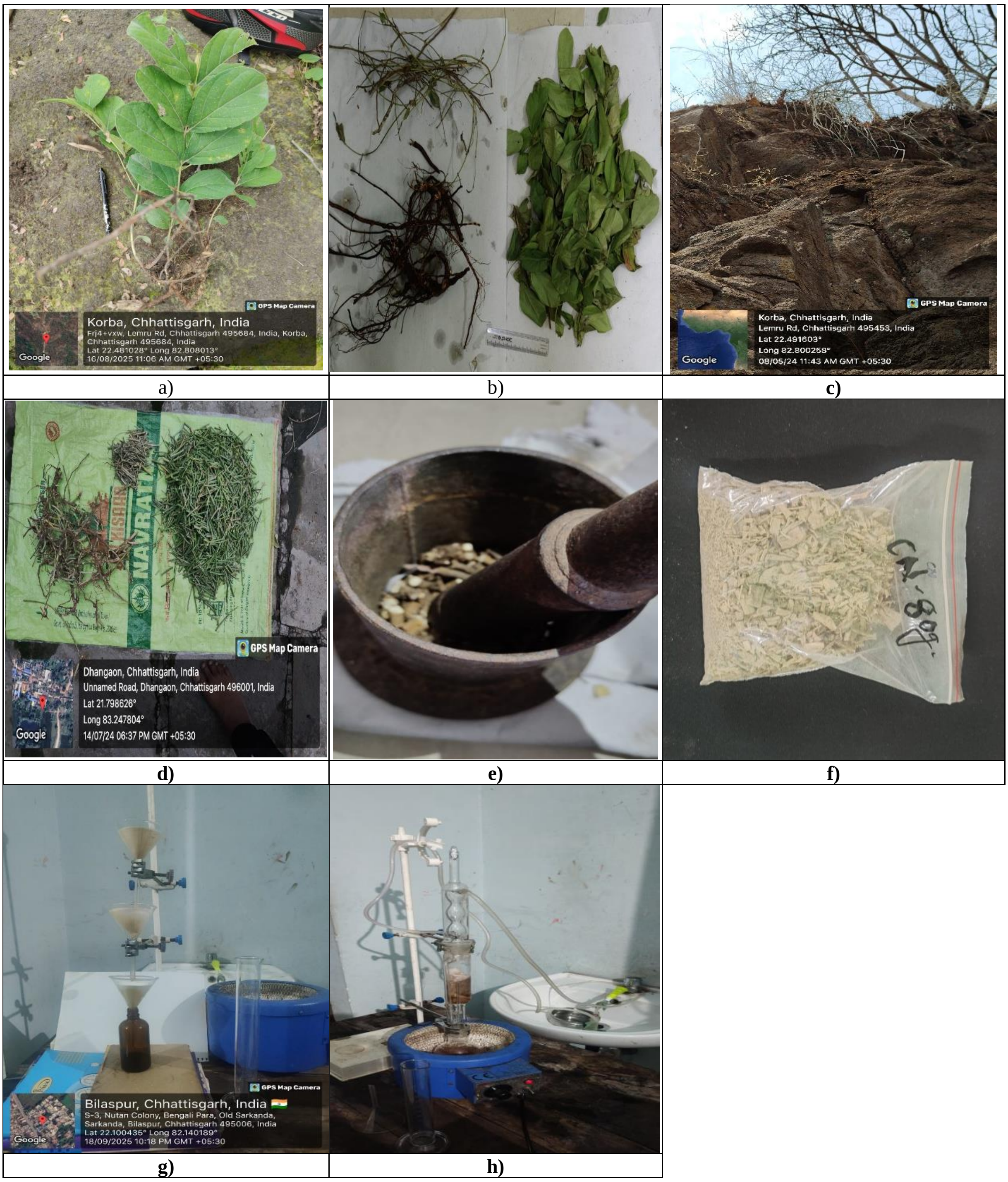

Fig 1: (a,b) Plant Sample 1 (c,d) Plant sample 2 (e,f) Crude material (g.h) Soxhlet extraction and filtration

