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An Overview on Kalamegha (*Andrographis paniculata*)

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Abstract

Remedial plants have been used as local wellsprings of medicines since ancient times. *Andrographis paniculata* is a possible medicinal plant that is commonly used around the world. This plant is most often used to treat vital cool, free entrails, fever due to a couple of infectious causes, jaundice, and as a liver and cardiovascular health tonic. The plant's concentrate and unadulterated mixtures have been evaluated for their antimicrobial, cytotoxic, anti-protozoan, mitigating, anti-oxidant, immunostimulant, anti-diabetic, anti-infective, anti-angiogenic properties. It has effect on insecticidal and poisonousness exercises, hepato-renal defense, sexual hormone balance, liver compound management. High performance liquid chromatography (HPLC) was used to decontaminate andrographolide, a diterpene lactone compound found in the methanolic portion of the plant *A. paniculata*. When tested in detachment, the compound showed strong anti-plasmodial activity. To overcome any obstacles that may need future discovery prospects, this study portrays the current research on *A. paniculata* in terms of restorative use, phytochemistry, pharmacological activity, harmfulness profile, and beneficial use.

Keywords: *A. paniculata,* Pharmacological Activity, Phytoconstituents.

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Introduction

It is estimated that about two-thirds of the general population in many non-modern countries rely enthusiastically on traditional specialist practitioners and restorative plants to fulfil particular clinical problem needs.[1] Researchers are currently studying several species focused on various plant species and their positive drug values, due to various problems with traditional medications. As a result, a thorough composing quest on individual species is needed to revive the current state of records. For decades, *Andrographis paniculata* has been used in Ayurvedic and Oriental medicine. Around 40 species make up the *A.* genus, which belongs to the Acanthaceae family. A few are well-known for their use in people's medicine to treat a variety of ailments. *A. paniculata* is the largest of these insignificant few. *A. paniculata*, also known as King of Bitters or Kalmegh, is a fragrant annual that grows to half a meter. Southeast Asia, China, America, the West Indies and Christmas Island are all home to this species, similar to peninsular India and Sri Lanka. It is commonly used due to its high remedial ability and the fact that it fills well in various soil types.[2] In China, India, Thailand and other Southeast Asian nations, the plant's airborne parts and clandestine establishments have been widely used as standard medicine to treat various ailments. In English, it is known as King of Bitters; in Sanskrit, it is known as King of Bitters in English, Mahatikta in Sanskrit, Kiryato in Gujarat, Mahatita in Hindi, Kalmegh in Bengali, it is known as Kalmegh; and in Thai, it is known as Fah Talai Jone.[3] For the most part, according to regular clinical experts in the Ayurvedic clinical process, reports on the beneficial properties constrained by this herb, a large number of studies have been led by subject matter experts, especially in Asia. According to phytochemical analyses, *A. paniculata* comprises a diverse variety of phytochemicals, including labdane diterpenoid lactones, flavonoids and other blends. It seems to possess a diverse collection of pharmacological properties.[4,5] Andrographolide, a diterpenic lactone compound with antiviral,[6] anti-inflammatory,[7] and anti-cancer properties,[8] have been discovered to have a wide variety of pharmacological impact.

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Plant Description

A. paniculata is a large Andrographis class remedial herb. The total number of species included in this group varies between

Table 1: Plant description

S.No.	*Scientific Classification*	*Name*
1.	Domain	Eukaryote
2.	Kingdom	Plantae
3.	Sub-kingdom	Tracheophytes
4.	Division	Angiosperms
5.	Superdivision	Spermatophyta
6.	Class	Dicotyledons
7.	Sub-Class	Gamopatalae
8.	Series	Bicarpellatae
9.	Order	Lamiales
10.	Family	Acanthaceae
11.	Sub-family	Acanthoideae
12.	Tribe	Justiciae
13.	Sub-tribe	Andrographideae
14.	Genus	Andrographis
15.	Species	paniculata

Figure 1: *A. paniculata* plant (16)

Figure 2: *A. paniculata* flower (16)

Morphology

Table 2: Morphology of *A. paniculata*

S. No.	*Traits*	*Characteristics*
1.	Plant Height	30–110 cm
2.	Stem	Dark green
	Length	30–100 cm
	Diameter	2–6 mm
	Shape	Quadrangular, longitudinal furrow and wings on the angles, and slightly swollen nodes.
3.	Leaves	Glabrous
	Length	2–12 cm
	Width	1–3 cm
	Arrangement	Lanceolate
	Shape	Pinnate, acute apex, entire margin
4.	Flowers	The petals are white with purple spots.
	Size	Axillary and terminal racemes or are small, laxly spreading racemes or panicles.
5.	Seed	Linear oblong capsules with acute ends
	Size	1.9 cm length, 0.3 cm width
	Color	Yellowish brown
	Shape	Sub-quadrate
6.	Flowering and Fruiting	December to April

studies, but it included 19,[9] 28,[10] 40,[11] and 44[12] species. The precise numbers of various forms of Andrographis are uncertain currently. The cumulative number of chromosomes in *A. paniculata* is 25 gametophytic[13] and 50 in sporophytic[14] counts. Furthermore, genotypic differentiation are important tests for identifying high-yielding germplasms (Table 1-3).

A. paniculata is a yearly, fanned, upright and herbaceous plant that grows in hedger ows on plane terrains, slope inclines, squander land, ranches, moist living room, beaches and along the side of the track. It can also be grown in the greenhouse.

Vernacular Names

Table 3: Synonyms

S. No.	*Language*	*Name*
1.	"Arabic"	"Quasabhuva"
2.	"Assamese"	"Chiorta", kalamegha
3.	"Azerbaijani"	"Acilar Sahi", "Acilar Xani" (Khnai)
4.	"Bengali"	"Kalmegh"
5.	"Burmese"	"Se-ga-gyi"
6.	"Chinese"	"Chuan Xin Lian"
7.	"English"	"The Creat", "King of Bitters"
8.	"French"	"Chirette verte", "Roi des amers"
9.	"Gujarati"	"kariyatu"
10.	"Hindi"	"Kirayat", "Kalpanath"
11.	"Indonesian"	"Sambiroto", "Sambiloto"
12.	"Japanese"	"Senshinren"
13.	"Kannada"	"Nelaberu"
14.	"Konkani"	"Vhadlem Kiratyem"
15.	"Lao"	"La-Sa-Bee"
16.	"Malay"	"Hempedu Bumi", "Sambiloto"
17.	"Malayalam"	"Nelavepu", "Kiriyattu"
18.	"Manipuri"	"Vubati"
19.	"Marathi"	"Oli-Kiryata", "Kalpa"
20.	"Mizo"	Hnakhapuri
21.	"Oriya"	"Bhuinimba"
22.	"Punjabi"	"Chooraita"
23.	"Persian"	"Nain-e Havandi"
24.	"Philippines"	"Aluy", "Lekha" and "Sinta"
25.	"Russian"	"Andrografis"
26.	"Sanskrit"	"Kalmegha", "Bhunimba" and "Yavatikta"
27.	"Scandinavian"	"Green Chiratta"
28.	"Sinhalese"	"Hin Kohomba" or "Heen Kohomba"
29.	"Spanish"	"Andrografis"
30.	"Tamil"	"Nilavembu"
31.	"Telugu"	"Nilavembu"
32.	"Thai"	"Fa-Talai-Jorn", "Fah-talai-jon (jone)"
33.	"Turkish"	"Acilar Krali", "Aci Pasa", "Aci Bey"
34.	"Urdu"	"Kalmegh", "Kariyat", "Mahatita"
35.	"Vietnamese"	"Xuyen Tam Lien"

