GREEN PUBLICATION International Journal of Research in Applied & Natural Science ISSN (Online):2208-2085

COMPARATIVE PHYTOCHEMICAL PROFILING AND SPECTROSCOPIC CHARACTERISATION OF *ELAEOCARPUS GANITRUS* AND *WITHANIA SOMNIFERA* EXTRACTS: IMPLICATIONS FOR EPILEPSY MANAGEMENT

Mamta Bhatia[1*]& Anju Goyal[2]

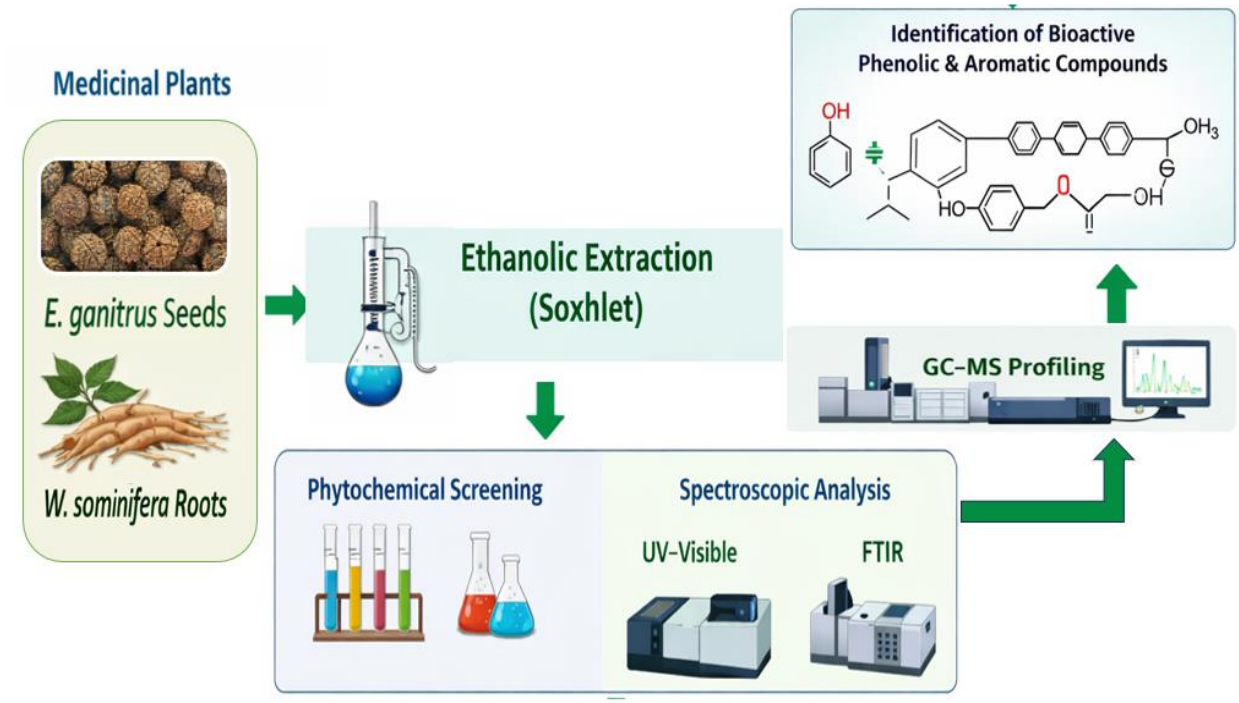
[1]**Research Scholar, Bhupal Nobles' University, Udaipur, Rajasthan (India)*
[2]*Faculty of Pharmacy, Bhupal Nobles' College of Pharmacy, Udaipur, Rajasthan (India)*

*** Correspondence:** mamtabhatia1095@gmail.com

Abstract
Medicinal plants are important sources of bioactive compounds with potential therapeutic applications. The present study aimed to perform a comparative phytochemical characterisation and GC–MS profiling of ethanolic extracts of Elaeocarpus ganitrus and Withania somnifera. Preliminary phytochemical screening revealed the presence of major phytoconstituents such as flavonoids, tannins, polyphenols, glycosides, and alkaloids in both extracts. UV–Visible spectroscopic analysis showed characteristic absorption peaks around 200–210 nm and 250–280 nm, indicating the presence of conjugated aromatic compounds and phenolic constituents. FTIR spectral analysis confirmed the presence of functional groups, including hydroxyl, carbonyl, and aromatic C=C bonds, suggesting the occurrence of phenolic and oxygenated phytochemicals. GC–MS analysis further identified several bioactive compounds, including phenolic derivatives and aromatic constituents, in both plant extracts. These phytochemicals are recognised for their antioxidant and neuroprotective properties, which may contribute to their potential pharmacological activity. Comparative analysis revealed overlapping classes of bioactive constituents in both plants, highlighting their significance as sources of biologically active molecules. The findings provide a scientific basis for further pharmacological investigations of these plants and support their traditional medicinal use.

Keywords: *Elaeocarpus ganitrus, Withania somnifera, Phytochemical screening, GC–MS analysis, FTIR spectroscopy, UV–Visible spectroscopy, Bioactive compounds.*

Graphical Abstract
Phytochemical Characterisation and GC-MS Profiling of *E.ganitrus* & *W. somnifera*



Introduction

Epilepsy is a chronic neurological disorder characterised by recurrent and unprovoked seizures resulting from abnormal electrical activity in the brain. It affects approximately 50–70 million people worldwide, making it one of the most common neurological disorders globally. (1) Despite the availability of several antiepileptic drugs (AEDs), nearly 30–40% of patients remain resistant to conventional therapies, a condition known as drug-resistant epilepsy. Moreover, long-term use of AEDs is often associated with adverse effects such as hepatotoxicity, cognitive impairment, tolerance, and behavioural disturbances. (2) These limitations underscore the need for safer and more effective therapeutic alternatives, particularly those derived from natural sources.

