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Crude ethanol extract of *Ficus capensis* leaves ameliorates anemia in phenylhydrazine-induced anaemic rats.

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Abstract
Background.
Ficus capensis is a medicinal plant used widely in Nigeria which is reported to have diverse functions, including blood-boosting potential.
Aim*. The effect of crude ethanol extract of Ficus capensis leaves in phenylhydrazine induced-anemic rats on hematological and biochemical parameters was investigated.*
Methods. *The experimental animals were randomly grouped into five groups of five rats each – group 1: normal control, group 2: negative control (anemic untreated), group 3: positive control (Standard Drug – Emzoron), group 4: Anemia + 100 mg/kg bw. of crude ethanol extract of F. capensis and group 5: Anemia + 200 mg/kg bw. of crude ethanol extract of F. capensis. Anemia was induced intraperitoneally in the rats using 20mg/kg bw. of phenylhydrazine for four consecutive days. The animals were confirmed to be anemic on the 5th day before the commencement of treatment. Blood was collected by retro orbital sinus for hematological analysis before and after the induction of anemia to monitor the animals for the symptoms of anemia before the commencement of treatment.*
Results*. In the acute toxicity study, the LD_{50} was found to be above 5000 mg/kg bodyweight. The random blood glucose concentration remained normal before, after induction and after treatment. Haemoglobin concentration, Packed Cell Volume (PCV) and Red Blood cells decreased ($p<0.05$) significantly after 4 days of phenylhydrazine induction, but increased ($p<0.05$) significantly after 14 days of treatment with standard drug and extracts of Ficus capensis. There were significant decreases ($p<0.05$) in Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Neutrophils, Lymphocytes, Monocytes, Eosinophils, Basophils, and significant increases ($p< 0.05$) in Platelets, Mean Corpuscular Hemoglobin Concentration, and White Blood Cells (WBC) in Group 2 (anemic untreated) after 14 days of treatment relative to Day 5 (after 4th day of induction of anemia). There were significant ($p<0.05$) decreases in cholesterol, triacylglycerol, and LDL cholesterol concentrations in the extract-administered groups (groups 4&5) relative to the anemic control. There was a significant ($p<0.05$) increase in HDL-cholesterol concentrations in the extract groups (4 and 5) relative to the non-anemic control. There were significant ($p< 0.05$) decreases in the liver function parameters and kidney function parameters in the standard drug and extract administered groups (groups 3,4 and 5) relative to anemic untreated group. The lactate dehydrogenase activity and Malondialdehyde (MDA) concentration decreased significantly ($p<0.05$) in the standard drug and extract administered groups (groups 3,4 and 5) relative to anemic untreated group.*
Conclusion. *Extracts of Ficus capensis not only reversed anemic conditions in the phenylhydrazine-induced rats, but it also improved the alterations in the biochemical parameters caused by the induction of anemia. This may be credited to its rich phytochemical, nutrient, and vitamin composition. Therefore, the results of the study recommend that F. capensis leaves could be used to ameliorate abnormalities associated with anemia.*
Keywords: *Ficus capensis, cholesterol, anemia, liver function test, extracts.*

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I. Introduction

The world interest has been renewed by the development of therapeutic agents from natural products and scientists have been prompted on the benefits of medicinal plant research as a substitute scientific tool for the treatment of diseases.[1,2]. These are unexplored, despite the premise and yet to be screened herbs for phytochemical and biologic activities; however, with high throughput screening methods, these numbers are attenuating extensively globally.[3,4].

Ficus plants belong to the mulberry family, *Moraceae*. *Ficus capensis*, is a deciduous tree with broad green leaves, spreading roots and branches. It produces fleshy fruits throughout the entire year in a single or branched raceme along main branches and the trunk. These fruits are eaten by many animals, though inedible by humans. Hemolytic disorder (HD) causes anemia, which is affecting people of all ages, posing a great threat to the global health care.

The global prevalence of anemia for the general population is on the rise, and it is calculated that 1.62 billion people are affected by this disease.[5]. Chemical exposures, including the administration of some drugs have been discovered to change the lifespan of red blood cells (RBCs) in the body,[6,7], and HD is a part of the clinical syndrome associated with such intoxication.[8,9]. Hemolysis can be caused by several chemicals via interaction with sulfhydryl groups, the inhibition of various enzymes, immune mechanisms, and the fragmentation of erythrocytes as they pass through the platelet (PLT)-fibrin mesh or by unknown or not well defined mechanisms[5]. The prior mentioned described an haemolytic disorder where erythrocytes have a shortened life span.[7]

Phenylhydrazine (PHZ) has been described as a suitable substance for inducing haemolytic disorder and studying anemia mechanisms[5]. Hemolytic disorder reduces the capacity of oxygen transfer and increases blood iron, which causes a series of changes in the body[9]. Oxidative stress on erythrocytes is considered a major mechanism of haemolysis[10]. Phenylhydrazine elevates reactive oxygen species (ROS) by elevating lipid peroxidation metabolites (malondialdehyde, MDA) and reduces antioxidant status, respectively[11]. There is paucity on the modulatory effect of ethanol extract of *F. capensis* on PHZ toxicity in rodents. There was an earlier study which focused on the effect of the aqueous extract of *F. capensis* and its combination with *C. aconitifolius* on phenylhydrazine-induced anemic rats[12]. Therefore, this study assessed the modulatory effects of the crude ethanol extract of *F. capensis* on haematological, biochemical, and oxidative stress parameters in PHZ-induced toxicity in wistar rats in order to ascertain its chemo-preventive benefit.

II. Materials And Methods

Sample Collection and Identification

The leaves of *F. capensis* were collected from Ifite, Awka South Local Government Area, Anambra State, Nigeria. The sample was identified by a taxonomist in the Department of Botany, Nnamdi Azikiwe University, Awka. The voucher number as deposited in the herbarium of Nnamdi Azikiwe University, Awka is 164.

Preparation of Ethanol Extract of F. capensis Leaf

The leaves were properly washed and air dried at room temperature for two weeks. The dried leaves were pulverized into powder using corona manual grinding machine. Exactly 1.5 kg of the pulverized leaf powder of *F. capensis* was soaked in 6 litres of 70% ethanol for 24 hrs for ethanol extraction. The ethanol mixture was sieved using muslin cloth and filtered using Whatman no 1 filter paper. The filtrate was concentrated using water bath at 50^0C. The biological yield of the extract after extraction was 125.7g. The ethanol extract was stoppered in universal bottles and preserved in the refrigerator for use.

