Andrographis Paniculata – A Review

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Received on: 15 May 2020
Revised on: 15 Apr 2020
Accepted on: 23 Apr 2020

Keywords:
- Ethnobotany
- Andrographolide
- common cold
- chemical constituents

Abstract
Andrographis paniculata (AP) is commonly known as creat or green chiretta belongs to the family Acanthaceae. It is also known as Kalmegh and popularly called as King of bitters. It was widely used in the traditional system of medicines such as Siddha system, Ayurvedic system and Chinese medicine for the regular treatment of a common cold. Some of the reported health benefits are Antidiabetic, Antipyretic, Hepatoprotective, Antioxidant, Antimalarial, Anti-cancer, Antityphoid, Anti-diarrhoea, antioedema, etc. Whole plant possesses medicinal property and leaves are explicitly used for therapeutic care. The plant contains four major diterpenoids such as andrographolide, neoandrographolide, 14-deoxyandrographolide, 14-deoxy-11,12-didehydroandrographolide and also includes other phytoconstituents such as flavonoidsesquiterpene lactones, etc. Andrographolide is found as major constituent in the leaves and reported for a wide variety of pharmacological activities. The purpose of this review is to brief the plant’s literatures survey via internet sources such as google scholar and PubMed providing a medium to explain the plant’s ethnobotany information on conventional usage, essential chemical constituents and selected plant pharmacology activities are obtained from existing research articles to frame the review. The present analysis also illustrates the pharmacological and phytochemical characteristics of Andrographis paniculata from which researchers may get benefited for further qualitative research.

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ISSN: 0975-7538
DOI: https://doi.org/10.26452/ijrps.v11i4.3162

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INTRODUCTION

Andrographis paniculata is an annual herbaceous plant native to India, Sri Lanka, Pakistan, and Indonesia and has a spread in China, Thailand, Mauritius, East and West Indies (Mishra et al, 2007). The plant usage was found in Chinese, Ayurvedic (Jayakumar et al, 2010), and the Siddha system of medicine (Sajeeb et al, 2015). The plant contains significant diterpenoid lactone known as andrographolide, which is responsible for antimalarial and anticancer activities (Sajeeb et al, 2015). Andrographolide can be isolated and purified by column chromatography methods, hydrotrropic microwave-assisted extraction, and soxhlet extraction (Jadhao, 2013). Its purity is determined by high-performance liquid chromatography, thin-layer chromatography, UV absorption spectrum, liquid chromatography-mass spectrometry, and differential scanning calorimetry. Andrographolide is found more in leaves (Jayakumar et al, 2013), whereas seeds have the lowest content (Ghosh et al, 2012). AP has the document of showing antifungal,
antibacterial, hypoglycaemic, antiviral, choleric, and hypocholesterolemic activity. The plant is known for its blood purifying activity (Raja and Pandiyyan, 2016). The herbal medicine of AP was widely used in the treatment of cancer, hypertension, influenza, and antidiabetic by the people of Asia, America, and Africa. AP also has shown anti-tumour, and anti-metastatic effects on Esophageal cancer (EC) (Li et al., 2017). AP is also used as a herbicidal agent (Biomol et al., 2013).