Medicinal plants have long been recognised as valuable sources of bioactive compounds with therapeutic potential. Many traditional herbal medicines possess neuroprotective, antioxidant, and anticonvulsant properties that may contribute to the management of neurological disorders, including epilepsy. (3) Phytochemicals, including flavonoids, phenolic acids, alkaloids, and terpenoids, have been reported to interact with neurotransmitter systems, modulate ion channels, and reduce oxidative stress in neuronal tissues. (4) Therefore, the identification and characterisation of bioactive constituents from medicinal plants remain a crucial area of research in the development of alternative antiepileptic therapies.

Among the medicinal plants traditionally used for neurological disorders, *Elaeocarpus ganitrus* Roxb. (commonly known as Rudraksha) has attracted considerable attention due to its diverse pharmacological properties. The plant belongs to the family Elaeocarpaceae and is widely distributed in India and Southeast Asia. It is a large, evergreen tree characterised by broad leaves and is widely distributed across tropical and subtropical regions. (5, 6) Members of the genus *Elaeocarpus* are predominantly evergreen trees or shrubs; however, certain species may also grow as epiphytes or lianas, while a few exhibit brief deciduous behaviour. The fruits of *Elaeocarpus* species are typically drupes that vary in size from small (less than 1 cm in diameter) to relatively large (approximately 4–7.5 × 3–5 cm), and are commonly blue in colour. Nevertheless, variations exist, with some species such as *E. holopetalus*, *E. ruminatus*, and *E. grandiflorus* producing fruits that are brown, black, or red. Various parts of *E. ganitrus* have been used in traditional medicine for the treatment of neurological conditions, stress disorders, and mental illnesses. The tree holds significant cultural, spiritual, and ornamental importance, particularly in India, where it is popularly referred to as Rudraksha. According to the International Union for Conservation of Nature (IUCN), a total of 38 *Elaeocarpus* species have been classified under various conservation categories, including critically endangered, endangered, vulnerable, near threatened, conservation dependent, and data deficient. Within India, these species are primarily distributed in the northeastern regions—such as Assam, Arunachal Pradesh, Sikkim, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura—as well as in the southern parts of the country. (7,8,9,10) Previous studies have reported the presence of several phytoconstituents in *E. ganitrus*, including flavonoids, phenolic compounds, alkaloids, and glycosides, which are believed to contribute to its neuroprotective and antioxidant activities. (11) Traditionally, Rudraksha fruits (beads) have been used for centuries in the treatment of various ailments such as stress, anxiety, pain, asthma, depression, hypertension, and epilepsy. In addition to its ethnomedicinal relevance, *E. ganitrus* exhibits a wide range of pharmacological activities, including antioxidant, anti-inflammatory, antibacterial, and antidiabetic effects. (12, 13)

Another well-known medicinal plant with significant neuropharmacological potential is *Withania somnifera* (L.) Dunal, commonly known as Ashwagandha. It belongs to the family Solanaceae and is widely used in Ayurvedic medicine as a rejuvenating herb. *W. somnifera* is known for its adaptogenic, anti-inflammatory, antioxidant, and neuroprotective effects. The plant contains a variety of bioactive compounds, particularly withanolides, which have been reported to exhibit significant pharmacological activities, including modulation of neurotransmitter systems and protection against neurodegenerative damage. (14) Due to these properties, *W. somnifera* has been investigated for its potential therapeutic role in neurological disorders such as epilepsy, anxiety, and neurodegenerative diseases.

Phytochemical screening and analytical techniques such as Gas Chromatography–Mass Spectrometry (GC–MS) play a crucial role in identifying and characterising bioactive compounds present in plant extracts. GC–MS is widely used for the analysis of volatile and semi-volatile phytoconstituents and provides valuable information regarding the chemical composition of medicinal plants. (15) Identification of such compounds helps in understanding the pharmacological potential of plant extracts and provides insight into their possible mechanisms of action.

Although several studies have reported the pharmacological activities of *Elaeocarpus ganitrus* and *Withania somnifera* individually, comparative phytochemical profiling of these plants remains limited. Moreover, identification of their major bioactive constituents through GC–MS analysis may provide valuable information regarding the presence of compounds that could contribute to anticonvulsant activity. Comparative phytochemical investigations can also help in understanding the similarities and differences in their chemical composition, which may be relevant to their therapeutic applications.

Therefore, the present study aimed to perform comparative phytochemical characterisation and GC–MS profiling of ethanolic extracts of *Elaeocarpus ganitrus* and *Withania somnifera*. The study was designed to identify the major phytoconstituents present in both plant extracts and to evaluate their chemical profiles, providing a scientific basis for their potential role in managing neurological disorders, such as epilepsy.

Figure 1: Rudraksha Seeds

Figure 2: Ashwagandha Roots

Materials and Methods

Plant Material Collection and Authentication

Seeds of *Elaeocarpus ganitrus* Roxb. And roots of *Withania somnifera* (L.) Dunal was collected from authenticated herbal sources in Rajasthan, India. The plant materials were identified and authenticated by a qualified botanist, and herbarium specimens were prepared and preserved in the Department of Pharmaceutical Chemistry, B.N. University, Udaipur, for future reference. The collected plant materials were cleaned to remove foreign matter and dried in the shade at room temperature.

