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Review Article

A Review on Phytochemical and Pharmacological Activity of Andrographis Echioides (L.) Nees

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ABSTRACT

As aboriginal sources of medications, medicinal plants are used from the ancient times. Nature is usually a golden sign to point out the outstanding phenomena of co-existence. Natural products from plants, animals and minerals are the premise for treating human diseases. Medicative are presently in demand and their acceptance is increasing progressively. Undoubtedly, plants play a very important role by providing essential services in ecosystems. The Acanthaceae is one of the source of medical plants with 250 genus and 2500 species. One of the active member among the genus is Andrographis. Andrographis comprises about 26 species. Andrographis echioides (L.) Nees is an understudied medicinal plant. It is used for the treatment of various disorders. We explored the chemical composition of Andrographis echioides (L.) Nees plant and the conducted the review is based on the physiochemical, pharmacological and phytochemical standards could be helpful for the identification, authentication, standardization and preparation of monograph for Andrographis echioides. The main aim of this review is to provide the in-depth knowledge of Andrographis echioides plant such as the phytochemical evaluation, pharmacognostical evaluation and the medicinal value of the plants given may helpful to the further researchers.

INTRODUCTION

Medicinal plant is an integral part of human life to combat the sufferings from the drawn of civilization [1]. Plants are containing more number of medicinal properties and it should be used to treat many diseases in humans. It contains plenty of medicinally bio-active compounds which are used to cure many diseases across the world [2]. It is estimated that more than 80,000 of total plant species have been identified and used as medicinal plants around the world [3]. India is one the country contains more than 45,000 plant species, out of that 15,000-20,000 plants are showing good medicinal properties, but currently 7,000-7500 plants only used for medicinal purposes [4].

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Acanthaceae is a family (the acanthus family) of dicotyledonous flowering plants containing almost 250 genera and about 2500 species. Most are tropical herbs, shrubs, or twining vines; some are epiphytes. *Andrographis* is a genus of flowering plants in the family *Acanthaceae*. They may be generally known as the False Water Willows [5], and several are called Periyanagai [6]. The species are native to the Indian subcontinent (including Myanmar, Sri Lanka and the West Himalaya region) [7, 8]. Many are endemic to India. They may be herbs or shrubs [6]. In traditional Indian medicine, several *Andrographis* species have been used in the treatment of Dyspepsia, Influenza, malaria and respiratory infections and as astringent and antidote for poisonous stings of some insects [9, 10]. More than 20 species of *Andrographis* have been reported to occur in India. *Andrographis echioides* (L.) Nees is an important medicinal plant and widely used around the world. *Andrographis echioides* (L) Nees also known as *Indoneesiella echioides* (L) Nees. This is commonly known as False Water Willow, is an abundantly growing in South India. *Andrographis echioides* plants are seen mostly in dry places, such as India, Sri Lanka and South Asian countries. The species of Indoneesiella is used in Goitre, liver diseases [11], Fertility problems, Bacterial [12], Malarial and fungal disorders. The leaf juice is mixed and boiled with coconut oils used to control falling and greying of hair [14]. The present review focus on the phytoconstituents and pharmacological properties of Andrographis echioides (L.) Nees. An extensive literature survey was collected using various search engines like PubMed, Web of Science, Scopus, SciFinder, Google Scholar, Science direct, etc. other literature sources like Wikipedia, Ethnobotanical books, chapters were also studied to get maximum information possible on the Andrographis echioides.

2. Plant Profile



FigNo.1: *Andrographis Echioides* (L.) Nees



Fig No.2: *Andrographis Echioides* (L.) Nees – Flower

2.1. Taxonomical Classification

Kingdom: Plantae – Plantes, Planta, Vegetal, Plants
Sub-Kingdom: Viridiplantae – Green Plants
Infrakingdom: Streptophyta – Land Plants
Superdivision: Embryophyta
Division: Tracheophyta – Vascular Plants, Tracheophytes
Subdivision: Spermatophytina – Spermatophytes, Seed Plants, Phanerogames
Class: Magnoliopsida
Superorder: Asteranae
Order: Lamiales

Family: Acanthaceae – Acanthacees
Genus: *Andrographis Wall*. Ex Nees – False Water Willow
Species: *Andrographis Echioides* (L.) Nees – False Water Willow

2.2. Vernacular Names

Common Name: False Water Willow
Tamil: Gopuram Tangi
Gujarati: Pitumba
Marathi: Ranchimani
Oriya: Lavalata

2.3. Distribution:

Native to: Bangladesh, India, Sri Lanka, West Himalaya.

Global Distribution: India and Sri Lanka.

Indian Distribution: State – Kerala, District/s: Kannur, Kottayam, Alappuzha, Kollam, Pathanamthitta, Malappuram, Palakad, Thiruvananthapuram, Kozhikkode, Thrissur, Ernakulam.

2.4. Habitat

Andrographis echioides is an herbaceous plant widely located in dry area of southern Asian countries [15]. The flowering season of Andrographis echioides is March-June, October-December [16].

3. Botanical Description

3.1. *Organoleptic* And Macroscopic Characteristics of *Andrographis Echioides*

Andrographis echioides plant contains more number of branchlets to 50cm long. The leaf was simple, opposite, decussate, lanceolate, entire margin, acuminate apex, reticulate venation, odour was characteristic and taste was bitter. The average leaf size was 7-8 cm in length and 2-3 cm width. The stem were green, woody, erect, square or quadrangular, up to 40cm height, bearing numerous branches and 2-4 mm thickness, odour was characteristic and taste was bitter. Outer surface was rough and hard [17]. The calyx of the flower is with sub equal lobes, lanceolate with glandular hairs. Corolla is white with brown tinge. It is tubular, showing the 2 + 3 lipped condition, which are unequal. Stamens-2, exserted and straight, style slender with capitate stigma. The capsules are ovoid, sparsely hairy, pointed above and narrowed below. The average number of the capsule per plant is 38, seed are yellow in colour and ovoid. Four seeds per capsule, 1.5mm across and glabarous [18]. Organoleptic and macroscopic characteristics of *A.echioides* leaf and stem are given In Table 1 and Fig.3.



Fig No.3: Macroscopic characteristics of *Andrographis echioides* (L.) Nees

Table 1: Organoleptic features of *Andrographis echioides* (L.) Nees

	Observation	Observation
Part	**Leaves**	**Stem**
Arrangement	Opposite	-
Size	7-8cm long, 2-3cm wide	2 to 4mm thickness, 40 cm height
Shape	Lanceolate to ovate	Square or quadrangular
Colour	Green	Green
Odour	Characteristics	Characteristics
Taste	Bitter	Bitter
Appearance	Scabrous	Rough and Hard
Margin	Entire	-
Apex	Acuminate	-
Base	Symmetrical	-
Petiole	Short	-
Texture	Short	-
Veination	Reticulate Veination	-
Outer surface	-	Light Green colour. Rough surface

3.2. Microscopic Characteristics

Leaf

The transverse section of leaf shows the upper and lower epidermis with glandular hairs. The mesophyll, in between the epidermis is made of palisade parenchyma cells compactly arranged without any intercellular spaces. The spongy cells are loosely arranged with intercellular spaces and air cavities for gaseous exchange. In the midrib region the Stele is surrounded a layer of compactly arranged parechymatous cells. The Stele is limited by the boarded parenchyma cells. The xylem is facing the upper epidermis where the phloem is towards the lower epidermis [18]. The transverse section of stem is represented in Figure: 4.

