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Review Article

A contemporary review on phytochemistry and pharmacology of *Andrographis paniculata*

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Abstract

Andrographis paniculata is a well-known medicinal plant that belongs to the Acanthaceae family and is also commonly known as "Kalmegh or king of bitters". It is a bitter herb used in Siddha, Ayurveda, and homoeopathy medicines, as well as tribal medicines in india and other countries. This article describes the synonyms, biological sources, phytoconstituents and various pharmacological activities of Andrographis paniculate includes Anti-inflammatory activity, hepatoprotective, antidiabetic, anticancer, antibacterial, antimalarial, antivenom, analgesic, antifertility, antioxidant, antidiarrhoel, neuroprotective, cardioprotective, antiviral and Nephroprotective activities.

Introduction

Since the birth of civilization, medicinal plants have been used by humans to combat disease [1]. More than 80,000 plant species have been identified and utilized as medical herbs around the world, according to estimates [2], Andrographis paniculata is a well-known medicinal plant that belongs to the Acanthaceae family and is also commonly known as "Kalmegh or king of bitters" [3,4]. It is a bitter herb used in Siddha, Ayurveda, and homoeopathy medicines, as well as tribal medicines in India and Other countries include Java, Malaysia, Indonesia, the West Indies (including Jamaica, Barbados, and the Bahamas), and various locations throughout the United States. The plant is primarily found in the plains of India, from Himachal Pradesh to Assam and Mizoram, West Bengal, and throughout South India, and the entire plant is used as Antimalarial, anti-inflammatory, antioxidant, antihepatitic, antihyperglycemic, anthelmintic, antibacterial, antipyretic, and anticancer properties are all present in the plant [5]. It is used in conditions where blood "abnormalities" are thought to be the origin of sickness, such as skin eruptions, boils, scabies, and persistent unexplained fevers, because of its purported "blood cleansing" effect [6], Lactones, diterpenoids, diterpene glycosides, flavonoids, and flavonoid glycosides are among the chemical elements found in the plant's aerial section, which is utilised medicinally [7].

Taxological classification [8]

Kingdom: Plantae, Plants;
Subkingdom: Tracheobionta, Vascular plants
Super division: Spermatophyta, Seed plants;
Division: Angiosperma
Class: Dicotyledonae
Sub class: Gamopetalae

Series: Bicarpellatae
Order: Personales
Tribe: Justicieae
Family: Acanthaceae
Genus: Andrographis
Species: paniculata

Synonyms

Arab: Quasabhuva; Assamese: Chirota, Bengali: Kalmegh; English: The Creat, King of Bitters; Gujrati: Kariyatu; Hindi: Kirayat; Japan: Senshinren; Kannada: Nelaberu; Malayam: Kiriyattu; Malaysia: Sambiloto, Hempedubumi; Marathi: Oli-kiryata; Oriya: Bhuinimba; Persian: Naine-havandi; Sanskrit: Bhuinimba, kalmegha; Scandinavian: Green Chiretta; Tamil: Nilavembu; Telugu: Nilavembu [9].

Botanical Description

It is a branched annual herb with a taproot, and plants are approximately 90-110 cm tall, The size of the leaves is 3-7 9 1-2.5 cm, green, simple, opposite, lanceolate, glabrous, petiole short. flowers are white, and petals have red-purple spots The seeds are tiny, plentiful, and yellowish brown in appearance [10]. The stem is dark green, 0.3～1.0m high, 2～6mm in diameter, Flowers are small and have a calyx with five small and linear sepals, corolla tubes that are narrow and about 6mm long, bilabiate upper lip that is oblong, and lower tips that are broad. The fruit is a compressed capsule longitudinally grooved with fine glandular hairs and they Very small seeds [11].

Phytoconstituents

There are a number of active ingredients that have been claimed to be present in Andrographis paniculata, they are Flavonoids, flavonoid glycosides, diterpene glycosides, lactones, and diterpenes. Flavonoids are primarily found in the root, but they can also be extracted from the leaves. where andrographolide was found to be abundant in leaves, and thus the majority of the research is focused on leaves rather than other parts of the plant [12]. The plant has a variety of metabolites. Terpenoids, flavonoids (flavones), noriridoides, xanthones, polyphenols, and marco elements are some of the metabolites found in plants [13]. Diterpenoid lactones are the most common metabolite extracted from A. paniculata. andrographolide is crystalline, colourless and bitter in flavour [14]. The main flavonoids found in A. paniculata are flavones [13]. Other compounds that have been reported which include 14-deoxy-11-oxoandrographolide,14-deoxy-11,12-didehydroandrographolide,andrographolideD,14deoxy andrographolide, Homoandrographolide, andrographosterol, andrographone, andrograpanin, stigmasterol,α-sitosterol, 5-hydroxy-7,8,2,3 tetra methoxy flavone, andrographoside, andropaniculosin, isoandrographolide,dihydroxy-di-deoxymethoxyflavone,3-O-beta-D-glucopyranysol-andrographolide and four xanthones 4,8dihydroxy-2,7dimethoxy-xanthone, 1,2-dihydroxy-6,8dimethoxyxanthone,3,7,8-trimethoxy-1-hydroxyxanthone, 1,8-dihydroxy-3,7-dimethoxy-xanthone [15].