GC-MS analysis

GC-MS Analysis of plant extract

GC-MS analysis was performed using a Shimadzu QP 2010 Ultra GC-MS (Shimadzu, Japan) to identify the bioactive compounds present in the Plant Sample 1, and Plant Sample 2 extracts. The prepared samples were injected (usually 1-2 µl) into the GC-MS system. Use an appropriate GC column, typically a non-polar capillary column, and set the temperature program to begin with a low initial 50 °C temperature, followed by a gradual increase to a higher final temperature of 300°C at a consistent rate of 5°C/min). Ensure the MS detector is calibrated and set to scan over a suitable mass range (e.g., 50-600 m/z). The samples were run and collect the chromatogram and mass spectra and analyzed the chromatographic peaks and corresponding mass spectra using NIST software provided with the GC-MS system to identify the compounds based on their retention times and mass fragmentation patterns. Quantitative analysis can be performed by comparing the peak areas with those of known standards.

Results: Herbarium of the plants specimen used in the present investigation was taxonomically identified and authenticated by the Botanical Survey of India (BSI), Central Regional Centre, Prayagraj. The plant sample 1 was identified as *Combretum nanum* Buch. - Ham. ex D. Don, belonging to the family *Combretaceae*. The authentication was carried out following standard botanical identification procedures. The verified identification was issued under BSI reference number 2506250008124, providing an authoritative basis for subsequent phytochemical and pharmacological analyses.

The Plant sample 2 was identified as *Cynanchum viminale* (L.) During the present study, *Sarcostema acidum* has been updated to its currently accepted synonym *Cynanchum viminale* (L.) according to the latest records in the Flora of Chhattisgarh maintained by the Botanical Survey of India (BSI), Allahabad, Prayagraj. This species is recorded as a new addition to the Chhattisgarh flora.

