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## Pharmacological Potentials of *Andrographis paniculata*: An Overview

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**Abstract:** The main objective of this review was to provide the details about the pharmacological potentials of *Andrographis paniculata*. It was found that the plant possessed wide varieties of pharmacological activities including hepatoprotective, gastroprotective, anti-allergic, anticancer, anti-inflammatory, anti-hyperglycemic, antioxidant, antimicrobial, antimalarial, antidiarrheal, larvicidal, ovicidal, testicular toxicity. Several active diterpene phytoconstituents such as andrographolide, andrographiside and neoandrographolide, 14-deoxyandrographolide and 14-deoxy-11, 12-didehydroandrographolide were also isolated from the different parts of the plant. Moreover, four xanthenes such 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 were obtained from the roots of *Andrographis paniculata*. It was revealed that andrographolide was responsible for anti-hepatotoxic, anti-allergic, anticancer, anti-inflammatory, antimicrobial activities, larvicidal, ovicidal and testicular toxicity while xanthenes showed anti-plasmodial potential. Neoandrographolide, another diterpene phytoconstituent, showed antidiarrheal activity of the medicinal plant. However, due to the presence of 14-deoxyandrographolide and 14-deoxy-11, 12-didehydroandrographolide, the plant possessed antioxidant activity as well. This review study provided the evidence based information to the future scientists for qualitative research and for isolation and characterization of bioactive compounds.

**Key words:** *Andrographis paniculata*, pharmacological potentials andrographolide

### INTRODUCTION

*Andrographis paniculata* (Burm. f.) Nees, belonging to the family of Acanthaceae, is widely used in traditional and folkloric medicines (Puri *et al.*, 1993) in Asia and Europe for a wide spectrum of ailments. The common name of this medicinal plant is “King of Bitters” and widely cultivated in Southern Asia (Jarukamjorn and Nemoto, 2008). The most common uses of the plant include liver disorders, bowel complaints of children and convalescence after fever (Puri *et al.*, 1993). In traditional Chinese medicine, the plant is used for the treatment of fever, common cold, respiratory tract infections etc. In addition to this, the plant has common uses in diabetes, peptic ulcer, skin infections, snake bites, non-infectious diarrhea and hypertension in traditional Indian, Thai and Malaysian medicines. Several researches have showed a wide variety of pharmacological potentials of the plant such anti-inflammatory, antiviral, hepatoprotective, antidiarrheal, cardiovascular, anticancer and others

(Jarukamjorn and Nemoto, 2008). The aim of the research was to provide a summary of pharmacological potentials of the plant.

### PHARMACOLOGICAL POTENTIALS

**Hepatoprotective and gastroprotective activities:** The principle phytoconstituent andrographolide are presented in *Andrographis paniculata* is responsible for its anti-hepatotoxic activity (Handa and Sharma, 1990). Kapil *et al.* (1993) reported that the diterpenes such as andrographiside (II) and neoandrographolide (III) showed greater protective effects on hepatotoxicity due to the presence of glucoside groups which revealed their strong antioxidant properties. The acidity, pepsin concentration, myeloperoxidase and H<sup>+</sup>K<sup>+</sup>ATPase activities in the experimental rats were reduced by the hydroalcoholic extract of the plant. The flavonoids present in the plant extract played an important role in maintaining the antioxidants and thiol concentration in gastrointestinal tract (Panneerselvam and Arumugam, 2011).

### ANTI-ALLERGIC ACTIVITY

The presence of diterpenes such as andrographolide and neoandrographolide showed the anti-allergic activity of *Andrographis paniculata*. The mechanism involved in anti-allergic effect of the plant was mast cell stabilizing activity against egg albumin induced degranulation (Gupta *et al.*, 1998).

