JOURNAL OF VETERINARY AND APPLIED SCIENCES
VOLUME 16, ISSUE 2: 1585 – 1596 (2026)
Published by: Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria
ISSN: 2315-6856; e-ISSN: 2636-5553; Website: www.jvasonline.com

Administration of methanolic leaf extract of *Andrographis paniculata* to Wistar rats: Effects on haematology, serum biochemistry and tissue levels of oxidative stress markers

Sabina M. Num-Adom and Justin Gbayange

Department of Veterinary Pathology, College of Veterinary Medicine, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.

==========

Abstract

This study investigated the effects of administration of crude methanolic leaf extract of *Andrographis paniculata* on some haematological and serum biochemical parameters of rats and their tissue levels of some oxidative stress markers. Crude methanolic leaf extract of *A. paniculata* was obtained by the cold maceration extraction method. Qualitative and quantitative phytochemical assays were carried out on the extract, and the results of the phytochemical analysis showed the presence of alkaloids (29.9%) and flavonoids (26.4%), tannins (16.7%), terpenoids (15.5%), saponins (4.0%), and phenols (3.8 %). Twenty-five rats were randomly assigned to five groups of five rats each. The rats in Groups A, B, C and D were given the extract orally at a daily dosage of 1000, 500, 350, 175 mg/kg, respectively for 14 days, while Group E rats were given 2 ml of normal saline, and they served as Control. Blood samples were collected for haematological and serum biochemical studies on day 15. After blood sample collection on day 15, the rats were sacrificed, and the liver and kidney tissues were collected for assay of oxidative stress markers. Results of the haematology showed that after the administration of the extract, the packed cell volume, haemoglobin concentrations and red blood cell counts of Groups A and B rats were significantly higher ($p < 0.05$) when compared to that of Group E rats. The serum alanine aminotransferase and alkaline phosphatase activity of the Group A, B and C rats were significantly ($p < 0.05$) higher than that of the control (Group E). The serum total protein and creatinine levels of the Group A rats was also significantly higher ($p < 0.05$) than that of the control group (Group E). Kidney superoxide dismutase (SOD) and catalase (CAT) activity of Group A rats was significantly ($p < 0.05$) higher than that of the Group E, while the liver SOD activity of the Group A, B and C rats was significantly higher ($p < 0.05$) than that of the Group E rats. It was concluded that administration of *A. paniculata* methanolic extract to rats positively improved their erythrocytic profile and affected their kidney and liver activity of oxidative stress markers.

Keywords: *Andrographis paniculata*; Methanolic extract; Haematology; Serum biochemistry; Tissue levels of oxidative stress markers; Rats.

*** Correspondence:** Sabina M. Num-Adom; Email: mbafannum@yahoo.co.uk; Phone: +2347031865755
Article History: Initial manuscript submission received – April 25, 2026; Final revised form received – July 19, 2026; Accepted for publication – July 23, 2026; Published – July 27, 2026.

Introduction

Over time humans have recognized certain plant materials that are suitable for use as herbs and herbal extracts that enhance health (Onwubiko *et al*., 2020). Globally, medicinal plants represent the most ancient form of medications and have been used for thousands of years (Marelli, 2021). The use of herbal products for self-medication has led to a greater interest in medicinal plants. This has increased interest in scientific investigations of plants for their biological effects in both humans and animals (Pandey *et al*., 2019). Biological properties and bioactive components of several plant species used traditionally have been investigated, and are utilized in bioassay-guided natural drug discovery processes (Jamshidi-Kia *et al*., 2018). Nevertheless, the phytochemical composition and the potential health benefits of many species have not yet been studied or still need to be more deeply investigated (Jamshidi-Kia *et al*., 2018).

Blood cells play an important role in health as they are involved in physiological processes such as immunity, oxygen transport and blood clotting, which when disturbed, can cause health alterations (Vuckvic *et al*., 2020). The blood also serves as a pathological reflector of the status of exposed humans and animals to toxicants and other conditions (Olafedehan *et al.,* 2010). Evaluation of the haematological profile usually furnishes vital information on the body's response to injury of all forms, including toxic injury (Ihedioha *et al.,* 2004). Blood regulates homeostasis, that is, stability, balance or equilibrium within the cells or the body (Andrey *et al*., 2016; Rodova *et al.,* 2016; Singh *et al.,* 2016; Yadav *et al.,* 2016).