Various parts of *A. panniculata* like leaves flowers and seeds are represented in Figure 1 to 3. For well improvement, soggy obscure spots, woodland and badlands are better.[15]

Medicinal Uses of *A. paniculata*

A. paniculata's elevated parts, roots and whole plant have long been used as traditional medicine in Asia to treat a range of ailments. Normal health authorities have prescribed it for gastrointestinal throbs, disturbances, pyrexia and sporadic fevers.[18-21] The whole plant has been used to treat dyspepsia, flu, loose bowels, stomach disease, and respiratory illness, among other things, as well as being aggressive to gush for snake-nibble and poisonous stings of some bugs (Table 4 and 5).[18,19]

Figure 3: *A. paniculata* Seeds (17)

Overwhelming contamination, fever-causing sickness, colic torment, lack of need, eccentric stools and loose bowels are all treated with the leaf separate.[22] Colds, hypertension, diabetes, harm, wilderness fever, and snake bites are all treated with a decoction of the raised parts in Malaysia.[23] In the Indian pharmacopoeia, it is a significant component of at least 26 ayurvedic medicines. In traditional Chinese medicine, it is known as the cool property flavour and is used to alleviate warmth and fever and expel toxic compounds from the body.[24] It is known as a cold-property spice in traditional Chinese medicine, and it is used to disperse poisons from the body and free the assemblage of warmth and fever.[25] India uses this spice for various ailments in the Ayurvedic medicinal system, pre-natal and post-natal considerations, such as dysmenorrhoea and leucorrhoea, confounded illnesses including jungle fever, jaundice, gonorrhoea and general ailments like bruises, scratches, bubbles and skin diseases.[26]

Table 4: Medicinal uses of *A. paniculata*

S. No.	*Plant element*	*Therapeutic uses*	*Reference*
1.	Whole Plant	Sarpa visha and insect sting treatment, Agnimandya, Sannipataj Jwara, Pravahika, malaria and Swasa roga	[18], [19]
2.	Leaf	Jwara, Shoola, Agnimandhya, Vibhandha and Pravahika, Prathishyaya, Shushka-Kasa, Shakhasrita, Rajayakshma, mouth ulcers, Shwasa Pranali Shoth, gastro-intestinal disorder and sores.	[22],[27],[28]
3.	Aerial part	Prathishyaya, Rakta Chaap, Madhumeha, Karka roga, malaria and snake bite, urinary tract infection.	[22],[23],[28]
4.	Root	Febrifuge, tonic, stomachic and antihelmintic.	[18]

A. paniculata as Folk Medicine in India

Table 5: Use of *A. Paniculata* as folk medicine in India[27]

S. No.	*Medicinal uses*	*How to use*
1.	Malaria	A quarter-pound of the whole plant is pounded, mixed in water, separated, and administered. After that, the plant is cut into small pieces and put inside. The plant is then chopped into small pieces aml of water for the time being. Within approximately 40 mL of the cool imbuement obtained is given twice daily.
2.	Post-natal care	In 400 mL of water, 25 g of powdered spice is bubbled, then reduced to 50 mL. To quench an unusual thirst, cool the sifted and provided within. This decoction is often used to treat eating sensations in the subject's palm and foot.
3.	Dysamenorrhoea	Around 10 g of leaf is ground with three dark peppers and permitted once a day for seven days.
4.	Instestinal worm Infestation	2 g of root and stem individual + 7 mustard seeds are ground into glue and mixed with mother's milk before being given inside. On the other hand, glue made from fresh leaves or a squeeze made from 5 g of root is mixed and offered inside with difficulty.
5.	Eczema	The powdered spice is mixed with oil and added to the wounds. For the next 40 days, a total of 2 g of powder is given once daily.
6.	Leucoderma	For 40 days, Once a day, A powdered herb of 2 g is given.
7.	Jaundice	A water concentrate of 10 g of the spice is provided three times a day for six days, with an equivalent amount of *Azadirachta indica* and *Hollarrhena antidysentrica* stem bark concentrates. The condition is handled by lowering a hot state.
8.	Abscess	Within, leaf paste (approx. 10 g) was issued. Additionally, any glue is added manually.
9.	Gonorrhea	A powdered spice is mixed with oil and added from afar. On the other side, plant juice is applied to the cuts. A total of 2 g of powder is also added inside.
10.	Infected wounds	The spice, along with turmeric is grounded into glue and added remotely. After that, the infected areas are coated with leaf glue and left for two days. The juice derived from 100 g of spice is conatained inside.

Table 6: Terpenoids of *A. Paniculata*

S.No.	Compounds	Category	Plant part	Reference
1.	Andro-grapholide	Diterpenoid lactone	Leaves and aerial parts	[31]
2.	Neo-andrographolide	Diterpenoid lactone	Leaves and aerial parts	[32]
3.	14-deoxy-andro-grapholide	Diterpenoid lactone	Aerial parts	[33]
4.	Andro-graphoside	Diterpene	Leaves and aerial parts	[34]
5.	14-deoxy-11, 12-di-de-hydro-andro-grapholide	Diterpenoid lactone	Aerial parts	[35]
6.	"19-O-beta-D-gluco-pyranosyl-ent-labda-8(17), 13-dien-15,16,19-triol"	"Ent-labdane diterpenoid lactone"	Aerial parts	[36]
7.	8 alpha-methoxy-14-deoxy-17 beta-hydroxy-andro-grapholide	"Ent-labdane diterpenoid lactone"	Aerial parts	[37]
8.	Andro-grapholactone	Diterpenoid lactone	Aerial parts	[38]
9.	"3,13,14,19-tetra-hydroxy-14-deoxy-ent-labda-8(17), 11-dien-16, 15olide and 3, 19 iso-propylidene-14-deoxy-ent-labda-8(17), 13-diene-16, 15-olide"	"Diterpenoid lactone"	Aerial parts	[38]
10.	14-deoxy-15-iso-propylidene-11, 12-di-dehydro-andrographolide	Unusual Terpenoid	Aerial parts and roots	[39]
11.	"3,7,19-tri-hydroxyl-8,11, 13-ent-labdatriene-15, 16-olide and 8 alpha, 17 beta-epoxy-3, 19-di-hydroxy-11, 13-ent-labdatrien-15, 16-olide"	"Diterpenoid lactone"	Aerial parts	[37]
12.	Andro-grapanin	Diterpene	Leaves	[40]

Phytochemistry of *A. paniculata*

A. paniculata has a variety of blends in its elevated parts and roots, which are sometimes used to remove the plant's complex guidance. The capriciousness in its produced material is addressed by various components such as geological area, assemble time and preparation procedure.[29-30] The division of different plant metabolites has resulted from photochemical examinations of *A. Paniculata*. "Terpenoids (entalabdane diterpene lactones)", which address many of its sections and accept action, are among these metabolites. Flavonoids are a type of flavonoid that is found in plants (flavones). Noiridoides, xanthones, polyphenols, and follow and large size fragments are among the various groupings of variations that have been separated (Table 8).