GC-MS Analysis

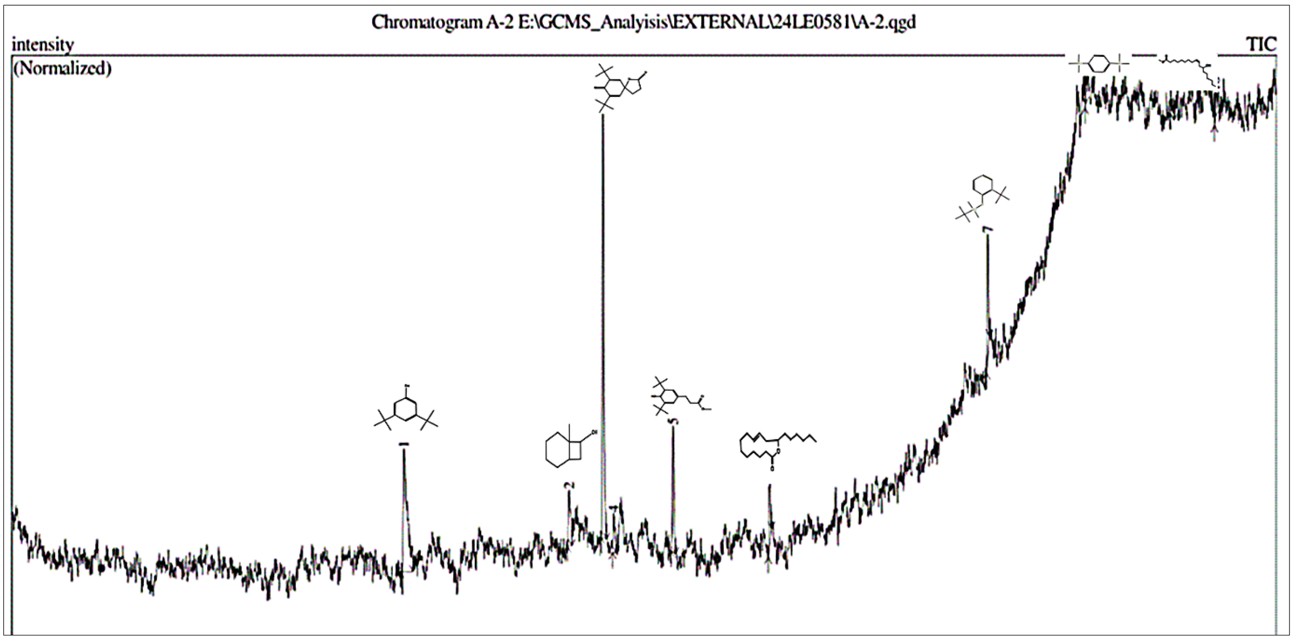

Fig 2: Chromatogram of *C. nanum*

Ten phytochemical constituents with a variety of chemical classes, including substituted phenols, spiro-ether antioxidants, terpene alcohols, aromatic acids, macrocyclic lactones, fatty acid derivatives, sterol derivatives, and minor silylated compounds, were found in the *C. nanum* extract according to GC-MS analysisa member of the spiro-ether antioxidant chemical class, was the main substance found. These substances are well known for their substantial lipid-stabilizing and free-radical scavenging capabilities, indicating a major part in *C. nanum*'s antioxidant potential (Remezov *et al*., 2025) [22]. The high concentration of this molecule suggests that the plant's primary biochemical characteristic is antioxidant activity.

Phenol, 3, 5-bis(1,1-dimethylethyl)- (25.87%), a substituted phenolic compound with antioxidant, antibacterial, and anti-inflammatory properties, was another significant component. The traditional therapeutic usage of *Combretum* species is supported by phenolic chemicals, which are well known for their capacity to neutralize reactive oxygen species and suppress microbial development (Vigneshwaran *et al*., 2025; Bello *et al*., 2025) [26, 46].

The macrocyclic lactone 13-hexyloxacyclotridec-10-en-2-one (10.49%) was also found in moderate concentrations. The antibacterial, antifungal, and pheromone-like bioactivities of macrocyclic lactones suggest a potential function in plant defencet systems (Dirar *et al*., 2014) [47]. The bicyclic terpene alcohol 6-methyl-bicyclo [4.2.0] octan-7-ol (6.27%) further enhances the extract's biological relevance by contributing to its aroma and antibacterial activity.

According to reports, fatty acid derivatives like 9-octadecenoic acid and 12-hydroxy-methyl ester (5.95%) have anti-inflammatory, antimicrobial, and wound-healing supportive properties that could enhance the plant's therapeutic profile (Abdelaziz *et al*., 2024; Tolba *et al*., 2025) [27, 48]. The antioxidant and antibacterial activity is further supported by the trace amounts of dicarboxylic acid molecules and derivatives of benzenepropanoic acid, which inhibit microbial enzymes and lipid peroxidation.

Membrane-modifying, anti-inflammatory, and antibacterial properties are linked to steroidal chemicals, which are represented by cholestane and 3, 4-epoxy derivatives (9.34%), indicating an additional pharmacological dimension to the extract (Dembitsky, 2023) [23]. On the other hand, trace amounts of silylated molecules like 1, 4-bis (trimethylsilyl) ethane and 1, 4-bis (trimethylsilyl) benzene were found; these chemicals are thought to be GC-MS derivatization artifacts with no direct biological significance.

Overall, antioxidant and antibacterial chemicals, especially phenolic and spiro-ether derivatives, are predominant in *Combretum nanum's* GC-MS profile. The plant's potential for pharmaceutical uses, particularly in the treatment of oxidative stress, inflammation, and microbial infections, is highly supported by this chemical makeup.