Oxidants are free radicals which are molecular entities with free unpaired electrons, possessing beneficial or detrimental roles within the body (Sundaram *et al*., 2021). They play a pivotal role in cell signaling and immune response but when they are produced in excess, the equilibrium is tipped and this leads to oxidative stress (Sadiq, 2023). Oxidative stress is an important driver in numerous diseases, through multiple interconnected molecular pathways that disrupt cellular homeostasis and promote sustained immune activation (Nambi, 2025; Chouikh *et al*., 2025). Oxidative stress has been identified as a major causative factor in the development and progression of several life threatening diseases, including neurodegenerative and cardiovascular disease (Nambi, 2025; Chouikh *et al*., 2025). Oxidative stress can be ameliorated with substances referred to as antioxidants (Sundaram *et al*., 2021). Antioxidants are chemicals that bind with free radicals and nullify their effect by giving up their electrons. The activity of antioxidants results in the termination of oxidative chain reactions, and the free radicals are no longer able to attack the cell (Othón-Díaz *et al*., 2023). It is believed that two-thirds of the world's plant species have some form of medicinal importance, and most of these may have excellent antioxidant potential (Krishnaiah *et al.* 2011).

Andrographis paniculata is a traditional herbaceous plant of the family Acanthaceae. It is widely cultivated across Europe and Asia (Jiashu *et al.* 2019; Kumar *et al.* 2020). The common names include creat, green chirreta or king of bitters (Sadhana *et al*., 2020). The vernacular names include: “Meje-meje” in Yoruba (Faluyi, 2021; Burkill *et al*., 1966), and “Pege” in Tiv (oral source). Traditionally, all parts of *A. paniculata* are used as a remedy for various ailments. Several studies have shown that varied parts of *Andrographis paniculata* possesses various pharmacologic activities which include: antimicrobial, cytotoxic, anti-protozoal, anti-inflammatory, antioxidant, immunostimulant, antidiabetic, anti-infective, hepatorenal protective, sex hormone modulatory, liver enzymes modulatory, insecticidal, neuroprotective, anti-cancer, antipyretic etc. (Chandrasekaran

et al., 2010; 2011). *Andrographis paniculata* has become naturalized in some tropical and subtropical countries, including Nigeria (Hossain *et al.,* 2021). The leaves and stems of the plant are most commonly used and have been reported to contain varied amounts of phytochemically active compounds such flavonoids, saponins, phenols, alkaloids, diterpenoids, mucilages, and tannins (Parihar, 2022).

Traditional medicine is used by people across all parts of the world (WHO, 2025). Globally, people are being empowered to choose the appropriate health care for their needs, hence integrative medicines that combines traditional and complementary medicines and biomedicine is becoming more popular (WHO, 2025). There is however growing concern about the toxicity and adverse effects of medicinal plants, some of which have remained either uninvestigated or poorly investigated and are increasingly used by patients for different diseases (Ghasemi, 2014).

A standardization strategy for medicinal plants with regards to their safety, efficacy and consistency is being advocated by the World Health Organization (WHO, 2025). These strategies include: authentication and identification of bioactive components and adulterants from genuine medicinal herbs (Umamaheswari *et al*., 2021). Although *A. paniculata* has been reported to have a broad range of pharmacological effects, such that commercial preparations of it have been produced and are in use in some countries, there is dearth of information on how the crude extract of this plant affects clinico-pathological parameters and the levels of oxidative stress markers in vivo. The present study orally administered crude methanolic leaf extract of *A. paniculata* to Wistar rats, and evaluated its effects on their haematology, serum biochemistry and tissue levels of oxidative stress markers.

Materials and Methods

Collection of the plant material: Fresh *Andrographis paniculata* plants (Figure 1) were collected in the month of September 2023 from an uncultivated farmland in Udei, Guma Local Government Area of Benue State, Nigeria. It was authenticated in the Department of Forestry, Joseph Sarwuan Tarka University, Makurdi, Nigeria, and was given a voucher number UAM/FH/0445, and stored in the Department's Herbarium. The leaves of the plant were dried under shed at room temperature and pounded using a mortar and pestle to obtain a powder.

Figure 1*:* Picture of *Andrographis paniculata,* taken from an uncultivated farmland in Udei, Benue State Nigeria.

Preparation of crude methanol extract of *Andrographis paniculata* leaves*:* Methanolic leaf extract of *A. paniculata* was obtained using the cold maceration method. About 148.5 g of the powder was soaked in 500 ml of methanol solvent and allowed to stand for 48 hours. The mixture was filtered using a Whatman filter paper. The filtrate was concentrated *in-vacuo* at 45^{o}C in a rotatory evaporator coupled to a thermocirculator. The dried extract was then weighed and the percentage yield of extract was calculated

using the standard formula. The extract was stored at 4°C in the refrigerator until when it was used for the study.

Preliminary phytochemical screening: Qualitative and quantitative phytochemical assays for the presence of phytoconstituents such as tannins, phlobatannins, glycosides, saponins, terpenoids, sterols, flavonoids, phenols, resins and balsams, alkaloids, phenols and anthraquinones were carried out on the plant extract using standard procedures (Evans and Evans, 2009).