Terpenoids

The most common terpenoid lactones isolated from *A. paniculata* are diterpenoid lactones (Table 6). Diterpenoids have been handed down and bound from this plant's flying bits and secret institutions. Andrographolide is the most well-known diterpenoids isolated from *A. paniculata,* both in quantity and frequency known of the diterpenoids isolated from *A. paniculata*. Andrographolide has an unpleasant taste and a horrid, transparent look[41] and it was discovered in pure form for the first time by Gorter in 1911. Deoxyandrographolide and neo-andrographolide are two winning diterpenoids that have been bounded by and wide from the flying parts of *A. Paniculata*. A handful of researchers in the field were able to separate these diterpenoids. Apart from the primary diterpenes, other diterpenes have been removed over time by various studies, one of which is an irregular 23 carbon terpenoid originating from the plant's root abd airborne sections.[31]

Flavonoids

The important flavonoids isolated from the aeronautical sections, stems, and whole plant of *A. Paniculata* are known as flavonoids.

Miscellaneous Compound

A few arbitrary combinations (Table 7) have been isolated, especially from *A. paniculata* establishments. Using a mixture of thin layer chromatography and fragment chromatography, four xanthones were extracted from the roots and listed as "1,8-di-hydroxy-3,7-di-methoxy-xanthone", "4,8-di-hydroxy-2,7-di-methoxy-xanthone", "1,2-di-hydroxy-6,8-di-methoxy-xanthone", "4,8-di-methoxy-xanthone". Five exceptional noriridoids were isolated from *A. panicukata* institutions, like andrigrapholide A-E, closely similar to curvifloruside.[48] Some researchers and his colleagues separated arabinogalactan proteins from dried flavors in 2007.[49] Minor segments Cromium, Manganese, Cobalt, Nickel, Zinc, Copper, Selenium, Rubidium, Strontium and Lead were defined and measured in the roots and full-scale segments (potassium and calcium). Destructive substances such as cinnamic, ferulic, and chlorogenic were all bound in the same way from the entire plant.[32-50]

Agricultural Techniques

Seed culture is a common way for plants to reproduce. Farm yield has been affected by planting and harvesting times.[52,53] When in question, plant *A. paniculata* seeds isolate 30 *15 cm between May and July to achieve a plant thickness of 222 thousand plants.[54,55] Regardless, seed torpidity is mechanically important for *A. paniculata* improvement.[56,57] However, hormones media and high-temperature water treatment have been suggested as solutions to this problem.[58,59] Because of changeability among

seed determined descendants and inadequate and delayed seedling establishment, this method is insufficient to meet the market amounts needed.[60-61] As a result, non traditional spread methods, such as plant tissue culture procedures, are optional techniques for delivering a large number of plantlets in a short period of time and increasing phytochemical content in *A. paniculata*. Tissue culture systems have been used to induce massive *A. paniculata* extension.[61-63]

According to researchers,[63] *in vitro* recovered *A. paniculata* contains a higher proportion of andrographolide and appears differently than mother plants. The suspension social orders of *A. paniculata* [64] can be used to optimize the ideal formation of andrographolide in a limited capacity to the middle. Plant tissue culture has also been active in producing new flavones from callus culture.[65-67]

Pharmacological Effect Possess by *A. paniculata*

The widespread use of different sections of the *A. paniculata* in public eye prescribing, Scientists investigated its pharmacological properties to encourage its use as a helpful expert in treating

Table 7: Flavonoids of *A. paniculata*

S. No.	*Compound*	*Category*	*Plant part*	*Reference*
1.	5,7,2′,3′-tetra-nethoxy-flavone	Flavonone	Whole plant	[32]
2.	"5-hydroxy-7,2′3′-tri-methoxy flavones"	"Flavone"	Whole plant	[32]
3.	"5-hydroxy-7,2′,6′ tri-methoxy-flavone"	Flavone	Root	[32]
4.	7-O-methyl-di-hydro-wogonin	Flavone	Root and aerial part	[31], [32]
5.	7-O-methyl-wogonin	Flavone	Root, aerial part and whole plant	[31], [32], [42], [43]
6.	"Flavone-1, 2′methyl-ether"	"Flavone"	Root, aerial part and whole plant	[31], [32], [44]
7.	7-O-methyl-wogonin-5-glucoside	Flavones	Root and aerial parts	[31], [32], [43]
8.	Flavone-1, 2′-O-glocoside	Flavonoids	Root, aerial part and whole plant	[31], [32], [43]
9.	"5-hydroxy-7,8,2′,5′-tetra-methoxy-flavone"	Flavonoids	Whole plant	[45]
10.	Di-hydro-skullcap-flavone	Flavone	Whole plant	[46]
11.	"5-hydroxy-7,8,2,3′ tetra-methoxy-flavone"	Flavone	Whole plant	[31], [32], [43]

Table 8: Miscellaneous compounds of *A. paniculata*

S. No.	*Compound*	*Category*	*Plant part*	*Reference*
1.	Arabino-galactan	Protein	"Herbs"	[51]
2.	"1,8-di-hydroxy-3,7-di-methoxy-xanthone"	Xanthone	Root	[47]
3.	"4,8-di-hydroxy-2,7-di-methoxy-xanthone"	Xanthone	Root	[47]
4.	"1,2-di-hydroxy-6,8-di-methoxy-xanthone"	Xanthone	Root	[47]
5.	"3,7,8-tri-methoxy-1-hydroxy-xanthone"	"Xanthone"	Root	[47]
6.	Andro-graphidoid A, B, C, D, E	Noriridoid	Root	[48]