Preparation of Plant Extracts

The dried plant materials were coarsely powdered using a mechanical grinder. Approximately 150 g of powdered seeds of *Elaeocarpus ganitrus* and 150 g of powdered roots of *Withania somnifera* were subjected to extraction using a Soxhlet apparatus with ethanol as solvent. The extraction was carried out until complete exhaustion of the plant material. The obtained extracts were filtered and concentrated using a water bath to remove the solvent. The dried extracts were stored in airtight containers at room temperature until further analysis. The percentage yield of extracts was calculated based on the weight of dried extract obtained. (16,17)

Preliminary Phytochemical Screening

Preliminary phytochemical screening of the ethanolic extracts was carried out using standard qualitative methods to detect the presence of major phytoconstituents. The extracts were tested for the presence of alkaloids, flavonoids, tannins, saponins, glycosides, polyphenols, and carbohydrates using established chemical tests such as Mayer's test, Wagner's test, Shinoda test, ferric chloride test, foam test, and Molisch's test and the observations were recorded in the given Table 1. (16,17, 18)

UV–Visible Spectroscopic Analysis

UV-visible spectrophotometric analysis was conducted on the liquid *Elaeocarpus ganitrus* seed extract using a UV-visible spectrophotometer. It was performed on extracts to identify the presence of conjugated phytoconstituents. The extracts were dissolved in a suitable solvent and scanned using a UV–Visible spectrophotometer within the wavelength range of 200–700 nm. The absorption maxima were recorded and analysed to determine the presence of aromatic and phenolic compounds.

Fourier Transform Infrared (FTIR) Analysis

FTIR spectroscopy was used to identify functional groups present in the plant extracts. The dried extracts were mixed with potassium bromide (KBr) and compressed into pellets. The spectra were recorded using an FTIR spectrophotometer in the range of 4000–400 cm^{-1}. The obtained absorption peaks were interpreted to identify characteristic functional groups, including hydroxyl, carbonyl, aromatic, and ether groups.

Gas Chromatography–Mass Spectrometry (GC–MS) Analysis

GC–MS analysis was performed to identify the major phytochemical constituents present in the ethanolic extracts of *Elaeocarpus ganitrus* and *Withania somnifera*. The analysis was carried out using a GC–MS system equipped with a capillary column. The operating conditions included a suitable carrier gas, controlled oven temperature program, and standard injection parameters.
The mass spectra obtained were compared with those available in the NIST mass spectral library for compound identification. The relative percentage of each compound was calculated based on peak area normalisation.

Results and Discussion

3.1 Preliminary Phytochemical Screening

In Table 1, Preliminary phytochemical analysis of the ethanolic extracts of *Elaeocarpus ganitrus* seeds and *Withania somnifera* roots revealed the presence of several important bioactive constituents. Both extracts showed positive results for flavonoids, tannins, polyphenols, and glycosides, while alkaloids and saponins were also detected in varying amounts. These phytoconstituents are known to possess significant biological activities, including antioxidant, neuroprotective, and anticonvulsant properties.
Flavonoids and phenolic compounds have been widely reported to interact with neuronal receptors and ion channels, thereby contributing to neuroprotective effects. The presence of these compounds in both plant extracts indicates their potential role in modulating neurotransmitter systems involved in seizure activity. The phytochemical profile suggests that both plants contain bioactive constituents that contribute to their pharmacological activity.

Table 1. Preliminary Phytochemical Screening Results

Test	***E. ganitrus* Seed Extract**	***W. somnifera* root Extract**
Carbohydrate	+ve	+ve
Proteins	+ve	+ve
Alkaloids	+ve	+ve
Glycosides	+ve	+ve
Volatile oil	-ve	-ve
Flavonoids	++ve	++ve
Tannins	+ve	+ve
Saponins	+ve	+ve
Polyphenols	++ve	++ve
Steroids	+ve	+ve

UV–Visible Spectroscopic Analysis

The UV–Visible spectroscopic analysis of the ethanolic extracts of *Elaeocarpus ganitrus* and *Withania somnifera* was carried out over a wavelength range of 200–800 nm to identify the presence of chromophoric compounds.
The UV spectrum of *Elaeocarpus ganitrus* (Fig. 3) and Table 2 exhibited a prominent absorption peak in the region of ~210–220 nm, along with a secondary broad absorption band observed between 250–300 nm. These absorption peaks indicate the presence of conjugated systems and aromatic chromophores within the extract.
The combined UV–Visible spectrum of *Elaeocarpus ganitrus* and *Withania somnifera* (Fig. 4) & Table 3 showed similar absorption patterns, with slight variations in absorbance intensity. The extract of *Withania somnifera* exhibited comparatively higher absorbance in the lower UV region (200–230 nm), suggesting a higher concentration of UV-absorbing constituents.
No significant absorption peaks were observed in the visible region (400–800 nm), indicating the absence of highly conjugated chromophores or colored pigments in both extracts.

