THERAPEUTIC EFFICACY OF PHYTOCHEMICALS AS ANTI-EPILEPTIC - A REVIEW

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Summary

Epilepsy is an important health problem. Epilepsy is a chronic disorder characterized by recurrent seizures. Various pharmacologic and surgical options are available, including different formulations for its treatment. There are number of drugs available for epilepsy in modern therapy. But the major disadvantages being faced are their chronic side effects. Herbal drugs are acting at target side having same mechanism of action as that of synthetic drugs. In this paper authors have discussed the potentials of important anti-epileptic plants which help the scientist for further research.

Keywords: Epilepsy, Seizures, Herbal drugs, Phytochemical.

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Introduction

A mental or neurological disorder encompasses broad range of conditions that result in dysfunction of brain, spinal cord and nerves[1]. In this modern era, epilepsy is the most frequent neurodegenerative disease. Epilepsy is a disorder that is being viewed as a symptom of disturbed electrical activity in the brain. It is a collection of many different types of seizures that vary widely in severity, cause, consequence, appearance and management. Epilepsy implies a periodic recurrence of seizures with or without convulsions. There are around 20 to 70 new cases of epilepsy per 100,000 people per year[2]. There are many classes of anti-epileptics that are of clinical usefulness with good prognosis for controlling seizures in most patients[3]. Despite this, many patients have seizures that are not adequately managed by the established antiepileptic drugs[4]. Moreover, the high incidence of adverse effects from the use of established antiepileptic drugs is also a source of widespread concern in patients who use them chronically. There are many mechanisms by which seizures can develop in either normal or pathologic brains. Three common mechanisms include:

1. Diminition of inhibitory mechanism (especially synaptic inhibition due to GABA).
2. Enhancement of the excitatory synaptic mechanism (especially those mediated by NMDA).
3. Enhancement of endogenous neuronal burst firing (usually by enhancing voltage dependent calcium currents).

Different forms of human epilepsy may be caused by any one or combination of the above said mechanisms[5-6]. Both *in vivo* and *in vitro* models are available for the evaluation of anti epileptic activities of drugs. In the *in vivo* methods, animals are used for the demonstration of an injury by exogenous agents of epileptic seizure on the brain with its physiological significance. *In vitro* models are employed to elucidate specific aspects of the mechanisms of injury. *In vivo* animal models have been categorized by external agents and chemical agents that initiate the epileptic seizures, for e.g., maximal electro shock (MES) □ induced epilepsy, pentylenetetrazol (PTZ) □ induced epilepsy, picrotoxin (PTX) □ induced epilepsy and also other chemical agents like isoniazid, biccuculine (BCL), strychnine(STZ), 4□aminopyridine, kainic acid □ induced epilepsy

models also kindled rat seizures. Mechanical methods like epilepsy induced by focal lesion, and genetic animal models of epilepsy, audiogenic models of epilepsy are available methods to screen the antiepileptic activities of drugs[7-8]. The alternative drug therapy for the management of this disease can be by the use of medicinal plants and their active principles having little or without side effects. The list of plants having anti-epileptic activity is listed in table 1.