Test Animals

A total of 38 male wistar albino rats weighing between150–180g were purchased from Chris Experimental Animal Farm and Research Laboratory, Awka, Anambra State and used for the experiment. They were maintained and housed in cages under standard environmental conditions (27°C±3°C, 12-hour light/dark cycle) in the Department of Applied Biochemistry Laboratory, Nnamdi Azikiwe University, Awka. They were allowed to acclimatize with the environment for one week before use. The animals were fed Vital grower's mash pellets purchased fromVital Feed Distributor at Awka, Anambra state and fed *ad libitum.* At the end of one-week acclimatization period, the animals were weighed, grouped and labeled.

Acute toxicity (LD_{50}) evaluation

The median lethal dose (LD_{50}) for each of the extracts were determined using Lorke's method[13] . Thirteen (13) male rats were used for the determination of the median lethal dose for each extract. The thirteen (13) rats were randomized into six groups; three rats each for the first phase which was given 10, 100 and 1000mg/kg bw and one rat each for the second phase which was given 1600, 2900 and 5000mg/kg bw as described in Lorke's method. The animals were monitored for changes in behaviour and mortality within 2 hrs, 24 hrs and 14 days after a single administration of the extracts.

Study design for Antianemic Properties

A total of twenty-five (25) male wistar rats were randomized into 5 groups of 5 rats each. After the induction of anemia with phenylhydrazine, the animals were treated for 14 days after which blood was collected by cardiac

puncture under ketamine anesthesia and used for hematological and biochemical analysis. They were grouped as follows:
Group A: Normal Control
Group B: Negative Control (Anemic untreated)
Group C: Positive Control (Std Drug-Emzoron)
Group D: Anemia + 100 mg/kg bw. of crude ethanol extract of *F. capensis*
Group E: Anemia + 200 mg/kg bw. of crude ethanol extract of *F. capensis*

Induction of Anemia

Anemia was induced intraperitoneally in the rats using 20mg/kg bw. of phenylhydrazine for four consecutive days. The animals were confirmed to be anemic on the 5th day before the commencement of treatment. Blood was collected by *retro orbital sinus* for hematological analysis before and after the induction of anemia to monitor the animals for the symptoms of anemia before the commencement of treatment.

Determination of bodyweight

The bodyweight of the experimental subjects were checked using an electronic weighing scale. The weight of the rats were monitored before, during, and after the experiment to know whether the extract has an effect on the bodyweight of the experimental rats.

Random Blood Glucose Concentration

The random blood glucose levels of the rats were checked before the induction of anemia, during, and after treatment using One Touch Glucometer (Life Scan, USA) and test strips based on the method of[14].

Haematological Analysis

Haematological parameters were determined using automated haematology analyzer (Mindray-BC-5300). The haematological parameters that were analysed include Haemoglobin (HGB), Packed Cell Volume (PCV), Red Blood Cells (RBC), Platelets (PLT), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), White Blood Cells (WBC), Neutrophils (NEUT), Lymphocytes (LYMPH), Monocytes (MON), Eosinophils (EOS), Basophils (BAS).

Lipid Profile

The lipid profile (Total Cholesterol, Triglycerides, High-Density Lipoprotein-cholesterol, Low-Density Lipoprotein-cholesterol, and Very Low-Density Lipoprotein-cholesterol) were determined using Randox test kits[15,16]. Low-density Lipoprotein-cholesterol (LDL-c) was calculated using a standard formula[17]. The procedure used was according to the manufacturer's instructions provided in the manual.

Liver Function Test

Serum biochemical indices routinely estimated for liver functions were analysed. They include: Alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), direct and total bilirubin. The parameters were determined using Randox diagnostic test kits. The procedures used were according to the manufacturer's instruction.

Kidney Function Test

Urea and creatinine were analysed using Randox test kits.The procedures were carried out according to the manufacturer'sinstructions.

Lipid Peroxidation

Lipid peroxidation was determined by the thiobarbituric acid-reacting substances (TBARS) assay method of[18]. The reaction depends on the formation of complex between malondialdehyde and theobarbituric acid (TBA). 0.4ml of serum was collected into the test tubes; 1.6mlof 0.25N HCl was added together with 0.5ml of 15% trichloroacetic acid and 0.5ml of 0.375% of thiobarbituric acid and then mixed thoroughly.
The reaction mixture was then placed in 100^{o}C boiling water for 15 minutes, allowed to cool and centrifuged at 3000 rpm for 10 minutes. The supernatant was collected and the optical density recorded at 532nm against reagent blank containing distilled water.
The lipid peroxidation activity was calculated using the formula:

$$\frac{\text{Optical density}}{\text{Time}} \times \frac{\text{extinction co-efficient}}{\text{amount of sample}}$$

Where the extinction coefficient value is $1.56 \times 10^{-5} M^{-1} CM^{-1}$
The unit is expressed as umol/MDA/mg of protein.

Lactate Dehydrogenase

Serum lactate dehydrogenase enzyme was determined using Randox diagnostic test kits. The procedures used were according to the manufacturer's instruction.

Electrolyte Concentration

The serum electrolyte concentration was analysed using AFT-300 electrolyte analyzer. The whole blood sample of the wistar rat was centrifuged at 4000 rpm for 10 mins. The serum was separated and used for the analysis. The probe of the electrolyte analyser aspirates the serum of the wistar rat which passes through the electrodes, aspiration pump and the electronic circuits which measure and process the electromotive force to give the test ion concentration. The electrolytes that were analyzed include Potassium ion (K^+), Sodium ion (Na^+), Chloride ion (Cl^-), Bicarbonate ion (BCO_3^-), Total Calcium (T^{cal}) and Ionized Calcium (n^{cal}).

3.2.17 Statistical Analysis

Data obtained from the experiments were analyzed using the Statistical Package for Social Sciences software for windows version 23 (SPSS Inc., Chicago, Illinois, USA). All the data collected were expressed as Mean ± SEM. Statistical analysis of the results obtained were performed by using ANOVA Tests to determine if significant difference exists between the mean of the test and control groups. The limit of significance was set at $p<0.05$.

