



Medicinal and pharmacological properties of *Andrographis paniculata*

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Abstract

A lot of literature reviews about *Andrographis paniculata* has been published previously. Researchers are critically involved in the research to extract out the potential medicinal value that possess by the “King of Bitter”. It has a broad pharmacological value. Traditionally many disease condition have been treated successfully. The success of the plant is due to the presence of few bioactive compounds such as andrographolide, homo-andrographolide andrographesterol, andrographopne which are identified through the phytochemistry studies of the plant which are having the wide therapeutic activities. The extremely bitter taste of the plant is due the compound known as andrographolide. However this bitter plant is having a sweet future for those appreciated the benefits of the plant. From the review it is proven that *Andrographis paniculata* is having antioxidant, hepatoprotective, antimicrobial, anticancer, antivenom, anti HIV, antimalarial, antipyretic, antifertility, antidiarrhoeal, antidiabetic, antihyperlipidemic activities. Variety of literature concerning about the toxicity studies has confirmed that the plant is safe to consume although few findings revealed that consuming *Andrographis paniculata* for a long period of time may possess some unwanted action especially in the fertility studies.

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Introduction

Andrographis paniculata is a plant that has been effectively used in traditional Asian medicines for centuries. Its perceived “blood purifying” property results in its use in diseases where blood “abnormalities” are considered causes of disease, such as skin eruptions, boils, scabies, and chronic undetermined fevers. The aerial part of the plant, used medicinally, contains a large number of chemical constituents, mainly lactones, diterpenoids, diterpene glycosides, flavonoids, and flavonoid glycosides. Controlled clinical trials report its safe and effective use for reducing symptoms of uncomplicated upper respiratory tract infections. Since many of the disease conditions commonly treated with *Andrographis paniculata* in traditional medical systems are considered self-limiting, its purported benefits need critical evaluation (Akbar, 2011).

Andrographis paniculata grows widely in many Asian countries, such as China, India, Thailand and Sri Lanka and has a long history of therapeutic usage in Indian and Oriental medicine. The herb is official in Indian Pharmacopoeia as a predominant constituent of at least 26 Ayurvedic formulations used to treat liver disorders. It is one of the herbs, which can be used to treat neoplasm as mentioned in ancient Ayurvedic literature. *Andrographis paniculata* is reported as a cold property herb in Traditional Chinese medicine (TCM) and is used to get rid of body heat and to expel toxins (Majee *et al.*, 2011). Table 1 represent the taxonomy of *Andrographis paniculata* (Alireza *et al.*, 2011).

Andrographolide, a bitter principle obtained from *Andrographis paniculata* is a diterpene lactone, responsible for various pharmacological activities. This is a well known phytoconstituent from Indian System of Medicine, used in the management of different diseases since time immemorial. Research activities worldwide to exhibit the beneficial role of Andrographolide are continuously enriching the

therapeutic arsenal of this important phytomolecule. In addition to the well known pharmacological activities like hepatoprotective, antioxidant, hypoglycemic etc., recent advances in the management of immune system and neoplastic diseases make andrographolide the phytoconstituent of the hour (Maiti *et al.*, 2006). The therapeutic value of *Andrographis paniculata* is due to its mechanism of action which is perhaps by enzyme induction (Meenatchisundaram *et al.*, 2009).

Table 1. Taxonomy of *Andrographis paniculata*.