Table 1: List of Plants having anti-epileptic activity

S. No.	PLANT	ACTIVE CONSTITUENT	ACTIVITY	REMARKS	REF NO.
1.	*Acorus calamus* (Araceae)	Rhizome. Asarone, ursolic acid.	• Metrazol induced convulsion • MES induced convulsion	The stem volatile fractions of rhizome exacerbated tonic seizures prevoked by metrazol in rats. The aqueous and the alcoholic extracts reduced the severity of MES induced seizure in rats.	9
2.	*Acorus gramineus* (Araceae)	Water extract of rhizome. Essential oils, asarones, 1-allyl-2,4,5 Trimethoxybenzene, Lignans.	• PTZ induced convulsion	*A. gramineus* at dose 5g/kg has anticonvulsant effect against PTZ induced seizures.	10
3.	*Aeollanthus suaveolens* (Labiatae)	Essential oil (gamma decanolactone, structurally related to lactones present in the essential oil).	• PTZ induced convulsion • MES induced convulsion	It has dose-dependent effects on anticonvulsant activity.	11
4.	*Afrormosia laxiflora* (Leguminosae)	Lyophilized root decoction. α-methyldeoxybenzoins angolensin, 2-*O*-methyl-angolensin and demethylpterocarpin.	• PTX induced convulsion • MES induced convulsion	Doses of 150-300mg/kg of extract significantly diminished the duration of convulsive symptoms and increased the seizure latency in both PCT and MES induced seizures when compared with controls.	12
5.	*Albizzia lebbeck* (Mimosaceae)	Alcoholic extract of leaves. Flavonoids, tannins and saponins	• MES induced convulsion • Kindled Rat Seizure Model • PTZ induced convulsion	Alcoholic extract of leaves of *A. lebbeck* showed anticonvulsant effect in MES and PTZ induced convulsions.	13
6.	*Ambrosia paniculata* (Asteraceae)	Decoction of the dry leaves.	• PCT induced convulsion, • Isoniazid Induced Convulsion	I.p injections (0.01 ml/g body wt.) of a decoction of the dry leaves significantly enhanced the latency to the first convulsion and survival time in mice injected with PCT (7 mg/kg) or isoniazid (210 mg/kg).	14

7.	*American ginseng* (Araliaceae)	Ginsenosides.	• PTZ induced convulsion • Pilocarpine induced convulsion	40-60 mg of the extract had significant effect on pilocarpine and PTZ induced seizures.	15-16
8.	*Annona diversifolia* (Annonaceae)	Ethanolic extract.	• Penicillin-induced seizures	The extract is effective in reducing the severity of behavioural and EEG seizures Induced by penicillin in rats.	17
9.	*Artimisia dracunculus* (Asteraceae)	Essential oil[trans anethole (21.1%),alpha- trans ocimene (20.6%), liminene (12.4%), alpha pinene(5.1%),allo ocimene(4.8%), methyl eugenol(2.2%), beta pinene(0.8%),alpha terpinolene(0.5%), bornyl acetate(0.5%) and bicyclogermacrene(0.5%)].	• PTZ induced convulsion • MES induced convulsion	The essential oil exerted dose dependent and time dependent anti seizure activity in both MES and PTZ models of experimental seizures with ED50 values of 0.84 and 0.26ml/kg respectively.	18
10.	*Artemisia verlotorum* (Compositae)	Crude hydroalcoholic extract(HE). α-thujone and camphor.	• PTZ induced convulsion • MES induced convulsion • Pilocarpine model • 3-Nitropropionic Acid-Induced Seizures	High doses of HE (2g/kg) prevented the onset of electroshock (75mA, 60Hz) and PTZ induced (75mg/kg i.p.) convulsions and also increased the latencies to convulsions induced by 3- Nitropropionic Acid (30mg/kg i.p) and pilocarpine (400mg/kg i.p) in mice.	19
11.	*Balanites aegyptiaca* (Balanitaceae)	Fruits. Palmitic, stearic, oleic and linoleic acids	• PTZ induced convulsion • PTX induced convulsion	The decoctionprotected mice against PTZ induced seizures, but had no effect on PTX induced seizures.	20

12.	*Bixa orellana* (Bixaceae)	Methanolic extract of leaves. Farnesyl acetate , occidentalol acetate, spathulenol and ishwarane.	• STR Induced Convulsion	In the STR induced anticonvulsant test, the extract increased the average survival time of the test animals (statistically significant at 250 and 500mg/kg).	21
13.	*Caesalpinia sappa* (Leguminosae)	80% aqueous MeOH Extracts of wood. Sappanchalcone and brazilin.		80% Aqueous MeOH extracts from the wood of *Caesalpinia sappan*, showed remarkable anticonvulsant activity.	22
14.	*Calliandra portoricensis* (Leguminosae)	Root and stem extracts.	• PTZ induced convulsion • MES induced convulsion	The aqueous extract of root and stem possess anticonvulsant activity in PTZ and MES induced convulsions.	23
15.	*Calotropis gigantia* (Asclepiadaceae)	Alcoholic extract of roots.	• PTZ induced convulsion	Significant anticonvulsant activity was seen as there was delay in the onset of PTZ induced convulsions as well as decrease in severity.	24
16.	*Carissa edulis* (Apocynaceae)	Root, bark extract.	• MES induced convulsion	*Carissa edulis* exhibited dose-dependent inhibition of the convulsion induced by MES test with 20 mg/kg providing 90% protection.	25
17.	*Casimiroa edulis* (Rutaceae)	Aqueous extract of leaves.	• MES induced convulsion	Single dose of 100mg/kg C. edulis vacuum dried aqueous extracts (VDA) orally administered to experimental animals elicited 50% abolition of MES induced seizures	26
18.	*Cassia sophera* (Caesalpiniaceae)	Ethanolic extract of seed.	• PTZ induced convulsion • MES induced convulsion.	Test drug (440mg/kg) produced significant anticonvulsant effect against hind limb tonic extension phase of maximum electroshock induced seizure test and seizures induced by PTZ.	27