III. Results

Results of the Acute Toxicity (LD_{50}) Test

The acute toxicity test (LD_{50}) of the crude ethanol leaf extract of *F. capensis* leaves showed that no deaths were recorded amongst the rats, although reduced activity was seen at 5000 mg/kg bodyweight signifying a symptom of toxicity.The results were shown in Table 1 below.

Table 1: Acute toxicity studies of crude ethanol extract of *F. capensis* leaf

Phase	Dose mg/kg	Death recorded in rats	Behavioural indices of toxicity
First	10	0/3	None
	100	0/3	None
	1000	0/3	None
Second	1600	0/1	None
	2900	0/1	None
	5000	0/1	Reduced activity

Result of Bodyweight

The bodyweights of the rats were recorded on day 0 (before the induction of anemia), day 5 (4^{th} day after induction of anemia), day 12 (after 7^{th} day of treatment) and day 19 (after 14^{th} day of treatment). The induction of anemia did not in any way affect the weight of the rats as no significant ($p>0.05$) difference was observed when test groups were compared with the control groups (Table 2). Although an increase in weight was recorded as the number of days of treatment increased in all the groups, the increase in weight can imply that the rats fed well, and not as a result of treatment with standard drug or crude ethanol extract.

Table 2: Bodyweight of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis*.

Groups	Weight (g)				
	Before induction Day 0	After 4^{th} day of ind. of anemia Day 5	After 7^{th} day of treatment Day 12	After 14^{th} day of treatment Day 19	% body weight
Normal Control	156.20±3.66	167.40±2.71	174.60±2.56	179.60±3.63	13.02
Anemic Untreated	153.80±3.47	160.75±3.52	165.40±3.80	171.00±2.84	10.05
Anemia + Standard drug (Emzoron)	150.00±3.07	156.60±3.94	163.78±1.65	172.23±4.10	12.90
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	166.80±3.94	171.60±3.25	176.35±2.69	188.00±5.70	11.27
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	171.00±3.67	175.40±3.53	182.60±5.81	195.23±4.85	12.41

Result of Random Blood Glucose Concentration

The random blood glucose concentration was examined in all the groups on day 0 (before the induction of anemia), day 5 (4^{th} day after induction of anemia), day 12 (after 7^{th} day of treatment) and day 19 (after 14^{th} day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on random blood glucose levels (Table 3). The result showed that the rats maintained normal blood glucose levels in all the different stages.

Table 3: Random blood glucose concentrations of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis*.

Groups	Glucose level (g/dl)			
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 7th day of treatment Day 12**	**After 14th day of treatment Day 19**
Normal Control	80.00±4.32	83.20±5.17	92.20±5.56	87.00±3.30
Anemic Untreated	78.80±3.12	94.80±5.70	89.00±5.87	90.50±10.82
Anemia + Standard drug (Emzoron)	91.00±8.21	80.60±2.87	92.00±3.30	109.80±1.07
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	92.20±8.81	90.20±4.37	101.60±6.13	97.60±1.12
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	90.00±7.99	85.60±8.18	91.20±4.61	92.40±4.50

Result of Haematological Analysis

The Hemoglobin (HGB) concentration was examined in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on HGB levels (Table 4). The results showed that there was a significant (p<0.05) decrease in HGB levels in all the test groups after a successful induction of anemia (Day 5). Treatment with standard drug and crude ethanol extract restored the levels of HGB to normalcy in groups 3, 4 and 5 after 14th day of treatment (Day 19).

Table 4: Haemoglobin (HGB) concentration of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis*.

Groups	HGB (g/dl)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	14.00±0.10	14.13±0.23	12.97±0.38
Anemic Untreated	13.93±0.48	8.20±0.67[a]	10.10±1.21[a]
Anemia + Standard drug (Emzoron)	13.50±0.78	8.53±1.24[a]	12.90±1.08[b]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	13.93±0.15	10.77±0.12[a]	12.53±0.27[b]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	14.03±0.38	10.77±0.40[a]	14.37±0.99[b]

[a]Significant decrease with respect to day 0; [b]Significant increase with respect to day 5.

The Packed Cell Volume (PCV) levels were measured in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on PCV levels. The result showed that there was a significant (p<0.05) decrease in PCV levels in all the test groups suggesting a successful induction of anemia (Day 5) compared with Day 0. Treatment with standard drug and crude ethanol extract were able to increase the PCV levels, in groups 3, 4 and 5 after 14th day of treatment (Day 19), indicating an ameliorative effect of the extract on the treated groups (Table 5).

Table 5: Packed Cell Volume (PCV) of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis* leaves.

Groups	PCV (%)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	49.97±1.34	52.40±1.22	39.00±0.93
Anemic Untreated	50.60±1.41	28.83±1.47[a]	29.00±3.93[a]
Anemia + Standard drug (Emzoron)	50.27±1.58	28.70±4.98[a]	37.93±3.47[b]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	50.70±1.06	32.93±0.38[a]	36.87±0.43[b]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	52.57±1.30	33.33±2.07[a]	43.40±2.61[b]

[a]Significant decrease with respect to day 0; [b]Significant increase with respect to day 5.

The Red Blood Cells (RBC) levels were examined in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on RBC levels (Table 6). The result showed that there was a significant (p<0.05) decrease in RBC levels in all the test groups suggesting a successful induction of anemia

(Day 5) compared with Day 0. Treatment with standard drug and crude ethanol extract were able to increase the RBC levels, in groups 3, 4 and 5 after 14th day of treatment (Day 19) as there was a significant (p<0.05) increase in groups 3, 4 and 5 when compared with anemic untreated (group 2).

Table 6: Red Blood Cells (RBC) of phenylhydrazine-induced anemic rats treated with ethanol extract of *F. capensis* leaves.

Groups	RBC (g/dl)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	8.11±0.10	8.37±0.28	6.78±0.26
Anemic Untreated	8.46±0.27	2.84±0.18[a]	4.11±0.36[a]
Anemia + Standard drug (Emzoron)	8.32±0.41	3.14±0.56[a]	5.40±0.57[b]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	8.52±0.12	6.07±0.16[a]	5.20±0.04[b]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	8.27±0.20	5.82±0.49[a]	5.83±0.42[b]

[a]Significant decrease with respect to day 0; [b]Significant increase with respect to day 5.