Pharmacognosy and Distribution

1. AP is a herbaceous plant usually grows in shady and moist places.

2. It is an annual herb that grows to a height of 30-110 cm.

3. The stem is green in colour and leans in shape, and long pointed leaves are present.

4. The plant has flowers, fruits, and small yellow-brown seeds. (Nitave and Koumaravelou, 2016).

Phytoconstituents

Twenty diterpenoids, ten flavonoids, and sesquiterpene lactone were reported from AP. The major diterpenoids are andrographolide, 14-deoxyandrographolide, neoandrographolide, 14-deoxy-11, 12-didehydroandrographide, isoandrographolide. Ethyl acetate soluble fractions of Ethanol or methanol extract contain 2’-O-D-glucopyranoside, 5, 2’-dihydroxy-7, 8 dimethoxyflavone, 7-O-methylwogonin, 5-hydroxy-7, 8-dimethoxyflavone, 2’-hydroxy-5, 7, 8 trimethoxyflavone, wightin, 5,7,8,2’ tetramethoxyflavone, 5-hydroxy-7, 8-dimethoxyflavone, andrographolide A, 5, 2’-dihydroxy-7, 8-dimethoxy flavone, andrographolide B, and rographolide C, from roots β-sitosterol, β-daucosterol and lupeol, triacylglycerols, monogalactosyl diacylglycerols from pods were isolated. Andrographis acid a diterpenoid was reported (Gupta et al., 1983; Tan et al., 2016; Chao and Lin, 2010; Li et al., 2007).

Taxonomic Classification

Kingdom-Plantae
Order-Lamiales
Family-Acanthaceae
Genus-Andrographis
Species- paniculata

Vernacular names
Arabic: Quasabhuva
Gujarati: Kariyatu
Tamil: Nilavembu
Kannada: Nelaberu
Telugu: Nelavembu
Marathi: Oil-kiryata
Hindi: Kirayat
Sanskrit: Kalamegha (Kumar et al., 2012)

Figure 1
Figure 1: Andrographis paniculata plant in Natural Habitat

Cultivation and Propagation

Usually cultivated by seeds, grows well in any type of soil with proper organic matter. The plant can be cultivated in plain land, grounds, hills, moist habitat, farms, and roadsides. It can also be grown through tissue culture. Andrographolide will be more in leaves during flowering. Good yield can be got within 90-100 days. The rainy season is the best time to cultivate the plant (Mishra et al., 2007; Nitave and Koumaravelou, 2016).

Reported therapeutic activities

Antimalarial, Antiviral, Antiinflammatory, Antioxidant, Analgesic, Sedative, Vermicidal, Antipyretic, Expectorant and many more pharmacological activities are reported by AP (Das et al., 2011).

Common cold

In this study, Kan Jang tablets made from Andrographis paniculata were given to group I with 52 volunteers and a placebo was given to group 2 with 53 volunteers for about three months by regular health check-up of the common cold. The results showed no change in group I and group II in the 1st and 2nd month, but in 3rd month the chances of occurrence of cold were 2.1 times lower for a group I that is
<table>
<thead>
<tr>
<th>Part of the plant used</th>
<th>Used by</th>
<th>Used in the form</th>
<th>Treat/Manage</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole plant</td>
<td>Amada, Cholanaikkan, Paniya, Kuruman, Muthuvan tribal people of Malappuram district, Kerala, India</td>
<td>-</td>
<td>Cholera, Cancer</td>
<td>(Chithra et al., 2016)</td>
</tr>
<tr>
<td>Whole plant</td>
<td>Yerukalas tribal people of cudadpah district, Andhra Pradesh, India</td>
<td>Decoction</td>
<td>Stomachic</td>
<td>(Chamratpan and Homchuen, 2005)</td>
</tr>
<tr>
<td>Whole plant</td>
<td>Yerukalas tribal people of cudadpah district, Andhra Pradesh, India</td>
<td>Decoction + cow urine+ pinch of benzoin</td>
<td>Edema</td>
<td>(Reddy et al., 1991)</td>
</tr>
<tr>
<td>Seeds, Leaves</td>
<td>Chanchal block of Malda district, West Bengal, India</td>
<td>A paste of seeds, leaves + Tulsi leaves paste +basak +honey consumed with warm milk</td>
<td>Bronchitis</td>
<td>(Sarker and Kar, 2014)</td>
</tr>
<tr>
<td>The whole plant, Leaves</td>
<td>Santhal tribe of Dohanagar, Naoagaon, Bangladesh</td>
<td>Leaves paste Juice of the whole plant Juice of whole plant + salt + water</td>
<td>Wounds itches Fever. Dysentery, diarrrhoea Helminthiasis</td>
<td>(Rahman et al., 2010)</td>
</tr>
<tr>
<td>Leaves</td>
<td>People of kolli hills Namakkal district, Tamil Nadu, India</td>
<td>Powder+ cow/goat milk</td>
<td>Diabetes</td>
<td>(Kadirvelmuru-gan et al., 2014)</td>
</tr>
<tr>
<td>Whole plant</td>
<td>Baiga tribe, India</td>
<td>Plant extract</td>
<td>Antityphoid, Antifungal</td>
<td>(Kapale, 2012)</td>
</tr>
<tr>
<td>Roots</td>
<td>Irula villages, India</td>
<td>-</td>
<td>Snake Antidote</td>
<td>(Muthulingam et al., 2013)</td>
</tr>
</tbody>
</table>

