

Andrographis paniculata: Review of its Curative Activities

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Abstract

Andrographis paniculata (*A. paniculata*) is a medicinal plant, it is rich in biologically active compounds and these compounds are found abundantly in the leaves, roots and stems. The plant is widely used in many parts of the world, mostly in Asia. *A. paniculata* plant is known to possess curative potentials because of its activities when used for the treatment of some diseases. Some of the established curative ability includes antioxidant, anti-inflammatory, anticold, antidiarrhea, antifever, antihypertension, antihyperlipidemia, antihyperglycemia, antimicrobial, anticancer, hepatoprotective, antifertility, antivenom and immune booster capacity. These curative abilities of *A. paniculata* has therefore prompted many researchers to continue investigation on the plant and its potentials. The objective of this article is to review some established literatures on the curative activities of *A. paniculata* and to suggest areas where the plant can still be useful.

Keywords: *A. paniculata*; plants; disease; treatment; curative; activity

1.0 INTRODUCTION

Andrographis paniculata (*A. paniculata*) popularly known as “King of Bitters” is one of the plants that belong to the “Acanthaceae” family. This plant falls in the category of medicinal plants that are widely used for the treatment of some diseases. The classification of *A. paniculata* is represented in the table 1 below.

The traditional practitioners and the medicinal plants contribute to about two-

thirds of the primary healthcare needs of most developing countries' population [1].

Researchers are re-evaluating various plant species and their therapeutic chemical principles often due to issues linked with orthodox drugs.

Ayurvedic (ancient medical tradition of healing and prolonging life) medicine has experienced a rich and deep-seated history for numerous health conditions, based on several medicinal herbs. *A. paniculata* is one

of the species used in the practice of ancient oriental and ayurvedic medicine.

A. paniculata is an annual plant, branched with green lanceolate leaves, grows about 60-70 cm of height [2]. The plant is native to South Asia country India, it is prevalent in the Asian countries like India, Sri Lanka, Pakistan, Java, Malaysia, and Indonesia. It is known as the 'king of bitters' due to its extremely bitter taste through and through the plant [3].

In Nigeria, it is called ewe korobi-jogbo (bitter like jogbo leaf) or popularized meje meje (seven-seven) among the Yorubas. It is grown specifically for its medicinal value, tolerant to various soil types and widely distributed [3]. Its roots and aerial parts are used in traditional medicine by China, India, Thailand, and other Southeast Asian countries regions for curing varieties of illness.

The whole of *A. paniculata* plants was being used in various drug formulation for the treatment of diabetes as well as in the treatment of oxidation. This review focused on its medicinal properties, phytochemistry and the pharmacological effects of its various extracts and compounds.

1.1 Medicinal uses

Different parts of the *Andrographis* plant are used alone [4]. Various extracts of the plant made using acetone, chloroform, ethanol, hexane, methanolic or aqueous extracts have different properties based on their composition. These extracts differ in the levels of andrographolide, the primary

bioactive component, giving them different pharmacological properties [5].

For centuries, the aerial parts, roots and whole plant of *A. paniculata* have been used in traditional Asian medicine to treat different ailments which can range from its use in stomach pain, inflammation, fever, intermittent fevers, dyspepsia, influenza, dysentery, malaria and even respiratory infections [6, 7].

Scientific studies including randomized, double-blind, placebo-controlled studies have shown the effectiveness of *Andrographis* extracts on infectious diseases. It displays strong antiviral activity

against dengue virus, herpes simplex virus type 1, influenza A, HIV, hepatitis B and hepatitis C [5].

In particular, andrographolide and 14-deoxy-11,12-didehydroandrographolide showed anti-HIV properties, but they are not as active as regular HIV treatments. Both aqueous and ethanol extracts show antimicrobial properties, with the ethanol extract inhibiting the growth of some gram-positive and gram-negative bacteria [5]

In traditional Chinese medicine, it is considered a cold herb used to reduce body heat and fever and eliminate toxins [8]. In Ayurvedic medicine, natives of Tamilnadu use it to treat various ailments such as dysmenorrhea, leucorrhoea, antenatal and postnatal care, as well as complicated ailments such as malaria, jaundice, gonorrhoea and general ailments such as wounds, cuts, ulcers and skin disease [9].

