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EPILEPSY AND ANTICONVULSANT POTENTIAL OF *NARDOSTACHYS JATAMANSI*: A REVIEW OF PATHOPHYSIOLOGY AND MEDICINAL PLANT APPLICATIONS

P. Madhumaya Devi*[1], S. Murugesan[2], V. Naveenkumar[2], K. Nandhini[2], A. Mohammed Oviaz[2], T. Nanda[2], Dr. K. Kaveri[3]

[1]Assistant Professor, Department of Pharmacology, Aadhi Bhagawan College of Pharmacy, Rantham, Tamilnadu.
[2]B. Pharm Final Year Student, Aadhi Bhagawan College of Pharmacy, Rantham, Tamilnadu.
[3]Principal, Aadhi Bhagawan College of Pharmacy, Rantham, Tamilnadu.

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***Corresponding Author: P. Madhumaya Devi**
Assistant Professor, Department of Pharmacology, Aadhi Bhagawan College of Pharmacy, Rantham, Tamilnadu.
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ABSTRACT

Epilepsy is a chronic neurological disorder characterized by recurrent and unprovoked seizures caused by abnormal electrical activity in the brain. It affects individuals of all age groups and has significant neurological, psychological, and social consequences. The condition results from an imbalance between excitatory and inhibitory neurotransmitters in the central nervous system, particularly glutamate and gamma-aminobutyric acid (GABA), leading to neuronal hyperexcitability and hypersynchronization. Seizures can be classified into generalized and partial types depending on the area of the brain affected. Although antiepileptic drugs are widely used for management, a considerable proportion of patients suffer from drug-resistant epilepsy, necessitating the search for alternative therapies. Medicinal plants have gained attention due to their potential neuroprotective and anticonvulsant properties. *Nardostachys jatamansi*, commonly known as Indian Spikenard, is an important medicinal herb belonging to the family Valerianaceae and traditionally used in neurological disorders. The plant contains various phytochemicals such as sesquiterpenes, flavonoids, lignans, alkaloids, and essential oils, which contribute to its anticonvulsant, sedative, and neuroprotective activities. This review highlights the pathophysiology of epilepsy, classification of seizures, and the pharmacological importance of *Nardostachys jatamansi* and other medicinal plants used in epilepsy management.

KEYWORDS: Epilepsy, Seizures, Anticonvulsant, *Nardostachys jatamansi*, Phytochemicals, Neuroprotection, Medicinal plants, GABA, Glutamate.

1. INTRODUCTION

1.1 EPILEPSY

Epilepsy is a chronic neurological disorder characterized by recurrent, unprovoked seizures caused by abnormal, excessive, and synchronized electrical discharges in the brain. It is considered one of the most common neurological disorders worldwide, occurring in individuals of all ages. The diagnosis of epilepsy is made if a person presents with two or more unprovoked seizures occurring after a period of more than 24 hours. Epilepsy can occur as a result of structural abnormalities of the brain, genetic, metabolic, infectious, or traumatic causes, or sometimes there may be no cause, in which case it is called idiopathic epilepsy. The symptoms of epilepsy depend upon the part of the brain affected, and symptoms can range from minor lapses of awareness to major generalized convulsive seizures with impaired consciousness. Epilepsy is a disorder of neuronal excitability, and it results from an imbalance of excitation and inhibition of central nervous system. From a neurobiological point of view, the phenomenon of epilepsy has been linked to the hyperexcitability of the neuronal networks and the hyper synchronization of the cortical neurons. Under normal physiological conditions, the excitability of the neurons is well regulated by the balance between the excitatory neurotransmitters like glutamate and the inhibitory neurotransmitters like gammaaminobutyric acid (GABA). However, in the case of epilepsy, the excitability of the neurons increases, leading to depolarization of the neurons, which in turn causes the action potential to be fired repetitively. Various changes in the brain, like hippocampal sclerosis, cortical dysplasia, brain tumors, and head injuries, also predispose individuals to the occurrence of seizures. Apart from these factors, the role of genetics in the occurrence of epilepsy is also very prominent in the case of childhood epileptic syndromes.

Epilepsy is a disorder that does not only influence the neurological system of an individual but has psychological, social, and economic implications as well. People living with epilepsy may be cognitively impaired, depressed, anxious, and stigmatized in society. The disorder has to be managed in the long term through the use of antiepileptic medication. In some instances, surgery may be required to manage epilepsy. However, despite the availability of effective treatment for epilepsy, one-third of the population suffers from drug-resistant epilepsy. Hence, it is crucial to conduct research on the management of epilepsy in order to improve the quality of life of the affected individuals.