Experimental animals: Twenty-five adult Wistar rats of both sexes weighing between 180 – 220 g were used for the study. They were obtained from the Animal House, Department of Pharmacology and Toxicology, College of Veterinary Medicine, Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria. The rats were housed under hygienic conditions in cages and kept in the Veterinary Teaching Hospital, Makurdi, Nigeria. They were fed with commercial rat chow. Feed and water were provided *ad libitum* throughout the experiment. The rats were acclimatized for two weeks prior to commencement of the experiment proper. All experimental procedures were conducted in strict compliance with internationally accepted guidelines for the care and use of laboratory animals. Ethical approval for the study was obtained from The College of Veterinary Medicine Ethics Committee of Joseph Sarwuan Tarka University (Approval Ref. No.: JOSTUM/CVM/ETHICS/2026/51).

Experimental design, animal groups and mode of administration: The dried extract was reconstituted by dissolving 1 g of extract in 2.5 ml distilled water to obtain a concentration of 400 mg/ml. The 25 rats were randomly assigned to five groups of five rats each (n = 5). The rats in Groups A, B, C and D were given the extract orally at daily dosage of 1000, 500, 350, 175 mg/kg respectively for 14 days. The rats in Group E were given 2 ml of normal saline orally daily, and served as Control. All administrations were done at 9.00 am every day. Clinical signs of abnormalities following administration of the extract were observed and recorded.

Blood sample collection: Blood samples were collected on the day after completion of administration of the extracts (day 15) via the media canthus. One millilitre of the blood was collected in sample bottles impregnated with ethylene diamine tetra acetic acid (EDTA) for haematological analysis, while 3 ml of the blood was collected in anticoagulant free sample bottles and allowed to clot for 45 minutes. The clotted blood was centrifuged at 3,000 revolutions per minute for 10 minutes, and the supernatant serum was collected for biochemical analysis.

Hematological and serum biochemical assays: Haematocrit values, haemoglobin concentration, red blood cell counts, total and differential leucocyte counts were determined using the methods described by Weiss and Wardrop (2010). Determination of serum activity of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP) and serum levels of proteins, creatinine, and urea were done using the methods described by Davidson *et al*. (1998).

Evaluation of tissue levels of oxidative stress markers: On day 15 (a day after completion of administration of the extracts), the rats were humanely sacrificed, and the kidney and liver tissue samples were harvested for evaluation of levels of oxidative stress markers. Slices of the liver and kidney were homogenized in ice cold 10% buffered phosphate saline (PBS) to make 10% homogenates. The homogenates were centrifuged at 10,000 g for 15 minutes at 4^{o}C and aliquotes separated and refrigerated until when required for use. Antioxidant enzymes including superoxide dismutase (SOD) and catalase, and levels of malondialdehyde (MDA) were assayed using

commercially available test kits procured from Northwest Life Science Specialties, Vancouver, WA.

Statistical analysis: Analysis of variance (ANOVA) and Turkey's post hoc tests were used to analyze the data generated from the treatment groups, using the Statistical Package for the Social Sciences (SPSS) software, and values of $P < 0.05$ were considered significant. Summary of the results were expressed as means and standard errors of means, and presented in tables.

Results

Yield of the extract: Percentage yield of crude methanol leaf extract of *A. paniculata* was 5.9%.

Phytochemical analysis results: The results of the preliminary qualitative and quantitative phytochemical screening of the leaf extract of *A. paniculata* (Table 1) revealed that the extract contained more alkaloids (29.8%) and flavonoids (26.4%), than tannins (16.7%), terpenoids (15.5%), saponins (4.0%) and phenols (3.8%). Phlebotanins, glycosides sterols, resin and balsams, and anthraquinones were not detected in the plant.

Clinical signs recorded in rats treated with the extract: The clinical signs observed in the rats on administration of methanol leaf extract of *A. paniculata* included: varying degrees of huddling together, anorexia, dullness and roughened hair coat. There was no mortality recorded with the use of the plant.

Haematology results: The effects of administration of varying doses of *A. paniculata* leaf extract on the haematology of the Wistar rats is presented in Table 2. The packed cell volume (PCV) and haemoglobin concentrations in Group A and B rats were significantly higher ($p < 0.05$) higher than that of the Group E (Normal control). All other haematological parameters evaluated did not significantly vary ($p > 0.05$) among the groups.

Table 1: Results of qualitative and quantitative phytochemical analysis of *A. paniculata* leaf extract.

S/No	Compounds	Qualitative	Quantitative (%)
1	Tannins	++	16.7%
2	Phlobatannins	-	-
3	Glycosides	-	-
4	Saponnins	+	4.0%
5	Terpenoids	++	15.5%
6	Sterols	-	-
7	Flavonoids	++	26.4%
8	Phenols	++	3.8%
9	Resin and Balsams	-	-
10	Alkaloids	++	29.8%
11	Balsams	-	-
12	Anthraquinones	-	-

Key: + indicates presence, while – indicates absence.

Table 2. Haematological parameters of rats given varied oral doses of *A. paniculata* leaf extract for 14 days, compared with untreated control.