The Platelets count (PLT) was examined in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to determine the effect of treatment with crude ethanol extract of *F. capensis* on PLT count (Table 7). The result showed that there was a significant (p<0.05) increase in PLT count in all the test groups after 4th day of induction of anemia (Day 5). Treatment with standard drug and crude ethanol extract showed a significant (p<0.05) decrease in groups 3, 4 and 5 after 14th day of treatment (Day 19) when compared with anemic untreated (group 2). Group 5 treated with 200mg/kg showed the lowest value in PLT count after 14th day of treatment (Day 19).

Table 7: Platelets (PLT) count of phenylhydrazine-induced anemic rats treated with ethanol extract of *C. aconitifolius* leaves.

Groups	PLT (10^9/L)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	771.33±26.03	812.67±55.26	876.00±45.57
Anemic Untreated	717.33±38.48	741.00±9.54	908.33±72.46
Anemia + Standard drug (Emzoron)	780.00±10.06	893.33±35.30	815.33±36.67
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	783.33±48.07	746.67±15.03	782.67±23.67
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	733.33±19.64	902.00±51.87	644.00±23.64

The Mean Corpuscular Volume (MCV) was examined in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to determine the effect of treatment with crude ethanol extract of *F. capensis* on MCV level (Table 8). The result showed that there was a significant (p<0.05) increase in MCV count in all the test groups after 14th day of treatment (Day 19) when compared with Day 0 (before induction of anemia).

Table 8: Mean Corpuscular Volume (MCV) of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis* leaves.

Groups	MCV (fL)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	61.40±0.90	62.67±0.72	57.57±0.97
Anemic Untreated	59.57±3.03	102.00±3.52[b]	69.87±3.83[c]
Anemia + Standard drug (Emzoron)	55.53±5.09	91.57±6.30	70.50±1.55
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	60.40±1.13	54.30±0.82	70.00±1.30[bd]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	58.33±3.96	57.50±1.81	74.53±1.03[bd]

[b]Significant increase with respect to day 5; [c]Significant decrease with respect to day 5; [d]Significant increase with respect to day 0.

The Mean Corpuscular Hemoglobin (MCH) was investigated in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to

ascertain the effect of treatment with crude ethanol extract of *F. capensis* on MCH level (Table 9). The result showed that there was a significant (p<0.05) increase in MCH count in all the test groups after 14th day of treatment (Day 19) when compared with Day 0 (before induction of anemia).

Table 9: Mean Corpuscular Hemoglobin (MCH) of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis* leaves.

Groups	MCH (pg)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	16.53±0.34	16.90±0.45	19.17±0.23
Anemic Untreated	16.90±0.32	28.87±0.55^{d}	24.37±0.94^{cd}
Anemia + Standard drug (Emzoron)	15.97±0.50	27.43±1.03^{d}	23.97±0.62^{cd}
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	15.90±0.15	17.80±0.64	24.33±0.67^{bd}
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	17.30±0.97	18.70±0.93	24.63±0.12^{bd}

^{b}Significant increase with respect to day 5; ^{c}Significant decrease with respect to day 5; ^{d}Significant increase with respect to day 0.

The Mean Corpuscular Hemoglobin Concentration (MCHC) was investigated in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to determine the effect of treatment with crude ethanol extract of *F. capensis* on MCH level (Table 10). The result showed no significant (p>0.05) difference in MCHC count in all the groups after 14th day of treatment (Day 19).

Table 10: Mean Corpuscular Hemoglobin Concentration (MCHC) of phenylhydrazine-induced anemic rats treated withcrude ethanol extract of*F. capensis* leaves.

Groups	MCHC (g/dl)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	26.97±0.39	26.93±0.55	33.33±0.55^{bd}
Anemic Untreated	26.37±0.90	28.40±1.46	34.97±0.63^{bd}
Anemia + Standard drug (Emzoron)	27.57±1.34	30.23±2.36	34.03±0.37^{bd}
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	27.63±0.87	32.77±0.77	33.73±0.33^{d}
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	30.80±2.15	32.53±1.02	33.07±0.35

^{b}Significant increase with respect to day 5; ^{d}Significant increase with respect to day 0.

The White Blood Cells count was investigated in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on WBC level (Table 11). The result showed that there was a significant (p<0.05) increase in WBC count in anemic untreated (group 2) after 14th day of treatment (Day 19) when compared with normal control and treated groups. The increase in WBC in group 2 (anemic untreated) could be as a result of mobilization of WBC to fight the anemic condition.

Table 11: White Blood Cells (WBC) count of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis* leaves.

Groups	WBC (10^9/L)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	8.08±0.98	9.28±2.30	12.06±1.35
Anemic Untreated	7.53±0.69	17.58±3.70^{d}	29.20±3.65^{bd}
Anemia + Standard drug (Emzoron)	7.64±0.66	20.66±5.31^{d}	22.39±8.59
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	10.33±0.89	24.22±0.88^{d}	9.44±1.44^{c}
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	9.44±1.44	22.87±5.75^{d}	8.80±0.53^{c}

^{b}Significant increase with respect to day 5; ^{c}Significant decrease with respect to day 5; ^{d}Significant increase with respect to day 0.

The Neutrophil (Neut) concentration was examined in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to estimate the effect of treatment with crude ethanol extract of *F. capensis* on neutrophil levels (Table 12). The result showed a significant (p<0.05) increase in Neutrophil levels in all the groups after a successful induction of anemia (Day 5) when compared with Day 0. Treatment with standard drug and crude ethanol extract restored the levels of Neutrophil to normalcy in groups 3, 4 and 5 after 14th day of treatment (Day 19).

Table 12: Neutrophils (NEUT) of phenylhydrazine-induced anemic rats treated with crudeethanol extract of*F. capensis* leaves.

Groups	Neut (%)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	27.80±0.75	27.07±0.49	19.77±3.32
Anemic Untreated	28.13±1.39	38.27±0.98[d]	36.00±7.91
Anemia + Standard drug (Emzoron)	29.17±0.88	42.23±5.83[d]	24.20±4.50[c]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	28.17±0.90	46.03±1.66[d]	25.23±2.03[c]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	26.40±1.59	46.23±1.60[d]	24.00±5.69[c]

[c]Significant decrease with respect to day 5; [d]Significant increase with respect to day 0.