Table 9: Potential pharmacology of *A. panniculata*

S. No.	*Activity*	*Pharmacology*	*Reference*
1.	Common cold	In a few companies, A. paniculata is a widely used plant to treat and avoid chronic colds. In a twofold outwardly impeded, counterfeit care controlled sample of 61 adult patients with vital infection, kan Jang tablets (made from A. Paniculata dry concentrate) were used for 5 days. The 1200 mg concentrate showed substantial clinical progress on day 4 of the treatment cycle. Shivering, sore throat, lethargy, solid pain, rhinitis, sinus torments and headache were significantly reduced during the two social occasions. In 1997, a treatment controlled study was conducted on 107 strong understudies in a nation school using Kan Jang tablets at a dose of 200 mg everyday for what seemed like an eternity to see how it could deter normal infection. Kan Jang tablets with a 2.1-overlay higher evasion score emerged uniquely in comparison to the bogus treatment kit in preventing ordinary infection. Another review recollecting normal cold with sinusitis for elsewhere revealed near triumph in a similar manner.	[70], [71], [72]
2.	Antimicrobial activity	The dried taste of *A. paniculata* watery concentrate, andrographolides and arabinogalactan proteins were tested for their ability to inhibit nicrobial growth. The watery concentrate and arabinogalactan proteins were shown to have anti-bacterial activity against "*Bacillus subtilis*", "*Escherichia coli*", and "*Pseudomonas aeruginosa*", while andro-grapholide was only found to have antibacterial activity against *B. subtilis*. Any one of three was similarly given a reason for posing a threat to *Candida albicans* parasitic growth. The hazard of bacterial growth against E. coli was measured in five exceptional noriridoides, andrographolides A-E. There was no inhibitory growth of any of the blends (MIC>100 g/mL). As sure monitors, gentamycin, chloramphenicol and Ciprofloxacin were included.	[48], [68]

S. No.	Activity	Pharmacology	Reference
3.	Immunostimulant activity	In mice, the new plant's ethanol concentrate and isolated diterpenes-andrographolide and neoandrographolide induced a massive (p 0.001) induction of neutralizer and a delayed delicateness reaction to sheep red platelets. The plant courses of action also induced an unknown healthy reaction in the animals, as measured by macrophage production, phagoocytosis of 14C-leucine stamped *E. coli* and splenic lymphocyte development. With andrographolide and neoandrographolide, Both antigen unambiguous and safe responses were activated at a lower demand than with ethanol, implying that compounds other than diterpenes found in the concentrate could often encompass an immunostimulator section. The human periphery blood lymphocytes extension was revamped as rate affectation list against regulation by 52 percent at low core interests by dichloromethane some portion of the methanol concentrate of new entire plant inside and out. The oil ether portion and liquid piece of the methanol remove increased human peripheral blood lymphocyte replication by 18%, 18% and 4%, respectively, implying that the immunostimulatory variants of the methanol remove should be stuffed in the dichloromethane division. The discovery led to the isolation of three diterpenes from the dichloromethane division:- andro-grapholide, 14-de-oxy-andro-grapholide and 14-de-oxy-11, 12-di-de-hydro-andro-grapholide. Both three combinations showed mild extension in human peripheral blood lymphocyte duplication at a concentration of 1 mol/L, with andro-grapholide showing the most addition (14 percent).	[73], [74]
4.	Insecticidal activity	The ovi-cidal and larvi-cidal properties of the unpleasant leaf concentrates of *Aedes paniculata* were tested using "benzene", "hexane", "ethylacetate", "methanol", and "chloroform" against early third in star hatchling of Culex quinquefasciatus and "*Aedes aegypti*". *Aedes aegypti* was found to be more sensitive to "benzene", "hexane", "ethylacetate", "methanol" and "chloroform" than *Culex quinque fasciatus*. The LC50 was found to be 112.19, 137.45, 118.67, 102.05, 91.20 mg/L and 119.58, 146.34, 124.24, 110.12, 99.54 mg/L respectively. The ovicidal production against the two mosquito species was best with methanol and ethyl acidic corrosive deduction remove. The methanol and ethyl acetate concentrate killed *Culex quinque fasciatus* completely at 200 mg/L and Aedes aegypti completely at 250 mg/L.	[75]
5.	Anti-bacterial activity	In the last two decades, researchers have looked into the essential antiviral development of *A. paniculata* and other pharmacological activities. Even though they have antiviral effectiveness against a few unique infections including dengue disease "sero-type 1 (DENV-1)", "Human paillomavirus type 16 (HPV 16)", "Herpes simplex disease type 1 (HSV-1)" and "Influenza-A" disruption, they are not widely used. Their revelations about the dangerous occupation of these contaminations in human neighbourhoods, such as HIV, were extremely inspiring and basic reasoning. *A. paniculata* vital antiviral role was shown by its hot liquid ethereal parts focus, which decreased the number of "HIV antigen-positive H9 cells". Recently, it was discovered that the *A. paniculata* methanol concentrate has essential block action against "DENV-1" *in vitro*. Another research discovered that andrographolide inhibited HPV 16 record activity, resulting in lower E6 oncoprotein levels and p53 restoration.	[76], [77], [78], [79]
6.	Anti-parasitic activity	The *A. paniculata* removes antiparasitic behaviour is recorded in explicit posts. Four xanthones isolated from roots were tested *in vitro* and *in vivo* for anti-malarial activity against "*Plasmodium faciparum* "and "*Plasmodium berghei*". One of the xanthones, "1,2-di-hydroxy-6,8-di-methoxy-xanthone", showed critical anti-plasmodial development *in vitro* (4 g/mL at "IC50 regard") and *in vivo* (62 % parasitaemia decline at 30 mg/kg partition) studies. Adult *Brugia malayi* worms were found to be resistant to the water concentrate of dried leaves *in vitro*. Water and methanol have recently been shown to have *in vitro* antihelmintic function against adult night crwalers Pheretima posthuma. At concentrations of 25 mg/mL, 50 mg/mL and 75 mg/mL, the concentrates produced massive effects. Regardless, the therapeutic relevance of anti-parasitic tests is uncertain due to the need to obtain outcomes at a high centre, which might not be scientifically feasible.	[47], [80], [81]
7.	Hepato-renal protective activity	The hepato-renal defensive synthesis of andro-grapholides and arabino-galactan proteins isolated from *A. paniculata* flavours was tested in mice for ethanol-induced disruption. Separate substances studies in the liver and kidney tissues showed intra-peritoneal pre-treatment of mice for 7 days with andro-grapholides (500 mg/kg body weight) before intra-peritoneal imbuement of ethanol (7.5 mg/kg body weight) decreased noxiousness. Both andro-grapholides and arabinogalactan greatly (p<0.0001) decreased levels of "glutamic-oxaloacetic transaminase", "glutamic pyruvic transaminase", stomach settling agent phosphatise, and LP synthetics in the liver and kidney as compared to the ethanol-treated community.	[49]
8.	Toxicity	The protection of *A. Paniculata* discrete (calm cold) has been shown in genotoxic tests, and the LD500 consider has been estimated to be greater than 5 g/kg rat body weight in an oral exceptional moxiousness study. After 60 days of therapy with ethanol concentrates of *A. paniculata* dry flavors at doses of "20, 200 and 100 mg/kg" in Sprague Dawley rats, no testicular toxicity was observed, as calculated by conceptive" organ weight", "testicular histology", ultra secret inspection of leyding cells, and "testosterone levels", implying an overall healthy hurtfulness profile.	[82], [83], [84]