Table 1: Classification of *A. paniculata*

Kingdom	Plantae
Class	Dicotyledonae
Order	Personales
Family	Acanthaceae
Genius	Andrographis
Species	<i>Paniculata</i>

Figure 1: Image of *Andrographis paniculata* plant

1.2 Phytochemical constituents of *A. paniculata*

About 60% of the world's population, majorly Asians and Africans uses traditional medicines which are the products of medicinal plants [10].

Aerial parts of *A. paniculata* are known for extraction of phytoconstituents. However, leaves, stems, roots and whole plants also contain medicinal compounds [11]. The phytochemical content varies depending on the part used, geography, season and time of harvest.

Studies carried out on *A. paniculata* have isolated various plant metabolites. Phytochemicals such as lactones, diterpenes, and flavonoids are found in the plant. The flavonoids compounds are mostly presents in the roots and were also later discovered to be contained in the leaves. The leaves constituents also include aldehydes, ketones and alkanes. The characteristic bitter taste of the leaves is said to be as a result of the presence of andrographolide and kalmegh [3]. Some other isolated compounds include flavones, noriridoids, xanthenes, polyphenols, some trace and also

macronutrients. Diterpenoid lactones are the most common terpenoids found in *A. paniculata*. They are present in both aerial parts and roots. Andrographolide is the most abundant of the identified diterpenoids in *A. paniculata* [12]. Compounds that were isolated from aerial parts include; deoxyandrographolide, andrographolide, neoandrographolide and 14-deoxy-11, 12-dihydroandrographolide [6]. The leaves also contain diterpene glucoside (deoxyandrographolide-

19-beta-d-glucoside), while the aerial parts yielded six ent-labdane-type diterpenoids, two diterpene glucosides and four diterpene dimers (bisandrographolide A, B, C and D) [13].

Two flavonoids, namely 5,7,2',3'-tetramethoxyflavonone and 5-hydroxy-7,2',3'-trimethoxy flavonone were produced by the whole plant [6], 14 diterpenoids and 12 new flavonoids were also present in the aerial parts [14]. New ent-labdane diterpenoid glycosides have also been isolated from aerial parts [7].

Investigation on the phytochemical analysis of the plant showed that biologically active components of its extracts contained phenols, triterpenoids, glycosides, steroids. Alkaloids, saponins, and tannins were also present in the plant [15].

2.0 Curative Activity of *A. paniculata*

2.1 Antihyperglycemia Activity

Hyperglycemia is the elevation of the blood glucose level which results in condition known as diabetes. According to the International Diabetes Federation (IDF) [16], it was reported that diabetes is one of the rapidly increasing worldwide health predicaments. Globally more than one in ten adults has diabetes. The projected prevalence of diabetes in adults age 20-76 years has been more than tripled from year 2000 to year 2022 from 151million to 537million. IDF [17] also reported that this value is expected to have amplified up to 643 million by the year 2030 and 783 million by the year 2045.

This implies that there is need for urgent intervention to avoid the surge. There is a continuous need for alternative medicine that are affordable and effective with less adverse effects. ‘Andrographolide’, the active component of *A. paniculata*, is known to have antihyperglycemic and antihyperlipidemic potentials when tested on rats fed with high amount of fat and fructose [18].

When the ethanol leaf extract of *A. paniculata* was administered to streptozotocin-induced diabetic Wister strain adult albino rats for four weeks, it produced a significant blood glucose reduction when compared with glibenclamide treated diabetic rats. It was also discovered at the end of 4 weeks administration of *A. paniculata* ethanol leaf extract, 500 mg/kg of the leaf extract produced 29.2% ($p = 0.000$) while 250 mg/kg of the extract produced 25.2% ($p = 0.000$) blood glucose reduction in the rats [19].

The in vitro study of *A. paniculata* using different solvents in the extractions of the leaf for the anti-oxidant properties played an important role for the selection of the ethanol extract as the best option in the study of its anti-hyperglycemic activities [19]. Out of the two doses of ethanol leaf extracts of *A. paniculata* used to reduce blood glucose, the 500 mg/kg of the extract showed greater reduction in blood glucose level which was comparable to glibenclamide [19].