Kingdom	Plantae, plants
Subkingdom	Tracheobionta, vascular plants
Superdivision	Spermatophyta, seed plants
Division	Angiosperma
Class	Dicotyledonae
Sub-class	Gamopetalae
Series	Bicarpellatae
Order	Personales
Tribe	Justicieae
Family	Acanthaceae
Genus	<i>Andrographis</i>
Species	<i>Paniculata</i>

Andrographis paniculata grows erect to a height of 30– 110 cm in moist, shady places. The slender stem is dark green, squared in cross-section with longitudinal furrows and wings along the angles. The lance-shaped leaves have hairless blades measuring up to 8 centimeters long by 2.5 wide. The small flowers are borne in spreading racemes. The fruit is a capsule around 2 centimeters long and a few millimeters wide. It contains many yellow brown seeds (Kumar *et al.*, 2012). Figure 1 represent the image of *A. paniculata*. The leaves of *Andrographis paniculata* contain maximum active principle like andrographolide, homo-andrographolide andrographesterol and andrographolone. Andrographolide is the major

constituent in leaves which is bitter substance. The leaves of the herb were found to contain the highest amount of andrographolide and the seeds contain the lowest. The average andrographolide content varied from 12.44 to 33.52 mg/g in dried leaves found maximum at 90-120 days (Parashar *et al.*, 2011).



Fig. 1. Image of *Andrographis paniculata*.

Andrographis paniculata is being used mainly for treating fever, liver disease, diabetes, snake bite (Patidar *et al.*, 2011). It is also used as antibiotic, antiviral, antimicrobial, anti-inflammatory, anticancer, anti-HIV, anti-allergic (Jegathambigai *et al.*, 2010). It is also utilised for common cold, hepatoprotective activity, antimalarial, antidiarrheal and intestinal effect, cardiovascular activity, antifertility activity, pain reduction (Jarukamjorn and Nemoto, 2008). It is also possess antifungal activity, cholerectic activity and in the Unani system of medicine, it is considered aperient, emollient, astringent, diuretic, emmenagogue, gastric tonic, carminative. It is recommended for use in cases of leprosy, gonorrhoea, scabies, boils, skin eruptions, chronic and seasonal

fevers, pharyngolaryngitis, dysentery, cough with thick sputum, carbuncle, sores (Akbar, 2011). It is also having potential to be used as herbicidal and it is used as antiarthritis (Alireza *et al.*, 2011).

Antioxidant activity

Hydroalcoholic extract of *Andrographis paniculata* possesses antioxidant activity against oxidative alterations in myocardium and confer significant cardioprotective activity by helping in retaining the cardiac function in a normal manner (Ojha *et al.*, 2009). In vitro antioxidant studies using 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay showed that ethanol extracts have superior free radical scavenging activity with IC₅₀ value = 10.9 than aqueous extracts with IC₅₀ value = 24.65. This study showed that pretreatment with ethanolic extract of *Andrographis paniculata* ethanolic provided significant antioxidant property (Wasman *et al.*, 2011). The active antioxidant compounds are better extracted in methanol for *Andrographis paniculata*. Also suggested that there is a direct correlation between the total polyphenols extracted and anti-oxidant activity. The methanol extract of the leaves of *Andrographis paniculata* exhibited appreciable activity indicating that *Andrographis paniculata* has promising free radical scavenging activity (Sharma and Joshi, 2011).

Evaluation of the antioxidant property of *Andrographis paniculata* by employing three different methods DPPH, Lipid Peroxidation and DNA cleavage protective assay was carried out. In both the DPPH and Lipid Peroxidation methods, gallic acid and α -tocopherol were used as a standard antioxidant for comparison to the antioxidant property of *Andrographis paniculata*. Whereas in the DNA cleavage, pBS plasmid was used to assess the protective activity of *Andrographis paniculata*. In the DPPH method the RSC (radical scavenging capacity) of the plant extract was measured spectrophotometrically at 512nm. The lipid peroxidation inhibition activity of plant extract was also evaluated by taking the absorbance of pink colored

complex formed at 535nm. In the DNA cleavage protective assay, the electrophoretic pattern of DNA after UV-induced photolysed H₂O₂ – oxidative damage were different in the absence and presence of methanolic extract of plant. In the above mentioned antioxidant assays the methanolic extract of *Andrographis paniculata* showed higher antioxidant activity than water- methanolic extracts (Huidrom and Deka, 2012).