Parameters	Group A (1000 mg/kg)	Group B (500mg/kg)	Group C (350mg/kg)	Group D (175mg/kg)	Group E (Untreated Control)
PCV (%)	49.60 ± 0.93*	51.40 ± 2.18*	45.60 ± 1.44	48.60 ± 2.38	45.00 ± 2.10
Hb (g/dL)	16.52 ± 0.31*	17.11 ± 0.73*	15.18 ± 0.49	16.18 ± 0.80	15.32 ± 0.69
RBC (10^{12}/L)	8.26 ± 0.15*	8.56 ± 0.36*	7.60 ± 0.24	8.10 ± 0.40	7.46 ± 0.35
MCV (fL)	60.02 ± 0.01	60.02 ± 0.01	60.03 ± 0.01	60.03 ± 0.01	60.01 ± 0.01
MCH (pg)	19.99 ± 0.02	19.98 ± 0.02	19.98 ± 0.02	19.99 ± 0.02	20.00 ± 0.00
MCHC (g/L)	33.30 ± 0.02	33.29 ± 0.03	33.24 ± 0.04	33.29 ± 0.03	33.32 ± 0.00
Total WBC (10^9/L)	16.22 ± 5.78	13.54 ± 2.99	13.0 ± 3.44	12.74 ± 3.60	15.74 ± 7.73
Eosinophils (%)	0.20 ± 0.20	0.40 ± 0.24	0.20 ± 0.20	0.40 ± 0.24	0.00
Neutrophils (%)	20.80 ± 1.02	20.40 ± 1.21	20.00±0.63	20.40 ± 1.43	18.40 ± 1.03
Lymphocytes (%)	78.00 ± 1.10	78.00 ± 0.77	79.40 ± 0.7	79.40 ± 0.98	81.00 ± 1.14
Monocytes (%)	1.00 ± 0.45	0.80 ± 0.49	0.40 ± 0.24	0.60 ± 0.40	0.40 ± 0.24

Key: * indicates a significant difference between the specified group and the Control group.

Table 3. Serum biochemical parameters of rats given varied oral doses of *A. paniculata* leaf extract for 14 days, compared with untreated control.

Parameters	Group A (1000 mg/kg)	Group B (500 mg/kg)	Group C (350 mg/kg)	Group D (175 mg/kg)	Group E (Control)
ALT (U/L)	24.40 ± 0.81^{c}	21.00 ± 0.45 ^{b}	19.40 ± 0.51 ^{b}	16.60 ± 0.81^{a}	17.00 ± 1.00 ^{a}
AST (U/L)	32.60 ± 1.60	30.80 ± 1.02	28.60 ± 1.08	31.40 ± 1.33	31.80 ± 1.43
ALP (U/L)	114.60 ± 2.68 ^{c}	110.00 ± 2.10 ^{c}	98.80 ± 6.34 ^{b}	81.20 ± 1.07^{a}	73.40 ± 1.17 ^{a}
Total Prot. (g/l)	77.40 ± 2.68 ^{c}	65.80 ± 1.59 ^{ab}	66.60 ± 1.54 ^{ab}	61.40 ± 2.23^{a}	68.40 ± 0.93 ^{b}
Creatinine (mg/dL)	0.68 ± 0.04 ^{c}	0.44 ± 0.11^{ab}	0.54 ± 0.02 ^{bc}	0.54 ± 0.05^{bc}	0.34 ± 0.05 ^{a}
BUN (mg/dL)	7.80 ± 0.37	7.60 ± 0.68	6.20 ± 0.58	6.00 ± 0.55	6.60 ± 0.51

$^{a, b, c}$ Different superscripts in a row indicate significant difference ($p < 0.05$) between the means of the groups.

Serum biochemistry results: The effect of methanolic extracts of *A. paniculata* on the serum biochemical parameters is presented in Table 3. Serum activity of ALT and ALP were significantly higher ($p < 0.05$) in the Groups A, B and C rats when compared to Groups D and E. Serum AST activity did not significantly vary ($p > 0.05$) among the groups. Serum total protein and creatinine levels were significantly ($p < 0.05$) higher in the Group A rats when compared with the Group E, but the BUN levels did not significantly vary ($p > 0.05$) among the groups.

Kidney and liver levels of oxidative stress markers: The effect of methanolic leaf extract of *A. paniculata* on tissue levels of oxidative stress markers are presented in Tables 4 and

5. The SOD and CAT activity in the kidney tissues of Group A rats were significantly ($p < 0.05$) higher than that of Group E rats, but there was no significant differences ($p > 0.05$) in the MDA levels in the kidney tissues (Table 4). Also, the SOD activity in liver tissue of Groups A, B and C rats were significantly higher ($p < 0.05$) than those of Groups D and E rats, but the liver CAT activity of Groups C and D rats were significantly lower than those of Groups A, B and E (Table 5). MDA levels in the liver tissues of Group C and D rats were significantly lower than those of Groups A, B and E (Table 5).