19.	*Celesia coromandeliane* (Scrophulariaceae)	Petroleum ether extract of aerial parts of Celesia coromandeliane(PECC). Steroids.	• STR Induced Convulsion • Leptazol induced convulsion.	Pretreatment with PECC caused significant protection against strychnine and leptazol induced convulsions.	28
20.	*Centella asiatica* (Apiaceae)	Ethanol extract.	• PTZ induced convulsion	70% ethanol extract of the drug administered i.p to mice produced anticonvulsant activity.	29
21.	*Centranthus longiflorus* (Valerianaceae)	Aqueous extract.	• Caffeine induced convulsion	The aqueous extract of CLE (100mg/kg) produced anticonvulsant effects to those produced by diazepam(5mg/kg)	30
22.	*Clitoria ternatea* (Leguminosae)	Methanolic extract.	• PTZ induced convulsion • MES induced convulsion	The extract was found to possess anticonvulsant activity.	31
23.	*Cotyledon orbiculata* (Crassulaceae)	Aqueous and methanolic extract of leaves.	• PTZ induced convulsion • BCL induced convulsion • NMDLA induced convulsion	Aqueous extract of *C. orbiculata* (50-400mg/kg, i.p.) and methanol extract(100-400mg/kg,i.p) significantly prolonged the onset of tonic seizures induced by PTZ(95mg/kg i.p). 100-200 mg/ i.p. of aqueous extract of *C. orbiculata* significantly delayed the onset of the tonic seizures induced by BCL (40mg/kg, i.p.), NMDL, 400mg/kg, i.p.). Methanol extract (100-400mg/kg, i.p.) significantly delayed the onset of the tonic seizures induced by BCL (40mg/kg, i.p) while 100mg/kg (i.p) significantly delayed the onset of NMDLA, (400mg/kg i.p) induced seizures. Methanolic extract (200mg/kg, i.p.) significantly reduced the incidence of seizures induced by BCL (40mg/kg, i.p.).	32

24.	*Crocus sativus* (Iridaceae)	Stigmas. Safranal.	• PTZ induced convulsion	Peripheral administration of safranal (72.75, 145.5 and 291mg/kg body wt., i.p.) induced a dose-dependent decrease in the incidence of both minimal clonic seizures(MCS)(145.5mg/kg body wt., $p<0.01$) and generalized tonic clonic seizures(GTCS)(145.5mg/kg body wt., $p<0.001$) following PTZ administration.	33
25.	*Cuminum cyminum* (Umbelliferae)	Essential oil.	• PTZ induced convulsion • MES induced convulsion	This effect *In vivo* ED_{50} = 0.12ml/kg was shown in both PTZ and MES induced seizures in male NMRI mice	34
26.	*Cymbopogon winterianus* (Poaceae)	Essential oil (EO) from fresh leaves.	• PTZ induced convulsion • STR induced convulsion	EO (200 and 400 mg/kg, ip) significantly reduced the number of animals that exhibited PTZ, STR induced seizures in 50% of the experimental animals ($p<0.05$).	35
27.	*Cyperus articulatus* (Cyperaceae)	Methanolic extract of rhizome.	• MES induced convulsion • PTZ induced convulsion • NMDLA induced convulsion • STR induced convulsion	This extract protected mice against maximal MES, PTZ & NMDLA induced seizures. The ED (50) for protection against seizures\was 306(154-541) mg/ i.p. for the PTZ test and 1005(797-1200) mg/kg i.p for the MES test. The ED(50) of methanolic extract against NMDLA induced turning behaviour was 875(623-1123) mg/kg i.p. *C. articulatus* L. methanolic extract protected 54% of mice from seizures induced by STR at the dose of 1000mg/kg i.p.	36
28.	*Delphinium denudatum* (Ranunculaceae)	Subfraction isolated from roots.	• MES, PTZ, BCL induced convulsion	The essential oil showed strong action in MES, sc PTZ and sc BIC test at doses of 600mg/kg.	37-41
29.	*Diospyros*	Aqueous extract of stem bark.	• MES induced	The extract has anticonvulsant property.	42