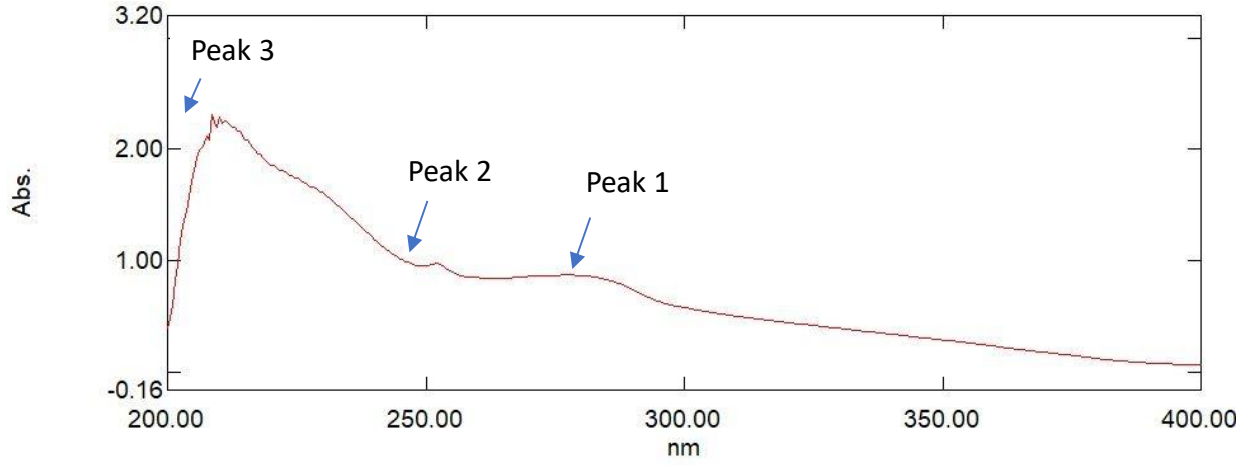


Figure 3. UV-VIS Spectrum of *Elaeocarpus ganitrus*

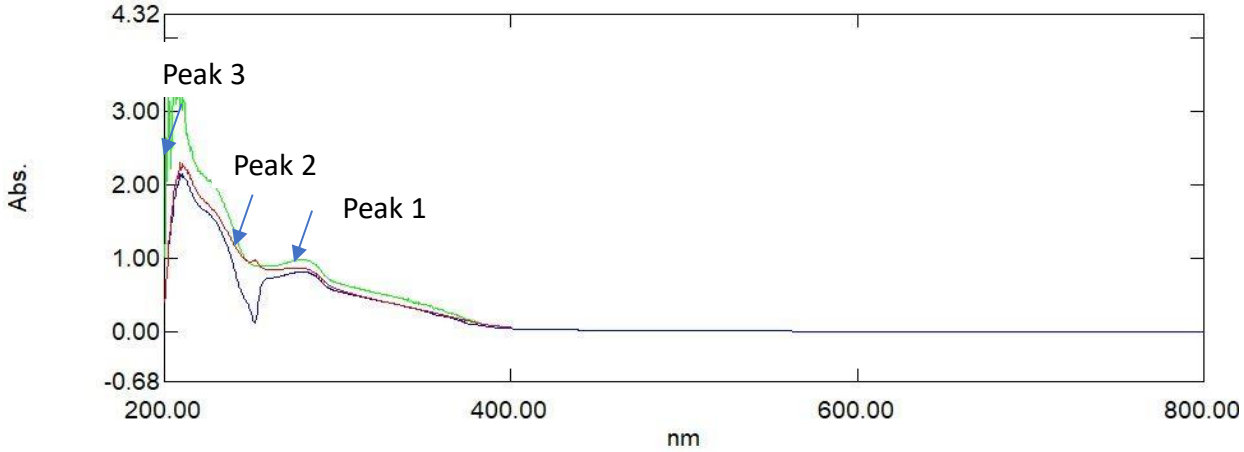


Figure 4. UV-VIS Spectrum of *Elaeocarpus ganitrus* & *Withania somnifera*

S. No.	Wavelength nm	Absorbance
1.	278.5	0.981
2.	258.0	0.902
3.	209.0	2.157

Table 2. UV -VIS Spectra absorbance of *E. ganitrus*

Table 3. Combined UV -VIS Spectra absorbance of *E. ganitrus* & *W. somnifera*

S. No.	Wavelength nm	Absorbance
1.	277.5	0.872
2.	252.0	0.974
3.	208.5	2.308

Discussion

The UV–Visible spectral analysis provides preliminary insight into the presence of conjugated and aromatic phytoconstituents in the plant extracts.

The strong absorption band observed in the region of 200–220 nm can be attributed to π→π* electronic transitions, which are characteristic of compounds containing double bonds and aromatic rings. This suggests the presence of phytochemicals such as phenolics and other unsaturated compounds.

The secondary absorption band observed between 250–300 nm indicates the presence of extended conjugation systems, which are typically associated with compounds containing substituted aromatic rings or conjugated double bond systems.

The comparatively higher absorbance observed in *Withania somnifera* in the lower UV region suggests a greater abundance or concentration of such chromophoric compounds in the extract.

The absence of absorption in the visible region confirms that the extracts predominantly contain non-pigmented phytoconstituents rather than highly conjugated colored compounds such as carotenoids or anthocyanins.

Overall, the UV–Visible spectral profile indicates the presence of conjugated phytochemicals with potential biological activity, providing a preliminary basis for further structural characterisation using advanced analytical techniques.

FTIR Spectral Analysis

Fourier Transform Infrared (FTIR) spectroscopy was employed to identify the functional groups present in the ethanolic extracts of *Elaeocarpus ganitrus* and *Withania somnifera*. The FTIR spectra of both extracts exhibited characteristic absorption bands corresponding to various functional groups associated with bioactive phytoconstituents.

A broad and intense absorption band observed in the region of 3200–3400 cm^{-1} indicates the presence of hydroxyl (–OH) groups, which are characteristic of alcohols and phenolic compounds. A prominent peak around ~1700 cm^{-1} corresponds to carbonyl (C=O) stretching vibrations, suggesting the presence of aldehydes, ketones, or carboxylic acids.