1.2 SEIZURE

A seizure, therefore, may be defined as the sudden, transient appearance of signs and/or symptoms caused by abnormal, excessive, and synchronous neuronal activity in the brain. Seizures are the primary clinical manifestations of epilepsy; however, seizures are not always associated with epilepsy. Seizures may be caused by fever, metabolic disorders, infections, head injuries, and drug withdrawal, but in the case of epilepsy, the seizures are recurrent and unprovoked. The clinical manifestations of seizures are determined by the part of the brain affected, the extent of the neuronal activity, and the time course of the seizure activity. Seizures may manifest as motor, sensory, autonomic, and psychological symptoms. Motor symptoms may include tonic, clonic, and myoclonic movements; sensory symptoms may include visual and auditory disturbances; autonomic symptoms may include sweating and palpitations; and psychological symptoms may include fear and Deja vu sensation.

1.3 CLASSIFICATION OF SEIZURE

1.3.1 Generalized Seizures

Generalized Tonic–Clonic Seizures (GTCS) (Grand Mal Epilepsy): It is characterized by a typical sequence of events including aura, epileptic cry, sudden loss of consciousness, fall to the ground, tonic phase (muscle stiffening), clonic phase (rhythmic jerking of muscles), followed by a period of relaxation and postepileptic phase with confusion and automatism.

Absence Seizures (Petit Mal Epilepsy): It is characterized by sudden onset of staring, unresponsiveness, and brief loss of consciousness without loss of postural control. The patient usually recovers immediately without confusion.

Myoclonic Seizures: It is characterized by single or multiple sudden, brief, shock-like involuntary muscle contractions, which may involve one muscle group or the whole body.

1.3.2 Partial Seizures:

Simple Partial Seizures (SPS): The clinical manifestations depend on the specific cortical region involved. These seizures are characterized by focal motor symptoms (such as localized convulsions) or sensory symptoms (such as paraesthesia) without impairment or loss of consciousness.

Complex Partial Seizures (CPS) (Temporal Lobe Epilepsy / Psychomotor Epilepsy): These seizures are characterized by the presence of aura, impaired consciousness, amnesia, and abnormal behaviour associated with automatisms such as lip smacking, chewing movements, or repetitive hand movement