### ANTICANCER ACTIVITY

*Andrographis paniculata* possessed anticancer activity and the inhibition of the proliferation of colon cancer cells and augmentation of the proliferation of human peripheral blood lymphocytes at low concentration were revealed by the dichloromethane crude extract of the medicinal plant (Kumar *et al.*, 2004). They also isolated three diterpene phytoconstituents such as andrographolide, 14-deoxyandrographolide and 14-deoxy-11, 12-didehydroandrographolide on fractionation of the dichloromethane extract. The anticancer activity was observed due to the presence of andrographolide which acted by the inhibition of *in vitro* proliferation of various types of tumor cell lines. This phytoconstituent showed its direct anticancer activity at G0/G1 phase of the cell-cycle through induction of cell-cycle inhibitory protein p27. The expression of cyclin-dependent kinase 4 (CDK4) was decreased and the production of tumor necrosis factor- $\alpha$  was increased which contributed to cytotoxicity of lymphocytes against cancer cells (Rajagopal *et al.*, 2003). In addition to this, the extract of the plant and andrographolide increased the levels of interleukin-2 and interferon- $\gamma$  in treated animals. The mechanism involved in the inhibition of tumor growth was to stimulate the cytotoxic T lymphocyte production through increased secretion of interleukin-2 and interferon- $\gamma$  (Sheeja and Kuttan, 2007).

### ANTI-INFLAMMATORY ACTIVITY

Shen *et al.* (2002) reported that the inflammatory responses produced by rat neutrophils were inhibited by the most important diterpenoid phytoconstituent andrographolide. The possible mechanism of inhibition of reactive oxygen species by andrographolide could be an antagonism of N-formyl-methionyl-leucyl-phenylalanine (fMLP), phorbol-12-myristate-13-acetate (PMA) and a direct protein kinase C (PKC) activator. It also suppressed the function of an essential integrin such as surface Mac-1 (CD11b/CD18) responsible for neutrophils adhesion and transmigration. The expression of inducible nitric oxide synthase (iNOS) was suppressed by andrographolide.

Moreover andrographolide could inhibit the activation of NF-kappaB and the expression of cyclo-oxygenase-II in human fibroblast cells. The diterpenoid also had inhibitory effect on the production of oxygen free radical by human neutrophils (Levita *et al.*, 2010). Sheeja *et al.* (2006) observed that in *in vitro* system, the formation of oxygen derived free radicals such as superoxide (32%) hydroxyl radicals (80%) lipid peroxidation (80%) and nitric oxide (42.8%) was inhibited by methanolic extract of *Andrographis paniculata*. The methanolic extract of the plant also completely inhibited carrageenan induced inflammation.

### ANTI-HYPERGLYCEMIC ACTIVITY

Zhang and Tan (2000) investigated the antihyperglycemic effects of the ethanolic extract of the aerial parts of *Andrographis paniculata* in normal and streptozotocin-induced type I diabetic rats. They found that the fasting serum glucose level in diabetic rats ( $p < 0.001$ ) was decreased in comparison with distilled water as a vehicle. Higher concentrations ( $p < 0.005$ ) of liver glutathione (GSH) were also identified in diabetic rats treated with extract (400 mg kg<sup>-1</sup> b.wt.) and metformin (500 mg kg<sup>-1</sup> b.wt.), twice a day for 14 days. Oral administration of crude extract of the plant leaves (10 mg kg<sup>-1</sup> b.wt.) for eight weeks also showed the antidiabetic effect in alloxan induced rat (Rahmat *et al.*, 2006).

### ANTIOXIDANT ACTIVITY

The antioxidant activity of *Andrographis paniculata* was observed due to the presence of 14-deoxyandrographolide and 14-deoxy-11, 12-didehydroandrographolide which were isolated from the plant (Koteswara *et al.*, 2004). Verma and Vinayak (2008) investigated the antioxidant effect of the aqueous extract of *Andrographis paniculata* in lymphoma containing mice. A significant increase in catalase, superoxide dismutase and glutathione S transferase activities was observed by the different doses of the aqueous extract of the medicinal plant which indicated the antioxidant properties of *Andrographis paniculata* and might reduce the oxidative stress. They also found that carcinogenic activity was decreased due to a significant reduction of lactate dehydrogenase activity on treatment with *Andrographis paniculata*. Even a comparison was done between an anticancer drug doxorubicin and aqueous extract of the plant. The results showed that the aqueous extract of *Andrographis paniculata* was more effective than doxorubicin in different enzymatic systems such as