Stem

T.S of the stem shows the well-defined epidermis with epidermal hairs. It is followed by the hypodermis and the chlorenchymatous cortex. The xylem elements are spherical in shape. The xylem is endarch. The phloem is encircling the xylem. Prominent pith is present in the center. The pith cells are polygonal and are compactly arranged [18]. The transverse section of stem is represented in Figure: 4.

Root

The outermost covering of the root is the epidermis which is composed of single layer of barrel shaped epidermal cells. It lacks stomata and cuticle. The epidermis is followed by the compactly arranged parenchymatous cortex. Secondary growth is present. The phloem is towards the epidermis and xylem are ate the center [18]. Figure: 4 shown the transverse section of root of A.echioides.



Stem Leaf Root

Figure No 4: Transverse sections of *Andrographis echioides* Leaf, Stem and Root

4. Phytochemical Study

The constituents present in the plant play a vital role in the identification of crude drug [19]. Phytochemical screening not only helps to reveal the constituents of the plant extracts and the one that predominates over the others but also is helpful in searching for bioactive agents those can be used in the synthesis of useful drugs [20].

4.1. Whole Plant

Preliminary phytochemical screening of *Andrographis echioides* whole plant in various solvent extracts (acetone, methanol, ethanol, petroleum ether, hexane, distilled water) show the presence of alkaloids, flavonoids, saponins, carbohydrates, proteins, phenols, steroids, tannins, cardiac glycosides, quinones, amino acids [21,22]. The various phytoconstituents isolated from methanolic extract of whole plant are Androgechoside A, Androgechoside B, Androechioside A, Androechioside B, 2',6'-Dihydroxyacetophenone 2'-O- β-D-glucopyranoside [23]. Nirubam K et al., 2016, studies shows the presence of 2 proteins biphosphate carboxylase. Maturase K in whole plant of Andrographis echioides [24].

4.2. Leaves

Preliminary phytochemical screening of *Andrographis echioides* leaves in various solvent extracts (n-hexane, chloroform, acetone, ethanolic, butanol, Methanolic, petroleum ether, ethyl acetate, dichlromethane, aqueous) shows the presence of alkaloids, flavonoids, terpenes, triterpenoids, gum, mucilage, phytosterols, coumarin, emodin, oils & fat [25, 26]. The elements present in the leaves are calcium, iron, magnesium, manganese, cadmium, nickel, sodium, lead,

chromium, zinc, silver & copper [27]. The list & details of reported phytoconstituents isolated from various leave extracts are given in the table no.2 & table no.3.

Table No 2: List of Compounds Isolated from Leaves of *Andrographis echioides* (L.) Nees

S. No	Extract	Number Of Compounds	Reference
1.	Acetone extract	13 compounds	25,30
2.	Aqueous extract	6 compounds	30
3.	Butanol extract	10 compounds	25
4.	Chloroform extract	17 compounds	25,30
5.	Ethanolic extract	13 compounds	25,30
6.	Ethyl acetate extract	26 compounds	26
7.	Methanolic extract	40 compounds	25,26,28,29
8.	Petroleum ether extract	5 compounds	26,30

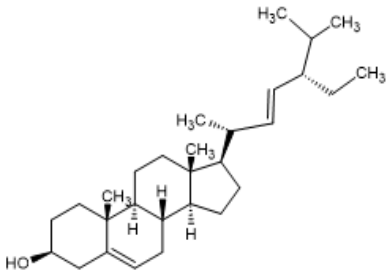
Table No.3: Details of compounds isolated from the leaves of *Andrographis echioides* (L) Nees.

S. No	Extract	Name Of The Compound	Molecular Formula	Molecular Weight	Rt	Reference
1.	Acetone extract	Hexadecanoic acid, ethyl ester	C18H36O2	284	17.97	25
		Ethyl Oleate	C20H38O2	310.52	19.57	25
		14-Hydroxy-15-methylhexadec15-enoic acid, ethyl ester	C19H36O3	312.48734	19.8	25
		2a,3b,5b,6aTetramethoxycarbonylbicyclo(2,2,2)oct-7-ene	C16H20	340.325	21.75	25
		Estra-1,3,5(10),6-tetraene-3,17-diol,diacetate, (17a')-	-	-	23.37	25
		Pentatriacontane	C35H72	492.31	1.49	30
		17-(2,4-Dinitrophenylhydrazono)-5beta-androstan-3alpha-ol	C25H34N4O5	470.30	1.64	30
		Limonine	C26H30O8	470.37	1.69	30
		Biflavanone	C30H22O4	446.35	1.71	30
		Echioidin	C22H22O10	446.35	1.76	30
		Phthalic acid, hexadecyl 3-methoxybenzyl ester	C32H46O5	510.32	1.85	30
		15α-Hydroxymollic acid	C30H48O5	488.32	1.91	30
		2,7-Dinitro-9H-xanthen-9-one	C13H6N2O6	286.19	2.09	30
2.	Aqueous extract	2-Methoxybutanamide	C5H11NO2	117.15	0.24	30
		3-Propoxypropylamine	C6H15NO	117.19	0.28	30
		1-Phenylcarbamoyl-2,3 phthaloylpyrrocoline	C23H14N2O3	366.29	1.30	30
		Pentatriacontane	C35H72	492.34	1.49	30
		17-(2,4-Dinitrophenylhydrazono)-5beta-androstan-3alpha-ol	C25H34N4O5	470.30	1.64	30
		Skullcapflavone I 2'-O-β-D-glucopyranoside	C23H24O11	476.27	1.71	30
3.	Butanol extract	E-2-Tetradecen-1-ol	C14H28O	212.3715	12.12	30
		6,10-Dodecadien-1- ol,3,7,11-trimethyl-,(E)-(n)-	C15H28O	224.38222	12.67	30
		E,E-6,8-Tridecadien-2-ol, acetate	-	-	14.15	30
		Ar-tumerone	C15H20 O	216.319	14.45	25