The absorption band near ~1600 cm^{-1} is attributed to aromatic C=C stretching vibrations, indicating the presence of aromatic rings. Additionally, peaks observed in the region of 1000–1300 cm^{-1} correspond to C–O stretching vibrations, which are typical of phenols, ethers, and other oxygen-containing functional groups.

These characteristic absorption bands confirm the presence of multiple functional groups associated with diverse phytochemical constituents in both plant extracts.

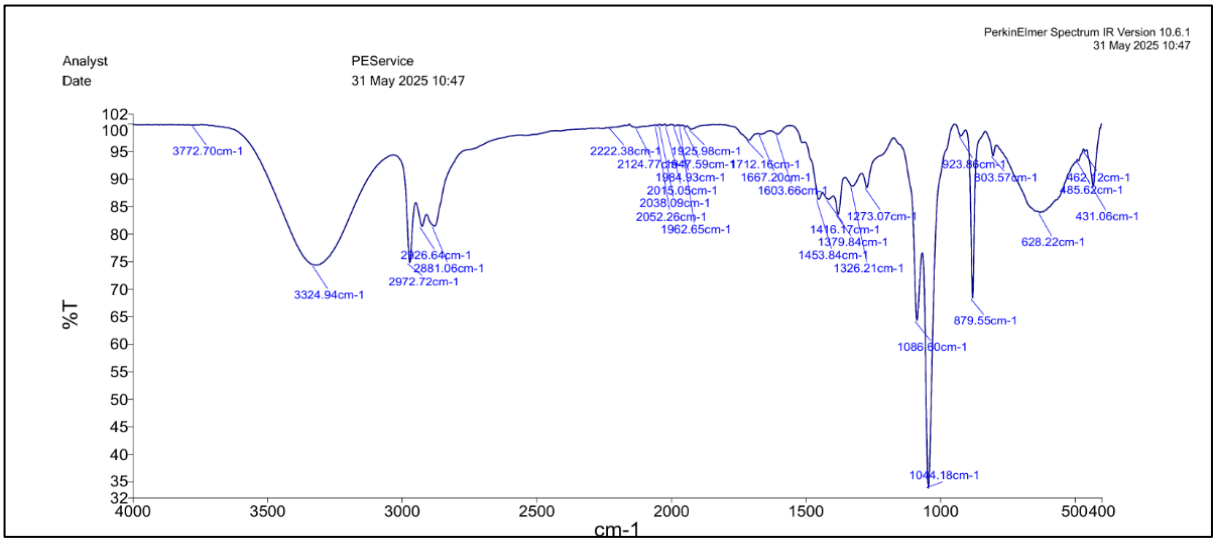


Figure 5. FTIR Spectra of *Elaeocarpus ganitrus*

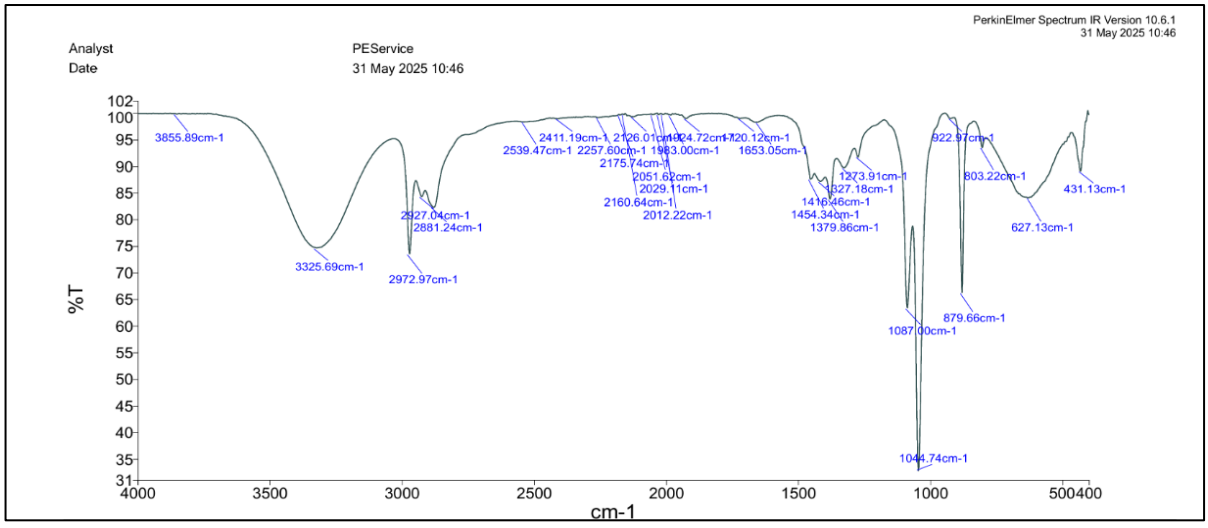


Figure 6. FTIR Spectra of *Withania somnifera*

DISCUSSION

The FTIR spectral analysis provides important insights into the chemical nature of the phytoconstituents present in the extracts of *Elaeocarpus ganitrus* and *Withania somnifera*.

The broad absorption band observed in the region of 3200–3400 cm^{-1} confirms the presence of hydroxyl groups, which are commonly associated with phenolic compounds and alcohols. These functional groups are known for their hydrogen-donating ability and play a crucial role in antioxidant activity.

The presence of carbonyl (C=O) stretching vibrations around 1700 cm^{-1} indicates the occurrence of aldehydes, ketones, and carboxylic acid derivatives. Such functional groups are often involved in biological interactions, including enzyme binding and modulation of biochemical pathways.