The beneficial effects of antioxidant properties *Andrographis paniculata* were studied in the diabetic animals. Diabetes was induced with single intraperitoneal injection of streptozotocin (45 mg/kg, i.p) dissolved in freshly prepared citrate buffer (pH 4.5), resulted in elevation of blood glucose levels, decrease in the superoxide dismutase and catalase activity. Oral administration of *Andrographis paniculata* (400 mg/kg, p.o) resulted in significant decrease in the blood glucose levels and increase in the activity of SOD and catalase. Study demonstrates that *Andrographis paniculata* (400mg/kg, p.o) showed potential antioxidant activity (Dandu and Inamdar, 2009).

Different µg/ml concentration of ethanolic extract (200µg to 1000µg/ml) was used for the estimation of antioxidant activity of *Andrographis paniculata*. Initially 200 to 400 µg/ml increases the working sample and inhibition also increased. Further 400 -1000µg/ml concentration decreased ratio of the activity was showed. Finally 91.01% of maximum antioxidant activity was observed at the concentration of 1000µg/ml (Doss and Kalaichelvan, 2012). Leaf extracts showed the highest antioxidant potential followed by stem and fruit extracts with the rabbit erythrocytes hemolysis and superoxide dismutase activity assays. However, *Andrographis paniculata* fruit extracts exhibited the highest DPPH free radical scavenging activity compared to the other extracts (Rafat *et al.*, 2010).

Anticancer activity

Three compounds were isolated from chloroform and methanolic extract of *Andrographis paniculata* which were coded as AND-6, AND-4, AND-11. Among those AND-4 possess cytotoxic activity against cancer cell lines Hep G2, HCT-116 using MTT Assay (Mulukuri *et al.*, 2011).

Andrographolide isolated from *Andrographis paniculata* at 0.35 mM, 0.70 mM and 1.40 mM induced DNA fragmentation and increased the percentage of apoptotic cells when TD-47 human breast cancer cell line was treated for 24, 48 and 72 hours. The results demonstrated that andrographolide can induce apoptosis in TD-47 human breast cancer cell line in a time and concentration-dependent manner by increase expression of p53, bax, caspase-3 and decrease expression of bcl-2 determined by immunohistochemical analysis (Harjotaruno *et al.*, 2007).

The methanolic extract of *Andrographis paniculata* was fractionated into dichloromethane, petroleum ether and aqueous extracts and screened for bioactivity. Results indicate that the dichloromethane fraction of the methanolic extract retains the active compounds contributing for both the anticancer and immunostimulatory activity. Dichloromethane fraction significantly inhibits the proliferation of HT-29 (colon cancer) cells and augments the proliferation human peripheral blood lymphocytes (HPBLs) at low concentrations. On further fractionation of the dichloromethane extract we could isolate three diterpene compounds, example andrographolide, 14-deoxyandrographolide and 14-deoxy-11,12-didehydroandrographolide. Andrographolide showed anticancer activity on diverse cancer cells representing different types of human cancers. Whereas all the three molecules showed enhanced proliferation and interleukin-2 (IL-2) induction in HPBLs (Kumar *et al.*, 2004).

The GC-MS evaluation of ethanolic leaf extract of *Andrographis paniculata* revealed that tetradecanoic, phytol, squalene, sitosterol compounds were having anticancer properties (Kalaivani *et al.*, 2012).

Hepatoprotective activity

In a research conducted to study the activity of *Andrographis paniculata* in liver protective activity, acute hepatotoxicity induced by paracetamol (150 mg/kg) in Swiss albino mice. Oral administration of *Andrographis paniculata* extract (100-200mg/kg) offered a significant dose dependent protection against paracetamol induced hepatotoxicity as assessed in terms of biochemical and histopathological parameters. Study revealed that the extracts of *Andrographis paniculata* offered protection against hepatotoxicity induced by paracetamol (Nagalekshmi *et al.*, 2011).