	mespiliformis (Ebenaceae)		convulsion		
30.	*Echinodorus berteroi* (Alismataceae)	Decoctions of the dried roots.	• PTX induced convulsion • Penicillin induced convulsion	The 30% decoction significantly increased the latency to the first PTX induced clonic convulsion (7 mg/kg, i.p), as well as survival time. Repeated administration of the 5% decoction (30-minute intervals) significantly reduced the amplitude (μV) of the epileptic spikes induced by topical application of penicillin to sensorimotor cortex, in curare-treated rats.	43
31.	*Equisetum arvense* (Equisetaceae)	Hydro-alcoholic extract.	• PTZ induced convulsion	In PTZ induced seizure, doses of 200mg/kg and 400mg/kg increased the first convulsion latency, diminished the severity of convulsions, reduced the percentage of animals which developed convulsion (50% and 25%) and protected animals from death.	44
32.	*Erythrina mulungu* (Papilionaceae)	Hydroalcoholic extract	• PTZ induced convulsion • STR induced seizure	*Erythrina mulungu* did not exhibit any protector effecting PTZ induced seizures, at any dose, an increase in the latency of convulsion and in the death time was observed in both doses(200 or 400 mg/kg) and routes (i.p or orally).	45
33.	*Erythrina velutina* (Papilionacace)	Hydroalcoholic extract.	• PTZ induced convulsion • STR induced convulsion	*Erythrina velutina* did not exhibit any protector effecting PTZ induced seizures, at any dose, an increase in the latency of convulsion and in the death time was observed in both doses(200 or 400 mg/kg) and routes (i.p or orally).	45
34.	*Eugenia*	Essential oil.	• MES induced	The essential oil exhibited anticonvulsant	46

	caryophyllata (Myrtaceae)		convulsion • PTZ induced convulsion	activity against tonic seizures induced by MES. Although it was not effective against clonic convulsions induced by i.p administration of PTZ, the seizure threshold which was determined by an increase in the dose of intravenously infused PTZ required to induce clonus, was elevated by the essential oil.	
35.	*Ferula gummosa* (Apiaceae)	Seed acetone extract.	• MES induced convulsion • PTZ induced convulsion	The seed acetone extract of *F.gummosa* protected mice against tonic convulsions induced by MES (the median effective dose [ED (50)] =198.3mg/kg and especially by PTZ [ED (50)=55mg/kg].	47
36.	*Ficus platyphylla* (Moraceae)	Saponin rich fraction (SFG) obtained from the methanol extract of stem bark.	• PTZ induced convulsion • STR induced convulsion	SFG protected mice against PTZ and STR induced seizures; and significantly delayed the onset of myoclonic jerks and tonic seizures	48
37.	*Ficus religiosa* (Moraceae)	Methanolic extract.	• MES induced convulsion • PTX induced convulsion	These findings suggested that the methanolic extract had anticonvulsant activity against MES and PTX induced convulsions in a dose dependent manner.	49
38.	*Ficus sycomorus L.* (Moraceae)	Aqueous extract of stem bark.	• PTZ induced convulsion • STR induced convulsion	The extract conferred 100% protection to rats treated with a convulsive dose of PTZ indicating anticonvulsive effect, but could not protect rats treated with STR even though it delayed the time of onset of death	50
39.	*Glycyrrhiza glabra* (Leguminosae)	Ethanolic extract of roots and rhizomes.	• PTZ induced convulsion	The extract significantly and dose dependently delayed the onset of clonic convulsions induced by PTZ.	51
40.	*Goodyera*	Whole plant.	• PTX induced	Goodyerin exhibited a significant and dose	52