Table 2: GCMS analysis of *C. nanum*

Name of the compound	Area %	Mol. Formula	Mol. Weight	RT (In Min.)	Nature of compound	Polarity	Activity	References
Phenol, 3,5-bis(1,1-dimethylethyl)-	25.87	C14H22O	206	22.989	Substituted phenol antioxidant	Low-moderate	Antioxidant, antimicrobial, anti-inflammatory, preservative-like activity	Vigneshwaran *et al*., (2025) [26], S. Bello *et al*., (2025) [46]
6-Methyl-bicyclo[4.2.0]octan-7-ol	6.27	C9H16O	140	30.566	Bicyclic terpene alcohol	Moderate	Antimicrobial, fragrance component, mild antioxidant	
7,9-Di-tert-butyl-1-oxaspiro(4,5)deca	34.34	C17H24O3	276	32.118	Spiro-ether antioxidant derivative	Moderate	Antioxidant, antimicrobial, stabilizer in oils	Remezov *et al*., (2025) [22]
Benzenepropanoic acid, 3,5-bis(1,1-d	3.6	C18H28O	292	32.608	Aromatic acid (antioxidant derivative)	Moderate	Antioxidant, lipid peroxidation inhibitor, antimicrobial	Nandika *et al*, (2021) [24]
13-Hexyloxacyclotridec-10-en-2-one	10.49	C18H32O2	280	35.333	Macrocyclic lactone	Low-moderate	Antimicrobial, antifungal, fragrance / pheromone-like bioactivity	Dirar *et al*., (2014) [47]
9-Octadecenoic acid, 12-hydroxy-, m	5.95	C19H36O3	312	39.77	Hydroxy fatty acid methyl ester	Low	Antimicrobial, anti-inflammatory, wound-healing supportive, emollient	Abdelaziz *et al*., (2024) [27], Tolba *et al*., (2025) [48]
Cholestane, 3,4-epoxy-, (3.alpha.,4.al	9.34	C12H22Si2	222	49.762	Steroid derivative (epoxy-sterol	very low	Anti-inflammatory, antimicrobial, membrane-modifying activity	Valery M. Dembitsky (2023) [23]
1,4-Bis(trimethylsilyl)ethane	1.24	C12H22Si2	222	54.232	Silylated aromatic (GC artifact)		No biological activity	Pinkas *et al*., (2010) [25]
1,4-Bis(trimethylsilyl)benzene	2.17	C16H28OSi	264	58.159	Silylated aromatic derivative	Low	No significant pharmacological activity	Mochizuki *et al*., (2006) [28]
3-(Hepta-1,3-dienyl)hexanedioic acid	0.72	C13H20O4	240	60.183	Dicarboxylic acid derivative	Moderate	Antimicrobial, antioxidant, mild anti-inflammatory	