S. No.	Activity	Pharmacology	Reference
9.	Anti-hyperlipidemic activity	Hyperlipidemia is a significant cause of artherosclerosis, which leads to heart disease (coronary artery obstruction) and stroke (obstacle occurs in the stockpile courses of the frontal cortex). Based on their findings, scientists proposed andrographolide as a potential medical specialist for atherosclerosis. Another study recently discovered that andrographolide and neoandrographolide have anti-hyperlipidemic properties. It is discussed the effects of andro-grapholide and neo-andro-grapholide on hyperlipidemic mice and rodents to a 75% yolk emulsion and a high-fat emulsion. In a section-dependent way, andro-grapholide and neo-andro-grapholide reduced greasy fat, overall cholesterol, and low-thickness lipoprotein cholesterol. Aspartate transaminase and alanine transaminase plasma levels were both marginally ($p < 0.01$) lower in the negative control group than in the positive control group (Simvastatin). In the arota of hyperlipidemic rodents, downregulation of iNOS verbalization and up-regulation of eNOS clarification revealed that these combinations had a lipid lipoprotein lowering effect. The delayed results of the hypolipidemic thesis necessitate further research into the subnuclera process and the associated hailing pathway.	[85], [86], [87], [88], [89]
10.	Anti-diabetic activity	Andro-grapholide and 14-de-oxy-11, 12- di-de-hydro-andro-grapholide and 14-deoxy-11, 12-di-de-hydro-andro-grapholide were isolated from the alcoholic concentrates of *A. Paniculata* aeronautical fragments, Fibronectin discharge, TGF-oxidative strain, and the apoptosis maker caspase-3 were all reduced in MES-13 cells, indicating diabetic nephropathy. The apoptosis marker caspase-3, the fibrosis marker cytokine TGF, and the plasminogen activator inhibitor-1 were all reduced. Compound 14-de-oxy-11, 12-di-dehydro-andro-grapholide displayed a greater movement than andro-grapholide. In the MES-13 cells, the two mixtures both reduced reactive oxygen species. In sterptozocin-induced hyperglycaemic rats, the watery concentrate (50 mg/kg) of *A. paniculata* crude content resulted in a substantial ($p < 0.05$) reduction (52.9%) in blood glucose levels. However, freeze-dried *A. paniculata* (62.5 mg/kg body weight) reduced blood glucose levels more significantly ($p < 0.001$) (61.81 percent). According to the findings, the fluid concentrate of *A. paniculata* did not result in a substantial decrease in blood glucose levels in normoglycemic rats.	[90], [91]

a variety of ailments, especially in Asia. Several experiments have discovered that this plant has antimicrobial, cyto-toxic, anti-protozoan, relaxing, anti-oxidant, immune-stimulant, "anti-diabetic", "anti-infective", "anti-angiogenic", "hepato-renal safe", "sex material modulatory", "liver mixtures modulatory", insecti-cidal, & harmfulness behaviors.[68-69] Andrographolide, a major ent-labdane diterpenoid found in *A. paniculata*, is the most prolific donor in pharmacological studies. Other ent-labdane diterpenoids, flavonoids, quinic acids, and xanthones (neoandrographolide and 14- deoxy-andro-grapholide) are also listed (Table 9).

Conclusion

The use of *A. paniculata* has skyrocketed in recent years due to its mind-boggling remedial possibilities. The ready available material on *A. paniculata* also clearly expresses the plant's wide range of pharmacological properties. It can be safely classified as one of the high-level catholicons due to its extensive pharmacological practices. Regardless, the pharmacological exercises of *A. paniculata* that are being investigated must be approved by a clinical review. Although only a few clinical trials were performed successfully without harmful effects or deaths, most focused on upper respiratory tract diseases with several conditions. The confirmation of *A. paniculata*'s excess of other natural behaviors on human research samples, such as anti-diabetic, anti-cancer, soothing and hepatoprotective operations, would bring a huge load of benefits to the world's greatest people. Shortly, *A. paniculata* is expected to be useful as a basic medicinal specialist on a number of, such as human illnesses and animal contaminations. Other than the pharmacology analysis, the examiners will concentrate on increasing the size of this plant to meet business needs to realize this dream. Tissue culture methods, including plant restoration, may be reasonable to make *A. paniculata* available for analysis (e.g., pharmacological evaluation and phytochemical testing to discover new bioactive combinations).

References

1. Farnsworth NR, Soejarto DD. Global importance of medicinal plants. In: Akerelev O, Heywood V, Synge H, editors. The conservation of medicinal plants. Cambridge: Cambridge University Press; 1991; 25–51.
2. Latto SK, Khan S, Dhar AK, Chaudhry DK, Gupta KK, Sharma PR. Genetics and mechanism of induced male sterility in *Andrographis paniculata* (Berm.f.) Nees and its significance. *Curr Sci.* 2006; 91:515–519.
3. Li J, Huang W, Zhang H, Wang X, Zhou H. Synthesis of andrographolide derivatives and their TNF-alpha and IL-6 expression inhibitory activities. *Bioorg Med Chem Lett.* 2007; 17:6891–6894.
4. Mishra SK, Sangwan NS, Sangwan RS. *Andrographis paniculata* (Kalmegh): a review. *Pharmacognosy Rev.* 2007;1:283–298.
5. Khare CP. Andrographis paniculata. In: KhareKhare CP, editor. *Indian medicinal plants, an Illustrated Dictionary.* New Delhi, India: Springer; 2007; 2.
6. Coon JT, Ernst E. *Andrographis paniculata* in the treatment of upper respiratory tract infections: a systematic review of safety and efficacy. *Planta Medica.* 2004;70(4):293–298.
7. Habtemariam S. Andrographolide inhibits the tumour necrosis factor-α-induced upregulation of ICAM-1 expression and endothelial-monocyte adhesion. *Phytotherapy Research.* 1998;12(1):37–40.
8. Ying H, Bu LIM, Ji X, Liu CY, Wang ZH. Modulation of multidrug resistance by andrographolid in a HCT-8/*5-FU* multidrug-resistant colorectal cancer cell line. *Chinese Journal of Digestive Diseases.* 2005;6(2):82–86.
9. Patidar S., Gontia A. S., Upadhyay A., Nayak P. S. Biochemical constituents in Kalmegh (*Andrographis paniculata* Nees.) under various row spacing's and nitrogen levels. *World Applied Sciences Journal.* 2011;15(8):1095–1099.
10. Niranjan A., Tewari S. K., Lehri A. Biological activities of Kalmegh (*Andrographis paniculata* Nees) and its active principles-A review. *Indian Journal of Natural Products and Resources.* 2010;1(2):125–135.
11. Boopathi C. Andrographis spp.: a source of bitter compounds for medicinal use. *Ancient Science of Life.* 2000;19(3-4):164–168.