The anti-hyperglycemic activity of 90% ethanol extract of *A. paniculata* was compared with a reference anti-diabetic drug glimeperide both in glucose loaded and alloxan induced diabetic rats [20]. The results

showed that ethanol leaves extract of *A. paniculata* significantly reduced the blood glucose level by 40.65 % in glucose loaded rats and 32.18 % in alloxan-induced diabetic rats.

The study strongly suggested that ethanol leaves extracts of *A. paniculata* possess important anti-diabetic properties and could be a prospective agent for treating diabetes [20].

The antidiabetic potentials of *A. paniculata* extracts, when the extract was combined with another medicinal plant *Caesalpinia sappan* and tested on diabetic induced rats, it showed that the combined extracts demonstrated safety of up to the dosage of 2000 mg/kg body weight. The blood glucose changes in the combined extracts (18.65 ± 13.16 , $p < 0.05$) was also significantly lower from diabetes mellitus in the non-fasting state [15].

Studies also showed that the result obtained when *A. paniculata* and *E. polyantha* leaves was administered on 40 diabetic rats, the impact on blood serum characteristics shows that among 20 respondents of each group, there was decrease in the fasting blood glucose level (<140 mg/dL) of about 70% and 80% of respondents, 50% and 75% decreased of uric acid (<7), 65% and 70% decreased of total cholesterol (<200 mg/dL). It was concluded that the respondents do not have any complaints after *A. paniculata* and *E. polyantha* capsules were consumed [21]

2.2 Cardiovascular activity

Cardiovascular disease (CVD) is a general term used to describe heart or blood vessels disease. CVD is usually linked to the build-up of fats deposits in the arteries (atherosclerosis) and an increase in the risk of

blood coagulation. There are 4 main types of CVD which includes: Coronary heart disease (which occurs when movement of oxygenated blood to the hearts muscle is blocked or reduced), Strokes and TIAs, Peripheral arterial disease, Aortic disease.

In 2019, an estimated sum of 17.9 million death occurred from CVD, which represents 32% of all global deaths. Heart attack and strokes contributed 85% of these deaths. Low income and middle income countries have over three quarters of deaths caused by CVD, as reported by WHO [22].

Research where the dichloromethane extract of *A. paniculata* was tested on Langendorff permeated rats hearts [23], the coronary vessels, cardiac muscle contraction, and also the heart rates of the rats was examined. At the end of the study, the pressure exerted during the fluid movement through the circulatory system or blood stream was noticeably reduced by up to 24.5 ± 3.0 at ($P < 0.05$) at doses of 3mg and 29.4 ± 8.5 mmHg ($P < 0.05$) at 1mg respectively, the 3mg dosage also reduced the heart rate by up to 49.5 ± 11.4 beats/minute ($P < 0.05$). The study showed that *A. paniculata* exhibits cardiovascular activity [23].

2.3 Hepatoprotective activity.

A. paniculata is widely used in traditional medicine as a hepatoprotective and liver enzyme stimulating Agent [3]. Studies showed that CCl₄-induced hepatotoxicity of liver functioning enzymes (which indicates liver damage) was substantially regulated by stems of *A. paniculata*, thus emphasizing its roles in regulating hepatotoxicity [24]. The results are consistent with the normal control

and established that *A. paniculata* has hepatoprotective properties. The Serum levels were significantly reduced [24].

Research also established that *A. paniculata* reversed the liver damage caused by the ingestion of paracetamol to normal [25]. Higher Aspartate Aminotransferase (AST) enzyme levels in ethanol-intoxicated respondents were noticeably reduced after administration of *A. paniculata* [26].

In a comparative study, leaf extract and andrographolide were tested against CCl₄-induced hepatic microsomal lipid peroxidation. The leaf extract was noted to be completely protected against high CCl₄-induced microsomal lipid peroxidation *in vitro*, while andrographolide did not, this indicated that the hepatoprotective role is not only due to the presence of andrographolide but also with the presence of some important compounds [27].

Report also showed that andrographolide, a methanol extract of the whole plant, and a methanol extract without andrographolide improved liver histology in rats by 48.6%, 32%, and 15%, respectively, in CCl₄-induced liver injury [28].