	schlechtendaliana (Orchidaceae)	Flavonol glycoside, Goodyerin .	convulsion	dependent sedative and anticonvulsant effect.	
41.	*Harpagophytum procumbens* (Pedaliaceae)	Secondary root aqueous extract.	• PTZ induced convulsion • PTX induced convulsion • BCL induced convulsion	*H. procumbens* secondary root aqueous extract (HPE, 100-800mg/kg i.p.) significantly (P<0.05-0.001) delayed the onset of and antagonized PTZ induced seizures. The plant's extract (HPE, 100-800mg/kg i.p.) also profoundly antagonized PTX induced seizures, but only partially and weakly antagonized BCL induced seizures.	53
42.	*Harpephyllum caffrum* (Anacardiaceae)	Stem bark aqueous extract.	• PTZ induced convulsion • PTX induced convulsion	*H. caffrum* stem bark extract (HCE, 100-800mg/kg i.p.) dose dependently and significantly delayed (p<0.05-0.001) the onset of the seizures and profoundly antagonized PTZ and PTX induced seizures.	54
43.	*Heracleum persicum* (Umbelliferae)	Acetone extract of seeds. Alkaloids,terpenoids and triterpenes.	• PTZ induced convulsion • MES induced convulsion	The extract showed a dose-dependent protective effect in both seizure models.	55
44.	*Herpestis monniera* (Scrophulariaceae)	Hersaponin.	• PTZ induced convulsion • MES induced convulsion	i.p. injections of high doses of *Bacopa* extract (close to 50 % of LD_{50}) given for 15 days demonstrated anticonvulsant activity.	56-58
45.	*Hippeastrum vittatum* (Amaryllidaceae)	Montanine, an isoquinoline alkaloid.	• PTZ induced convulsion	When given i.p., montanine dose-dependently protected against PTZ provoked convulsions.	59
46.	*Hypericum perforatum*	Aqueous and ethanolic extracts of aerial parts.	• PTZ induced	In the PTZ test, the extracts (0.1–1 g/kg, i.p.) delayed the onset of tonic convulsions	60

	(Clusiaceae)		convulsion • MES induced convulsion	and protected mice against mortality. In the MES test, both extracts did not show any anti seizure activity.	
47.	*Ipomea fistula* (Convolvulaceae)	Marsillin.	• STR induced convulsion	Marsillin also significantly protected the animals from STR induced convulsions	61
48.	*Ipomoea stans* (Convolvulaceae)	Infusion of plant.	• PTZ induced convulsion	Results showed *Ipomoea stans* provides protection against a low dose of PTZ (40 mg/kg).	62
49.	*Kalanchoe crenata* (Crassulaceae)	Extract.	• PTZ induced convulsion • STR induced convulsion	The CH_2Cl_2/CH_3OH extract significantly increased the latency period in seizures induced by PTZ and significantly reduced the duration of seizures induced by the three convulsant agents. The extract protected 20% of animals against death in seizures induced by STR.	63
50.	*Laurus nobilis* (Lauraceae)	Essential oil of leaves. Methyleugenol, eugenol and pinene.	• MES induced convulsion • PTZ induced convulsion	The essential oil protected mice against tonic convulsions induced by MES and especially by PTZ.	64
51.	*Lavandula stoechas* (Lamiaceae)	Aqueous-methanolic extract of flowers	• PTZ induced convulsion	The plant extract600 mg/kg) significantly reduced the severity and increased the latency of convulsions induced by PTZ.	65
52.	*Leonotis leonurus* (Lamiaceae)	Aqueous extract of dried leaf.	• PTZ induced convulsion • PTX induced convulsion • NMDLA induced convulsion	*L. leonurus* extract in the doses of 200 and 400 mg/kg respectively protected 37.5% and 50% of animals used and significantly ($p < 0.05$; Student's t-test) delayed PTZ (90 mg/kg), PTX & NMDLA-induced tonic seizures.	66
53.	*Lychnophora species*	Methanolic fraction yielding 4,5-di-O-[E]-caffeoylquinic acid.	• PTZ induced	This substance was injected i.p. in mice and showed anticonvulsant effect against PTZ	67