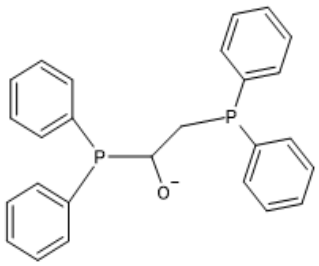
		5-Hexenoic acid,(9-decen2-yl) ester	-	-	15.93	25
		4',5,7-Trihydroxy isoflavone	C15H10O5	270.2369	17.22	25
		Ethyl 9-hexadecenoate	C18H34O2	282.4614	17.88	25
		16-Octadecenoic acid, methyl ester	C19H36O2	296.49	19.15	25
		Ethanol, 2-(9,12-octadecadienyloxy)-,(Z,Z)-	C20H38O2	310	19.5	25
		Eicosanoic acid, 3-methyl-, methyl ester	-	-	21.63	25
4.	Chloroform extract	Phenol, 2,4-bis(1,1- dimethylethyl)-	C14H22O	206.3239	12.63	25
		1,4-Dicyano-2- cyclohexylbenzene	C14H14N2	210.27436	14.52	25
		Flavone	C15H10	222.239	15.7	25
		Pentadecanoic acid, 13- methyl-, methyl ester	C17H34O2	270.4507	17.15	25
		n-Hexadecanoic acid	C16H32O2	256.4241	18.03	25
		10-Octadecenoic acid, methyl ester	C19 H36 O2	296.4879	18.83	25
		Ethyl Oleate	C20 H38 O2	310.52	19.45	25
		3,5-Dicarbethoxy-1-methyl1,4,5,6,7,8-hexahydropyrrolo (2,3-b)azepin-4,7-dione	-	-	21.4	25
		Butanoic acid, 3-methyl-, hexadecyl ester.	-	-	23.18	25
		Sebacic acid, di(4-isopropoxyphenyl) ester	C28H38O6	470.34	1.64	30
		3,9-Epoxypreg-16-en-20-one-3-methoxy 7,11,18-triacetoxy	C28H38O9	518.42	1.85	30
		Cimigol	C30H48O5	488.35	1.91	30
		1,2,4-Cyclohexanetricarboxylic acid, 2,2,4-trimethylpentyl ester	C33H60O6	552.36	1.99	30
		Tethyanine	C40H50	530.35	2.04	30
		5,7,3',4'-tetrahydroxyflavone	C15H10O6	286.23	2.09	30
		3-(5-Methoxy-2,2-dimethyl-2Hchromen-8-yl)-3-oxopropanoic acid	C15H16O5	276.31	2.27	30
		9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	C18H30O2	278.40	2.68	30
4.	Ethanolic extract	O-Himachalene	C15H24	204.3511	12.68	25
		Oxacyclotetradecan-2-one	-	-	14.15	25
		Ar-tumerone	C15H20O	216.319	14.5	25
		Curlone	C15H22O	218.33458	14.9	25
		Pentadecanoic acid, 14- oxo-,methyl ester	C16H30O3	270.40800	17.28	25
		4'-Methoxy-5,7- dihydroxy isoflavone	C16H12O5	284.2635	17.93	25
		E,E,Z-1,3,12- Nonadecatriene-5,14-diol	C19H34O2	294	19.05	25
		Ethanol,2-(9,12- octadecadienyloxy)-,(Z,Z)-	C20H38O2	310	19.55	25
		Tricosan-2-ol	-	-	21.63	25
		Withanolide	C28H38O6	470.30	1.64	30

		Dihydroechioidinin	C16H14O5	286.19	1.69	30
		Adipic acid, eicosyl 4-methylpent2-yl ester	C32H62O4	510.36	1.86	30
		Cimigol	C30H48O5	488.35	1.91	30
		5,7-Dihydroxy-3-(4-methoxyphenyl) chromen - 4 - one (Biochanin A)	C16H12O5	284.22	2.09	30
5.	Ethyl acetate extract	Propanamide, 2-Hydroxy-	C3H7O2N	89	2.55	26
		1,2-ethanediol, diacetate	C6H10O4	146	9.86	26
		2-propanone, 1-(acetyloxy)-	C5H8O3	116	11.15	26
		Diphenylmethane	C13H12	168	12.50	26
		Phenol, 2,4-bis(1,1- dimethylethyl)-	C14H22O	206	13.37	26
		3(4h)-dibenzofuranone, 4a,9bdihydro-6-(6-hydroxy-m-tolyl)-8,9b-dime	C21H20O3	320	15.74	26
		3,5-diethoxycarbonyl-2,6-dimethylpyridine 894 941	C13H17O4N	251	16.30	26
		Benzothieno[2,3-d]pyrimidin4(3h)-one, 5,6,7,8-tetrahydro-	C10H10ON2S	206	16.30	26
		E-15-heptadecenal	C17H32O	252	16.64	26
		1-hexadecene	C16H32	224	16.64	26
		1-eicosyne	C20H38	278	17.10	26
		Hexadecanoic acid, ethyl ester	C18H36O2	284	18.66	26
		Linoleic acid ethyl ester	C20H36O2	308	20.23	26
		9,17-octadecadienal, (z)-	C18H32O	264	20.23	26
		9,12-octadecadienoic acid, ethyl ester	C20H36O2	308	20.23	26
		1-octadecyne	C18H34	250	20.69	26
		Eicosanoic acid, ethyl ester	C22H44O2	340	22.22	26
		2-propen-1-one, 1-(2,6-dihydroxy4-methoxyphenyl)-3-phenyl-, (e)-	C16H14O4	270	22.42	26
		1,2-benzenedicarboxylic acid, mono(2-ethylhexyl) ester	C16H22O4	278	23.34	26
		Octadecanoic acid, ethenyl ester	C20H38O2	310	25.29	26
		Phthalic acid, 2-methoxyethyl tetradecyl ester	C25H40O5	420	25.83	26
		Benzeneacetic acid, 3-methoxy4-[(trimethylsilyl)oxy]-, ethyl ester	C14H22O4Si	282	26.11	26
		Benzene, 2-[(tertbutyldimethylsilyl)oxy]-1-isopropyl-4-methyl	C16H28OSi	264	26.24	26
		E-11(13-methyl)tetradecen-1-ol	C15H30O	226	26.28	26
		Z-8-pentadecen-1-ol acetate	C17H32O2	268	26.28	26
		3-oxa-4- (trifluoromethyl)bornane	C10H15OF3	208	26.28	26
6.	Methanolic extract	Methyl 2,8dimethyltridecanoate	C16H32O2	256.42408	16.5	25
		4'-Methoxy-5,7dihydroxy isoflavone	-	-	18.8	25
		Cyclohexan-1-ol-3one-1-carboxylic acid, 6-(2,3dimethoxyphenyl)-	-	-	19.15	25
		Ethyl Oleate	C20H38O2	310.52	19.72	25
		Elaidic acid, isopropyl ester	C21H40O2	324.541	21.78	25
		Isopropyl stearate	C21H42O2	326.568	23.38	25