2.4 Antioxidant activity.

Research has proven the antioxidant activity and constituents of *A. paniculata*. Andrographolide and an aqueous extract of *A. paniculata* herbs were tested for their antioxidant activity against nicotine-induced oxidative stress in some internal organs of male Wistar rats. The results showed that their administration meaningfully reduced the level of lipid peroxidation and also increased the antioxidant enzyme status in the organs tested when compared with the

group that was treated with nicotine alone [29].

Assessment on the antioxidant effects of an aqueous extract of *A. paniculata* on liver defense systems in mice with lymphoma showed that, aqueous and hydroalcoholic extracts increased the enzymes catalase, superoxide dismutase, and glutathione-S-transferase actions, while the actions of lactate dehydrogenase activity was decreased [30].

Reports found that the hydroalcoholic extract of *A. paniculata* prevented isoproterenol-induced lipid peroxidation and positively impacted antioxidant enzymes such as SOD, CAT, GPX. The glutathione levels in the heart were also reduced [31].

In addition, the extract also prevented the leakage of lactate dehydrogenase from the heart and prevented isoproterenol-induced myocardial ischemic damage, thereby supporting the antioxidant activity of *A. paniculata* and its potential in heart disease [31].

Methanol and aqueous extracts of *A. paniculata*, and isolated compounds such as andrographolide and 14-deoxy-11, 12-didehydroandrographolide, showed the inhibition of lipid peroxidation and free radical scavenging activity in Sprague Dawley rats against DPPH [32].

The Methanolic extracts also inhibited lipid peroxidation by 55.6% to 63.9%, which was noticeably more than the 33.78% to 33.77% inhibition observed with aqueous extracts ($P < 0.05$).

The methanolic extracts also showed free radical scavenging activity which range from

45.67% to 53.82%. Andrographolide showed 40.2% activity, while 12-didehydroandrographolide had 46.43% activity. In contrast, water extracts showed worse free radical scavenging activity, ranging from 25.29% to 28.77%. Both extracts and isolated compounds showed lower free radical scavenging activity compared to positive controls such as quercetin (89%) and butylated hydroxyl anisole (71%) [32].

2.5 Antimicrobial activity.

A methanol extract of *A. paniculata* was found to inhibit *Plasmodium falciparum* significantly at a 50% inhibitory concentration (IC₅₀) of 7.2 µg/mL [33].

The Ethanol extract of *A. paniculata* leaves inhibited the growth of *Escherichia coli* and *Staphylococcus aureus* in vitro [34]. Additionally, a 50% methanol extract of the leaves inhibited the growth of *Proteus vulgaris* in vitro.

However, when the dried powder from the aerial parts was tested against *E. coli*, *Staphylococcus aureus*, *Salmonella typhi* or *Shigella*, no antibacterial activity was observed in vitro [35]. The ethanolic extract of *A. paniculata* was effective against upper respiratory tract infection [9]. The aqueous extracts, andrographolides and arabinogalactan proteins isolated from the dried *A. paniculata* were also tested for antimicrobial activity. Results showed that the aqueous extract and arabinogalactan proteins had antibacterial activity against *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa*. Andrographolide

only showed activity against *Bacillus subtilis*. All three were also found to have antifungal activity against *Candida albicans* [36].

The antimicrobial activity of two ethanolic extract of *A. paniculata* and andrographolide were tested against; *E. coli*, *Shigella sonnei*, *Pseudomonas aeruginosa*, *Streptococcus pneumonia*, *Salmonella typhimurium*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Legionella pneumophila*, and *Bordetella pertussis*, using disc diffusion method [37]. Among all the tested concentrations, antimicrobial activities was observed on only two out of all the pathogens *Legionella pneumophila* and *Bordetella pertussis* treated with *A. paniculata* extract while there was no antimicrobial activities of andrographolide observed against any of the organisms [37].

2.6 Antihyperlipidemia Activity

Hyperlipidemia refers to a condition that occurs because of the elevation of blood lipid level. This condition can also be linked to the hardening of the arteries and some other serious health conditions such as heart failure, stroke, and peripheral artery disease. This condition can be life threatening if it is not properly treated and managed.

Andrographis paniculata and *Caesalpinia sappan* ethanol extracts were tested on high fat fed rats [15]. At the end of the study, it was discovered from the lipid profiles that no

significant differences were observed in the cholesterol levels between the groups of rats tested, but there was an increase in their triglyceride levels [15].