Pharmacological activities

Anti-inflammatory activity

K sheeja et al investigated the anti-inflammatory activity of methanol extract of *Andrographis paniculate* in carrageenan induced mice using paw oedema method. The extract at a dose of 10mg/kg i.p proved marked anti-inflammatory activity by completely inhibits the carrageenan induced paw oedema formation [16].

Hepatoprotective activity

G. Rajalakshmi et al have studied the hepatoprotective activity of ethanol powder extract of Andrographis paniculata in paracetamol induced liver damage rats. at a dose of 500mg/kg body weight proved marked hepatoprotective activity due to its antioxidant property of free radical inhibition [17].

Ant diabetic activity

Blood glucose lowering effect of ethanol extract and aqueous extract of Andrographis paniculata was studied in both glucose loaded and alloxan-induced diabetic rats. At a dose of ethanol extract is given 2g/kg b.w whereas aqueous extract is given at a dose of 0.8g/kg b.w The study clearly shows that the aqueous and ethanolic extractives of A. paniculata can cause considerable blood sugar changes. In both glucose-loaded and alloxan-loaded mice, the reducing effects were observed [18].

Anticancer activity

Here, Andrographis paniculata leaves were dried and extracted with ethanol, water and acetone extract was studied for invitro anticancer activity by using neuroblastima (IMR-32) and human colon (HT-29) cancer cell line. The results were found that ethanol extract showed nearly 50% i.e inhibition concentration (IC50) for IMR-32and HT-29cell lines at 200 μg/ml, where other extracts display 50% inhibition at 250 μg/ml concentration for HT-29cell lines. Based on these

findings, water, ethanol, and acetone extracts of A. paniculata leaves could be created as herbal medicines to treat IMR-32 and HT-29 cancer cell lines instead of chemotherapy agents [19].

Antibacterial activity

Antibacterial activity of methanolic extract of Andrographis paniculate leaves show a significant effect in vitro against Gram-positive bacteria such as Mycobacterium tuberculosis, Enterococcus faecalis, and methicillin-resistant Staphylococcus aureus clinical isolates. The methanolic extract of Andrographis paniculata shows the prescence of terpenoids that have enough potential to kill drug resistant grampositive bacteria [20].

Antivenom activity

The alcoholic extract of Andrographis paniculate was used to study the antivenom activity at different concentraction by invitro assay of HRBC membrane lysis. Hypotonicity-induced HRBC membrane lysis is inhibited by A. paniculata by 53.6, 53.8, and 67.2 percent, respectively at a concentration of 10g/ml of the alcoholic extract of A. paniculata showed the maximum activity [21].

Analgesic activity

G. Shivaprakash et al have investigated the study of analgesic activity of aqueous extract of Andrographis paniculata by using animal module such as acetic acid induced writhing model. At a dose of 100mg and 500mg/kg p.o that significantly reduce the abdominal constriction in male swiss albino mice [22].

Antifertility

Anti-fertility effect was studied by M S Zoha et al in different experimental condition in mice the dried powder of Andrographis paniculata was mixed with animal food(rats pellets) at a dose of 2g/kg B.W per day For a period of six weeks, the female mice were allowed to consume and mated with male animal which is proven for fertility which did not receive the drug and non of the female animal were pregnant [23].

Antioxidant activity

Here, the ethanolic extract of Andrographis paniculata was used to study the In vitro antioxidant activity was measured by using the ferrous reducing antioxidant power assay, 1, 1- diphenyl-2-picryl hydrazyl (DPPH) scavenging activity, lipid peroxidation inhibitory activity, and superoxide scavenging activity. The inhibitory concentration was shown at a dose of 0.5mg/ml,0.1mg/ml and 0.9mg/ml. the result indicates that ethanolic extract shows more potent on antioxidant activity [24].