The lymphocytes (LYMPH) concentration was examined in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to estimate the effect of treatment with crude ethanol extract of *F. capensis* on lymphocytes levels (Table 13). The result showed a significant (p<0.05) decrease in lymphocytes levels in all the groups after a successful induction of anemia (Day 5) when compared with Day 0. Treatment with standard drug and crude ethanol extract gave rise to a significant (p<0.05) increase in the levels of lymphocytes in groups 3, 4 and 5 after 14th day of treatment (Day 19) when compared with anemic untreated (group 2).

Table 13: Lymphocytes (LYMPH) of phenylhydrazine-induced anemic rats treated withcrude ethanol extract of*F. capensis* leaves.

Groups	Lymph (%)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	71.03±0.64	70.83±0.27	79.93±3.43
Anemic Untreated	66.33±2.45	51.23±3.01[a]	50.60±11.44
Anemia + Standard drug (Emzoron)	65.93±1.62	49.60±0.47[a]	75.47±4.32[b]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	70.60±1.32	51.53±0.50[a]	81.13±7.92[b]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	68.50±1.40	52.43±2.27[a]	74.73±6.78[b]

[a]Significant decrease with respect to day 0; [b]Significant increase with respect to day 5.

The monocytes (MON) concentration was examined in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on monocytes levels (Table 14). The result showed a significant (p<0.05) increase in monocytes levels in all the test groups after a successful induction of anemia (Day 5) when compared with Day 0. Treatment with standard drug and crude ethanol extract gave rise to a significant (p<0.05) decrease in the levels of monocytes in groups 3, 4 and 5 after 14th day of treatment (Day 19) when compared with anemic untreated (group 2).

Table 14: Monocytes (MON) of phenylhydrazine-induced anemic rats treated with crudeethanol extract of*F. capensis* leaves.

Groups	Mon (%)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	0.37±0.03	0.37±0.03	0.00±0.00
Anemic Untreated	0.43±0.09	2.13±0.03[d]	0.50±0.25[c]
Anemia + Standard drug (Emzoron)	0.43±0.03	2.17±0.03[d]	0.13±0.13[c]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	0.43±0.12	2.13±0.09[d]	0.17±0.12[c]
Anemia + 200 mg/kg crude ethanol	0.20±0.00	2.13±0.09[d]	0.17±1.02[cd]

extract of *F. capensis*			

[c]Significant decrease with respect to day 5; [d]Significant increase with respect to day 0.

The Eosinophils (Eos) concentration was investigated in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on Eos levels. The result in Table 15 below showed no significant (p>0.05) difference in Eosinophils levels in all the test groups after a successful induction of anemia (Day 5). After 14th day of treatment, a significant (p<0.05) decrease in the levels of Eosinophils were observed in all the test groups compared with Day 0 (before induction) and after 4th day of induction of anemia (Day 5).

Table 15: Eosinophils (EOS) of phenylhydrazine-induced anemic rats treated with crude ethanol extract of*F. capensis*leaves.

Groups	Eos (%)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	1.20±0.00	1.23±0.03	0.30±0.12[ac]
Anemic Untreated	1.37±0.23	1.17±0.03	0.23±0.15[ac]
Anemia + Standard drug (Emzoron)	1.27±0.07	1.47±0.07	0.20±0.10[ac]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	1.23±0.19	1.13±0.03	0.40±0.10[ac]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	1.10±0.00	1.20±0.12	0.20±0.10[ac]

[a]Significant decrease with respect to day 0; [c]Significant decrease with respect to day 5.

The Basophyls (BAS) concentration was investigated in all the groups on day 0 (before the induction of anemia), day 5 (4th day after induction of anemia), and day 19 (after 14th day of treatment) to ascertain the effect of treatment with crude ethanol extract of *F. capensis* on neutrophil levels (Table 16). The result in Table 16 below showed a significant (p<0.05) increase in Basophyl levels in all the groups after a successful induction of anemia (Day 5) when compared with Day 0. No values were seen after 14th day of treatment (Day 19) in all the groups.

Table 16: Basophyls (BAS) of phenylhydrazine-induced anemic rats treated with crude ethanol extract of *F. capensis* leaves.

Groups	Bas (%)		
	Before induction Day 0	**After 4th day of ind. of anemia Day 5**	**After 14th day of treatment Day 19**
Normal Control	0.17±0.03	0.13±0.03	0.00±0.00[ac]
Anemic Untreated	0.13±0.03	0.30±0.06	0.00±0.00[ac]
Anemia + Standard drug (Emzoron)	0.13±0.03	0.37±0.03	0.00±0.00[ac]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	0.17±0.07	0.37±0.03	0.00±0.00[ac]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	0.10±0.00	0.40±0.00	0.00±0.00[ac]

[a]Significant decrease with respect to day 0; [c]Significant decrease with respect to day 5.

Result of Biochemical Analysis

Effect of Extract on Lipid Profile

Effect of crude ethanol extract of *F. capensis* was monitored on lipid profile (Table 17). The results showed a significant (p<0.05) increase in total cholesterol (TCHOL), low density lipoprotein cholesterol (LDL-C), triglycerides (TRIG) and very low density lipoprotein (VLDL) in anemic untreated (group 2) as a result of anemic condition when compared with normal control and treated groups. Standard drug and extract treated groups were found to confer restorative effects on these groups as they were able to restore the TCHOL, LDL-C, TRIG and VLDL levels in anemic condition back to normalcy (Table 17). Group 5 (treated with 200mg/kg crude extract) compared favorably to group 3 (group treated with standard drug). A significant (p<0.05) decrease in HDL-c level was observed in anemic untreated (group 2) when compared with normal control and treated groups. The standard drug and extract treated groups showed an ameliorative effect by restoring the levels in anemic condition back to normalcy. Group 5 (treated with 200mg/kg crude extract) compared favorably with group 3 (group treated with standard drug).

Table 17: Effect of treatment with crude ethanol extract of *F. capensis* on lipid profile of phenylhydrazine-induced anemic rats.