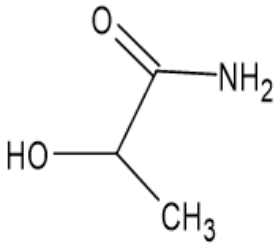
		Estra-1,3,5(10)-trien17a'-ol, 3-methoxy17-(2-methylallyl)-	-	-	25.53	25
		O-Methylisourea	C2H6ON2	74	3.08	26
		Silane, Dimethyl-	C2H8SI	60	3.08	26
		Benzenemethanamine, N-Methyl-	C8H11N	121	9.56	26
		Hydroxyurea	CH4O2N2	76	11.78	26
		1-Octadecanamine	C18H39N	269	11.90	26
		2,2'-Bithiophene	C8H6S2	166	12.07	26
		Diphenylmethane	C13H12	168	12.52	26
		1-Hexadecene	C16H32	224	14.40	26
		Acetamide, 2-Fluoro-	C2H4ONF	77	14.96	26
		Propanoic Acid, 2(Aminooxy)-	C3H7O3N	105	14.96	26
		2-Butynone, 1-Acetyl-4-[1piperidyl]-	C11H17ON	179	15.15	26
		8-Pentadecanone	C15H30O	226	15.32	26
		8-Octadecanone	C18H36O	268	15.32	26
		1,6;3,4-Dianhydro-2-Deoxy.Beta.-D-Lyxohexopyranose	C6H8O3	128	15.32	26
		10-Nonadecanone	C19H38O	282	17.49	26
		3,5-Octanedione, 2,2,7trimethyl-	C11H20O2	184	17.49	26
		9,12,15-Octadecatrienoic Acid, Methyl Ester, (Z,Z,Z)-	C19H32O2	292	19.68	26
		Octadecanoic Acid, Methyl Ester	C19H38O2	298	19.91	26
		Acetamide, 2-Fluoro-	C2H4ONF	77	20.92	26
		O-Methylisourea	C2H6ON2	74	21.67	26
		S-[Tri-T-Butoxysilyl]-2mercaptoethylamine	C14H33O3NSSI	323	23.30	26
		D-Erythro-Pentose, 2deoxy-	C5H10O4	134	23.30	26
		Propionic acid	C3H6O2	74.07854	3.522	28
		Benzene	C6H6	78.11	3.668	28
		Glycerin	C3H8O3	92.09382	7.734	28
		Naphthalene	C10H8	128.1705	8.780	28
		2,6-Dimethoxyamphetamine	C11H17NO2	195.26	18.104	28
		Indole -3- ethanamine	C10H12N2	160.22	18.205	28
		1,2-Benzenediamine	C6H8N2	108.143	18.641	28
		9,12-Octadecadienoic acid	C19H34O2	294.4721	19.847	28
		Phenylephrine	C9H13NO2	167.20502	19.905	28
		Indole -3- ethanamine	C10H12N2	160.22	21.749	28
		Lupeol	C30H50O	-	3.750	29
7.	Petroleum ether extract	Stigmasterol	C29H48O	412	24.49	26
		Phosphine Oxide,1,2 Ethanediylbis[Diphenyl]	C26H24O2P2	430	31.70	26
		2r-Acetoxymethyl-1,3,3-Trimethyl-4t-(3methyl-2-Buten-1-yl)-1t-Cyclohexanol	C17H30O3	282	28.56	26
		5,7,3',4'-tetrahydroxyflavone	C15H10O6	286.23	2.09	30
		9,12-Octadecadienoic acid (Z,Z)	C18H32O2	280.42	2.68	30



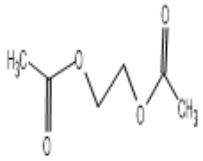
Stigmasterol



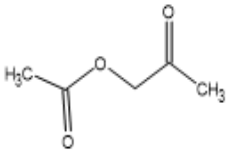
Phosphine Oxide,1,2 Ethanediylbis[Diphenyl]



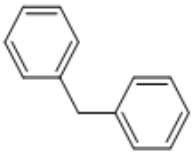
Propanamide, 2-Hydroxy-



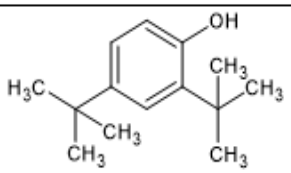
1,2-Ethanediol,Diacetate



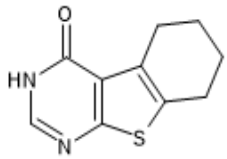
2-Propanone,1-(Acetyloxy)-



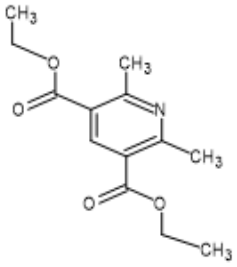
Diphenylmethane



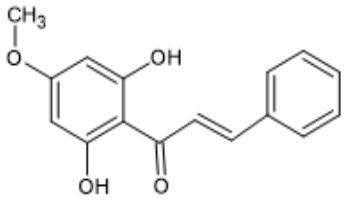
Phenol, 2,4-Bis(1,1Dimethylethyl)-



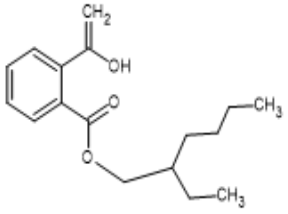
Benzothieno[2,3-D]Pyrimidin-4(3h)-One,5,6,7,8-Tetrahydro



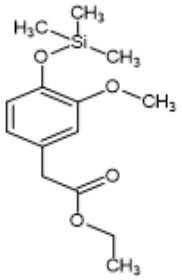
3,5-Diethoxycarbonyl-2,6-Dimethylpyridine



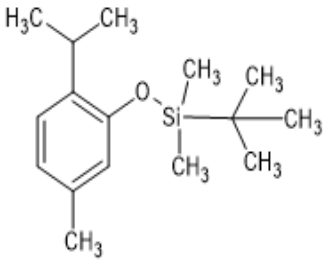
2-Propen-1-One, 1-(2,6-Dihydroxy-4-Methoxyphenyl)-3-Phenyl-,(E)-



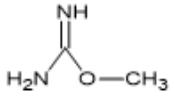
1,2-Benzenedicarboxylic acid,mono(2-ethylhexyl) ester



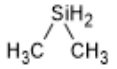
Benzeneacetic acid,3-Methoxy 4-[(trimethylsilyl)oxy]-,ethyl ester



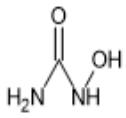
Benzene,2-[(tert-butyldimethyl silyl)oxy]-1-isopropyl-4-methyl



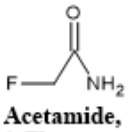
O-Methylisourea



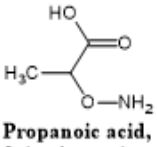
Silane,Dimethyl



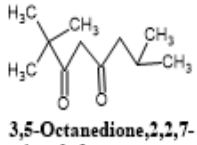
Hydroxyurea



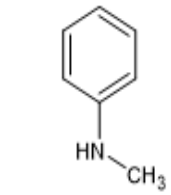
Acetamide, 2-Fluoro-



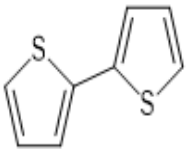
Propanoic acid, 2-(aminooxy)-



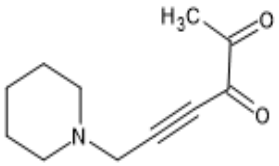
3,5-Octanedione,2,2,7-trimethyl-



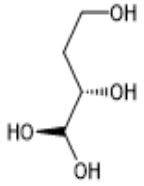
Benzenemethanamine, Methyl-



2,2'-Bithiophene



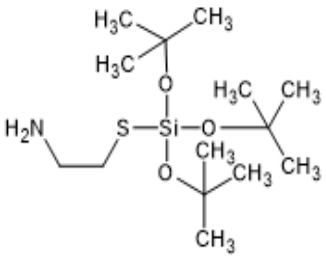
2-Butynone,1-Acetyl-4-1-[1-Piperidyl]