Result showed that the triglyceride levels in *A. paniculata* is (262.53 ± 159.34), in *Caesalpinia sappan* is (188.7 ± 42.0), *A. paniculata* and *Caesalpinia sappan* 100 mg (176.59 ± 35.42), and *A. paniculata* and *Caesalpinia sappan* 200 mg (135.31 ± 27.76) were significantly different from the normal group ($p < 0.05$). The *A. paniculata* -treated group showed significantly lower High Density Lipoproteins (HDL) and Low Density Lipoproteins (LDL) [15].

3.0 Recommendations

The result from the toxicity test of ethanol leaves extract of *A. paniculata* on the animals tested [19] showed that there was no motility noticed at 4g /kg dose level. The animals also did not show any stereotypical reactions which may be noticed because of their lethal nature. The behaviors of all the animals tested also revealed to be in good condition. There were no changes that occurred with regards to their body mass and their regular food intake. Hence the leave extract of *A. paniculata* has reflected not to pose harmful effect on the respondents [19]. This suggests that will pose no threat when used in moderation for curative purpose.

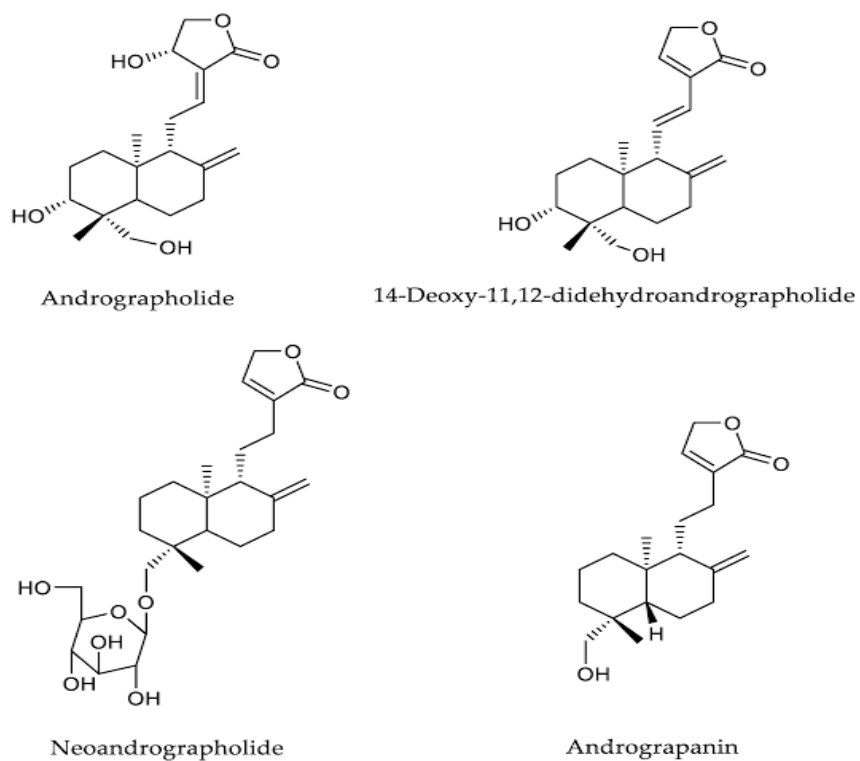


Figure 2: Structure of bioactive components of *A. paniculata*

4.0 Conclusion

Having thoroughly studied the wide range of the curative activities of *A. paniculata* on various diseases, from this review, it was observed that the plant is a rich source of biologically active components because of its curative ability on diseases.

The chemical constituents showed it possesses high therapeutic properties. It can therefore be easily deduced from the findings of this review that *A. paniculata* exhibits antihyperglycaemia, anti-oxidant, cardiovascular and antihyperlipidemia, and hepatoprotective and antimicrobial properties. The plant has a very good potency. Therefore, it can be concluded that *A. paniculata* is a rich source of important compounds, this makes it a potential plant for drug formulations.

Further studies should also be carried out on the antileprosy, antiepilepsy, antimeningitides, antitetanus and antituberculosis potentials of the plant.

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