The effect of *Andrographis paniculata* extract was studied on ethanol induced hepatic damage in rats. Treatment with aqueous extract of *Andrographis paniculata* (50mg/kg, 100mg/kg, 200mg/kg body weight) was found to protect the rat from hepato toxin action of ethanol an evidenced significant reduction in the elevated serum transaminase levels (Vetriselvan *et al.*, 2010).

Antimicrobial activity

Ethanol extract of the aerial part of *Andrographis paniculata* was prepared and evaluated for antimicrobial activity against eleven bacterial strains by determining minimum inhibitory concentration and zone of inhibition. Minimum inhibitory concentration values were compared with control and zone of inhibition values were compared with standard ciprofloxacin in concentration 100 and 200 µg/ml. The results revealed that, the ethanol extract is potent in inhibiting bacterial growth of both Gram-negative and Gram positive bacteria (Mishra *et al.*, 2009).

Antimicrobial activity of leaf extract of *Andrographis paniculata* Wall., was studied using different solvent like chloroform, acetone, ethanol and water against bacterial strains like *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and fungal strains *Aspergillus niger* and *Penicillium chrysogenum*. The antimicrobial activity was determined by disc diffusion method. Out of the four extract used, acetone and ethanol extracts were found to be highly active against *Staphylococcus aureus* and *Bacillus subtilis*. Highest in acetone (12 mm) and lowest in ethanol (10 mm) (Hosamani *et al.*, 2011)

The chloroform extracts of the stem and the root of *Andrographis paniculata* showed considerable antibacterial and antifungal activities. The chloroform extract of the stem (100 µg/ml) showed the significant antibacterial activity against all the tested organisms compared with the standard benzyl penicillin, but the chloroform extract of the root (100 µg/ml) showed moderate activity against the organisms tested with the standard benzyl penicillin. These extracts also showed moderate antifungal activity against the tested organisms compared with the standard fluconazole (Radhika and Lakshmi, 2010).

The antimicrobial activity of aqueous extract, andrographolides and arabinogalactan proteins from *Andrographis paniculata* were evaluated. The aqueous extract showed significant antimicrobial activity, which may be due to the combined effect of the isolated arabinogalactan proteins and andrographolides (Singha *et al.*, 2003).

Hot and cold methanol extract of leaves and whole plant of *Andrographis paniculata* were screened separately for their anti-bacterial activity against *Staphylococcus aureus* (MTCC-737) and *Escherichia coli* (MTCC-452) using agar well diffusion method. The susceptibility of the microorganisms to the extracts was compared with each other and with selected standard antibiotic. It was observed that hot methanol

extracts of leaves showed the significant anti bacterial activity against both bacteria while least bacterial activity was recorded with cold methanolic extracts of whole plant of *Andrographis paniculata*. Phytochemical analysis revealed the presence of flavonoids, alkaloids, phenols, glycoside, tannins and saponins (Sharma *et al.*, 2011).

An ethanol extract of the leaves inhibited the growth *in vitro* of *Escherichia coli* and *Staphylococcus aureus*. A 50% methanol extract of the leaves inhibited growth *in vitro* of *Proteus vulgaris*. However, no *in vitro* antibacterial activity was observed when dried powder from the aerial parts was tested against *E. coli*, *Staphylococcus aureus*, *Salmonella typhi* or *Shigella* species (Meenatchisundaram *et al.*, 2009).

The antifungal activity of extracts of *Andrographis paniculata* was evaluated by agar well diffusion method against five selected fungal species. Stem extracts of *Andrographis paniculata* showed high antifungal activity against *A.oryzae*, *Penicillium* sp and *C.albicans*. The root extracts showed high antifungal activity against *A. niger*, *A. flavus*, *C.albicans*, *Penicillium* sp and *A.oryzae* and also leaf extracts showed high antifungal activity against *Penicillium* sp and *A. flavus* but did not show antifungal activity against *C.albicans*, *A. niger*, *A.oryzae* (Rajalakshmi *et al.*, 2012).