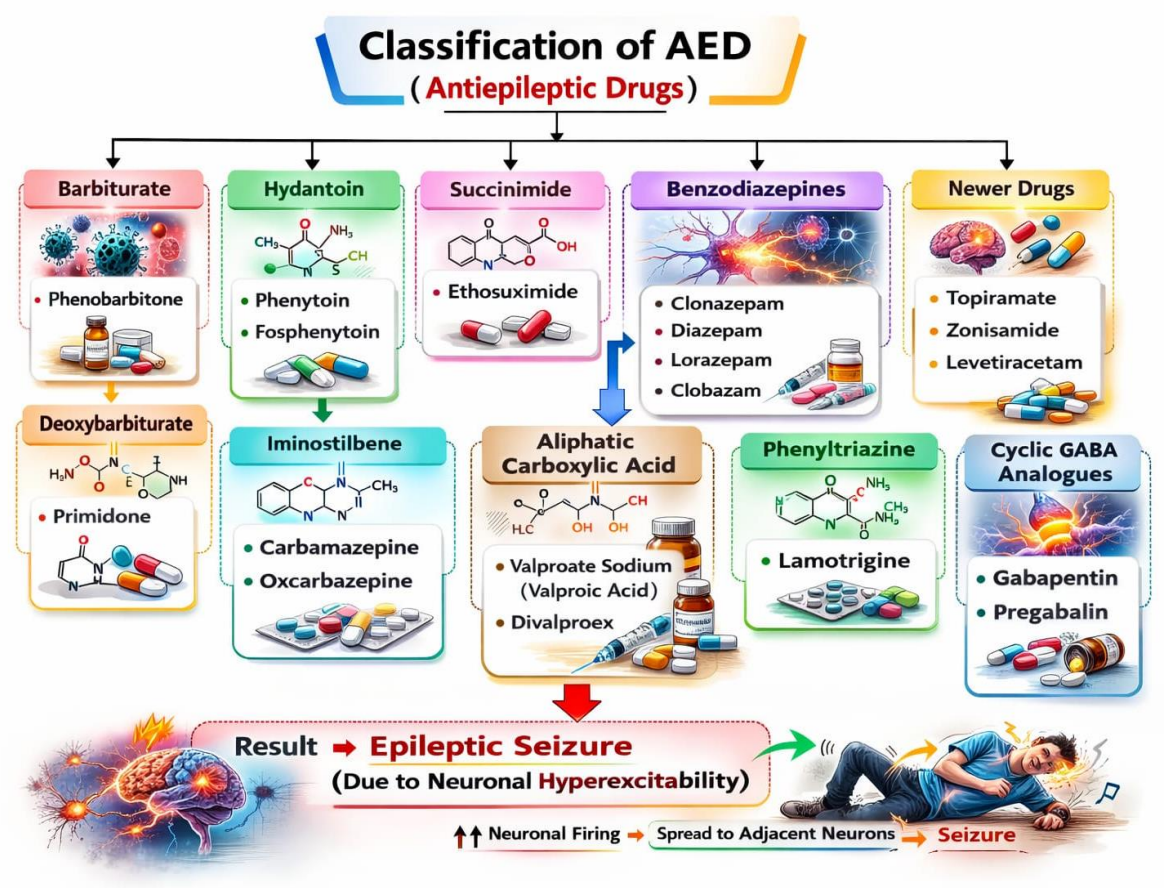


Fig. 1: Classification Of Anti-Eplieptic Drug.

1.4 PATHOPHYSIOLOGY OF ANTICONVULSION

Epilepsy occurs due to abnormal excitability and hyper synchronization of cortical neurons. Normally, brain activity is balanced by excitatory and inhibitory neurotransmitters.

- **Excitatory neurotransmitters** like *glutamate* increase neuronal depolarization by allowing sodium (Na^+) and calcium (Ca^{2+}) ions to enter the cell.
- **Inhibitory neurotransmitters** like *GABA* reduce neuronal excitability by allowing chloride (Cl^-) ions to enter, causing hyperpolarization.

In epilepsy, this balance is disturbed due to

- Alterations in voltage-gated sodium, potassium, and calcium channels
- Excess stimulation of NMDA and AMPA glutamate receptors causing increased calcium influx and excitotoxicity
- Reduced GABAergic inhibition (decreased GABA synthesis or receptor dysfunction)
- Structural abnormalities such as hippocampal sclerosis, cortical dysplasia, brain tumors, or traumatic injury

Repeated seizures can cause neuronal death, formation of abnormal excitatory connections (especially in the hippocampus), inflammation, oxidative stress, and blood–brain barrier dysfunction. This process is called epileptogenesis.

Antiepileptic drugs act by restoring balance through

- Blocking sodium or calcium channels
- Enhancing GABA activity
- Reducing glutamate-mediated excitation

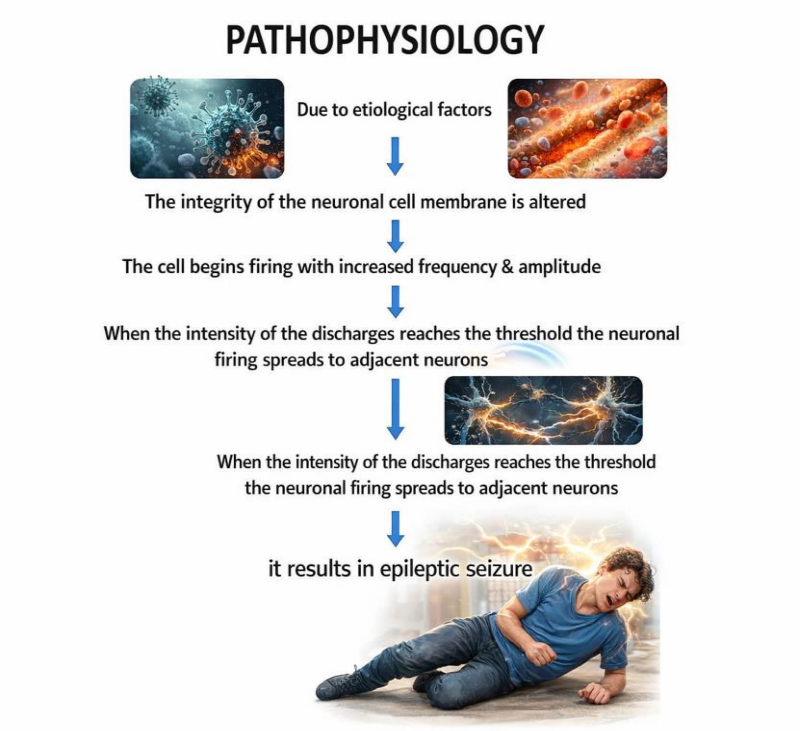


Fig. 2: Pathophysiology.