Groups	**TCHOL (mg/dl)**	**HDL-C (mg/dl)**	**LDL-C(mg/dl)**	**TRIG (mg/dl)**	**VLDL (mg/dl)**
Normal Control	88.00±3.61	46.33±10.52	24.67±2.40	36.73±13.51	4.93±0.48
Anemic Untreated	120.33±5.17[e]	35.33±4.06	40.67±4.26[e]	76.87±6.16[e]	8.13±0.85[e]
Anemia + Standard drug (Emzoron)	98.00±4.16[h]	43.33±2.19	31.00±1.15[h]	48.47±4.10	6.20±0.23
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	112.00±4.16[e]	39.67±6.33	31.67±5.24	66.00±9.38	6.33±1.05
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	104.00±6.56[eh]	44.33±2.40	33.00±1.73[h]	53.01±4.21	6.60±0.35

[e]Significant increase with respect to normal control; [h]Significant decrease with respect to anemic untreated.

Effect of Extract on Liver Function Parameters

Effect of crude ethanol extract of *F. capensis* was monitored on liver function parameters, alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP), total bilirubin (T.BIL) and direct bilirubin (D.BIL). The results in Table 18 below showed a significant (p<0.05) increase in ALT, AST, ALP, T.BIL and D.BIL in anemic untreated (group 2) when compared with normal control and treated groups, which could be as a result of liver injury. Standard drug and extract treated groups were found to confer restorative effects on these groups as they were able to restore the ALT, AST, ALP, T.BIL and D.BIL in anemic condition back to normalcy. Group 5 (treated with 200mg/kg crude extract) compared favorably with group 3 (group treated with standard drug).

Table 18: Effect of treatment with crude ethanol extract of *F. capensis* on liver function parameters of phenylhydrazine-induced anemic rats.

Groups	**ALT (U/L)**	**AST (U/L)**	**ALP (U/L)**	**T. BIL (mg/dl)**	**D. BIL (mg/dl)**
Normal Control	10.00±1.15	16.33±0.33	31.93±1.68	1.47±0.11	0.36±0.04
Anemic Untreated	22.00±5.13[e]	31.33±2.60[e]	52.50±3.84[e]	1.91±0.05[e]	0.89±0.05[e]
Anemia + Standard drug (Emzoron)	12.33±2.60	19.67±1.76[h]	36.60±5.71[h]	1.48±0.04[h]	0.46±0.08[h]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	14.33±2.33	23.00±2.31[h]	38.27±5.87	1.62±0.06	0.36±0.04[h]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	13.00±4.04	21.33±0.88[h]	34.87±6.77[h]	1.49±0.09[h]	0.28±0.02[hj]

[e]Significant increase with respect to normal control; [h]Significant decrease with respect to anemic untreated; [j]Significant decrease with respect to standard drug.

Effect of Extract on Kidney Function Parameters

Effect of crude ethanol extract of *F. capensis* was assayed on kidney function parameters (urea and creatinine) as shown in table 19. The results showed a significant (p<0.05) increases in urea and creatinine in anemic untreated (group 2) when compared with normal control and treated groups, which could be as a result of kidney injury. Standard drug and extract treated groups were found to confer restorative effects on these groups as they were able to restore the urea and creatinine levels in anemic condition back to normalcy.

Table 19: Effect of treatment with crude ethanol extract of *F. capensis* on kidney parameters of phenylhydrazine-induced anemic rats.

Groups	Urea (mg/dl)	Creatinine (mg/dl)
Normal Control	8.03±0.88	2.40±0.15
Anemic Untreated	13.63±0.80[e]	4.43±0.12[e]
Anemia + Standard drug (Emzoron)	8.67±0.26[h]	2.67±0.34[h]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	9.53±0.18[h]	2.66±0.30[h]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	8.37±0.12[h]	2.15±0.07[h]

[e]Significant increase with respect to normal control; [h]Significant decrease with respect to anemic untreated.

Effect of Extract on Lipid Peroxidation (Malondialdehyde)

The effect of crude ethanol extract of *F. capensis* on malondialdehyde was monitored to ascertain the level of lipid peroxidation. Malondialdehyde (MDA) is a product of lipid peroxidation. The results in table 20 showed a significant (p<0.05) increase in MDA levels in anemic untreated (group 2) when compared with normal control and treated groups. Treatment with standard drug and crude ethanol extract were able to attenuate the levels of MDA in groups 3, 4 and 5 and restored them to normalcy.

Table 20: Effect of treatment with crude ethanol extract of *F. capensis* on malondialdehyde (MDA) concentration of phenylhydrazine-induced anemic rats.

Groups	MDA (µmol/L x 10^{-8})
Normal Control	1.57±0.20
Anemic Untreated	5.87±0.22[e]
Anemia + Standard drug (Emzoron)	2.90±0.78[eh]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	2.20±0.23[h]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	2.70±0.10[h]

[e]Significant increase with respect to normal control; [h]Significant decrease with respect to anemic untreated.

Effect of Extract on Lactate Dehydrogenase Activity

The effect of crude ethanol extract of *F. capensis* on lactate dehydrogenase (LDH) activity was monitored. The results in table 21 below showed a significant (p<0.05) increase in anemic untreated (group 2) when compared with normal control and treated groups. Treatment with standard drug and crude ethanol extract were able to attenuate the levels of LDH in groups 3, 4 and 5.

Table 21: Effect of treatment with crude ethanol extract of *F. capensis* on lactate dehydrogenase (LDH) activity of phenylhydrazine-induced anemic rats.

Groups	LDH (U/L)
Normal Control	207.00±8.89
Anemic Untreated	363.00±14.80[e]
Anemia + Standard drug (Emzoron)	276.30±28.05[eh]
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	250.00±18.45[h]
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	263.70±24.90[h]

[e]Significant increase with respect to normal control; [h]Significant decrease with respect to anemic untreated.

Effect of Extract on Electrolyte Levels

The effect of treatment with crude ethanol extract of *F. capensis* was investigated on the electrolyte levels of all the groups. The electrolytes measured included the potassium ion (K^+), sodium ion (Na^+), chloride ion (Cl^-), bicarbonate ion (BCO_3^-), total calcium (T^{cal}) and ionized calcium (n^{cal}). The results obtained in table 22 below showed no significant (p>0.05) differences in anemic untreated (group 2) compared with normal control (group 1) and treated groups (groups 3, 4 and 5).