Dichloromethane (DCM) extract revealed lowest minimum inhibitory concentration (MIC) value (100 µg/mL) against *Microsporum canis*, *Candida albicans*, and *Candida tropicalis*, whereas methanol (MEOH) extract revealed lowest MIC (150 µg/mL) against *C. tropicalis* and *Aspergillus niger*. DCM extract showed lowest minimum fungicidal concentration (MFC) value (250 µg/mL) against *M. canis*, *C. albicans*, *C. tropicalis* and *A. niger*, whereas MEOH extract showed lowest MFC (250 µg/mL) against *Trichophyton mentagrophytes*, *Trichophyton rubrum*, *M. canis*, *C. albicans*, *C. tropicalis* and *A. niger* (Sule *et al.*, 2012).

Andrographis paniculata showed the presence of promising antibacterial substances against *B. cereus* and *L. monocytogene* under normal and osmotic stress (Pitinidhipat and Yasurin, 2012).

The methanol extracts of *Andrographis paniculata* possess the ability of inhibiting the activity of DENV-1 (dengue virus serotype 1) in *in vitro* assays (Tang *et al.*, 2012). Andrographolide, neoandrographolide and 14-deoxy-11,12-didehydroandrographolide, ent-labdene diterpenes isolated from *Andrographis paniculata* showed viricidal activity against herpes simplex virus 1 (HSV-1) (wiart *et al.*, 2005).

Chloroform extract of *Andrographis paniculata* (30mg/ml) leaves and roots exhibit some antibacterial activity against *Staphylococcus aureus*. In the study conducted in Asia Metropolitan University, Malaysia revealed that the zone of inhibition of *Andrographis paniculata* against *Staphylococcus aureus* were as follow: leaves (17.33 mm), roots (10.67 mm), Erythromycin (24.00 mm), leaves and Erythromycin (20.67 mm), roots and Erythromycin (21.67 mm), leaves and roots (17.33 mm). The findings proved that the plant is having potential antibacterial activity against *Staphylococcus aureus* (Sivananthan and Elamaran, 2013).

Antidiabetic and antihyperlipidemic

The purified extract and andrographolide significantly ($P < 0.05$) decreased the levels of blood glucose, triglyceride, and LDL compared to controls. However, no changes were observed in serum cholesterol and rat body weight. Metformin also showed similar effects on these parameters (Nugroho *et al.*, 2012).

The hot water and ethanol extracts of *Andrographis paniculata* collected from Chittagong exhibited a significant hypoglycemic (blood glucose lowering) activity in both glucose-loaded and alloxan-induced diabetic rats. Oral administration of glucose (1.5 g/kg body weight) increased the blood sugar level while the

intraperitoneal (ip) administration of alloxan (40 mg/kg body weight) enhanced the blood sugar level much higher than that of the glucose-loaded rats. The hot water (0.8 g/kg b.w.) and ethanol extracts (2 g/kg b.w.) of *Andrographis paniculata* reduced the elevated glucose level by 41.51 and 41.82%, respectively in glucose-loaded rats as compared to the respective diabetic control rats. On the other hand, administration of hot water and ethanol extracts of *A. paniculata* decreased the blood sugar level by 46.21 and 45.13%, respectively in alloxan induced diabetic rats, when compared with that of diabetic control rats (Alamgir *et al.*, 2007).

The chloroform extract of *Andrographis paniculata* roots was tested for its antihyperglycemic activity in alloxan induced diabetic rats using chronic and acute studies. The blood glucose lowering activity was determined after oral administration at doses of 50, 100 and 150 mg/kg body weight in acute study. Where as in case of chronic study blood glucose, protein, albumin and creatinine levels were estimated after 4 weeks of treatment at the dose of 300 mg/kg. The study proved significant antidiabetic activity of chloroform extract of *Andrographis paniculata* roots (Rao, 2006).