Discussion

In the present study, the percentage yield of *A. paniculata* leaf (5.9%) was lower than that reported by other researchers (Nagajothi *et al*., 2018; Harihan *et al*., 2021). This lower yield may be attributed to the type of solvent used for the extraction and/or the parts of the plant extracted. It has been earlier reported by Harihan *et al.* (2021) that some solvents extract more bioactive substances than others; thus in the present study methanol extracted less bioactive components of *A. paniculata* leaves.

Table 4. Kidney tissue levels of oxidative stress markers in rats given varied oral doses of *A. paniculata* leaf extract for 14 days, compared with untreated control.

Groups and their treatments	Mean ± standard error		
	Superoxide dismutase (IU/mg protein)	Catalase (IU/mg protein)	Malondialdehyde (µmol/mg protein)
Group A (1000 mg/kg)	8.49 ± 0.36 [b]	0.34 ± 0.00 [b]	6.67 ± 0.25
Group B (500 mg/kg)	6.75 ± 0.55 [b]	0.23 ± 0.01 [a]	6.02 ± 0.37
Group C (350 mg/kg)	6.54 ± 0.91 [b]	0.24 ± 0.017 [a]	5.46 ±0.24
Group D (175 mg/kg)	6.92 ± 1.69 [b]	0.24 ± 0.01 [a]	6.44 ±1.04
Group E (Untreated control)	5.41 ± 0.59 [a]	0.26 ± 0.01 [a]	5.35 ± 0.24

[a, b] Different superscripts in a column indicate significant difference ($p < 0.05$) between the means of the groups.

Table 5. Liver tissue levels of oxidative stress markers in rats given varied oral doses of *A. paniculata* leaf extract for 14 days, compared with untreated control.

Groups and their treatments	Mean ± standard error		
	Superoxide dismutase (IU/mg protein)	Catalase (IU/mg protein)	Malondialdehyde (µmol/mg protein)
Group A (1000 mg/kg)	11.72 ± 1.96 [b]	0.22 ± 0.021 [b]	7.08 ± 0.16 [b]
Group B (500 mg/kg)	10.40 ± 1.51 [b]	0.25 ± 0.012 [b]	6.83 ± 0.12 [b]
Group C (350 mg/kg)	8.00 ± 2.84 [b]	0.11 ± 0.012 [a]	4.73 ± 0.39 [a]
Group D (175 mg/kg)	5.75 ± 0.72 [a]	0.13 ± 0.01 [a]	4.80 ± 0.49 [a]
Group E (Untreated control)	4.89 ± 0.86 [a]	0.27 ± 0.03 [b]	6.38 ± 1.01 [ab]

[a, b] Different superscripts in a column indicate significant difference ($p < 0.05$) between the means of the groups.

The findings in the present study that the extract had a higher percentage of alkaloids followed by flavonoids, tannins, terpenoids and phenols agrees with earlier reports by Anuradha *et al*. (2022). Alkaloids exhibit a broad spectrum of biological activities. They have been reported to possess antioxidant, anti-inflammatory, anti-cancer, antimicrobial and anti-malarial, immunomodulatory, hepatoprotective, anti-diabetic, cardioprotective and analgesic properties (Pereira *et al*., 2023). Flavonoids act as powerful antioxidants and play important role in the prevention and treatment of a wide range of chronic diseases. They also possess anti-inflammatory, antimicrobial, anti-diabetic, anticancer and neuroprotective effects, with possible wide therapeutic applications (Kaloun, 2025; Zheng *et al*., 2025). Saponins have been considered an anti-nutritive factor but recent studies have shown that they possess pharmacological activities such as anti-tumor, anti-oxidative, anti-inflammatory, anti-diabetic, and neuro-protective activities (Nguyen *et al*., 2020). Saponins have also been reported to exhibit potent antibacterial activity against multidrug-resistant pathogens (Ibrahim *et al*., 2026). Tannins are known for their antioxidant, anti-inflammatory and cardio-protective properties, and have therapeutic applications in metal chelation, the promotion of vascular health and disease prevention (Cosme *et al*., 2025; Melo *et al*., 2023). It has been posited that natural compounds resemble endogenous metabolites and metabolic intermediates more closely than synthetic compounds; thus they are more likely to be recognized by active biotransporters (Ehrenworth and Peralta-Yahya, 2018). Bioactive compounds in plant are critical to survival and functioning of various organisms (Riaz *et al*., 2023). The bioactive constituents/secondary metabolites recorded in the plant extract in the present study can serve as a source of novel compounds that could be used in the treatment of many diseases and prevention of various conditions in man and animals.