Antimalarial activity

The Antimalarial activity of Andrographis paniculata and its bioactive compounds such as (Andrographolide, Neoandrographlide, Deoxyandrographolide &andrographiside) have been reported individually by investigators Purnima Misra et.al on plasmodium berghei (NK) 65 infections in Mastomys natalensis. the results indicate that among the four diterpenes the neoandrographolide and deoxyandrographolide were found to be most effective in inhibition of parasitaemia level [25].

Antidiarrhoeal activity

The Anti diarrheal activity was studied insitu on E.coli enterotoxin which produces induced secretory responses that leads to cause diarrheal syndrome in the rabbit and guinea- pig ileal loop. An ethanol, chloroform,1-butanol extracts of the aerial parts of the plant which consists of active constituents of diterpene lactones, andrographolide, neo-andrographolide which shows the potent anti secretory activity at dose of (300mg/ml) in vivo against Eschericia coli enterotoxin induced diarrhoea where as the aqueous extract of the aerial part was not active [26].

Cardiovascular activity

The aerial parts of the Andrographis paniculata was extracted with dichloromethane (DCM) was used to study the cardiovascular activity in isolated perfused rat hearts by using the Langendorff-perfused model and method. The DCM extract reduces A. paniculata significantly reduces the coronary perfusion pressure up to 24.5 ± 3.0 ($P < 0.05$) and 29.4 ± 8.5 mm Hg ($P < 0.05$) at doses of 3 mg and 1 mg/ml, and respectively the heart rate by up to 49.5 ± 11.4 beats/minute ($P < 0.05$) at the dose of 3 mg [27].

Nephroprotective activity

T Rajendrakumar et al have investigated the study of ethanolic extract of Andrographis paniculata in preventing cisplastin induced Nephrotoxicity by using Wistar albino rats. When cisplastin is administered intraperitoneally at a dose of 7.5mg/kg which will induce nephrotoxicity in order to prevent the ethanolic extract of A. paniculata was given at a dose of 500mg/kg body weight for 15days prior to the administration of CP [28].

Antiviral activity

The antiviral activity of Andrographis paniculata, leaves were extracted using aqueous and ethanol and the isolated compound andrographolide was studied against NDV2K35 strain of Newcastle disease virus by

in ovo technique. The ethanolic and aqueous extract of A. paniculata at a dose of 2.5µg/mL conforms the antiviral activity against NDV [29].

Neuroprotective activity

The neuroprotective effect of the ethanolic extract of A. paniculata leaves shows the prescence of active constitutent of andrographolide and evaluated its neuroprotective mechanisms using glutamate-treated HT22 mouse hippocampal neuronal cells. Five mM glutamate reduced cell survival significantly to 55.90 ± 2.16% and 5 µM AG will restore the cell viability to 102.19 ± 13.98%, Andrographolide will decrease the early apoptosis by inhibiting Ca2+ influx, intracellular reactive oxygen species production and lipid peroxidation. Moreover, AG regulated the levels of Bcl-2, Bid, Bax, and apoptosis-inducing factor. AG also inhibited the phosphorylation of mitogen activated protein kinases including p38, extracellular signal-regulated kinase, and c-Jun N-terminal kinase [30].

Immunomodulatory Activity

In 1993 Anju puri et al. have studied that the ethanolic extract and purified diterpene andrographolides of A.paniculata induces significant stimulation effect on antibody and delayed type of hypersensitivity (DTH) response to sheep red blood cells(SRBC) in mice. The extract at a dose of 25mg/kg was given for 7days prior to the immunization with sheep red blood cells. The A.paniculata shows the potent stimulator effect on both antigen specific and non specific responses [31].

Traditional uses of *Andrographis paniculata*

In India, this plant is used as a decoction, juice, paste, leaf potency, aerial parts, roots, and whole plants to treat many types of fever (chronic, malaria, typhoid and overheat)[32].upper respiratory infections (influenza, whooping cough, bronchitis and asthma), snakebite/scorpion sting [33],diabetes [34],dysentery/diarrhea, cholera and digestive disorder [35],rheumatism(frozen joint and joint pain, gout and arthritis) [36], stomach ache, Head ache [37],skin disease [38] and it has blood purifying property there fore it is used for leprosy,gonnorhea,scabies,boils, and in many conventional system [39],constipation [40]wounds,ulcer, dizziness, abdominal cramps [41], It is used as a cure for torpid liver and jaundice, [42,43],

Conclusion

Andrographis paniculata has been used to cure a variety of conditions, showing Anti-inflammatory activity, hepatoprotective, antidiabetic, anticancer, antibacterial, antimalarial, antivenom, analgesic, antifertility, antioxidant, antidiarrheal, neuroprotective, cardioprotective, antiviral and Nephroprotective activities.

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