2. PLANT PROFILE

Whole Plant: ***Nardostachys Jatamansi***

Fig. 3: ***Nardostachys Jatamansi.***

2.1 Synonyms: Botanical synonyms of Nardostachys jatamansi are also given in the literature, which indicates that the taxonomic position of the species has varied with time. Some of the synonyms of Nardostachys jatamansi are given as Nardostachys grandiflora, Nardostachys chinensis, and Nardostachys spicata. The synonyms of the plant are important to avoid confusion while dealing with pharmacognosy studies.

2.2 Other Names: Apart from its scientific name, this plant is also known by the common English name Indian Spikenard. In pharmacology and herbal medicine, it is also known by the common name Spikenard Oil Plant, primarily due to its aromatic rhizome, which is used to make essential oil.

2.3 Vernacular Names

These vernacular names are important in ethnomedicine and traditional herbal preparations.

Table: 1 Vernacular Name.

Language	Vernacular Name
Hindi	Jatamansi
Sanskrit	Jatamansi
Nepali	Tagar
Bengali	Jatamansi
Kannada	Sugandha Valli

2.4 Taxonomy

The taxonomical classification of *Nardostachys jatamansi* is as follows:

- **Kingdom:** Plantae
- **Division:** Angiosperms
- **Class:** Dicotyledons
- **Order:** Dipsacales
- **Family:** Valerianaceae
- **Genus:** Nardostachys
- **Species:** jatamansi

The plant belongs to the family of Valerianaceae, a family known for its sedative and neuroactive properties.

2.5 Morphology: Nardostachys jatamansi is a perennial herb with the characteristics of having fragrant rhizomes and tufted basal leaves. It grows up to 30-50 cm in height and has small pink or reddish flowers arranged together. It has linear-lanceolate leaves without a stalk, arranged in a rosette at the base of the stem. It has a thick, short, and branched rhizome covered with brown scales, containing the major bioactive compounds of the plant. The rhizome of the plant contains volatile oils, causing the strong and distinct smell of the herb.

2.6 Botanical Description: The botanical profile describes the plant's vegetative and reproductive parts in detail. The roots survive the years, are woody in texture, and have a specific fragrance; the stems are short or absent; the leaves are found at the base of the plant and are narrow in shape; the flowers are small, bisexual, and in cymose arrangement. The plant grows in rocky environments in the Himalayas at higher altitudes and has specific adaptations: a deep rhizome to store water and aromatic compounds, which serve as secondary metabolites.

2.7 Geographical Distribution: Nardostachys jatamansi is native to a vast region of the Himalayas, occurring in India, Nepal, Bhutan, and Tibet. It is typically found in areas with an altitude of 3,000-5,000 meters, occurring in rocky alpine meadows and along the periphery of temperate forests. Apart from its natural habitat, it is cultivated under artificial conditions for the purpose of extracting its essential oil and herbal extracts.

2.8 Composition of Phytochemicals: Phytochemical analysis has confirmed that Nardostachys jatamansi contains a variety of bioactive compounds. Its major bioactive compounds include sesquiterpenes, such as jatamansone and nardosinone, and flavonoids, lignans, alkaloids, steroids, and essential oils. These compounds have been attributed to the plant's anticonvulsant, sedative, anti-inflammatory, and neuroprotective properties. The composition of these compounds varies with altitude, climate, and method of extraction.

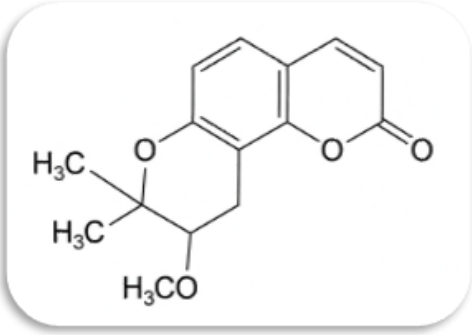


Fig. 4: Valeranol.