The finding in the present study that administration of *A. paniculata* on Wistar rats at 1000 mg/kg body weight and 500 mg/kg body weight of the extract led to significantly higher PCV, RBC counts and Hb. concentration is considered a plus for the extract, and it may be that the extract enhances erythropoiesis or facilitates the release of red blood cells from the bone marrow or the body reserves. The enhancement of the erythrocytic profile is thought to be as a result of the bioactive compounds recorded in the phytochemical analysis (Xu *et al*., 2021; Taliikwa, 2025). Flavonoids have been reported to exhibit strong antioxidant properties that protects hematopoietic tissues from oxidative injury and modulate gene expression related to erythropoiesis and iron metabolism (Ooi *et al*., 2022; Kumar *et al*., 2023). Alkaloids has been reported to exhibit haematinic effects by stimulating erythroid precursor cells and enhancing hemoglobin synthesis (Adewuyi *et al*., 2024). Saponins have also been reported to improve nutrient absorption and modulate immune responses that affect iron status (Ye *et al*., 2023).

The significantly higher serum ALT and ALP activity recorded for rats in Group A (given 1000 mg/kg body weight of extract) suggests that the plant extract should be used with caution at higher doses as severe increases in serum hepatic enzymes are indicative of liver damage. The kidney maintains a constant extracellular environment through its involvement in the excretion of metabolites including urea, creatinine and uric acid. Abnormal levels of these catabolites and some electrolytes in the serum indicate impairment of renal function. Such impairment of the renal functions could result from exposure to different nephrotoxic substances (Sales and Foresto, 2020). In the present study, the finding of significantly higher serum creatinine levels in the Group A rats given 1000 mg/kg

extract call for caution in its usage at higher doses.

In the present study, administration of the plant extract led to a modulatoy effect on the kidneys and the livers of all treatment groups indicated by the higher concentrations of SOD, CAT and MDA in the kidney and liver tissues of most of the treatment groups when compared to the control. These effects on the kidney and liver levels of oxidative stress markers suggest that the leaf extract has good anti-oxidant potentials (Krishnaiah *et al.* 2011).

Conclusion: Results of this study showed that *Andrographis paniculata* leaf extract has some bioactive constituents/secondary metabolites that could serve as a source of novel compounds that can be used in the treatment of many diseases and prevention of various conditions in man and animals. These bioactive components may have been responsible for the positive effects of the extract on the erythrocytic profile of the treated rats. The recorded effects of the highest dose (1000 mg/kg) on the biochemical markers of liver and kidney function calls for caution in the use of such high dose.

Acknowledgement

We acknowledge the support of Mr. Terna Nyam of the Clinical Pathology Laboratory, Joseph Sarwuan Tarka University, Makurdi (JOSTUM), Department of Forestry (JOSTUM), staff of Clinical Pathology Laboratory and Veterinary Biochemistry Laboratory of the College of Veterinary Medicine, JOSTUM, Nigeria.

Conflict of Interest

The authors declare no conflict of interests.

References

Adewuyi HA, Kabiru AY, Muhammad HL, Lukman HY, Owolabi MS, Jonathan I, El-Gazzar AM, Mahmoud MH, Batiha GE, Lawal B (2024). Pre-clinical protective potentials of Carica papaya constituents in experimentally induced anemia. *American Journal of Translational Research*, 16(7): 3259 – 3272.

Andrey ZM and Vladimir ZM (2016). An integral concept of regulating immune homeostasis. *Journal of Clinical and Experimental Pathology*, 6: 267.

Anuradha CH, Bhargavi S, Kaliswari YJ, Hemanth CH and Bhagyasri V (2022). Phytochemical screening of Andrographis paniculata leaf extract collected from Dr. V. S. Krishna government degree college campus, *World Journal of Pharmaceutical and Life S ciences*, 8: 46 – 49.

Burkill, I.H, W. Birtwistle, F. Foxworthy, J. Scrivenor, and J. Watson, (1966) A Dictionary of the Economic Products of the Malay Peninsula, Ministry of Agriculture and Cooperatives, Kuala Lumpur, Malaysia.

Chandrasekaran CV, Gupta A and Agarwal A (2010). Effect of an extract of *Andrographis paniculata* leaves on inflammatory and allergic mediators *in vitro.* Journal of Ethnopharmacology, 129(02): 203 – 207.

Chandrasekaran CV, Thiyagarajan P, Deepak HB, Agarwal A (2011). *In vitro* modulation of LPS/calcimycin induced inflammatory and allergic mediators by pure compounds of *Andrographis paniculata* (King of bitters) extract. *International Immunopharmacology*, 11(01): 79 – 84

Chouikh A, Chenguel A, and Ali AB (2025). Understanding the Role of Free Radicals, Oxidative Stress, and Antioxidants: A Comprehensive Review. *Letters in Applied Nanobioscience*, 14(2): 1 – 18.

Cosme F, Aires A, Pinto T, Oliveira I, Vilela A and Gonçalves BA (2025). Comprehensive Review of Bioactive Tannins in Foods and Beverages: Functional Properties, Health Benefits, and Sensory Qualities. *Molecules*, 30(4): 800.

Davidson MG, Else RW and Lumsden JH (1998). Determination of plasma proteins. In Manual of Small Animal Clinical Pathology, 1st ed. British Veterinary Association, Gloucestershire, UK.