Table 22: Effect of treatment with crude ethanol extract of *F. capensis* on electrolyte levels of phenylhydrazine-induced anemic rats.

Groups	K^+ (mmol/L)	Na^+ (mmol/L)	Cl^- (mmol/L)	BCO_3^- (mmol/L)	T^{cal} (mmol/L)	n^{cal} (mmol/L)
Normal Control	5.73±0.15	132.7±2.40	103.33±0.67	19.33±1.45	1.53±0.17	0.77±0.09
Anemic Untreated	7.77±1.72	132.0±1.73	102.67±1.76	21.33±0.88	1.20±0.23	0.60±0.12
Anemia + Standard drug (Emzoron)	5.13±0.07[h]	132.33±0.33	97.33±0.33[fh]	18.33±0.88	1.13±0.13	0.57±0.07
Anemia + 100 mg/kg crude ethanol extract of *F. capensis*	5.73±0.28	133.33±1.45	102.30±2.19[i]	20.67±0.88	1.43±0.23	0.70±0.12
Anemia + 200 mg/kg crude ethanol extract of *F. capensis*	6.37±0.19	135.00±1.53	106.67±1.20[gi]	20.66±1.45	1.70±0.25	0.83±0.12

[f]Significant decrease with respect to normal control; [g]Significant increase with respect to anemic untreated; [h]Significant decrease with respect to anemic untreated; [i]Significant increase with respect to Standard drug.

IV. Discussion

The acute toxicity test (LD_{50}) of the crude ethanol leaf extract of *F. capensis* leaves (table 1) showed that no deaths were recorded amongst the rats, but reduced activity was seen at 5000 mg/kg (signifying a symptom of toxicity) during the investigation and therefore the leaves could be safe for animal consumption at concentration below 5000mg/kg. The bodyweight of animals administered crude ethanol extract of *F. capensis*

leaves is shown in table 2. The bodyweight of all groups of animals studied in respect to the initial and final bodyweight changes increased significantly ($p<0.05$). Though there was an increase in the bodyweight of the anemic untreated (group 2), it had the lowest change in bodyweight. This could be attributed to the reduced action of enzymes involved in digesting starch in the anemic untreated rats, while the higher values in percentage bodyweight (groups 1, 3, 4 & 5) could be attributed to the non-toxic nature of the extracts of the plant.

Table 3 showed the results of Random blood glucose levels. The rats maintained normal blood glucose levels before induction (Day 0), after induction (Day 5), and after treatment (Day 19). Tables 4 and 5 showed that after induction of anemia (Day 5), there was a significant ($p<0.05$) decrease in Hemoglobin (HGB) concentration and Packed Cell Volume (PCV) levels respectively in the phenylhydrazine induced groups (2, 3, 4 and 5) relative to the normal control (group 1). The reduction in HGB concentration and reduction in PCV values by more than 50% of the baseline values in all rats on the 4th day after phenylhydrazine administration is an indication that the animals were anemic. After 14 days of treatment with *F. capensis* leaves, there were significant ($p<0.05$) decreases in HGB and PCV values in group 2 (anemic untreated) relative to group 1(normal control). Groups 3 and 4 showed no significant ($p>0.05$) difference relative to group 1, while significant ($p<0.05$) increases in HGB and PCV values were observed in groups 3,4 and 5 when compared to group 2 (anemic untreated). This indicates that there was a gradual reversal of anemic condition following treatment for 14 days with extracts of *F. capensis* and standard drug. Red blood cells (RBC) also showed a significant ($p<0.05$) decrease in all groups (Table 6) after 4th day of induction of anemia relative to group 1 (normal control). After 14th day of treatment with standard drug and crude ethanol extracts of *F. capensis*, the results showed significant increases in groups 3,4 and 5 relative to group 2 (anemic untreated). This indicates that extracts of *F. capensis* increased RBC count, therefore, could be said to have reversed the anemic condition after 14 days of treatment. [6] (Berger,2007), asserted that animals were considered anemic when decreases in HGB level, RBC count, PCV and impaired erythrocyte deformability are observed following phenylhydrazine administration. The body's response to low PCV level resulting in the production of blood cells in order not to deprive the animal of oxygen in circulation could be the reason for the increase in PCV[19], reported the formation of reactive oxygen species when phenylhydrazine drug was induced because of oxidative damage to red blood cells. Ezeigwe et al,[20] reported high percentage of flavonoids, alkaloids, tannin and saponin in the ethanol leaf extracts of *F. capensis* when compared with that of *C. aconitifolius.* Flavonoids in plants possess medicinal benefits which includes antioxidant and anti-inflammatory activities[21]. They have the ability to scavenge hydroxyl radicals, superoxide anions and lipid peroxy radicals[22], therefore supports its antioxidant activity. Thus, the rich milieu of phytochemicals (saponins, flavonoids and alkaloids) and antioxidants in the plant extract could be responsible for the increase in RBC count and thus could reverse the damaging effects of phenylhydrazine anemia. These results agreed with reports on treatment with extracts of *Tectona grandis*[23] and extracts of *M. indica, A. hybridus* and *T. occidentalis*[24], which increased the concentration of haemoglobin and red blood cells after treatment in phenylhydrazine induced anemic rats[25]. A significant decrease ($p<0.05$) in haemoglobin (HGB) concentrations was observed in groups 2,3,4 and 5 relatives to group 1 (normal control) after 4th of induction of anemia. A significant increase ($p<0.05$) in HGB concentrations was observed in groups 3, 4, and 5 relatives to group 2 (anemic untreated) after 14th day of treatment with standard drug and crude ethanol extract. The anemic rats that were administered extracts at 200 mg/kg of the extract showed the highest HGB concentration, possibly indicating that from the dosages, the potency of the extract as a blood booster was expressed in the rats as shown in table 4. This suggests that the animals recovered from anemia when treated with the plant extract, which might induce the haemopoietic pathway. This result confirms scientific reports of Ogbe et al, [24] where extracts of *M. indica, A. hybridus* and *T. occidentalis* elevated HGB concentration in rats.