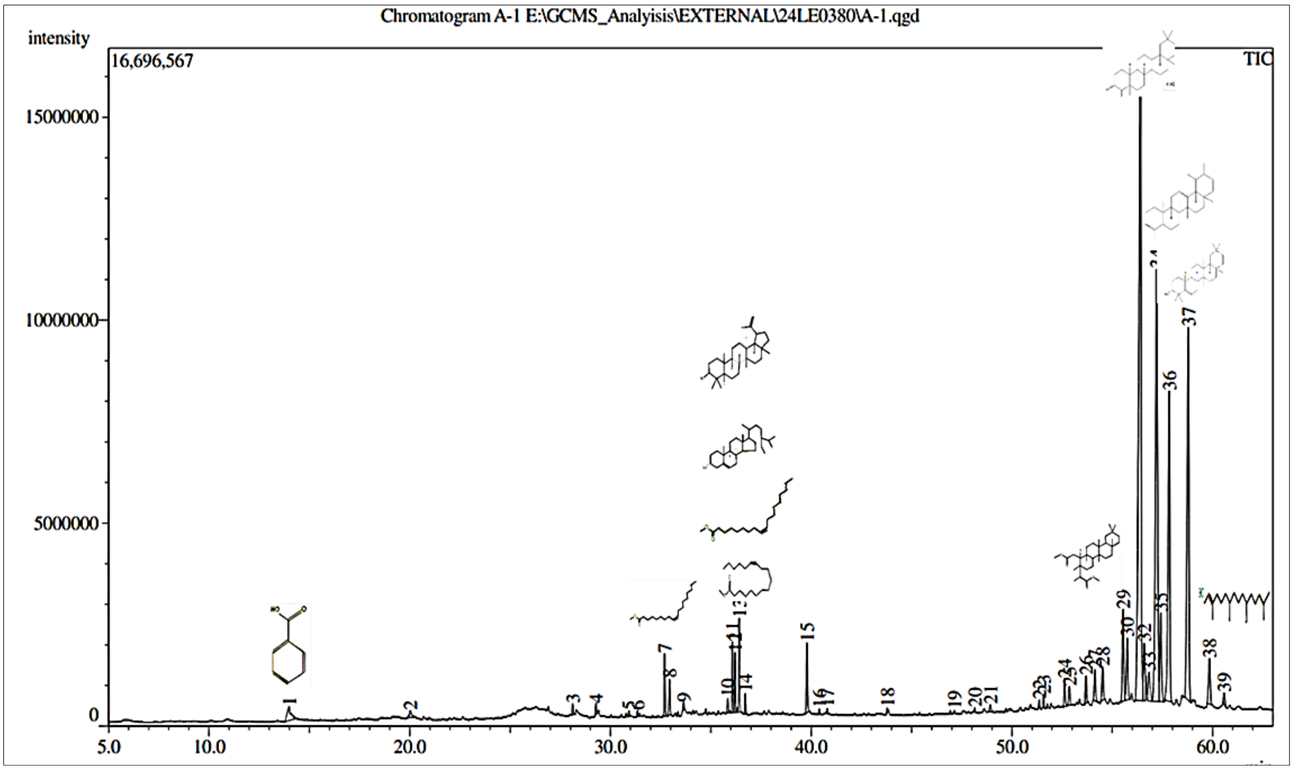

Fig 3: Chromatogram of *C. viminale*

Benzoic acid (1.03%) was found among the low-molecular-weight molecules at an early retention time, indicating the existence of aromatic carboxylic acids with established antibacterial preservation qualities (Tripathy *et al*., 2025) [41]. Aromatic acids, fatty acid methyl esters, terpenoids, sterols, and a preponderance of pentacyclic triterpenoids were all present in *C. viminale's* chemically varied profile. Non-polar and mid-polar phytoconstituents predominate in the extract, according to the discovered compounds and their proportionate peak regions, which is consistent with the plant's historical therapeutic significance. 7,9-di-tert-butyl-1-oxaspiro (4,5) deca derivative (34.34%), There were trace levels of fatty acid methyl esters, including hexadecanoic acid, methyl ester, 9,12-octadecadienoic acid (Z,Z), methyl ester, and 9-octadecenoic acid (Z), methyl ester. These fatty acid derivatives are frequently found in GC-MS profiles of C. viminale extracts and have been extensively documented for their anti-inflammatory, antioxidant, and antibacterial properties (Priya & Priya, 2021; Iordache *et al*., 2009) [49, 50]. The identification of hydroxy fatty acid methyl ester provides more evidence for the function of lipid-derived molecules in antibacterial support and membrane protection.

Additionally, terpenoid components including longifolenaldehyde (0.61%) and phytol (1.74%) were found. While sesquiterpene aldehydes like longifolenaldehyde contribute to antibacterial and fragrance-related bioactivities, phytol, a diterpene alcohol, is well-known for its anti-inflammatory and antioxidant properties (Choudhary *et al*., 2019; Moglad *et al*., 2024) [51, 37]. These substances might contribute to both plant defense and medicinal effectiveness.

Moderate levels of steroidal and sterol-based substances were found, such as ergost-5-en-3-ol, stigmasterol, and cholesta-5, 20, 24-trien-3-ol. The pharmacological value of C. viminale is greatly increased by phytosterols, which are recognized for their membrane-stabilizing, immunomodulatory, antioxidant, and anti-inflammatory qualities (Bakrim *et al*., 2022; Yusnaini *et al*., 2023) [31, 29]. Stigmasterol's availability and significance in the plant's bioactivity are suggested by its frequent detection with different peak regions.

The GC-MS profile's most notable characteristic was the high concentration of pentacyclic triterpenoids, specifically β-amyrin (30.39%), lupeol (18.35%), 24-norursa-3,12-diene (13.58%), and β-amyrone (10.99%). Strong anti-inflammatory, analgesic, hepatoprotective, antibacterial, and anticancer properties are well known for these substances (Musa *et al*.; Dalimunthe *et al*., 2024) [35]. The predominance of triterpenoids makes it evident that C. viminale is a medicinal plant rich in triterpenes, supporting its traditional usage in chronic and inflammatory.