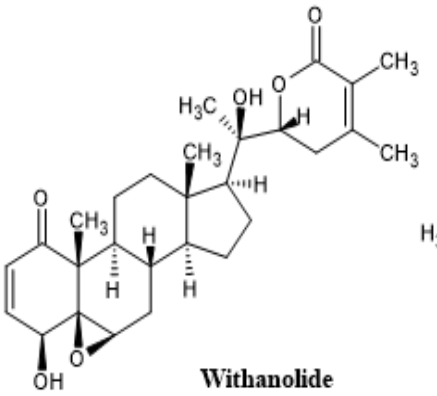
D-Erythro-pentose, 2-deoxy-



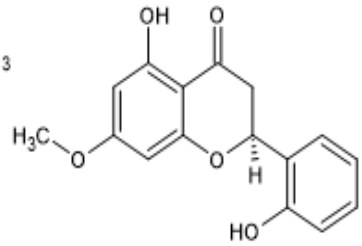
1-Hexadecene



S-[Tri-t-butoxysilyl]-2-Mercaptoethylamine



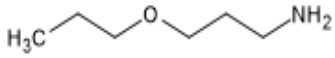
Withanolide



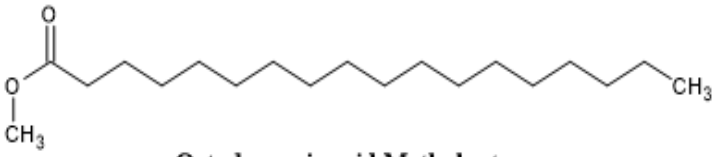
Dihydroechioidinin



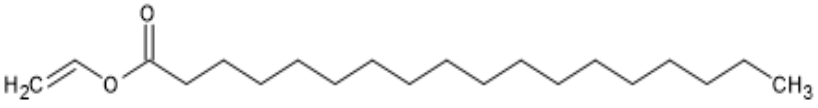
1-Octadecanamine



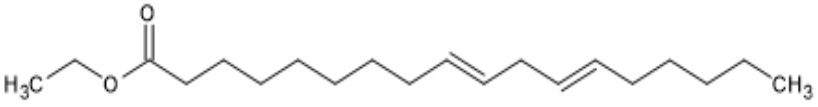
3-Propoxypropylamine



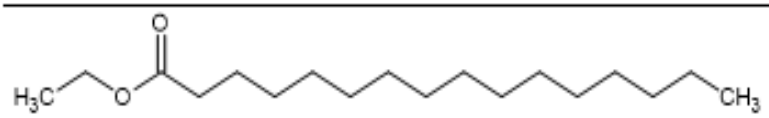
Octadecanoic acid,Methyl ester



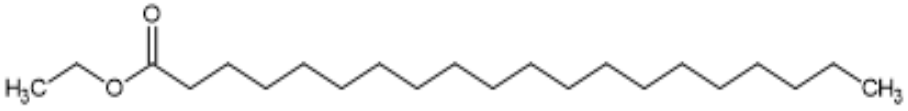
Octadecanoic acid,Ethenyl ester



9,12-Octadecanoic acid,Ethyl ester



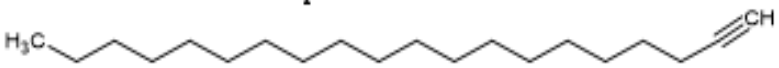
Hexadecanoic acid,Ethyl ester



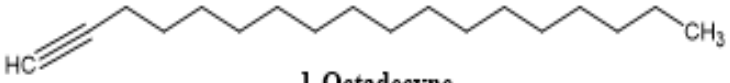
Eicosanoic acid,Ethyl ester



E-15-Heptadecenal



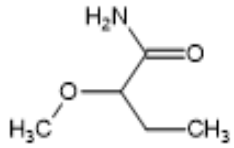
1-Eicosyne



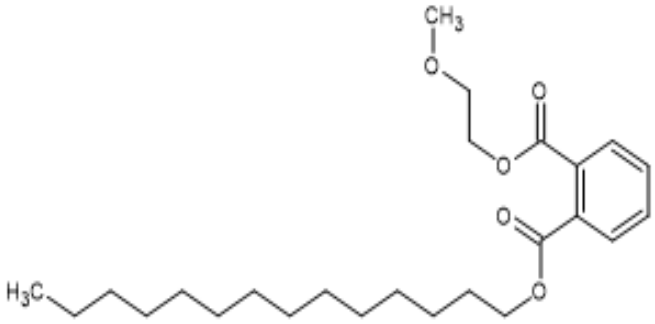
1-Octadecyne



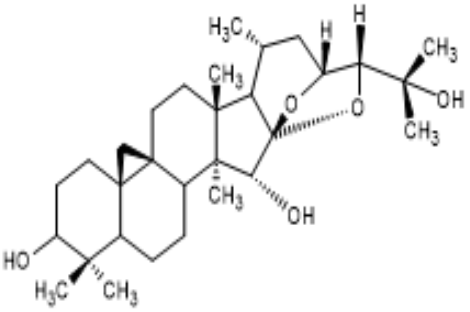
1-Hexadecene



2-Methoxybutanamide



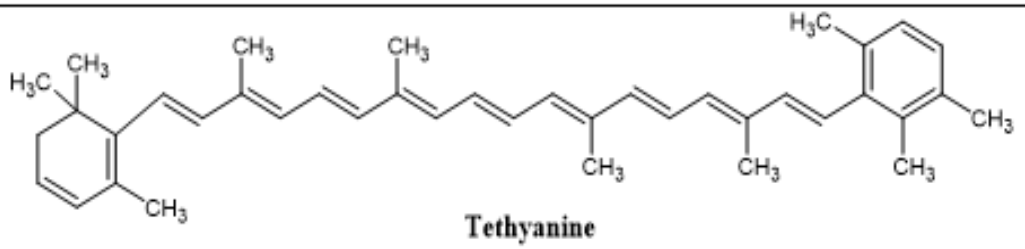
Phthalic acid,2-Methoyethyl tetradecyl ester



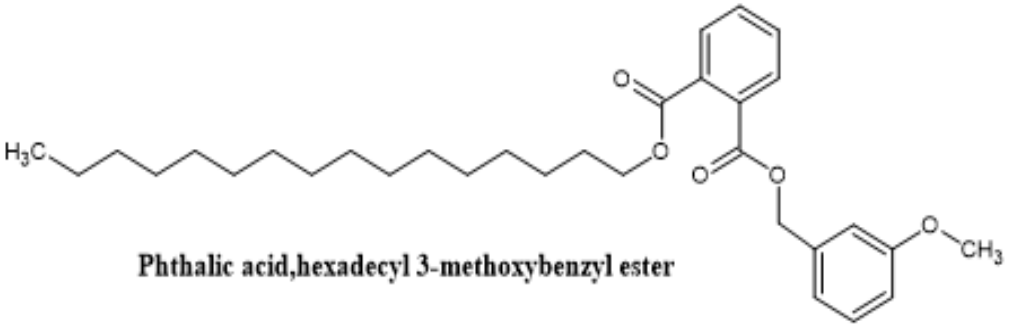
Cimigol



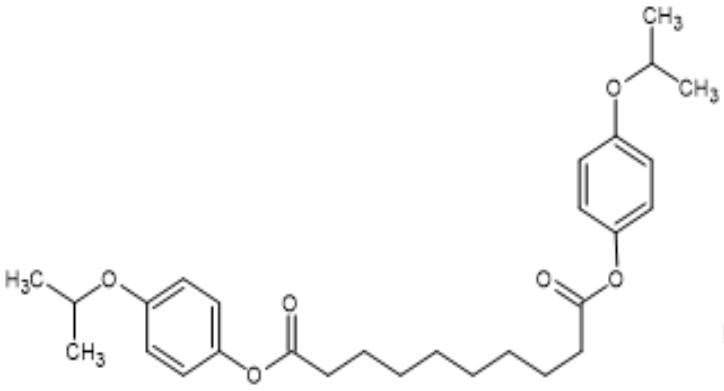
Pentatriacontane



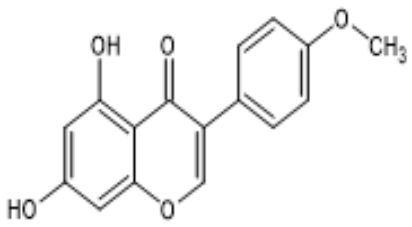
Tethyanine



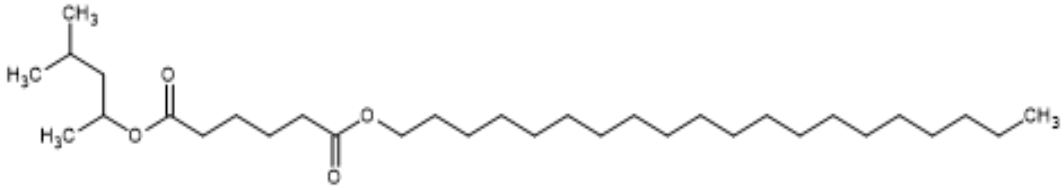
Phthalic acid,hexadecyl 3-methoxybenzyl ester