The results (Tables 8, 9 and 10) showed significant ($p<0.05$) increases in MCV (Mean Corpuscular Volume), MCH (Mean Corpuscular Hemoglobin), and MCHC (Mean Corpuscular Hemoglobin Concentration) in all the groups inducted with anemia after 4 days of induction relative to Day 0 (before induction). These results agreed to the reports that PHZ is known to induce increase in MCV (Mean Corpuscular Volume), MCH (Mean Corpuscular Hemoglobin) and MCHC (Mean Corpuscular Hemoglobin Concentration) levels[25].

Findings also show a significant ($p<0.05$) increase in the WBC count (table 11) of animals in groups 2, 3, 4 and 5 after 4th day of induction of anemia (Day 5). The increase in the White Blood Cells (WBC) count, in group 2 (table11) after 14th day of treatment with extracts and standard drug compared with other groups could be a result of the physiologic response of the system in boosting the body's defense mechanisms after administration of phenylhydrazine drug. According to[26], the animal's immune system may assume that the cause of anemia could be a result of infection or disease and hence the production of white blood cells to fight such infections is increased. Following a foreign attack on the system by pathogens, it gives rise to a rapid increase in WBC count and boosting the body's defense mechanisms will be the normal physiologic response of the system[27].

The lipid profile results (table 17) indicated a significant (p<0.05) decrease in total cholesterol in groups 3,4 and 5 relatives to the anemic untreated (group 2). This suggests that treatment with standard drug and crude ethanol extract of *F. capensis* were significant in modulating cholesterol concentrations[28]. The attenuation in serum cholesterol could be beneficial to individuals with hypercholesterolemia, thereby reducing the risk of cardiovascular diseases and other diseases[29]. This decrease in cholesterol concentrations might be attributed to the phytochemicals present such as saponins. Saponins have been reported to reduce the uptake of cholesterol in the gut through intra-lumenal physicochemical interaction[30] and thereby help reduce cholesterol. High Density Lipoprotein (HDL)-Cholesterol concentrations showed a significant (p<0.05) increase in the groups (3,4 and 5) relative to the anemic untreated (group 2). HDLs remove cholesterol from plasma and cells of non-hepatic tissues, returning it to the liver[31]. HDL inhibits the oxidation of LDL by transition metal ions, but also prevents 12-lipooxygenase-mediated formation of lipid hydroperoxides[32]. Triacylglycerol concentrations as shown in the groups treated (3, 4 and 5) showed significant (p<0.05) decreases relative to anemic untreated (group 2). The decrease observed in triacylglycerol concentrations in the extract-treated groups and standard drug-treated group could be attributed to the rich milieu of phytochemicals found in the leaves. High levels of LDL, which are tagged "bad cholesterol", increase the chances of developing atherosclerosis[25]. Increased LDL concentrations are associated with atherosclerosis, heart attack, stroke, and cardiovascular diseases[33,34]. VLDL cholesterol concentrations showed no (p>0.05) significant differences in the treated groups (groups 3,4 and 5). Earlier studies revealed that a combination of ethanol leaf extract of *F. capensis* and *C. aconitifolius* was safe and may be useful in the management of lipid profile complications resulting from anemia[28].

The results obtained (Table 18) showed a significant (p<0.05) increase in liver function parameters (ALT, AST, ALP, T.BIL, D.BIL) in anemic untreated (group 2) compared to other groups. An increase in serum liver function parameters is an indication of an injury to the liver causing a release of AST, ALT from the cytosol, especially in membrane damage[35]. The results obtained showed a decline in serum liver function test parameters in extract and standard drug-treated groups (3, 4 and 5) relative to the anemic untreated (group 2). This suggests a protective effect of crude ethanol extracts of *F. capensis* against liver injuries. This is in line with our research which revealed that aqueous extract of *F. capensis* when given in combination with *C. aconitifolius* significantly restored the complications caused in the liver function enzymes suggesting a protective and restorative potential in cases of liver damage or injury[12].

The results obtained (table 19) showed a significant (p<0.05) increase in kidney function parameters (urea and creatinine) in anemic untreated (group 2) compared to other groups. An increase in kidney function parameters could be a sign of an underlying condition affecting the kidneys[36]. The results obtained showed a decrease in blood urea and creatinine in extract and standard drug-treated groups (3, 4 and 5) relative to the anemic untreated (group 2) indicating a protective effect of crude ethanol extracts of *F. capensis* against kidney injuries.

Lactate dehydrogenase (LDH) is found in red blood cells, and lysis of red blood cells (hemolytic anemia) leads to increase in LDH in the blood stream as seen in table 21. Treatment with standard drug and crude ethanol extract showed an ameliorative effect with significant (p<0.05) decrease in groups (3,4 and 5) relative to group 2 (anemic untreated).

Low or high levels of serum electrolytes are indication of tubular dysfunction[37]. Table 22 showed the results for serum electrolyte levels. The results obtained showed no significant (p>0.05) differences in groups (2, 3, 4 and 5) relative to the normal control (group 1) as they maintained normal safety values and this proposes the safe use of this extracts in the doses administered without any risk of hyper or hypokalemia, natremia, alkalosis, acidosis or chloremia.

V. Conclusion

This study showed that *F. capensis* crude ethanol extracts possess anti-anemic potential, lending credence to the use of these plant extracts in folk medicine for the management of hemolytic anemia. The observations from this study revealed that leaves of *F. capensis* not only possess anti-anemic properties as reportedly used by traditional healers, but have hypolipidemic potential, which could be beneficial to individuals predisposed to cardiovascular diseases. Further studies are warranted to determine the bioactive component present in *F. capensis* leaves that could be responsible for both anti-anemic and hypolipidemic effects.

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Conflict of Interest

The authors declare that there is no conflict of interest in this research.

Author's Contribution

The laboratory experiments were conducted by Obiajulu Christian Ezeigwe, Valentine Osita Godwin Nwobodo, Chukwuemeka Obumneme Okpala and Ebele Lauretta Iloanya. Obiajulu Christian Ezeigwe performed the statistical analysis of the results. Original draft of the manuscript was written by Chukwuemeka Obumneme Okpala. The manuscript was edited and reviewed by Obiajulu Christian Ezeigwe, Valentine Osita Godwin Nwobodo and Ebele Lauretta Iloanya All the authors read and approved the final version of the manuscript.

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