	(Asteraceae)		convulsion	induced seizures at doses of 25 & 50 mg/kg.	
54.	*Magnolia dealbata* (Magnoliaceae)	Ethanol extract of leaves.	• PTZ induced convulsion	*Magnolia dealbata* (in doses of 30, 100, 300 mg/kg) delayed the onset of PTZ induced mioclonus and clonus, but also hindered the presence of tonic seizures and avoided mortality.	68
55.	*Magnolia grandiflora* (Magnoliaceae)	Seeds.	• MES induced convulsion	Ethyl ether and Hydroalcoholic extract orally administered in a single dose of 250 mg/kg (calculated on lipidic base) and 200 mg/kg, exhibited abolition of the extensor reflex of maximal electric induced-seizure test in 50 and 40% of the experimental animals, respectively.	69
56.	*Mimosa pudica* (Leguminosae)	Decoction of leaves.	• PTZ induced convulsion • PTZ induced convulsion • PTX induced convulsion	The decoction of leaves given i.p. at dose of 1000- 4000 mg/kg protected mice against PTZ and STR induced seizure but had no effect against PTX induced seizures	70
57.	*Myristica fragrans* (Myristicaceae)	n-hexane fraction of acetone insoluble part of petroleum ether extract of seeds.	• MES induced convulsion	The incidence of convulsion was 50% in mice receiving 100mg/kg of the drug extract in MES test.	71
58.	*Nardostachys jatamansi* (Valerianaceae)	Ethanol extract of root.	• MES induced convulsion • PTZ induced convulsion	*N. jatamansi* root extract against MES model significantly increase the seizure threshold as indicated by a decrease in the extension/flexion (E/F) ratio. However, the extract was ineffective against PTZ induced seizures.	72-73
59.	*Nauclea latifolia* (Rubiaceae)	Root bark.	• MES induced convulsion	The decoction from the bark of the roots of *N. latifolia* protected mice against MES,	74

			• PTZ induced convulsion • STR induced convulsion	PTZ and STR induced seizures.	
60.	*Nepeta sibthorpii* (Labiatae)	Ursolic acid.	• PTZ induced convulsion	The oral administration of ursolic acid (2.3mg/kg) produced a significant anticonvulsant effect by reducing number and lethality of PTZ induced seizures	75
61.	*Nigella sativa* (Ranunculaceae)	Thymoquinone.	• PTZ induced convulsion	Tymoquinone, the active component of *N. sativa* is found to be effective against PTZ induced seizures.	76
62.	*Ocimum sanctum* (Labiateae)	Ethanolic and chloroform extract of stem and leaves.	• MES induced convulsion	Ethanolic and chloroform extract of stem and leaves has effective anticonvulsant property.	77
63.	*Passiflora edulis* (Passifloraceae)	Aqueous extract.	• NMDLA induced convulsion • STR induced convulsion	The ED_{50} for the protection against seizures induced by strychnine was 320mg/kg i.p. For NMDLA induced turning behaviour, the ED_{50} was 300mg/kg i.p.	78
64.	*Passiflora incarnata* (Passifloraceae)	Hydroalcoholic extract of flower.	• PTZ induced convulsion	An ED_{50} value of Pasipay in the PTZ model was 0.23mg/kg (%95CL:0.156, 0.342). Pasipay at the dose of 0.4mg/kg prolonged the onset time of seizure and decreased the duration of seizures compared to saline group ($p<0.001$). At the dose of 0.4 mg/kg, seizure and mortality protection percent were 100%.	79
65.	*Persea americana* Mill (Lauraceae)	Aqueous extract of leaf.	• PTZ induced convulsion • PTX induced	The leaf extract of plant 100-800mg/kg i.p.) significantly ($p<0.05$-0.001) delayed the onset of and antagonized PTZ, PTX	80