33% protection effect was reported (Melchior et al., 1997).

**Antipyretic activity**

The research aimed to show the antipyretic activity of methanolic leaf extract of Andrographis paniculatain Brewer's yeast induced pyrexia in albino rats. Pyrexia was induced in the rats, and 25 female albino rats were selected and divided into five groups, 5 in each group. Group 1 acted as a control. Group 2 was served with 150mg/kg of paracetamol, and group 3 was given with 50mg/kg of AP methanolic leaf extract, group 4 and group 5 was served orally with 100mg/kg,200mg/kg of AP methanolic leaf extract respectively and body temperature was measured at 30,60,90,120 mins time interval. The reports concluded that group 5 showed significant antipyretic effects when compared to standard drugs (Akintola et al., 2018).

**Antidiabetic activity**

In this research, ethanolic extract and hot water extract of AP were studied for hypoglycaemic activity. Both the extracts demonstrated hypoglycaemic activity in alloxan-induced diabetic rats and glucose administered rats. The ethanolic extract reduced...
blood sugar level by 46.21%, and hot water extract reduced blood sugar level by 45.13% in alloxan-induced diabetic rats. Ethanolic extract and hot water extract reduced the blood glucose level by 41.81% and 41.51 % respectively, in glucose administered rats. Hence this study concluded that both the extracts showed hypoglycaemic activity (Hos-sain et al., 1970).

**Antibacterial activity**

In the present study, 100 urine samples of suspicious patients were acquired and examined for the presence of bacteria and found to identify 47 isolates of Escherichia coli, Klebsiella pneumonia, pseudomonas aeruginosa, Proteus mirabilis, and Staphylococcus aureus. Ethanolic extract of AP was analyzed for antibacterial activity by the disc diffusion method. The results showed more inhibitory activity towards Staphylococcus aureus 26mm, Escherichia coli 21mm, Klebsiella pneumonia 23mm, Pseudomonas aeruginosa 19mm but no antimicrobial activity was reported in Proteus mirabilis. The study also reported the presence of oils, resins, phenols, flavonoids, tannins, terpenoids, and steroids in AP ethanolic extract. Hence this work confirmed the presence of Antimicrobial activity of ethanolic extract of AP (Rajeswari et al., 2018).

**Wound healing activity**

The wound healing property of AP was analyzed in Albino Wistar rats. They were selected and divided into four groups. Group 1 was served with topical application of blank placebo, group 2 were dressed with placebo having 5% AP extract, group 3 rats were applied 10% AP extract, and group 4 were used with intrasite gel. The results found that groups 3 and 4 reported better wound healing property compared to groups 1 and 2 (Al-Bayaty et al., 2012).

**Antioxidant and gastroprotective activity**

Ethanolic and aqueous leaf extracts of AP were studied for its antioxidant and gastroprotective activities. Sprague Dawley rats were divided into six groups, 6 in each group the rats were made to withdraw from food for two days and then treated with orogastric incubations. Group 1 was treated with carboxymethyl cellulose, group 2 is positive control which received omeprazole, group 3 and group 4 was given with 250mg/kg, 500mg/kg of aqueous AP leaf extract respectively, group 5 and 6 were served with 250mg/kg, 500mg/kg of ethanolic AP leaf extract respectively and the rats were given 95% ethanol orally after 1 hour. The rats were sacrificed and analyzed for histology. The results showed a notable and dose-dependent reduction in the gastric lesion and increased mucus content and gastric lesion of the stomach in groups 2, 3, 4. Whereas group 5, 6 showed better gastroprotective activity (Wasman et al., 2011).