The extract's anti-inflammatory and cytotoxic properties are further enhanced by additional triterpenoid derivatives such friedelan-3-one, lup-20(29)-en-3-one, glutinol, and lupane triterpenoid acetates. Skeletons of the oleanane and lupane types are especially well-known for their wide range of pharmacological properties, which include hepatoprotective and anticancer properties.

Overall, the GC-MS study of *C. viminale* shows that the extract is mostly made up of sterols and non-polar pentacyclic triterpenoids, with terpenoids and fatty acid derivatives providing support. The plant's purported anti-inflammatory, antibacterial, antioxidant, and cytotoxic properties are clearly supported by this phytochemical composition, which also emphasizes the plant's potential for more pharmacological and drug-development research.

Table 3: GCMS analysis of *C. viminale*

Name of compound	Area %	Mol. formula	Mol. weight	RT	Natre of compound	Activity	Polarity	Reference
Benzoic acid	1.03	C7H6O2	122	13.988	Aromatic carboxylic acid	Antimicrobial preservative	Poilar	Tripathy *et al*, (2021) [41]
Hexadecanoic acid, methyl ester	1.08	C17H34O2	270	32.679	Fatty acid methyl ester (FAME)	Anti-inflammatory, antioxidant (general). Frequently detected by GC-MS in C. viminale extracts.	non-polar	Priya & priya (2021) [49], Al-Owaise*t al*,.(2014)
Card-20(22)-enolide, 3-[(2,6-dideoxy	0.75	C36H54O14	710	32.935	Cardiac glycoside / steroidal aglycone (putative)	Cardioactive / cytotoxic for related cardenolides	mid polar	Georg Petschenka *et al*,.(2022) [39]
9,12-Octadecadienoic acid (Z,Z)-, me	1.23	C19H34O2	294	36.073	PUFA methyl ester	Anti-inflammatory, antioxidant (general). Detected in GC-MS profiling.	Non-polar	Priya & priya (2021) [49], Iordache *et al*,.(2009) [50]
9-Octadecenoic acid (Z)-, methyl este	1.05	C19H36O2	296	36.202	MUFA methyl ester	Anti-inflammatory / antimicrobial (general)	Non-polar	Priya & priya (2021) [49], Iordache *et al*,.(2009) [50]
Phytol	1.74	C20H40O	296	36.409	Diterpene alcohol	Antioxidant, anti-inflammatory	non-polar	Priya & priya (2021) [49], Choudhary *et al*,.(2019) [51]
9-Octadecenoic acid, 12-hydroxy-, m	1.34	C19H36O3	312	39.786	Hydroxy fatty acid ester	antimicrobial support from fatty acid derivatives	non-polar	Fasih Ahmad & Mukherjee(1998) [52]
Longifolenaldehyde	0.61	C15H24O	220	52.624	Sesquiterpene aldehyde	Antimicrobial / fragrance (general terpenoid activities)	non-polar	Moglad *et al*,.(2024) [37]
Cholesta-5,20,24-trien-3-ol, (3.beta.)-	0.47	C24H42O	382	52.858	Sterol derivative	Sterols: membrane/antioxidant effects.	mid polar	Dutta *et al*,.(2021) [32],
Lupeol	0.6	C30H50O	426	53.689	Pentacyclic triterpenoid (lupane)	Strong anti-inflammatory, anticancer	non-polar	Dalimunthe *et al*,.(2024) [35]
Ergost-5-en-3-ol, (3.beta.)-	0.91	C28H48O	400	54.137	Sterol	Immunomodulatory, antioxidant	mid polar	Yusnaini *et al*,.(2023) [29]
Stigmasterol	0.93	C29H48O	412	54.517	Phytosterol	Anti-inflammatory / antimicrobial	mid polar	Bakrim *et al*,.(2022) [31]
Stigmasterol	2.65	C29H50O	414	55.338	Phytosterol	Anti-inflammatory, cholesterol-	mid polar	Bakrim *et al*,.(2023) [31]
.beta.-Amyrone	1.9	C30H48O	424	55.74	Pentacyclic triterpenoid ketone	Anti-inflammatory, analgesic, hepatoprotective.	non-polar	Dutta *et al*,.(2021) [32], Almeida *et al*,.(2015) [33]
.beta.-Amyrin	30.39	C30H50O	426	56.406	Pentacyclic triterpenoid	Anti-inflammatory, analgesic, hepatoprotective	non-polar	Musa *et al*, (2024)
Lup-20(29)-en-3-one	1.88	C30H48O	424	56.939	Lupane triterpenoid (ketone)	anti-inflammatory/cytotoxic	non-polar	Dalimunthe *et al*,.(2024) [35]
D:A-Friedo-2,3-secooleanane-2,3-dio	1.12	C32H5O4	502	56.836	Oleanane/friedo-type triterpenoid derivative	Oleanane derivatives often show cytotoxic/anti-inflammatory effects	Non-polar	
Lupeol	18.35	C30H50	426	57.20	Pentacyclic triterpenoid		non-polar	Dalimunthe *et*