Ehrenworth AM and Peralta-Yahya P (2017). Accelerating the semisynthesis of alkaloid-based drugs through metabolic engineering. *Nature Chemical Biology*, 13(3): 249 – 258.

Evans WC and Evans D (2009). General methods associated with the phytochemical investigation of herbal products. Trease and Evans Pharmacognosy, 16th ed., Saunders, Elsevier, pp. 135 – 147.

Faluyi O (2021). Nigeria's medicinal plants: *Andrographis paniculata* (meje meje). *Punch*, February 21, 2021.

Ghasemi M, Azhnaz M and Tahamtani Y (2014). Protective effects of Ephedra pachyclada extract on mouse models of carbon tetrachloride-induced chronic and acute liver failure. *Tissue Cell*, 46(1): 78 – 85.

Hariharan T, Vasan P and Gopalakrishna MTR (2021). Phytochemical analysis of Andrographis paniculata whole plant powder. *The Pharma Innovation Journal,* 10(7): 842 – 845.

Hossain S, Urbi Z, Karuniawati H, Mohiuddin RB, Moh Qrimida A, Allzrag AMM, Ming LC, Pagano E and Capasso R (2021). *Andrographis paniculata* (Burm. f.) Wall. ex Nees: An updated review of phytochemistry, antimicrobial pharmacology, and clinical safety and efficacy. *Life (Basel)*, 11(4): 348.

Ibrahim, NA, Rathore D, Janiyani K, Gupta A, Sulieman AME, Tahir HE, Mir RH, Fatima SB, Adnan M and Surti M (2026). A comprehensive review on plant-derived bioactive saponins as promising antimicrobial agents: from bioavailability challenges, molecular mechanistic insights to therapeutic applications. Naunyn-Schmiedeberg's *Archives of Pharmacology*, 399: 1657 – 1687.

Ihedioha JI, Okafor C and Ihedioha TE (2004). The haematological profile of the Sprague Dawley out bred albino rat in Nsukka. *Animal Research International*, 1: 125 – 132.

Jamshidi-Kia F, Lorigooini Z, Amini-Khoei H (2018). Medicinal plants: past history and future perspective. *Journal of Herbmed Pharmacology*, 7(1): 1 – 7.

Jiashu L, Yaoying M, Jingjing W, Huaxing H, Wang X, Chen Z, Jinliang C, Haiyan H, Chao H (2019). A review for the neuroprotective effects of andrographolide in the central nervous system. *Biomedical Pharmacotherapy*, 117: 109078

Kaloun, K (2025). Flavonoids as Bioactive Compounds: Pharmacological Properties and Therapeutic Potential. *Journal of Pharmacognosy and Natural Products*, 11(01): 343

Krishnaiah D, Sarbatly R, Nithyanandam R. (2011) A review of the antioxidant potential of medicinal plant species. *Food Bioproducts Processing*, 89: 217 – 233.

Kumar A, Nirmal P, Kumar M, Jose A, Tomer V, Oz E, *et al*. (2023). Major phytochemicals: recent advances in health benefits and extraction methods. *Molecules,* 28(2): 887.

Kumar G, Singh D, Tali J, Dheer D, and Shankar R (2020). Andrographolide: Chemical modification and its effect on biological activities. *Bioorganic Chemistry*, 95: 103511.

Marrelli, M (2021) Medicinal *Plants,* Plants, 10, 1355.

Melo L, Martins V, Silva A, Rocha H, and Scortecci K (2023). Biological and pharmacological aspects of tannins and

potential biotechnological applications. *Food Chemistry*, 414: 135645.

Nagajothi S, Mekala P, Raja A, Raja MJ and Senthilkumar P (2018). Andrographis paniculata: qualitative and quantitative phytochemical analysis. *Journal of Pharmacognosy and Phytochemistry*, 7(4): 1251 – 1253.

Nambi NR (2025). The Central Role of Oxidative Stress in Chronic Inflammation: Pathways and Treatment Targets. *Newport International Journal of Public Health and Pharmacy*, 6(3): 114 – 118.

Nguyen LT, Fărcaș AC, Socaci SA, Tofană M, Diaconeasa ZM, Pop OL, Salanță LC (2019). An Overview of Saponins – A Bioactive Group. *Bulletin UASVM Food Science and Technology,* 77(1): 2344 – 2344.

Olafedehan CO, Obun AM, Yusuf MK, Adewumi OO, Oladefedehan AO, Awofolaji AO and Adeniji, AA (2010). Effects of residual cyanide in processed cassava peal meals on haematological and biochemical indices of growing rabbits. *Proceedings of 35th Annual Conference of Nigerian Society for Animal Production*, pp. 212.

Onwubiko JI, Igwillo UC, Mbaoji CO, Ifreke LM (2020). Review of Ethnoveterinary medicine for animal healthcare in Nigeria. *International Journal of Recent Research in Life Sciences*, 7(3): 37 – 44.