**Antimicrobial and Antioxidant activity**

Chloroform, water, acetone, isoamyl alcohol, ethanol, petroleum ether extracts of AP were studied for antioxidant and antimicrobial activity. Isoamyl alcohol followed by ethanol extract reported more antibacterial activity against gram-positive bacteria - Micrococcus luteus, Staphylococcus aureus and gram-negative bacteria – Escherichia coli, Klebsiella pneumonia but no activity was shown by chloroform, acetone, water, petroleum ether extracts in gram-positive bacteria. No inhibition was seen in Escherichia coli by isoamyl alcohol, and ethanolic extracts were analyzed for their antioxidant activity and reported to have antioxidant and antimicrobial activity (Doss and Kalaichelvan, 2012).

**Antimalarial activity**

1,8-Dihydroxy-3,7-dimethoxy xanthone, 4,8-Dihydroxy-2,7-dimethoxy xanthone, 1,2-Dihydroxy-6,8-dimethoxy xanthone, 3,7,8-Trimethoxy-8-hydroxy xanthone were isolated and characterized and checked for antimalarial activity using NMR, MS, IR spectroscopic methods. The results of in vitro study showed that 1,2-Dihydroxy-6,8-dimethoxy xanthone has more anti-plasmodial activity with IC$_{50}$ value 4μg/ml. It also showed antimalarial activity against plasmodium berghei infected Swiss albino mice provided with 30mg/kg dose through IP route for four days in vivo system resulted in a substantial reduction of 62 % in parasitaemia (Dua et al., 2004).

**Hepatoprotective activity**

This research was carried to know LD$_{50}$ and hepatoprotective effect of aqueous leaf extract in carbon tetrachloride (CCL$_4$) intoxicated rats, 30 Wistar rats were divided into six groups of 5 each group I was control fed with 1ml/kg per day up to 5 days, a group I, II, III, IV, V, VI were given with standard dye and tap water on the 1st day. Group II was induction control given with 30% carbon tetrachloride in 1ml/kg for four days, group III was given with 30% CCL$_4$ in liquid paraffin and silymarin 100mg/kg for four days, group IV was given with 30% CCL$_4$, and group V, VI are administered with 100,200,300 mg/kg aqueous leaf extract of AP from 2nd day to 5th day, group V, VI were administered with 100,200,300 mg/kg aqueous leaf extract of AP from 2nd day to 5th day. On 6th day animals were sacrificed. The results showed an increase in activity of aspartate aminotransferase, direct bilirubin, alanine aminotransferase, alkaline phosphatase in rats which are treated with CCL$_4$ and extract-treated.
rats. Evident reduction in serum levels of total protein, high-density lipoprotein, glutathione, albumin came to normal levels in rats treated with CCl\(_4\) and the plant extract. LD\(_{50}\) of the plant extract was more than 300mg/kg. Thus the study concluded AP leaf extract showed hepatoprotective effect (Nasir et al., 2013).

CONCLUSION

Plants are considered to be safe, economical and less toxic among the most significant sources of medicinal products. The majority of the population even now depends upon medicinal plants for medical care. Medicinal plants are less known to show adverse effects. WHO reported around 21,000 plant species are recognized as medicinal plants. Andrographis paniculata is one such medicinal plant used from ancient times, and it is noted for its wide range of ethnobotanical uses. This review on Andrographis paniculata reported activities such as Antidiabetic, Antioxidant, Antimalarial, Antimicrobial, and Hepatoprotective. It is also used in the treatment of cold, wound healing, cancer, ulcer, and skin diseases. There are still a few pharmacological activities to report, so further studies are required to be carried out.

Conflict of interest

The authors declare that they have no conflict of interest for this study.

Funding support

The authors declare that they have no funding support for this study.

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