		O		2				*al*,.(2024) [35]
Glutinol	2.77	C30H50O	426	57.417	Pentacyclic alcohol	Analgesic / anti-inflammatory	non-polar	Valdez *et al*,.(2024) [45]
beta.-Amyrone	10.99	C30H48O	424	57.833	Pentacyclic triterpenoid ketone	Anti-inflammatory, analgesic, hepatoprotective.	non-polar	Dutta *et al*,.(2021) [32], Almeida *et al*,.(2015) [33]
24-N-orursa-3,12-diene	13.58	C29H46	394	58.788	Triterpene hydrocarbon	cytotoxic/antimicrobial activity	non-polar	Subba etai,.(2025) [44]
Friedelan-3-one	1.57	C30H50O	426	59.836	Pentacyclic triterpene	Anti-inflammatory	non-polar	Dutta *et al*,.(2021) [32], Dalimunthe *et al*,.(2024) [35]
Lup-20(29)-en-3-ol, acetate, (3.beta.)	0.34	C32H52O2	468	60.565	Triterpenoid acetate (ester)	Anticancer / anti-inflammatory	non-polar	Dalimunthe *et al*,.(2024) [35]

Discussion

Non-polar and mid-polar bioactive components, such as spiro-ether antioxidants, substituted phenols, terpenoids, macrocyclic lactones, fatty acid derivatives, and steroidal compounds, dominated the chemically varied phytochemical profile of the *Combretum nanum* extract, according to GC-MS analysis. Antioxidant activity is a crucial biochemical feature of *C. nanum*, as evidenced by the prevalence of 7,9-di-tert-butyl-1-oxaspiro (4,5) deca derivative as the primary constituent. Strong free-radical scavenging and lipid-stabilizing abilities are well-known characteristics of spiro-ether antioxidants, which are essential for shielding cellular membranes from oxidative damage. Since phenolics are good at neutralizing reactive oxygen species and preventing microbial development, the significant abundance of substituted phenolic compounds, especially phenol, 3,5-bis(1,1-dimethylethyl)-, further supports the extract's antioxidant and antibacterial capabilities. These results offer compelling phytochemical evidence for the traditional medicinal use of *Combretum* species in the treatment of oxidative stress-related diseases, infections, and inflammation.

The extract had significant amounts of fatty acid derivatives, sterols, terpenoid alcohols, and macrocyclic lactones in addition to antioxidant chemicals, all of which add to the plant's wide pharmacological significance. While fatty acid derivatives like 9-octadecenoic acid methyl ester are known to have anti-inflammatory, antibacterial, and wound-healing supporting properties, macrocyclic lactones and terpenoids are linked to antimicrobial and plant defense roles. Membrane-stabilizing and anti-inflammatory properties are further enhanced by steroidal ingredients, such as cholestane and epoxy derivatives, indicating potential synergistic interactions among the phytochemicals. The total chemical profile clearly shows *C. nanum* as a major source of antioxidant and antibacterial ingredients, even though the trace silylated chemicals found are probably GC-MS aberrations. Its potential for pharmaceutical uses is substantially supported by this phytochemical makeup, especially in the treatment of microbial infections, oxidative stress, and inflammatory situations.