The aromatic C=C stretching band near 1600 cm^{-1} suggests the presence of aromatic structures, which are important for molecular stability and interaction with biological targets. These aromatic compounds often contribute to pharmacological activities due to their ability to participate in π-electron interactions.

Furthermore, the C–O stretching vibrations observed in the region of 1000–1300 cm^{-1} confirm the presence of oxygenated functional groups such as phenols and ethers. These groups are associated with enhanced solubility and bioavailability, as well as significant biological activities.

Overall, the FTIR analysis indicates that both plant extracts are rich in oxygenated and aromatic functional groups, which are commonly associated with bioactive phytochemicals and may contribute to their therapeutic potential.

GC–MS Analysis

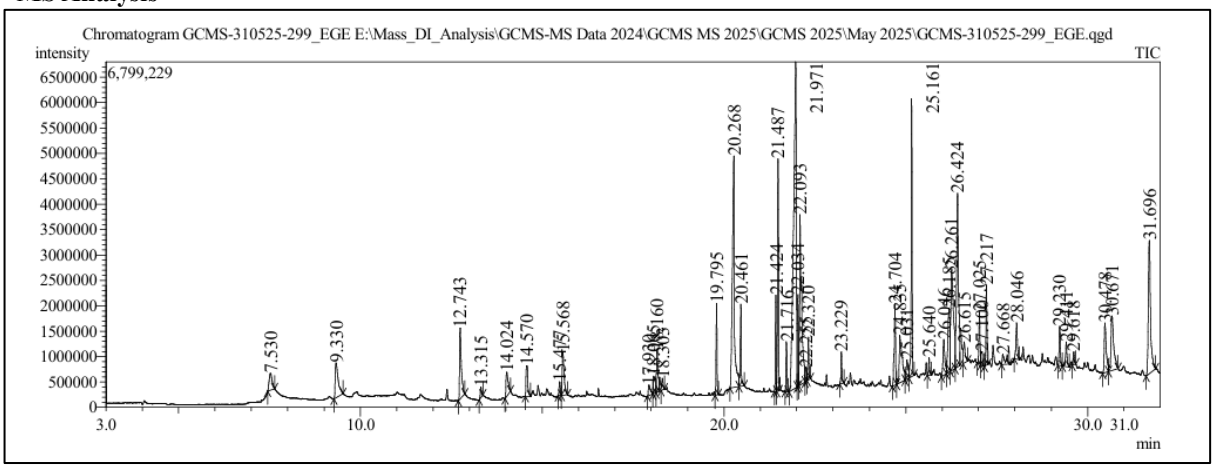


Figure 7. GC/MS chromatogram of *Elaeocarpus ganitrus* seed extract

Table 4 – Chemical constituents present in the extract of *Elaeocarpus ganitrus* Seeds as Per Peak Report in GC-MS Analysis

S.No	Compound Name	Rt (min)	Peak Area %	Molecular Formula	Mol. Wt. g/mol
1	Phenol, 2-methoxy-	9.330	1.94	C10H12O2	164
2	2-Methoxy-4-vinylphenol	12.743	2.30	C9H10O2	150
3	Vanillin	14.024	1.00	C8H8O3	152
4	trans-Isoeugenol	14.570	1.03	C10H12O2	164
5	2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	15.568	1.53	C10H12O4	196.20
6	Tetradecanoic acid	18.160	1.21	C14H28O2	228
7	Hexadecanoic acid, methyl ester	19.795	1.42	C17H34O2	270
8	n-Hexadecanoic acid	20.268	9.10	C16H32O2	256
9	Hexadecanoic acid, ethyl ester	20.461	1.57	C18H36O2	284
10	Butyl 9,12-octadecadienoate	21.424	1.56	C22H40O2	336
11	9-Octadecenoic acid, methyl ester	21.487	3.97	C19H36O2	296
12	6-Octadecenoic acid	21.971	16.50 (Major)	C18H34O2	282
13	Linoleic acid ethyl ester	22.034	1.75	C20H36O2	308
14	(E)-9-Octadecenoic acid ethyl ester	22.093	6.39	C20H38O2	310
15	9-Octadecenoic acid (Z)-, oxiranylmethyl ester	24.704	2.04	C21H38O3	338
16	Glycerol, 2-TMS-	24.835	2.60	C6H16O3Si	164
17	Phthalic acid, di(2-propylpentyl) ester	25.161	5.08	C24H38O4	390
18	Glycerol, 1-tert-butyl 3-trimethylsilyl ether	26.185	2.67	C10H24O3Si	220
19	(E)-3,3'-Dimethoxy-4,4'-dihydroxystilbene	26.261	4.96	C16H16O4	272.29
20	2-Chloroethyl oleate	26.424	6.55	C20H37ClO2	344
21	1,1,6-trimethyl-3-methylene-2-(3,6,9,13-tetramethyl-6-ethenye-	27.217	1.34	C33H56	452

	10,14-dimethylene-pentadec-4-enyl)cyclohexane				
22	3,4-Divanillyltetrahydrofuran	28.046	0.96 *(borderline)*	C20H24O5	344
23	Phenol, 4,4'-(tetrahydro-1H,3H-furo[3,4-c]furan-1,4-diyl)bis[2-methoxy-	30.478	1.88	C20H22O6	358
24	Phenol, 4,4'-(tetrahydro-1H,3H-furo[3,4-c]furan-1,4-diyl)bis[2-methoxy-	30.671	2.84	C20H22O6	358
25	γ-Sitosterol	31.696	5.50	C29H50O	414