			convulsion • BCL induced convulsion	induced seizures, but only weakly antagonized BCL induced seizures.	
66.	*Pimpinella anisum* (Umbelliferae)	Essential oil.	• PTZ induced convulsion • MES induced convulsion	The essential oil suppressed tonic convulsions induced by PTZ or MES. It also elevated the threshold of PTZ induced clonic convulsions in mice.	81
67.	*Piper guineense* (Piperaceae)	Water extract.	• NMDLA induced convulsion • MES induced convulsion • PTZ induced convulsion	The extract protected mice against convulsions induced by NMDLA and MES but it had no significant effect on PTZ induced convulsions.	82
68.	*Piper longum* (Piperaceae)	Piperine.	• Rat Kainate Model	Piperine suspensions, injected i.p., 1h before injection of the threshold intracerebro ventricular dose of kainite for the induction of clonic convulsions (1nmol), blocked these convulsions with an ED_{50} (and 95% confidence interval) of 46 (25-86) mg/kg	83
69.	*Portulaca oleracea* (Portulacaceae)	10% ethanolic extract.	• PTZ induced convulsion	10% ethanolic extract significantly suppressed the PTZ induced convulsions.	84
70.	*Piper tuberculatum* (Piperaceae)	Piplartine(an alkaloid)isolated from the roots.	• PTZ induced convulsion	Piplartine, an alkaloid isolated from the roots of P. tuberculatum is found to possess anticonvulsant property at a dose of 50mg/kg and 100mg/kg i.p.	85
71.	*Pongamia glabra* (Leguminosae)	Seeds. Pongamol .	• MES induced convulsion	Pongamol isolated from the seeds of *P. glabra* has anticonvulsant property.	86
72.	*Psidium guyanensis*	Essential oil obtained from leaves.	• PTZ induced	At oral doses of 100, 200, and 400 mg/kg,	87

	(Myrtaceae)		convulsion • PTX induced convulsion • STR induced convulsion	the essential oil attenuated the severity of PTZ induced seizures and offered a dose-related protection but it was found to be ineffective against convulsions induced by PTX and STR.	
73.	*Qualea grandiflora* Mart. (Vochysiaceae)	Crude hydroalcoholic extract and fractions of leaves.	• PTZ induced convulsion	The treatment with crude hydroalcoholic extract (EH) in a dose of 500 mg/kg, i.p. significantly delayed the onset of clonic PTZ convulsions, increased the time for death, suppressed the tonic PTZ convulsion, and decreased severity and number of convulsions.	88
74.	*Rhus chirindensis* (Anacardiaceae)	Stem bark aqueous extract	• PTZ induced convulsion • PTX induced convulsion • BCL induced convulsion	*R. chirindensis* stem bark aqueous extract (RCE, 100-800mg/kg i.p.) significantly delayed ($p<0.05$-0.001) the onset of, and antagonized PTZ, PTX induced seizures but weakly antagonized BCL induced seizures.	89
75.	*Ruta chalepensis* (Rutaceae)	Ethanol extract.	• PTZ induced convulsion	A delay in the onset of seizures and a dose dependent suppression in the tonic phase and mortality induced by PTZ	90
76.	*Salvodra persica* (Salvadoraceae)	Stem extracts.	• PTZ induced convulsion	The extracts of *Salvadora persica* showed protection against PTZ induced convulsion by increasing the latency period and diminishing the death rate.	91
77.	*Salvia haematodes* (Labiatae)	Aqueous extract of root.	• MES induced convulsion	It was found to possess significant anticonvulsant activities.	92
78.	*Sanseviera liberica* (Agavaceae)	Aqueous root extract.	• STR induced convulsion • PTX induced	The extract (100 and 200 mg/kg) produced dose-dependent and significant ($P < 0.05$) increases in onset to clonic and tonic convulsions, and at 400 mg/kg, showed	93