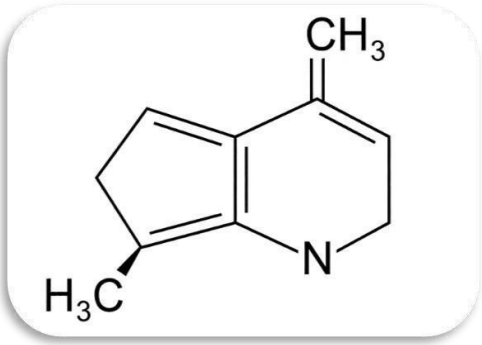


Fig. 5: Nardostachone.

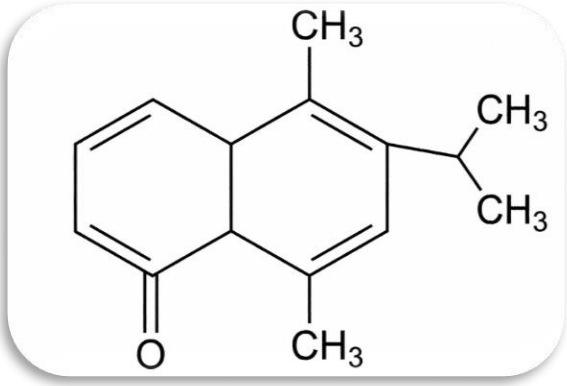


Fig. 6: Jatamansone.

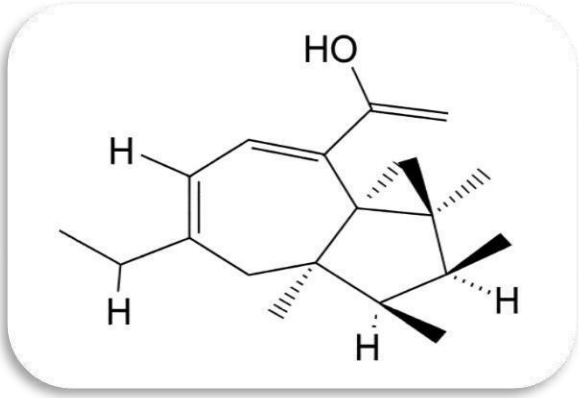


Fig. 7: Jatamansic acid.

2.9 Medicinal Uses Associated with Their Phytochemicals

Table 2: Medicinal Uses Of *Nardostachys Jatamansi* Plant.

Medicinal Uses	Phytochemicals
Treatment of epilepsy and convulsions	Jatamansone, nardosinone
Sedative and anti-anxiety agent	Essential oils, flavonoids
Neuroprotective activity, memory enhancement	lignans, alkaloids
Anti-inflammatory and antioxidant effects	Sesquiterpenes, steroids
Treatment of insomnia	Volatile oils, nardosinone

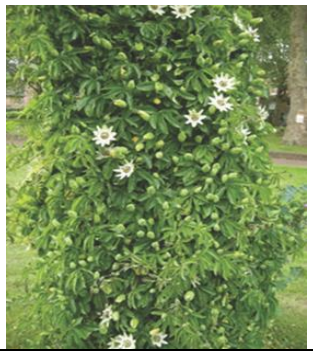
3. LITERATURE REVIEW

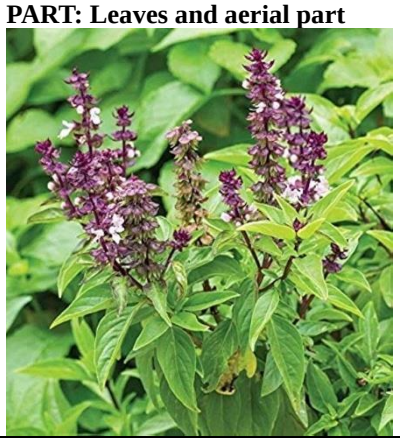
Table 3: Literature Review of Medicinal Plant.