Water extract of *Andrographis paniculata* 10 mg/kg body weight can prevent induction of hyperglycaemia significantly ($P < 0.001$) induced by oral administration of glucose 2 mg/kg body weight. But any how failed to do so in adrenaline induced hyperglycaemia. It also failed to demonstrate any "fasting blood sugar lowering effect" upon chronic administration (6 weeks) of *Andrographis paniculata*. So probably *Andrographis paniculata* prevents glucose absorption from gut. Whole experiment was done on rabbits (Borhanuddin *et al.*, 1994).

Anti-human immunodeficiency virus (HIV) activity

Aqueous extracts of the leaves inhibited HIV-1 infection and replication in the lymphoid cell line MOLT-4. A hot aqueous extract of the aerial parts reduced the percentage of HIV antigen-positive H9 cells. Dehydroandrographolide inhibited HIV-1 and HIV-1 (UCD123) infection of H9 cells at 1.6mg/ml and 50mg/ml, respectively, and also inhibited HIV-1 infection of human lymphocytes at 50mg/ml. A methanol extract of the leaves suppressed syncytia formation in co-cultures of uninfected and HIV-1-infected MOLT cells (median effective dose [ED₅₀] 70mg/ml) (Meenatchisundaram *et al.*, 2009).

Antipyretic activity

Intragastric administration of an ethanol extract of the aerial parts (500mg/kg body weight) to rats decreased yeast-induced pyrexia. The extract was reported to be as effective as 200 mg/kg body weight of aspirin, and no toxicity was observed at doses up to 600 mg/kg body weight. Intragastric administration of andrographolide (100 mg/kg body weight) to mice decreased brewer's yeast induced pyrexia. Intragastric administration of deoxyandrographolide, andrographolide, neoandrographolide or 11,12-didehydro-14-deoxyandrographolide (100 mg/kg body weight) to mice, rats or rabbits reduced pyrexia induced by 2,4-dinitrophenol or endotoxins (Meenatchisundaram *et al.*, 2009).

Antidiarrhoeal activity

Herba *Andrographis paniculata* has antidiarrhoeal activity in situ. An ethanol, chloroform or 1-butanol extract of the aerial parts (300mg/ml) inhibited the *E. coli* enterotoxin-induced secretory response-which causes a diarrhoeal syndrome in the rabbit and guinea-pig ileal loop assay. However, an aqueous extract of the aerial parts was not active. The constituent diterpene lactones, andrographolide and

neoandrographolide, exhibited potent antisecretory activity in vivo against *Escherichia coli* enterotoxin induced diarrhoea. Andrographolide (1 mg per loop) was as active as loperamide when tested against heat labile *E. coli* enterotoxin-induced diarrhoea and more effective than loperamide when tested against heat-stable *Escherichia coli* enterotoxin induced diarrhoea. Neoandrographolide (1 mg per loop) was as effective as loperamide when tested against heat-labile *E. coli* enterotoxin induced diarrhoea and slightly less active than loperamide when tested against heat-stable *E. coli* enterotoxin-induced diarrhoea. The mechanism of action involves inhibition of the intestinal secretory response induced by heat labile *Escherichia coli* enterotoxins, which are known to act through the stimulation of adenylate cyclase, and by inhibition of the secretion induced by heat-stable *E. coli* enterotoxins, which act through the activation of guanylate cyclase. Incubation of murine macrophages with andrographolide (1–50 mol/l) inhibited bacterial endotoxin-induced nitrite accumulation in a concentration- and time dependent manner (Meenatchisundaram *et al.*, 2009).