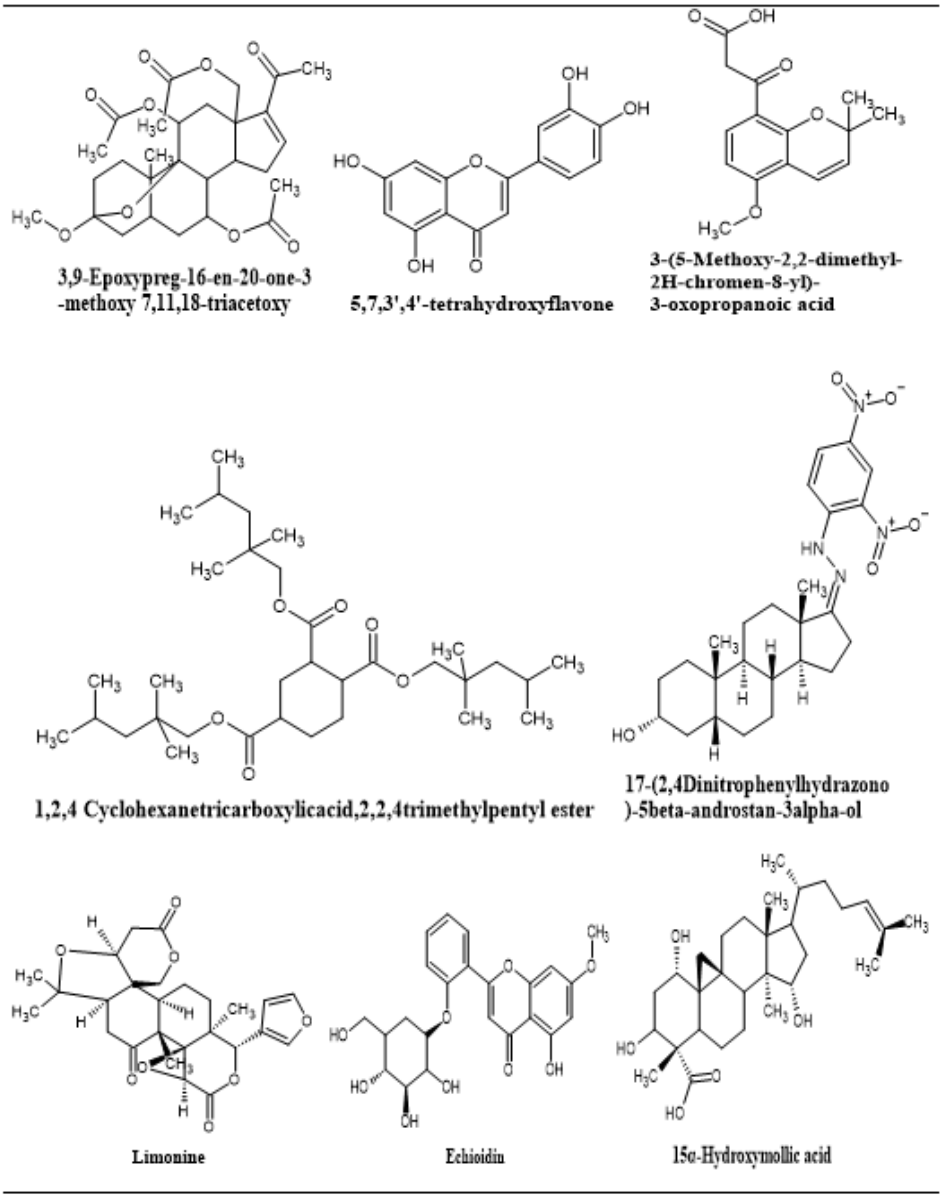
Sebacic acid,di(4-isopropoxyphenyl)ester



5,7-Dihydroxy-3-(4-methoxyphenyl)chromen-4-one(Biochanin A)



Adipic acid,eicosyl 4-methylpent-2-yl ester



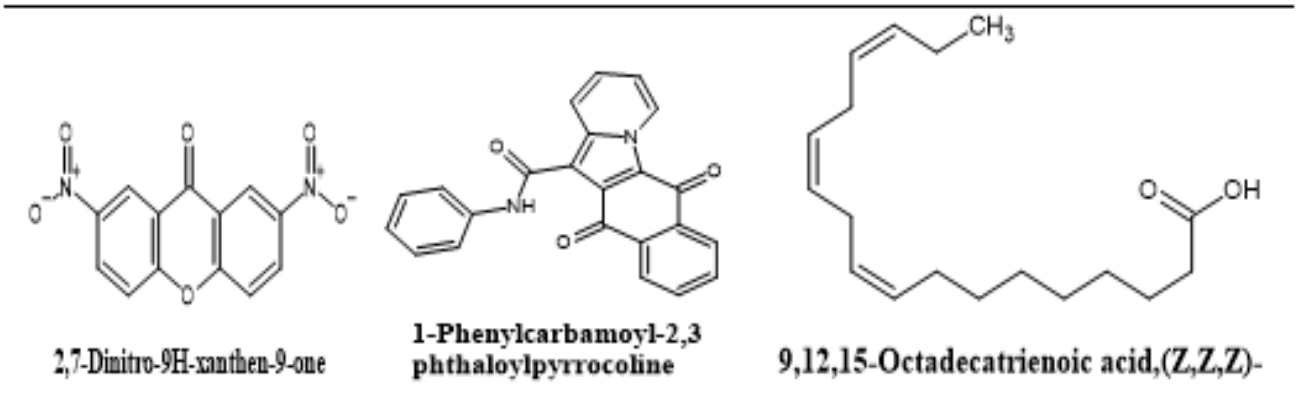


Figure No 5: Phytoconstituents of *Andrographis echioides* (L.) Nees

4.3. Stem

The preliminary phytochemical screening of *Andrographis echioides* stem Ethanolic extract shows the presence of alkaloids, flavonoids, tannins, saponins, steroids, cardiac glycosides, triterpenes, anthocyanins, leuco anthocyanin, coumarin, glycosides, terpenoids, emodin, proteins [17,31].

4.4. Aerial Parts

Preliminary phytochemical screening of *Andrographis echioides* aerial parts in various solvent extracts (Hexane, chloroform, ethyl acetate, methanol) shows the presence of alkaloids, terpenoids, steroids, flavonoids, phenols, tannins, glycosides, carbohydrates, amino acids, saponins [32].