Ooi SL, Pak SC, Campbell R, Manoharan A (2022). Polyphenol-rich ginger (*Zingiber officinale*) for iron deficiency anaemia and other clinical entities associated with altered iron metabolism. *Molecules*. 27(19): 6417.

Othón-Díaz ED, Fimbres-García JO, Flores-Sauceda M, Silva-Espinoza BA, López-Martínez LX, Bernal-Mercado AT and Ayala-Zavala J F (2023). Antioxidants in oak (Quercus sp.): Potential application to reduce oxidative rancidity in foods. *Antioxidants*, 12: 861.

Pandey BP, Thapa R and Upreti A (2019). Total Phenolic Content, Flavonoids Content, Antioxidant and Antimicrobial Activities of the Leaves, Peels and Fruits of Locally Available Citrus Plants Collected from Kavre District of Nepal. International Journal of Pharmacognosy and Chinese Medicine, 3(3): 1 – 6.

Parihar S (2022). A review on pharmacological activities of Andrographis paniculata. *Biological Sciences*, 02(01): 155 – 165.

Pereira AG, Cassani L, Garcia-Oliveira P, Otero P, Mansoor S, Echave J, Xiao J, Simal-Gándara J and Prieto MA (2023). Plant alkaloids: production, extraction, and potential therapeutic properties. In: Natural Secondary Metabolites: From Nature, through Science, to Industry. Cham: Springer International Publishing, pp. 157 – 200.

Riaz M, Khalid R, Afzal M, Anjum F, Fatima H, Zia S, Rasool G, Egbuna C, Mtewa AG, Uche CZ, Muhammad and Aslam A (2023). Phytobioactive compounds as therapeutic agents for human diseases: a review. *Food Science and Nutrition*, 11(6): 2500 – 2529.

Rodova M, Kim S and Mottaleb MA (2016). Hepcidin Regulation by Bone Morphogenic Protein signaling and iron homeostasis. *Journal of Nutrition and Food science,* 6(4): 521.

Sadhana HM, Joghee S and lakshmi H (2020). Andrographis Paniculata – A Review. *International Journal of Research in Pharmaceutical Sciences*, 11(4): 5395 – 5400.

Sadiq IZ (2023). Free radicals and oxidative stress: signaling mechanisms, redox basis for human diseases, and cell cycle regulation. *Current Molecular Medicine*, 23: 13 – 35.

Sales G and Foresto RD (2020). Drug-induced nephrotoxicity. *Revista da Associação Médica Brasileira*, 66(suppl 1): s82 – s90.

Singh M and Shoaib MM (2016). Interleukin 1-α: A modulator of melanocyte homeostasis in vitiligo. *Biochemistry and Analytical Biochemistry*, 5(2): 273.

Sundaram SS and Shukla AK (2021) Free radicals versus antioxidants. In: Sundaram SS and Shukla AK (Eds.), Potential Therapeutic Applications of Nano-antioxidants,; Springer Singapore: Singapore, pp. 1 – 17.

Taliikwa NC (2025). Phytochemicals in haematopoiesis: Unraveling the role of herbal extracts in nutritional and inflammatory anaemias. *NOSR Applied Sciences*, 13(2): 77 – 81.

Umamaheswari D, Muthuraja R, Kumar M, and Venkateswarlu BS (2021). Standardization of herbal drugs – An overview. *International Journal Pharmacological Science Reviews and Research*, 68(33): 213 – 219.

Vuckovic D, Bao EL, Akbari P, Lettre G, Sankaran VG, Soranz N (2020). The polygenic and monogenic basis of blood traits and diseases. *Cell*, 182: 1214 – 1231.

WHO (World Health Organization) (2025). Global traditional medicine strategy 2025 – 2034. Health Systems Performance Assessment (HSPA) Toolkit for Universal Health Coverage. World Health Organization (WHO), Geneva.

Weiss DJ, and Wardop KJ (2010). Schalm's Veterinary Haematology, 6th ed., Blackwell Publishing Ltd, London.

Xu T, Zhang X, Liu Y, Wang H, Luo J, Luo Y, and An P (2021). Effects of dietary polyphenol supplementation on iron status and erythropoiesis: a systematic review and meta-analysis of randomized controlled trials. *American Journal of Clinical Nutrition*, 114: 780 – 793.

Yadav H, Jain S, Bissi L and Marotta F (2016). Gut microbiome derived metabolites to regulate energy homeostasis: How microbiome talks to host. *Metabolomics,* 6: e150.

Ye XW, Li CS, Zhang HX, Li Q, Cheng SQ, Wen J, *et al*. (2023). Saponins of ginseng products: a review of their transformation in processing, *Frontiers in Pharmacology,* 14. 1177819.

Zheng X, Zhang X and Zeng F (2025). Biological functions and health benefits of flavonoids in fruits and vegetables: A contemporary review. *Foods,* 14: 155.