S.NO	PLANT NAME, PROFILE AND PART USED	BIOLOGICAL SOURCE & FAMILY	CHEMICAL CONSTITUENT	REFERENCE
1.	**NAME:** JATAMANSI **PART:** Root 	**BIOLOGICAL SOURCE:** ***Nardostachys jatamansi*** **FAMILY: Valerianaceae**	Sesquiterpenes Jatamansone, nardosinone	**Swati Goyal1 (2021)**

2.	**NAME:Coffee Senna, Septicweed** **PART:** Whole plant  	**BIOLOGICAL SOURCE:** ***Cassia occidentalis* Linn** **FAMILY: Leguminose**	presence of glycosides, flavonoids, triterpinoids	**Jalalpure S (2016)**
3.	**NAME:**Indian Sarsaparilla **PART:**Stem & Leaves 	**BIOLOGICAL SOURCE:***Hemidesmus indicus* **FAMILY:** Apocynaceae	Cardiac glycosides, triterpenoids, phenolic compounds and tannins	***Javed Khan Pathan* (2019)**
4.	**NAME:**Avocado **PART:**Leaf 	**BIOLOGICAL SOURCE: *Persea americana*** **FAMILY:** Laureacea	carotenoids, terpenoids, D-mannoheptulose, persenone A and B, phenols, and glutathione.	**Ojewole JA, (2006)**
5.	**NAME:** ilama or red ilama **PART:** root & bark 	**BIOLOGICAL SOURCE:** *Annona diversifolia* **FAMILY:** *Annonaceae*	Palmitone (16-hentriacontanone)	**Gonzalez-Trujano ME (2001)**
6.	**NAME: Orange** **PART: Lea** 	***Biological source: Citrus sinenses*** ***FAMILY: Rutaceae***	flavonoids and volatile monoterpenes	**Nadithe Laxman Reddy (2016)**

7.	**NAME:Sirupulladi** **PART: Leaves** 	***BIOLOGICAL SOURCE: Desmodium triflorum*** ***FAMILY: Fabaceae***	alkaloids, flavonoids, steroids, saponins, and tannins	***Vaibhav Bhosle (2013)***
8.	**NAME:** Vacha, calamus. **PART:**Rhizomes 	***BIOLOGICAL SOURCE:*** *Acorus calamus Linn* ***FAMILY:*** *Acoraceae*	β-Asarone and α-Asarone	**Savitha D. Bhat, Ashok B. K (2012)**
9.	**NAME:** Patharchatta **PART:** stems and roots 	**BIOLOGICAL SOURCE**: *Kalanchoe pinnata* FAMILY:Crassulacea	sterols, terpenes, and flavonoids	A Mora-Pérez (2016)
10.	**NAME:** morning-glory **PART:**leaf 	**BIOLOGICAL SOURCE**: Ipomoea asarifolia **FAMILY:** Convolvulaceae	flavonoids, saponins, alkaloids, tannins, and phenols	Samaila S. Chiroma (2022)
11.	**NAME:** Athalakkai **PART:**leaves 	Biological **Source:** Momordica tuberosa, **Family:** Cucurbitaceae	saponins, triterpenoids, flavonoids, steroids, carbohydrates.	Jayapradha Shivanand Totad (2015)

12.	**NAME:** Dhawada **PART: Stem & Bark** 	Biological source. Anogeissus latifolia Family. Combretaceae	Triterpenoids and Steroids. Flavonoids (Quercetin and Rutin), Gallotannins, Tannins	Vikas Chandra Sharma (2018)
13.	**NAME: Nigerian or tropical mint** **PART:flowers andleaves** 	**BIOLOGICAL SOURCE: *Aeollanthus suaveolens*** **FAMILY: Lamiaceae**	2-Decan-5-olide, Linalyl acetate, Linalool	**Coelho de Souza GP (1997)**
14.	**NAME: *Passiflora*** **PART:leaves** 	**BIOLOGICAL SOURCE: *Passiflora caerulea*** **FAMILY:*Passifloraceae***	lavonoids, alkaloids armalinici, and chrysin. Tetraphyllin B and epitetraphyllin B, and cyanogenic glycosides	**Felieu-Hemmelmann K. (2013)**
15.	**NAME: Punarnava or Punarnavaa** **PART:root** 	**BIOLOGICAL SOURCE: *Boerhaavia diffusa*** **FAMILY: *Nyctaginace***	alkaloids(punarnavine), rotenoids (boeravinones A–F), and flavonoids	**Kaur M, Goel R.K(2011)**
16.	**NAME: Prostrate Globe Amaranth** **PART: whole plant** 	**BIOLOGICAL SOURCE: Gomphrena serrata** **FAMILY: Amaranthaceae,**	bioflavonoids, tannins, saponins, and glycosides.	**Subba Reddy D(2018)**