			convulsion • BCL induced convulsion • PTZ induced convulsion	complete protection against seizures induced by STR, PTX and BCL but not with PTZ.	
79.	*Sclerocarya birrea* (Anacardiaceae)	Aqueous extract of stem bark.	• PTZ induced seizures • PTX induced seizures • BCL induced convulsion	Anticonvulsant agents used *S. birrea* stem bark aqueous extract (100-800mg/kgp.o.) significantly (P<0.05-0.001) delayed the onset of and inhibited PTZ induced seizures. The plant extract (SBE, 100-800mg/kg p.o.) also markedly inhibited PTX induced seizures but only weakly inhibited BCL induced seizures.	94
80.	*Scutellaria baicalensis* (Lamiaceae)	Wogonin.	• PTZ induced convulsion • MES induced convulsion • STR induced convulsion	Wogonin significantly blocked convulsion induced by PTZ and electroshock but not convulsion induced by STR.	95
81.	*Scutellaria lateriflora* (Lamiaceae)	Aerial part.	• Pilocarpine induced convulsion • PTZ induced convulsion	The results from this study indicate that *Scutellaria lateriflora* has anticonvulsant activity in rodent models of acute seizures.	96
82.	*Scutellaria radix* (Lamiaceae)	Aqueous extract.	• PTZ induced convulsion • MES induced convulsion	Aqueous extract had little effect on PTZ, 85mg/kg,s.c.) induced clonic seizures but significantly inhibited MES induced tonic seizures with an ED_{50} of 3.6g/kg.	97
83.	*Sesbania grandifolia* (Leguminosae)	Petroleum ether extract of leaves. Triterpene	• PTZ induced convulsion • STR induced	The benzene: ethyl acetate fraction (BE) of the acetone soluble part of a petroleum ether extract significantly delayed the onset	98

			convulsion • MES induced convulsion	of convulsions in PTZ and STR induced seizures in mice and reduced the duration of tonic hind leg extension in the MES induced seizures in mice.	
84.	*Spondias mombin* (Anacardiaceae)	Ethanolic and methanolic extracts of leaves. Phenolic compounds.	• PTX induced convulsion	Ethanolic and methanolic extracts of leaves exhibited anticonvulsant properties in the PTX induced convulsions model.	99
85.	SuHeXiang Wan	Essential oil.	• PTZ induced convulsion • PTX induced convulsion • STR induced convulsion	Preinhibition of the fragrance oil markedly delayed the appearance of PTZ induced convulsion, but showed weak activities on PTX and STZ induced convulsions.	100
86.	*Sutherlandia frutescens* (Fabaceae)	Shoot aqueous extract.	• PTZ induced convulsion • PTX induced convulsion • BCL induced convulsion	*S. frutescens* shoot aqueous extract (SFE, 50-400 mg/kg i.p.) significantly delayed ($p<0.05$-0.001) the onset of and antagonized PTZ, PTX induce seizures, but only weakly antagonized BCL induced seizures.	101
87.	*Taxus wallichiana* (taxaceae)	Methanol extract of leaf.	• PTZ induced convulsion	Plant extract has controlled the PTZ induced convulsions in mice.100 and 200mg/kg i.p. doses of the extract significantly ($P<0.05$) inhibited the mio clonus and clonus while inhibition of tonus and hind limb tonic extension (HLTE) was highly significant ($P<0.01$).	102
88.	*Tetrapleura tetraptera* (Leguminosae)	Volatile oil extracted from the fresh fruits.	• Leptazol induced convulsion	A dose of 0.4ml of the oil per mouse protected 78% of the animals when administered 30 min prior to leptazol.	103
89.	*Viscum capense* (Loranthaceae)	Methanol extract.	• PTZ induced convulsion	The extract of *V. capense* has anticonvulsant activity.	104

			• BCL induced convulsion • NMDLA induced convulsion		
90.	Vitex agnus (Lamiaceae)	Hydrophilic extract of fruit. 8-Cineole, αterpinol, sabinene, β-caryophyllene and β-selinene and *cis*-β-farnesene.	• Kindled Rat Seizure Model	These results indicate that *Vitex agnus* can reduce or prevent epileptic activity as demonstrated by reduction of afterdischarge duration (ADD) and stage 5 duration(S5D) in a dose dependent manner.	105

Conclusion

Herbal plants are well known and have potential source of curing aliments from the time of immemorial. The health care systems are going to become more and more expensive therefore, we have to develop technologies to essentially introduce and integrate herbal medicine system in our health care. This can be possible only through the development of standardized herbal products. So here we summarize the important anti-epileptic plants with more efficacy and lesser side effects.

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