12. Parixit B., Bharath C., Rajarajeshwari N., Ganapaty S. The genus Andrographis—a review. *International Journal of Pharmaceutical Sciences*. 2012;4(1):1835–1856.
13. Saggoo M., Bir S. Meiotic studies in certain members of family Acanthaceae from South India. *The Journal of the Indian Botanical Society*. 1986;65(3):310–315.
14. Roy S. K., Datta P. Chromosomal biotypes of *Andrographis paniculata* in India and Bangladesh. *Cytologia*. 1988;53(2):369–378.
15. Mishra S. K., Sangwan N. S., Sangwan R. S. *Andrographis paniculata* (Kalmegh): a review. *Pharmacognosy Reviews*. 2007;1(2):283–298.
16. https://www.google.com/search?q=andrographis+paniculata&rlz=1C1CHNY_enIN681IN685&sxsrf=ALeKk02Wm9yCpFca5_wuC3ZqM0GKY4e3qQ:1619511269187&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjkgKPP_Z3wAhUY7HMBHTNfChAQ_AUoAXoECAEQAw&biw=1366&bih=657 [last accessed on 2021 May 12]
17. https://www.google.com/search?q=andrographis+paniculata+seed&tbm=isch&ved=2ahUKEwiM3trR_Z3wAhUow3MBHbEFA7gQ2cCegQIABAA&oq=andrographis+paniculata+seed&gs_lcp=CgNpbW-cQAzICCAAyBAgAEBg6BAgAEEM6BggAEAgQHjoECAAQHlCW8BRYsPcUYOn9FGgAcAB4AIAB9ASIAY0OkgELMC4xLjEuMS4xLjGYAQCgAQGqAQtnd3Mtd2l6LWItZ8ABAQ&sclient=img&ei=6seHYIzBEaiGz7sPsYuMwAs&bih=657&biw=1366&rlz=1C1CHNY_enIN681IN685#imgrc=yf4JSuajsTeWIM [last accessed on 2021 May 12]
18. Chopra RN. *Glossary of Indian medicinal plants*. New Delhi: Council for Scientific and Industrial Research; 1980; 18.
19. Jarukamjorn K, Kondo S, Chatuphonprasert W, Sakuma T, Kawasaki Y, Emito N. Gender-associated modulation of inducible CYP1A1 expression by andrographolide in mouse liver. *Eur J Pharm Sci*. 2010;39:394–401.
20. Chaturvedi GN, Tomar GS, Tiwari SK, Singh KP. Clinical studies on Kalmegh (*Andrographis paniculata* Nees) in infective hepatitis. *J Int Inst Ayurveda*. 1983;2:208–211.
21. Balu S, Alagesaboopathi C. Anti-inflammatory activities of some species of *Andrographis* Wall. *Anc Sci Life*. 1993;13:180–184.
22. Saxena S, Jain DC, Bhakuni RS, Sharma RP. Chemistry and pharmacology of *Andrographis* species. *Indian Drugs*. 1998;35:458–467.
23. Perry LM. *Medicinal plants of East and Southeast Asia: attributed properties and uses*. Cambridge: MIT Press; 1980.
24. Deng WL. Preliminary studies on the pharmacology of the *Andrographis* product dihydroandrographolide sodium succinate. *Newslett Clin Herb Med*. 1978;8:26–28.
25. Deng WL. Preliminary studies on the pharmacology of the *Andrographis* product dihydroandrographolide sodium succinate. *Newslett Clin Herb Med*. 1978;8:26–28.
26. Alagesaboopathi C, Dwrakan P, Ramachandran VS. *Andrographis paniculata* Nee in tribal medicine of Tamil Nadu. *Anc Sci Life*. 1999;19: 28–30.
27. Panossian A, Davtyan T, Gukassyan N, Gukasova G, Mamikonyan G, Gabrielian E, et al. Effect of andrographolide and Kan Jang fixed combination of extract SHA-10 and extract SHE-3 on proliferation of human lymphocytes, production of cytokines and immune activation markers in blood cell culture. *Phytomedicine*. 2002;9:598–605.
28. Poolsup N, Suthisisang C, Prathanturarug S, Asawamekin A, Chanchareon U. *Andrographis paniculata* in the symptomatic treatment of uncomplicated upper respiratory tract infection: systematic review of randomized controlled trials. *J Clin Pharm Ther*. 2004;29(1):37–45.
29. Phosphane N, Rangkadilok N, Thongnest S, Ruchirawat M, Ruchirawat J. Determination and variation of three active diterpenoids in *Andrographis paniculata* (Burm.f.) Nees. *Phytochem Anal*. 2004;15:365–371.
30. Li WK, Fitzloff JF. HPLC-PDA determination of bioactive diterpenoids from plant materials and commercial products of *Andrographis paniculata*. *J Liq Chromatogr Relat Technol*. 2004;27:2407–2420.
31. Reddy MK, Reddy MV, Gunasekar D, Murthy MM, Crux C, Bodo B. A flavones and an unusual 23-carbon terpenoid from *Andrographis paniculata*. *Phytochemistry*. 2003;62:1271–1275.
32. Koteswara Rao Y, Vimalamma G, Rao CV, Tzeng YM. Flavonoids and andrographolides from *Andrographis paniculata*. *Phytochemistry*. 2004;65:2317–2321.
33. Kumar RA, Sridevi K, Kumar NV, Nanduri S, Rajagopal S. Anticancer and immunostimulatory compounds from *Andrographis paniculata*. *J Ethnopharmacol*. 2004;92:291–295.