17.	**NAME: Sweet basil or Simply basil** **PART: Leaves and aerial part** 	**BIOLOGICAL SOURCE:** Ocimum basilicum **FAMILY: Lamiaceae**	*linalool, 1,8cineole(cineole), eugeno, methyl chavicol (estragole), and methyl cinnamate.*	**Koutroumanidou E, (2013)**
18.	**NAME: DITTANY OF CRETE** **PART: LEAVES AND FLOWER** 	**BIOLOGICAL SOURCE:** Origanum dictamnus **FAMILY:** Rutaceae	Flavonoids (e.g., Luteolin, Apigenin), Ursolic Acid, Carvacrol p-Cymene, γ-Terpinene	**da Fonseca DV (2019)**
19.	**NAME: kalonji** **PART: seed** 	**BIOLOGICAL SOURCE:** Nigella sativa **FAMILY:** Ranunculaceae	thymoquinone (TQ), carvacrol, alpha-hederin, and p-cymene.	**Noor NA, Aboul Ezz HS**
20.	**NAME: Spearmint** **PART: leaves** 	**BIOLOGICAL SOURCE:** Mentha spicata **FAMILY:** Lamiaceae	**Carvone,Limonene, 1,8-Cineole(Eucalyptol): Pinene and Pinene, Borneol**, **Polyphenols:** .	**Mahboubi M. (2021)**

4. DISCUSSION

Epilepsy is a complex neurological disorder resulting from abnormal neuronal activity within the brain. The underlying mechanism involves hyperexcitability and hypersynchronization of neuronal networks due to an imbalance between excitatory and inhibitory neurotransmission. Excitatory neurotransmitters such as glutamate increase neuronal depolarization, whereas inhibitory neurotransmitters like GABA reduce neuronal activity. Disruption of this balance leads to repetitive neuronal firing and seizure generation. Structural abnormalities such as hippocampal sclerosis, cortical dysplasia, brain tumors, and traumatic brain injuries can also contribute to epileptogenesis.

Seizures are classified into generalized seizures and partial seizures depending on their origin in the brain. Generalized seizures affect both hemispheres and include tonic–clonic, absence, and myoclonic seizures. Partial seizures originate from a localized region of the brain and are further classified into simple partial seizures, which occur without loss of consciousness, and complex partial seizures, which involve impaired consciousness and automatisms.

Although conventional antiepileptic drugs are effective for many patients, approximately one-third of individuals experience drug-resistant epilepsy. This limitation has led to increasing interest in herbal medicines and plant-based therapies. *Nardostachys jatamansi* is a well-known medicinal plant traditionally used in Ayurvedic medicine for neurological disorders, including epilepsy, insomnia, and anxiety.

Phytochemical studies reveal that the rhizomes of *Nardostachys jatamansi* contain bioactive compounds such as jatamansone, nardosinone, flavonoids, lignans, and essential oils. These compounds exhibit anticonvulsant, sedative, anti-inflammatory, and neuroprotective properties. The anticonvulsant activity is believed to be associated with modulation of neurotransmitter systems, particularly enhancement of GABAergic activity and reduction of glutamate-mediated excitotoxicity.

The literature review also indicates that several other medicinal plants, including *Cassia occidentalis*, *Hemidesmus indicus*, *Acorus calamus*, *Boerhaavia diffusa*, and *Nigella sativa*, possess anticonvulsant properties due to their diverse phytochemical constituents such as alkaloids, flavonoids, terpenoids, and glycosides. These natural compounds may act through various mechanisms such as antioxidant activity, modulation of ion channels, and neuroprotection.

5. CONCLUSION

Epilepsy is a major neurological disorder characterized by recurrent seizures resulting from abnormal neuronal activity and neurotransmitter imbalance. Despite the availability of several antiepileptic drugs, treatment resistance and adverse effects remain significant challenges. Medicinal plants have emerged as promising alternatives for the management of epilepsy due to their diverse bioactive compounds and neuroprotective effects. *Nardostachys jatamansi* is a valuable herbal plant with significant anticonvulsant, sedative, and neuroprotective properties attributed to its phytochemical constituents such as jatamansone and nardosinone. Further pharmacological and clinical studies are required to validate its efficacy and develop safe, plant-based therapeutic agents for epilepsy management.

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