catalase, superoxide dismutase, glutathione S transferase and lactate dehydrogenase in liver of lymphoma containing mice. Ojha *et al.* (2009) found that the activities of antioxidant enzymes such as super oxide dismutase, catalase and glutathione peroxidase were increased by the hydroalcoholic extract of the medicinal plant. Beside this, the prevention of the leakage of lactate dehydrogenase from heart was performed by the plant extract. Moreover, myocardial ischemic injury in rats induced by isoproterenol was also treated by the extract which showed significant results. Finally, it was concluded that *Andrographis paniculata* possessed a significant antioxidant activity.

#### ANTIMICROBIAL ACTIVITY

Poolsup *et al.* (2004) reported antimicrobial activity of *Andrographis paniculata*. They found that the plant extract may be effective against uncomplicated upper respiratory tract infection. Xu *et al.* (2006) also investigated the antimicrobial activity against nine bacterial strains such as *Salmonella typhimurium*, *Escherichia coli*, *Shigella sonnei*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Streptococcus pneumoniae*, *Streptococcus pyogenes*, *Legionella pneumophila* and *Bordetella pertussis*. The ethanolic extracts of *Andrographis paniculata* inhibited only two human pathogens including *Legionella pneumophila* and *Bordetella pertussis*. However, antimicrobial activity was due to the presence of an active chemical compound e.g., andrographolide in the ethanolic extract of the plant.

#### ANTIMALARIAL ACTIVITY

A considerable antimalarial activity was identified from *in vivo* and *in vitro* studies of *Andrographis paniculata* and complete inhibition of the growth of parasite was revealed by the chloroform extracts of the plant at 0.05 mg mL<sup>-1</sup> drug dose (Rahman *et al.*, 1999). Dua *et al.* (2004) isolated four xanthenes such 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 from the roots of *Andrographis paniculata* by column and thin-layer chromatographic methods. A substantial anti-plasmodial potential against *Plasmodium falciparum* was revealed and IC<sub>50</sub> value of the plant extract was 4 µg mL<sup>-1</sup>. A significant reduction (62%) in parasitaemia was also observed when the Swiss Albino mice with *Plasmodium berghei* infection were treated with 30 mg kg<sup>-1</sup> dose. The chloroform extract of the plant also inhibited the growth of malaria parasites such as *Plasmodium falciparum* and *Plasmodium berghei* (Rahman *et al.*, 1999).

#### ANTIDIARRHEAL ACTIVITY

A significant antidiarrhoeal activity against *E. coli* was revealed by the alcoholic extract of the plant. The effect produced by diterpenes such as andrographolide and neoandrographolide present in the extract was similar to loperamide against *E. coli* enterotoxins where andrographolide was more effective in epidemics of neonatal diarrhea (Gupta *et al.*, 1990).

#### LARVICIDAL, OVICIDAL AND TESTICULAR TOXICITY

The benzene, hexane, ethyl acetate, methanol and chloroform leaf extracts of *Andrographis paniculata* were investigated for larvicidal and ovicidal activities against *Culex quinquefasciatus* Say and *Aedes aegypti* L. They reported that all of the extracts were more effective against *Culex quinquefasciatus* than *Aedes aegypti* while methanol and ethyl acetate extracts of the plant showed ovicidal activity against *Culex quinquefasciatus* and *Aedes aegypti*. The results also showed 100% mortality against two mosquito species exerted by methanol and ethyl acetate extracts (Govindarajan, 2011). No testicular toxicity effect of *Andrographis paniculata* was found in male rats (Burgos *et al.*, 1997).

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