5. Pharmacological Activity

5.1. Anti - Arthritic Activity

Bhuvaneswari *et al*., (2022) evaluated the anti-arthritic acitivity of ethanolic stem extract of *Andrographis echioides* in Inhibition of protein denaturation model & Human red blood cell (HRBC) membrane stabilization model. In protein denaturation inhibition experiment both *Andrographis* (65% to 85%) and standard Diclofenac drug (84% to 97%) showed potential inhibition in a dose-dependent Manner (20, 40, 60, 80 and 100µg/ml). The ethanolic extract of stem of Andrographis echioides at different concenrations (20, 40, 60, 80 and 100 µg/ml) acts as good stabilization of HRBC. Bhuvaneswari *et al*., (2016) work showed the ability of ethanolic stem extract of *Andrographis echioides* shows the anti-arthritic activity [31].

5.2. Antiangiogenic Activity

Muralidharan *et al*., (2021) explored the anti-angiogenic effect of *Andrographis echioides* ethanolic whole plant extract using in ovo chick chorioallantoic membrane assay. *A.echioides* inhibited angiogenesis in ovo using CAM assay and possible mechanism mentioned could be blocking of Mir-21-5P/TIMP3 signaling pathway an important pathway of angiogenesis. Limitations of the study include this study being only the primary step, investigation into characterization and mechanism of anti-angiogenic of *A.echioides* has to be entailed in further research works [33].

5.3. Anti - Bacterial Activity

Antibacterial activity of *Andrographis echioides* leaves extracts viz., acetone, aqueous, crude, chloroform, ethanol, ethyl acetate, methanol and petroleum ether were evaluated against both gram positive and gram negative bacteria such as *Escherichia coli, Staphylococcus aureus, Bacillus cereus, Escherichia coli, Serratia marcescens, Enterobacter amnigenus, Klebsiella pneumonia, Klebsiella oxytoca* and *Brevibacterium paucivorans, Bacillus subtilis, Enterococcus faecalis, streptococcus epidermis, Pseudomonas aeruginosa, Salmonella typhi* using standard disc diffusion assay. This studies clearly revealed that all the extracts possess Antibacterial properties against tested bacterial species expect petroleum ether extract. The petroleum ether extract no result found against the tested bacterial species. The some leaves extracts no result found against the tested bacterial species. The some leaves extracts ethanol, methanol, acetone and ethyl acetate possess broad spectrum Antibacterial activity compared to chloroform, petroleum ether & aqueous extracts [35, 36, 37, 43]. The antibacterial activity of green synthesized AgNPs from leaves of *Andrographis echioides* was tested against five bacterial isolates such as *Staphylococcus aureus,*

Escherichia coli, *Salmonella typhi*, *Micrococcus luteus* and *Pseudomonas aeruginosa* using Agar well diffusion method. The highest antibactial activity was found against Escherichia coli (28mm) and *Staphylococcus aureus* (23mm) respectively [38]. Various stem extracts (acetone, aqueous, chloroform, ethanol, ethyl acetate, methanol, petroleum ether) of *Andrographis echioides* studied for antibacterial activity against both gram positive & gram negative bacteria species using disk diffusion assay. The study clearly reveals that stem extracts of *Andrographis echioides* acetone, ethanol, ethyl acetate possess broad spectrum Antibacterial activity compared to chloroform, petroleum ether & aqueous extracts [31, 35, 36]. Fathima *et al*., (2019) explored silver nanoparticles of *Andrographis echioides* Methanolic fruit extract against Helicobacter pylori. From the results it is evident that Andrographis echioides fruit extract can be used as antibacterial agent [39]. The antibacterial activity of different solvent extracts (hexane, chloroform, ethyl acetate, Methanol). By the micro-dilution bio assay method revealed that *Andrographis echioides aerial parts* (root, stem and leaves) extract possess bioactive compounds, which inhibits the growth of microorganism. Among the six pathogens tested the gram negative bacteria *Klebsiella pneumonia* and *Vibrio cholera* was most susceptible to the extracts and the rest of the pathogens showed almost similar kind of MIC values [31]. Acetone, ethanol, methanol, chloroform, petroleum ether, hexane, distilled water extract of Andrographis echioides whole plant was studied for antibacterial activity against test organism Escherichia coli (MTCC-1687), Staphylococcus aureus (MTCC-3160), Salmonella typhi (MTCC-98) using agar well diffusion method. Experimental findings reveal Andrographis echioides is the best herbal to control specially S.typhi, E.coli, S.aureus [22].

5.4. Anti - Cancer Activity (Anti - Proliferative)

The ethanolic extract of whole plant *Andrographis echioides* was used to evaluate the anti-proliferative activity in human breast Adenocarcinoma Cancer Cell Line (MC7 7) using MTT assay and was compared with 5-FU. The extract possessed anti-proliferative potential was less compared to 5-FU [33]. Karthiga Muralidharan *et al*., (2020) explore the anticancer attribute of ethanolic extract of whole plant of *Andrographis echioides* (EEAE) in human colon carcinoma using MTT assay and DNA fragmentation test in 29 cell lines. This study revealed that ethanolic extract of whole plant of *Andrographis echioides* exhibited apoptotic activity that in turn induced cytotoxicity in HT-29 colon cancer lines [40]. The study of anti-cancer against the human breast cancer cell line (MCF-7) using the stem ethanolic extract of *Andrographis echioides* done by Bhuvaneswari *et al*., (2016). The cytotoxicity activity of ethanolic stem extract of *Andrographis echioides* showed better inhibition in a dose-dependent manner against MCF-7 human breast cancer cell line [31]. The silver nanoparticle prepared from the leaves of *Andrographis echioides* studied for cancer activity against Human breast adenocarcinoma cell line (MCF-7) done by Elangovan *et al*., (2015). The results suggest that AgNPs may exert its anticancer activity on MCF-7 cell line by suppressing its growth [38].

5.5. Anti - Diabetic Activity

The Anti – Diabetic Activity of Ethanol extract of *Andrographis echioides* leaves was studied by inhibition of albumin denaturation technique. Ethanol extract of this plant possesses significant anti - hyperglycemic effect in alloxan induced diabetic rats [41]. Sindhu sivalingam *et al*., (2016) evaluated effect of *Andrographis echioides* (L.) Nees methanol leaf extract on glucose uptake by

3T3-L1 cell line. Results of the study suggest that the tested extract of *A.echioides* is effective in enhancing glucose uptake. Moreover, the glucose uptake activity could be increased by isolation and purification of single bioactive compounds from the leaves [42]. S Gurupriya *et al*., (2018) examined the lupeol isolated from the methanolic extract of leaves of *Andrographis echioides* for alpha amylase and alpha glucosidase inhibition using an in vitro model. The lupeol exhibited siginificant α-amylase and α-glucosidase inhibitory activities with an IC50 value 36.2 ± 0.42 and 41.4 ± 0.34 % respectively and well compared with standard acarbose drug. Therefore it is suggested that lupeol is a potential source for natural anti - diabetic and antioxidant compounds and could have potential use in the management of diabetes mellitus [29].

5.6. Anti - Fungal Activity

Aqueous, acetone, chloroform, crude, ethanol, ethyl acetate, methanol, petroleum ether extracts of *Andrographis echioides* leaves and stems was evaluated for its anti - fungal activity against *Aspergillus niger, Aspergillus flavus, Candida albicans, Candida dubliniensis, Candida tropicalis, Cryptococcus neoformans* using disk diffusion method. The result showed the acetone, crude, ethyl acetate, ethanol, acetone & ethyl acetate extracts possess broad spectrum antifungal activity and chloroform, petroleum ether & aqueous extracts showed no zone of inhibition against all the tested fungal pathogens [31, 34, 36, 37].