34. Kuroyanagi M, Sato M, Ueno A, Nishi K. Flavonoids from *Andrographis paniculata*. *Chem Pharm Bull*. 1987;35:4429–4435.
35. Jain DC, Gupta MM, Saxena S, Kumar S. LC analysis of hepatoprotective diterpenoids from *Andrographis paniculata*. *J Pharm Biomed Anal*. 2000;22:705–709.
36. Zou QY, Li N, Dan C, Deng WL, Peng SL, Ding LS. A new *ent*-labdane diterpenoid from *Andrographis paniculata*. *Chin Chem Lett*. 2010;21:1091–1093.
37. Ma XC, Gou ZP, Wang CY, Yao JH, Xin XL, Lin Y, et al. A new *ent*-labdane diterpenoid lactone from *Andrographis paniculata*. *Chin Chem Lett*. 2010;21:587–589.
38. Xou C, Chou GX, Zhen TW. A new diterpene from the leaves of *Andrographis paniculata* Nees. *Fitoterapia*. 2010;81:610–613.
39. Behera PR, Nayak P, Baric DP, Rautray TR, Thirunavoukkarasu M, Chand PK. ED-XRF spectrometric analysis of comparative elemental composition of *in vivo* and *in vitro* roots of *Andrographis paniculatata* (Burm.f.) Wall. ex Nees-a multi-medicinal herb. *Appl Radiat Isot*. 2010;68:2229–2236.
40. Liu J, Wang ZT, Ge BX. Andrograpanin, isolated from *Andrographis paniculata*, exhibits anti-inflammatory property in lipopolysaccharide-induced macrophage cells through down-regulating the p38 MAKs signaling pathways. *Int Immunopharmacol*. 2008;8:951–958.
41. Siripong P, Kongkathip B, Preechanukool K, Picha P, Tunsuwan K, Taylor WC. Cytotoxic diterpenoid constituents from *Andrographis paniculata* Nees leaves. *Sci Asia*. 1992;18:187–194.
42. Gupta KK, Taenia SC, Dhar KL, Atal CK. Flavoniods of *Andrographis paniculata*. *Phytochemistry*. 1983;22:314–315.
43. Varma A, Padh H, Shrivastava N. Andrographolide: a new plant-derived antineoplastic entity on horizon. *Evid Based Complement Alternat Med*. 2011.
44. Zhou B, Zhang D, Wu X. Biological activities and corresponding SARs of andrographolide and its derivatives. *Mini Rev Med Chem*. 2013;13(2):298–309.
45. Lim JC, Chan TK, Ng DS, Sagineedu SR, Stanslas J, Wong WS. Andrographolide and its analogues: versatile bioactive molecules for combating inflammation and cancer. *Clin Exp Pharmacol Physiol*. 2012;39(3):300–310.
46. Kishore PH, Reddy MV, Reddy MK, Gunasekar D, Caux C, Bodo B. Flavonoids from *Andrographis lineate*. *Phytochemistry*. 2003;63:457–461.
47. Dua VK, Ojha VP, Roy R, Joshi BC, Valecha N, Devi CU, et al. Anti-malarial activity of some xanthones isolated from the roots of *Andrographis paniculata*. *J Ethnopharmacol*. 2004;95:247–251.
48. Xu C, Chou GX, Wang CH, Wang ZT. Rare noriridoids from the roots of *Andrographis paniculata*. *Phytochemistry*. 2012;77:275–279.
49. Singh PK, Roy S, Dey S. Protective activity of andrographolide and arabinogalactan proteins from *Andrographis paniculata* Nees. against ethanol-induced toxicity in mice. *J Ethnopharmacol*. 2007;111:13–21.
50. Kuroyanagi M, Sato M, Ueno A, Nishi K. Flavonoids from *Andrographis paniculata*. *Chem Pharm Bull*. 1987;35:4429–4435.
51. Chaos WW, Lin BF. Isolation and identification of bioactive compounds in *Andrographis paniculata* (Chuanxinlian) *Chin Med*. 2010;5:17.
52. Bhan M. K., Dhar A. K., Khan S., Lattoo S. K., Gupta K. K., Choudhary D. K. Screening and optimization of *Andrographis paniculata* (Burm.f.) Nees for total andrographolide content, yield and its components. *Scientia Horticulturae*. 2006;107(4):386–391. doi: 10.1016/j.scienta.2005.09.001.
53. Nemade S., Mohod N., Wankhade S., Paturde J. Effect of planting and harvesting dates on yield and quality of kalmegh (*Andrographis paniculata*) *Journal of Medicinal and Aromatic Plant Sciences*. 2003;25(4):981–983.
54. Singh M., Singh A., Tripathi R., et al. Growth behavior, biomass and diterpenoid lactones production in Kalmegh (*Andrographis paniculata* Nees.) strains at different population densities. *Agricultural Journal*. 2011;6(3):115–118.
55. Parashar R., Upadhyay A., Singh J., Diwedi S. K., Khan N. A. Morpho-physiological evaluation of *Andrographis paniculat*a at different growth stages. *World Journal of Agricultural Sciences*. 2011;7(2):124–127.
56. Talei D., Valdiani A., Abdullah M. P., Hassan S. A. A rapid and effective method for dormancy breakage and germination of king of bitters (*Andrographis paniculata* Nees.) seeds. *Maydica*. 2012;57(2):98–105.