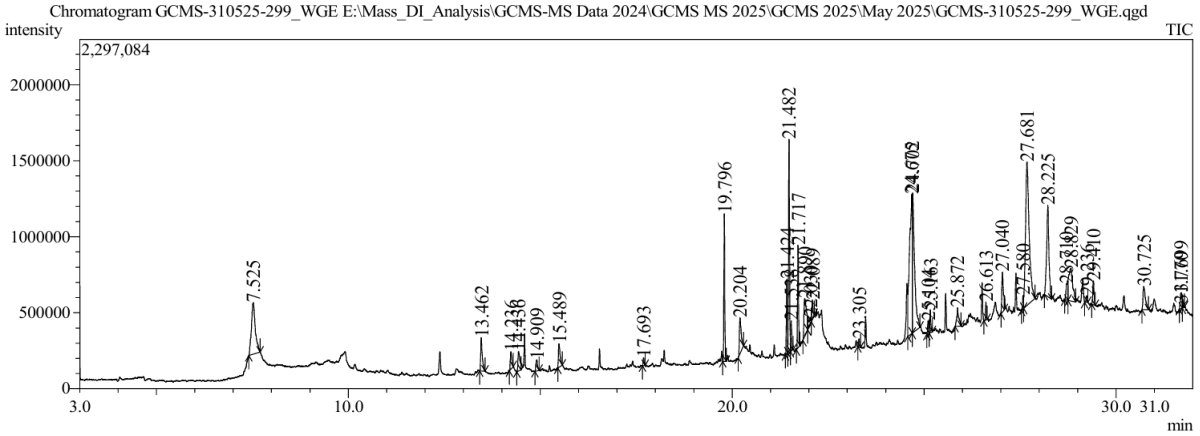


Figure 8. GC/MS chromatogram of *Withania somnifera* Roots extract

Table 5 – Chemical constituents present in the extract of *Withania somnifera* Roots as Per Peak Report in GC-MS Analysis

Peak No.	Compound Name	Retention Time (min)	Area %	Molecular Formula	Mol. Wt. g/mol
1.	Hexadecanoic acid, methyl ester	19.796	4.50	C17H34O2	270
2.	n-Hexadecanoic acid	20.204	2.20	C16H32O2	256
3.	9-Octadecenoic acid, methyl ester (E)	21.482	6.72	C19H36O2	296
4.	Heptadecanoic acid, 16-methyl-, methyl ester	21.717	3.11	C19H38O2	298
5.	6-Octadecenoic acid	21.890	3.10	C18H34O2	282
6.	Gamma-sitostenone	24.675	12.22	C29H48O	412
7.	Androst-4-en-3-one, 17-hydroxy-, (10.alpha.,17.beta.)-	24.702	10.50	C19H28O2	288
8.	13-Docosenamide (Z)	27.040	2.05	C22H43NO	337
9.	Lanosterol	27.681	17.64	C30H50O	426
10.	Stigmastane-3,6-dione, (5.alpha.)-	28.829	4.42	C29H48O2	428
11.	β-Sitosterol acetate	29.410	1.01	C31H52O2	456
12.	Ergost-5-en-3-ol, acetate, (3.beta.,24R)-	30.725	1.88	C30H50O2	442
13.	γ-Sitosterol	31.699	0.95	C29H50O	414

The GC–MS analysis of the ethanolic extracts of *Elaeocarpus ganitrus* and *Withania somnifera* revealed a diverse range of phytoconstituents belonging to phenolics, fatty acids, esters, sterols, and other bioactive classes.

A total of 45 compounds were identified in *Elaeocarpus ganitrus*, whereas 34 compounds were detected in *Withania somnifera*, indicating rich phytochemical diversity in both plant extracts.

In *Elaeocarpus ganitrus*, the chromatographic profile was predominantly characterised by fatty acids and their derivatives. The major constituents identified included 6-octadecenoic acid (16.50%), n-hexadecanoic acid (9.10%), and (E)-9-octadecenoic acid ethyl ester (6.39%). In addition, phenolic compounds such as vanillin, trans-isoeugenol, and 2-methoxy-

4-vinylphenol were detected. A stilbene derivative, (E)-3,3′-dimethoxy-4,4′-dihydroxystilbene (4.96%), and the phytosterol γ-sitosterol (5.50%) were also identified.
In contrast, *Withania somnifera* exhibited a phytochemical profile dominated by sterols and steroidal compounds. The major constituents included lanosterol (17.64%), γ-sitosterol (12.22%), and an androst-4-en-3-one derivative (10.50%). Fatty acid esters such as 9-octadecenoic acid methyl ester (6.72%) and trimethylsilyl derivatives were also observed, indicating the presence of lipidic components. The major phytoconstituents identified in *Elaeocarpus ganitrus* and *Withania somnifera* extracts are presented in Tables 4 and 5, respectively.
Overall, the GC–MS results demonstrate that *Elaeocarpus ganitrus* is rich in phenolic and fatty acid constituents, whereas *Withania somnifera* is characterised by a higher abundance of sterols and steroidal compounds.