Antifertility activity

Dry leaf powder of *Andrographis paniculata*, when fed orally to male albino rats, at a dose level of 20 mg powder per day for 60 days, resulted in cessation of spermatogenesis, degenerative changes in the seminiferous tubules, regression of Leydig cells and regressive and/or degenerative changes in the epididymis, seminal vesicle, ventral prostate and coagulating gland. There was reduction in the weight and fluid content of the accessory glands (Akbarsha *et al.*, 1990). No toxicity of andrographolide (50 mg/kg) treatment for up to 8 weeks on number and motility of sperm could be observed (Sattayasa *et al.*, 2010).

Antimalarial activity

The 50% inhibitory concentration (IC₅₀) of *Andrographis paniculata* (7.2 µg/ml) and the plant extract was found to inhibit the ring stage of the

parasite (two strains of *Plasmodium falciparum*) and did not show any *in vivo* toxicity (Mishra *et al.*, 2009). In an another separate study four xanthenes were isolated from the roots of *Andrographis paniculata* using a combination of column and thin-layer chromatographic methods. They were characterized as 1,8-di-hydroxy-3,7-dimethoxy-xanthone, 4,8-dihydroxy-2,7-dimethoxy-xanthone, 1,2-dihydroxy-6,8-dimethoxy-xanthone and 3,7,8-trimethoxy-1-hydroxy xanthone by IR, MS and NMR spectroscopic methods. *In vitro* study revealed that compound 1,2-dihydroxy-6,8-dimethoxy-xanthone possessed substantial anti-plasmodial activity against *Plasmodium falciparum* with its IC₅₀ value of 4 microg ml⁻¹. Xanthenes bearing hydroxyl group at 2 position demonstrated most potent activity while xanthenes with hydroxyl group at 1,4 or 8 position possessed very low activity. *In vivo* anti-malarial sensitivity test of this compound on Swiss Albino mice with *Plasmodium berghei* infection using Peters' 4-day test gave substantial reduction (62%) in parasitaemia after treating the mice with 30 mg kg⁻¹ dose. *In vitro* cytotoxicity against mammalian cells revealed that 1,2-dihydroxy-6,8-dimethoxy-xanthone is non-cytotoxic with its IC₅₀ > 32 microg ml⁻¹ (Dua *et al.*, 2004).

Antivenom activity

Intraperitoneal injection of an ethanol extract of the aerial parts (25 g/kg body weight) to mice poisoned with cobra venom markedly delayed the occurrence of respiratory failure and death. The same extract induced contractions in guinea-pig ileum at concentrations of 2 mg/ml. The contractions were enhanced by physostigmine and blocked by atropine, but were unchanged by antihistamines. These data suggest that extracts of the aerial parts do not modify the activity of the nicotinic receptors but produce significant muscarinic activity, which accounts for its antivenom effects (Meenatchisundaram *et al.*, 2009).

Toxicity and dosing

In a research to determine toxicity and dosing, the LD₅₀ of the alcohol extract, obtained by cold maceration, is 1.8 g/kg. The LD₅₀ of andrographolide (yield 0.78% w/w from whole plant) in male mice through intraperitoneal route is 11.46 g/kg. In the study on HIV-positive patients a dose of 1,500-2,000 mg of andrographolides was given daily for six weeks. Side effects were common and the study was discontinued early despite some improvements in CD4+ counts. Until definitive information on *Andrographis paniculata* and its constituents on reproduction is available, it would be prudent for both men and women to avoid this herb during desired conception and for women during pregnancy (Akbar, 2011)

Conclusion

From the review it can be concluded that *Andrographis paniculata* which is a famous medicinal plant which is used in China and India for a centuries is having a promising medicinal value. Critical research using this plant must be conducted so that the hidden medicinal value can be extracted out for the beneficial of the publics. From the review it was proven that *Andrographis paniculata* is having antioxidant, hepatoprotective, antimicrobial, anticancer, antivenom, anti HIV, antimalarial, antipyretic, antifertility, antidiarrhoeal, antidiabetic, antihyperlipidemic activities.

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