5.7. Anti - Inflammatory Activity

The methanolic extract of whole plant *Andrographis echioides* was evaluated for its anti-inflammatory activity using egg albumin denaturation assay. The study was assessed using Diclofenac sodium as the standard drug. The methanolic extract of *Andrographis echioides* showed excellent anti-inflammatory activity comparing to the NSAID (Non-Steroidal anti-inflammatory drugs) Diclofenac sodium, it showed almost same activity [22]. De-yang Shen *et al*., (2012) examined chemical constituents from *Andrographis echioides* and their Anti-inflammatory Activity. The result of the study suggested that the *Andrographis* species are valuable sources for the discovery of natural Anti-inflammatory lead drugs [23]. The in-vitro anti-inflammatory properties of aqueous, ethanolic, chloroform extracts of whole plant *Andrographis echioides* were evaluated by protein denaturation assay. Aspirin was a positive control. There was a dose-dependent increase in protease inhibition of protein denaturation in three extracts from the concentration ranging from 100 to 500 ug /ml. All the three extracts of *Andrographis echioides* showed better in-vitro anti-inflammatory effect compounds. The study concluded an innovative finding that aqueous, ethanolic, choloform of *Andrographis echioides* possessed potent in vitro anti-inflammatory effect attributed to its flavonoid, phenyl glycosides compounds [43]. The anti-inflammatory properties of ethanolic stem extract of *Andrographis echioides* was investigated using inhibition of albumin denaturation, Hypo-tonicity induced hemolysis, Anti-lipoxygenase activity. The study was assesses using Diclofenac sodium as the standard drug. The result shows maximum inhibition of albumin denaturation, hypo-tonicity induced hemolysis, anti-lipoxygenase activity with standard drug diclofenac sodium. The study revealed that the stem of Andrographis echioides have potential source for natural anti-inflammatory activity [31].

5.8. Antioxidant Activity

In this study is to analyse the in-vitro antioxidant property of aqueous, ethanolic & chloroformic extracts of *Andrographis echioides*. DPPH free

radical scavenging assay was performed to evaluate the antioxidant potential of Andrographis echioides. There is a dose dependent increase in the percentage of inhibition of DPPH free radical by the extracts. All the three extracts (aqueous, ethanolic and chloroformic extracts) of *Andrographis echioides* showed significant increase in the antioxidant property with the concentration ranging from 100 - 500 µg. The study concluded that different extracts of *Andrographis echioides* showed effective antioxidant properties and it could protect the biological system against oxidative stress including ageing, cancer, diabetes and cardiovascular disorders. Venkatachalam Vigneshwaran *et al*., (2020) studied antioxidant potential of Methanolic extract of whole plant *Andrographis echioides*. The result of study have showed antioxidant activity in DPPH, FRAP, ABTS, H2O2, reducing power, metal chelating efficiency with little variation [45]. Antioxidant activity of *Andrographis echioides* leaves viz., ethanol, methanol & crude extract were evaluated by DPPH free radical scavenging activity, reducing power assay, nitric oxide scavenging activity, ABTS radical scavenging activity, FRAP(Ferric Reducing/ Antioxidant power) assay. Superoxide anion radical scavenging assay. The results shows ethanolic & Methanolic extract of *Andrographis echioides* have high DPPH scavenging activity, superoxide scavenging assay and also having Nitric oxide scavenging activity [28, 29, 34, 37, 41, 46]. S.K. Basu *et al*., explored the Methanolic extract of *Andrographis echioides* aerial parts for its antioxidant activity against acetaminophen induced hepatotoxicity in Wistar albino rats. Results indicate that *A.echioides* possesses antioxidant effects against acetaminophen induced hepatotoxicity in rats [47].

5.9. Anti - Thrombolytic Activity

In this study, green synthesized AgNPs of *A.echioides* have tested for its potential anti-thrombolytic properties for cardiovascular disease. The results revealed AgNPs of *A.echioides* acts as an anti-thrombolytic by preventing the clotting of blood [48].

5.10. Anthelmintic Activity

The ethyl acetate, methanol and aqueous extracts from the whole plant of *Andrographis echioides* were investigated for their anthelmintic activity against *Pheretima poshtuma.* The results revealed that the test extracts of *Andrographis echioides* exhibited significant anthelmintic activity at concentration of 50 mg/ml. The use of *A.echioides* as an anthelmintic has been confirmed and further studies are suggested to isolate the active principles responsible for the activity [49].

5.11. Anti - Ulcer Activity

In this study to determine the antiulcer activity of the ethanol extract from the leaves of *Andrographis echioides. Andrographis echioides* showed a dose dependent curative ratio compared to ulcer control. The ethanol leaf extract of *Andrographis echioides* showed the presence of flavonoids and their glycosides, tannins and triterpenoids. These phytoconstituents present in the extract could be the possible agents involved in the prevention of gastric lesions induced by pylorus ligation [50]. Fathima *et al*., (2019) studied Urease inhibitory activities of silver nanoparticle of *Andrographis echioides* fruit extract against *Helicobacter pylori*. From the results it is evident that *Andrographis echioides* fruit extract can be used as an anti-ulcer agent [39].

5.12. Diuretic Activity

The diuretic activity of petroleum ether, chloroform extract of *Andrographis echioides* was

studied and the activity was compared with furosemide as standard. The chloroform extract exhibited significant diuretic activity as evidenced by increased total urine volume and the urine concentration of Na^+, K^+ and Cl^-. The results thus support the use of as diuretic agent [51].

5.13. Hepatoprotective Activity

The hepatoprotective activity of methanolic extract of aerial parts of *Andrographis echioides* was investigated in Wistar albino rats. Hepatotoxicity was induced that *A.echioides* possesses hepatoprotective effects against acetaminophen induced hepatotoxicity in rats [47].

5.14. Larvicidal Activity

The larvicidal potential of *Andrographis echioides* ethanolic leaf extract was tested against larvae of *Aedes aegypti*. The ethanolic leaf extract shows lethal effect towards larvae of *A.aegypti* with LC50 values of 108.3 mg/l. from the results, it is evident that *Andrographis echioides* ethanolic leaf extract possess larvicidal activity [52].

CONCLUSION

Andrographis echioides (L.) Nees is an important herb widely distributed in south India. This review provides valuable information about the various phytoconstituents and biological activities of *Andrographis echioides*. It is reported that *Andrographis echioides* contain different classes of chemical constituents including flavonoids, alkaloids, essential oils, fatty acids, steroids, terpenoids, polyphenols, glycosides together with a several medicinal benefits such as anti-oxidant, anti-inflammatory, anti-diabetic, hepatoprotective, anti-microbial & anticancer. An assessment of *Andrographis echioides* revealed that it has a significant number of phytochemical components. It also has a wide variety of pharmacological properties. The plant can thus be utilized to treat a variety of illness and in a number of pharmaceutical formulation and drug development investigations. We assume that the *Andrographis* agents for a variety of disorders in the near future to cure human diseases as well as some animal diseases. To fulfill this dream, the researchers might focus on multiplication of this plant to meet commercial demand besides the pharmacology study.

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