DISCUSSION

The GC–MS profiling of *Elaeocarpus ganitrus* and *Withania somnifera* highlights distinct yet complementary phytochemical compositions that may contribute to their potential role in epilepsy management.
In *Elaeocarpus ganitrus*, the presence of phenolic compounds such as vanillin, isoeugenol, and methoxyphenol derivatives suggests strong antioxidant activity. Oxidative stress is a key factor in epileptogenesis, and these compounds may help in reducing neuronal damage by scavenging free radicals. Additionally, the identification of stilbene derivatives indicates possible resveratrol-like neuroprotective effects, further supporting its role in mitigating seizure-induced neuronal injury.
Fatty acids such as 6-octadecenoic acid and n-hexadecanoic acid, which were found in high abundance, are known to contribute to neuronal membrane stabilisation and modulation of ion channels. These effects are critical in reducing neuronal hyperexcitability, a hallmark of epileptic seizures. Moreover, their anti-inflammatory properties may help in controlling neuroinflammation associated with chronic epilepsy.
In *Withania somnifera*, the predominance of sterols such as lanosterol and γ-sitosterol indicates active steroidal biosynthesis pathways. These phytosterols exhibit significant neuroprotective and anti-inflammatory activities and are known to stabilise neuronal membranes. Such properties are beneficial in preventing neuronal degeneration and seizure progression.
Although *Withania somnifera* is widely recognised for its withanolides, these compounds were not detected in the present GC–MS analysis due to their non-volatile nature, higher molecular weight, and thermal instability. Instead, the detection of sterol precursors such as lanosterol provides indirect evidence of withanolide biosynthesis.
Fatty acid esters identified in *Withania somnifera* further support its anticonvulsant potential through modulation of neuronal ion channels and reduction of inflammatory responses.
Comparatively, *Elaeocarpus ganitrus* appears to exert its effects primarily through antioxidant and neuroprotective mechanisms, whereas *Withania somnifera* contributes through steroidal and neurotransmitter-modulating pathways. This complementary mode of action suggests that both plants may act synergistically in epilepsy management.
Overall, the identified phytoconstituents from both extracts indicate that their anticonvulsant potential may be attributed to a combination of antioxidant, anti-inflammatory, neuroprotective, and membrane-stabilising mechanisms.

Discussion

Medicinal plants contain diverse phytoconstituents that contribute to their therapeutic properties. In the present study, preliminary phytochemical screening indicated the presence of flavonoids, tannins, polyphenols, glycosides, and alkaloids in both *Elaeocarpus ganitrus* and *Withania somnifera* extracts. These classes of compounds are widely reported to exhibit antioxidant, neuroprotective, and anti-inflammatory activities, which may underlie their pharmacological potential. (19, 20)
UV–Visible spectroscopic analysis revealed absorption maxima in the region of 200–210 nm and 250–280 nm, indicating the presence of conjugated systems and aromatic chromophores. Such spectral features are characteristic of phenolic and flavonoid-like compounds, which are known to interact with biological targets through electronic and structural properties. (21)
FTIR analysis further confirmed the presence of key functional groups, including hydroxyl (–OH), carbonyl (C=O), aromatic C=C, and C–O stretching vibrations. These findings indicate the presence of oxygenated and aromatic phytoconstituents commonly associated with significant biological activities. (22)
GC–MS profiling provided detailed insights into the chemical composition of the extracts. In *Elaeocarpus ganitrus*, phenolic derivatives and stilbene-related compounds were identified, whereas *Withania somnifera* showed a predominance of sterols and steroidal compounds such as lanosterol and γ-sitosterol. Although withanolides were not detected, the presence of sterol precursors supports their biosynthetic origin. (23)
The comparative analysis of both plant extracts indicates overlapping classes of bioactive constituents, particularly phenolic and aromatic compounds, which may facilitate interactions with biological systems through mechanisms such as hydrogen bonding and π–π interactions.
These phytoconstituents collectively suggest multiple mechanisms relevant to epilepsy management. Phenolic compounds contribute to antioxidant activity and reduction of oxidative stress, fatty acids aid in neuronal membrane stabilisation and modulation of ion channels, and phytosterols exhibit anti-inflammatory and neuroprotective effects. (24,25)
Comparatively, *Elaeocarpus ganitrus* appears to act predominantly through antioxidant mechanisms, whereas *Withania somnifera* exerts its effects via steroidal and neuroprotective pathways. These complementary mechanisms may enhance their overall therapeutic potential.

Overall, the integrated analytical findings indicate that the presence of diverse bioactive compounds may contribute to anticonvulsant activity, thereby supporting the potential role of these plants in epilepsy management.

Conclusion

The present study provides a comprehensive phytochemical and spectroscopic evaluation of *Elaeocarpus ganitrus* and *Withania somnifera* using preliminary phytochemical screening, UV–Visible spectroscopy, FTIR, and GC–MS analysis. The findings confirmed the presence of diverse bioactive constituents, including flavonoids, polyphenols, glycosides, alkaloids, fatty acids, and phytosterols.

The analytical results revealed that *Elaeocarpus ganitrus* is rich in phenolic and antioxidant compounds, whereas *Withania somnifera* predominantly contains sterols and steroidal constituents. These distinct phytochemical profiles suggest that the two plants may act through different but complementary mechanisms.

The identified compounds are associated with antioxidant, anti-inflammatory, neuroprotective, and membrane-stabilising properties, which are relevant to epilepsy management. Based on these findings, it can be inferred that the combined presence of these phytoconstituents may produce a synergistic effect, where antioxidant mechanisms from *Elaeocarpus ganitrus* and neuroprotective steroidal pathways from *Withania somnifera* collectively contribute to enhanced therapeutic potential.

The comparative profiling revealed similarities in the chemical composition of the two plants, particularly in terms of phenolic and aromatic compounds that are known for their biological activity. These findings support the traditional medicinal significance of *Elaeocarpus ganitrus* and *Withania somnifera*, highlighting their potential as sources of bioactive compounds. Thus, the study provides scientific evidence supporting the potential synergistic role of these plants in epilepsy management. However, further pharmacological and clinical investigations are required to validate this synergistic effect and to elucidate the underlying mechanisms.

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