A broad range of low- and high-molecular-weight phytoconstituents were found in the *C. viminale* extract, according to the GC-MS analysis, indicating a chemically complex and pharmacologically significant profile. The plant's historic usage in treating illnesses is supported by the early elution of benzoic acid, which suggests the presence of aromatic carboxylic acids with proven antibacterial and preservation qualities. The biological potential of the extract is further enhanced by trace levels of fatty acid methyl esters, such as hexadecanoic acid, methyl ester, and unsaturated octadecanoic acid derivatives.

It is commonly known that these lipid-derived compounds have antibacterial, antioxidant, and anti-inflammatory properties, mainly by disrupting membranes and inhibiting inflammatory mediators. The identification of hydroxy fatty acid methyl esters further emphasizes the function of lipid-based substances in protecting cellular membranes and inhibiting microbial development. Terpenoid components including phytol and longifolenaldehyde indicate complementing antibacterial, anti-inflammatory, and antioxidant properties, supporting the plant's defense mechanisms and therapeutic value.

The prevalence of sterols and pentacyclic triterpenoids, which together make up a significant amount of the extract, is a distinguishing characteristic of the *C. viminale* GC-MS profile. The extract's medicinal relevance is increased by phytosterols including ergost-5-en-3-ol and stigmasterol, which are recognized for their immunomodulatory, anti-inflammatory, membrane-stabilizing, and antioxidant properties. It is evident that *C. viminale* is a medicinal plant rich in triterpenes due to the large quantity of pentacyclic triterpenoids, such as β-amyrin, lupeol, 24-norursa-3,12-diene, and β-amyrone.

Strong phytochemical support for the plant's traditional usage in chronic inflammatory and systemic illnesses is provided by these chemicals' well-established anti-inflammatory, analgesic, antibacterial, hepatoprotective, and anticancer properties. The extract's anti-inflammatory and cytotoxic efficacy is further enhanced by the presence of triterpenoid derivatives of the oleanane and lupane types. Overall, the GC-MS profile demonstrates *C. viminale's* potential as a useful source of bioactive chemicals for upcoming pharmacological and drug development research and firmly validates the plant's purported pharmacological qualities.

Conclusion

Both *Combretum nanum* and *Cynanchum viminale* have chemically varied and pharmacologically relevant metabolite compositions, which amply supports their traditional medicinal usage, according to GC-MS-based phytochemical profiling. The extract of *C. nanum* was primarily enriched with non-polar and mid-polar bioactive constituents, especially substituted phenolic compounds and spiro-ether antioxidants, which support its strong antibacterial and antioxidant properties. While the presence of fatty acid derivatives, terpenoids, macrocyclic lactones, and steroidal compounds suggests synergistic interactions contributing to antimicrobial, anti-inflammatory, and membrane-stabilizing effects, the dominance of 7,9-di-tert-butyl-1-oxaspiro (4,5) deca derivative highlights antioxidant activity as a key biochemical characteristic of this species.

In a similar vein, *C. viminale* showed phytochemical profile rich in terpenoids, sterols, and pentacyclic triterpenoids, as well as supportive fatty acid derivatives. Strong phytochemical support for the plant's traditional use in systemic, infectious, and chronic inflammatory illnesses is provided by the high abundance of triterpenoids such β-amyrin, lupeol, and β-amyrone. Its anti-inflammatory, antioxidant, immunomodulatory, and cytotoxic properties are further enhanced by the presence of phytosterols and lipid-derived substances. Overall, the results show that *C. viminale* and *C. nanum* are both important sources of bioactive phytochemicals with substantial therapeutic value. These findings provide a solid scientific basis for more bioactivity-guided fractionation, mechanistic research, and drug development targeted at using these plants to treat microbial infections, oxidative stress, and inflammation.

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