57. Lattoo S. K., Dhar R. S., Khan S., et al. Comparative analysis of genetic diversity using molecular and morphometric markers in *Andrographis paniculata* (Burm. f.) Nees. *Genetic Resources and Crop Evolution.* 2008;55(1):33–43. doi: 10.1007/s10722-007-9212-y.
58. Kumar B., Verma S. K., Singh H. P. Effect of temperature on seed germination parameters in Kalmegh (*Andrographis paniculata* Wall. ex Nees.) *Industrial Crops and Products.* 2011;34(1):1241–1244. doi: 10.1016/j.indcrop.2011.04.008.
59. Kumar R. N., Chakraborty S., Nirmal K. Methods to break seed dormancy of *Andrographis paniculata* (Burm. f. Nees): an important medicinal herb of tropical Asia. *Asian Journal of Experimental Biological Sciences.* 2011;2(1):143–146.
60. Kataky A., Handique P. Micropropagation and screening of antioxidant potential of *Andrographis paniculata* (Burm. f) Nees. *Journal of Hill Agriculture.* 2010;1(1):13–18.
61. Martin K. P. Plant regeneration protocol of medicinally important *Andrographis paniculata* (Burm. f.) Wallich ex Nees via somatic embryogenesis. *In Vitro Cellular and Developmental Biology-Plant.* 2004;40(2):204–209. doi: 10.1079/IVP2003520.
62. Purkayastha J., Sugla T., Paul A., Solleti S., Sahoo L. Rapid in vitro multiplication and plant regeneration from nodal explants of *Andrographis paniculata*: a valuable medicinal plant. *In Vitro Cellular & Developmental Biology—Plant.* 2008;44(5):442–447. doi: 10.1007/s11627-008-9156-8.
63. Dandin V. S., Murthy H. N. Regeneration of *Andrographis paniculata* Nees: analysis of genetic fidelity and andrographolide content in micropropagated plants. *African Journal of Biotechnology.* 2012;11(61):12464–12471.
64. Gandi S., Rao K., Chodisetti B., Giri A. Elicitation of andrographolide in the suspension cultures of*Andrographis paniculata* . *Applied Biochemistry and Biotechnology.* 2012;168(7):1729–1738. doi: 10.1007/s12010-012-9892-4.
65. Bowes B. The fine structure of wall modifications and associated structures in callus tissue of *Andrographis paniculata* Nees. *New Phytologist.* 1969;68(3):619–626.
66. Behera P. R., Nayak P., Barik D. P., Rautray T. R., Thirunavoukkarasu M., Chand P. K. ED-XRF spectrometric analysis of comparative elemental composition of in vivo and in vitro roots of *Andrographis paniculata* (Burm.f.) Wall. ex Nees-a multi-medicinal herb. *Applied Radiation and Isotopes.* 2010;68(12):2229–2236. doi: 10.1016/j.apradiso.2010.06.019.
67. Jalal M. A. F., Overton K. H., Rycroft D. S. Formation of three new flavones by differentiating callus cultures of *Andrographis paniculata* . *Phytochemistry.* 1979;18(1):149–151. doi: 10.1016/S0031-9422(00)90934-8.
68. Singh PK, Roy S, Dey S. Antimicrobial activity of *Andrographis paniculata*. *Fitoterapia.* 2003;74:692–694.
69. Chandrasekaran CV, Gupta A, Agarwal A. Effect of an extract of *Andrographis paniculata* leaves on inflammatory and allergic mediators *in vitro*. *J Ethnopharmacol.* 2010;129:203–207.
70. Hancke J., Burgos R., Caceres D., Wikman G. A double-blind study with a new monodrug Kan Jang: decrease of symptoms and improvement in the recovery from common colds. *Phytotherapy Research.* 1995;9(8):559–562. doi: 10.1002/ptr.2650090804.
71. Cáceres D. D., Hancke J. L., Burgos R. A., Wikman G. K. Prevention of common colds with *Andrographis paniculata* dried extract. A pilot double blind trial. *Phytomedicine.* 1997;4(2):101–104. doi: 10.1016/S0944-7113(97)80051-7.
72. Melchior J., Palm S., Wikman G. Controlled clinical study of standardized *Andrographis paniculata* extract in common cold-a pilot trial. *Phytomedicine.* 1997;3(4):315–318. doi: 10.1016/S0944-7113(97)80002-5.
73. Puri A, Saxena R, Saxena RP, Saxena KC, Srivastava V, Tandon JS. Immunistimulant agents from *Andrographis paniculata*. *J Nat Prod.* 1993;56:995–999.
74. Kumar RA, Sridevi K, Kumar NV, Nanduri S, Rajagopal S. Anticancer and immunostimulatory compounds from *Andrographis paniculata*. *J Ethnopharmacol.* 2004;92:291–295.
75. Govindarajan M. Evaluation of *Andrographis paniculata* Burm.f. (Family: Acanthaceae) extracts against *Culex quinquefasciatus* (Say) and *Aedes aegypti* (Linn) *Asian Pac J Trop Med.* 2011;4:176–181.
76. Tang L. I. C., Ling A. P. K., Koh R. Y., Chye S. M., Voon K. G. L. Screening of anti-dengue activity in methanolic extracts of medicinal plants. *BMC Complementary and Alternative Medicine.* 2012;12, article 3 doi: 10.1186/1472-6882-12-3.
77. Fangkham S., Ekalaksananan T., Aromdee C., et al. The effect of andrographolide on Human papillomavirus type 16 (HPV16) positive cervical cancer cells (SiHa) *International Journal of Infectious Diseases.* 2012;16(supplement 1):p. e80.
78. Aromdee C., Suebsasana S., Ekalaksananan T., Pientong C., Thongchai S. Stage of action of naturally occurring andrographolides and their semisynthetic analogues against herpes simplex virus type 1 in vitro. *Planta Medica.* 2011;77(9):915–921. doi: 10.1055/s-0030-1250659.
79. Xu H. X., Wan M., Loh B. N., Kon O. L., Chow P. W., Sim K. Y. Screening of traditional medicines for their inhibitory activity against HIV-1 protease. *Phytotherapy Research.* 1996;10(3):207–210. doi: 10.1002/(SICI)1099-1573(199605)10:3<207::AID-PTR812>3.0.CO;2-U.
80. Zaridah M. Z., Idid S. Z., Wan Omar A., Khozirah S. In vitro antifilarial effects of three plant species against adult worms of subperiodic *Brugia malayi* . *Journal of Ethnopharmacology.* 2001;78(1):79–84. doi: 10.1016/S0378-8741(01)00286-0.
81. Padma Y., Narasimhudu C. L., Devi S., Natha N. M. B., Naga R. B., Philip G. H. In vitro anthelmintic activity of *Andrographis paniculata* (burm.f.) nees. *International Journal of Pharmaceutical Research and Developement.* 2011;3(3):202–205.
82. Chandrasekaran CV, Thiyagarajan P, Sundarajan K, Goudar KS, Deepak M, Murali B, et al. Evaluation of the genotoxic potential and acute oral toxicity of standardized extract of *Andrographis paniculata* (Kalmcold) *Food Chem Toxicol.* 2009;47:1892–1902.
83. Burgos RA, Caballero EE, Sanchez NS, Schroeder RA, Wikman GK, Hancke JL. Testicular toxicity assessment of *Andrographis paniculata* dried extract in rats. *J Ethnopharmacol.* 1997;58:219–224.
84. Balu S, Alagesaboopathi C, Elango V. Antipyretic activities of some species of *Andrographis* Wall. *Anc Sci Life.* 1992;12:399–402.
85. Yang T., Shi H.-X., Wang Z.-T., Wang C.-H. Hypolipidemic effects of andrographolide and neoandrographolide in mice and rats. *Phytotherapy Research.* 2013;27(4):618–623. doi: 10.1002/ptr.4771.
86. Al-Attar A. M. Hypolipidemic effects of coenzyme Q10 in experimentally induced hypercholesterolemic model in female rats. *The American Journal of Pharmacology and Toxicology.* 2010;5(1):14–23. doi: 10.3844/ajptsp.2010.14.23.
87. Briel M., Ferreira-Gonzalez I., You J. J., et al. Association between change in high density lipoprotein cholesterol and cardiovascular disease morbidity and mortality: systematic review and meta-regression analysis. *British Medical Journal.* 2009;338, article b92 doi: 10.1136/bmj.b92.
88. Stamler J., Daviglus M. L., Garside D. B., Dyer A. R., Greenland P., Neaton J. D. Relationship of baseline serum cholesterol levels in 3 large cohorts of younger men to long-term coronary, cardiovascular, and all-cause mortality and to longevity. *Journal of the American Medical Association.* 2000;284(3):311–318. doi: 10.1001/jama.284.3.311.
89. Chen J.-H., Hsiao G., Lee A.-R., Wu C.-C., Yen M.-H. Andrographolide suppresses endothelial cell apoptosis via activation of phosphatidyl inositol-3-kinase/Akt pathway. *Biochemical Pharmacology.* 2004;67(7):1337–1345. doi: 10.1016/j.bcp.2003.12.015.
90. Lee MJ, Rao YK, Chen K, Lee YC, Chung YS, Teng YM. Andrographolide and 14-deoxy-11,12-didehydroandrographolide from *Andrographis paniculata* attenuates high glucose-induced fibrosis and apoptosis in murine renal mesangeal cell lines. *J Ethnopharmacol.* 2010;132:497–505.
91. Husen R, Pihie AH, Nallappan M. Screening for antihyperglycaemic activity in several local herbs of Malaysia. *J Ethnopharmacol.* 2004;95:205–208.