Hematological Parameters and Lipid Profile Changes in Albino Rats due to Administration of Ethanol Extract of *Ipomea batatas* Leaves

M. O. Enemali [a*], J. Akolo [b], G. S. Haruna [b], J. E. Bulus [b], P. J. Kassah [b] and I. C. Ejiogu [c]

[a]*Department of Applied Biochemistry, Faculty of Biosciences, Nnamdi Azikiwe University, Awka, Nigeria.*
[b]*Department of Biochemistry and Molecular Biology, Faculty of Natural and Applied Sciences, Nasarawa State University, Keffi, Nigeria.*
[c]*Department of Human Biochemistry, Nnamdi Azikiwe University, Awka, Nigeria.*

Original Research Article

ABSTRACT

Leaves of *I. batatas* have been implicated in both the hematopoietic process and in the management of hyperlipidemia in man. The current study evaluated the hematopoietic potentials and the lipid profile stabilizing potential of ethanol leaf extract of *I. batatas* in albino rats. The study was carried out at the Department of Biochemistry and Molecular Biology of the Nasarawa State University, Keffi, between March 2019 and October 2019. The determination of the phytochemical composition of the leaves was carried out. Sixteen albino rats weighing between 100-150g were randomly distributed into 4 groups of 4 rats each. Animals in group 1 served as the control while animals in groups 2, 3, and 4 served as the test groups and were administered 200, 300 and 400g/kg body weight respectively of ethanol leaf extract of *I batata* for fourteen days following standard procedures. The extract contained terpenoids in high amount, flavonoids and alkaloids in moderate amounts, while glycosides, phenolic, and steroids were present in low amounts. WBC counts increased significantly across the test groups compared to the control. PLT decreased significantly ($P = 0.05$) in all the test groups when compared to the control group. MCV increased

_____

*Corresponding author: E-mail: mo.enemali@unizik.edu.ng;

significantly (P = 0.05) in all the test groups when compared to the control group. MCH increased significantly (P = 0.05) in group 2 but decreased significantly in groups 3 and 4 when compared to the control group. The lipid profile parameters; triglycerides (TAG), total cholesterol (TC), low density lipoprotein (LDL-C) showed no significant changes but HDL-C decreased significantly in group 4 compared to the control. The outcome of this study revealed that the ethanol leaves extract of *I. batatas* may possess a hematopoietic effect but may not be effective in the management of hyperlipidemia.

1. INTRODUCTION

The term "medicinal plant: refers to any plant, in which one or more of its parts contains active ingredients which can be used for therapeutic purposes or contain lead compounds that can be used for the synthesis of useful drugs [1]. Medicinal plants are the richest sources of drugs for traditional system of medicine especially in most developing countries owing to their wide distribution and diversity. Dhanalakshmi and Manavalan in 2014 opined that due to the medicinal efficacy of plants, they have continued to play a dominant role in the maintenance of good human health [2]. Medicinal compounds obtained from plants have been part of the evolution of human healthcare for thousands of years [3]. According to Ebeye et al. [4], many people have for centuries developed various herbal medicines using locally available plants as a remedy to their health challenges. Oluwatosin et al. [5], also reported that herbal medicines derived from plant extracts are increasingly being utilized to treat a wide range of diseases such as anemia, malaria, diabetes, ulcers, and these plants often serve as good sources of bioactive compounds that may boost the endogenous antioxidant defense system in organisms. In Kagawa, Japan, a variety of white sweet potato was eaten raw to treat anaemia, hypertension and diabetes [6], implying that the plant possesses hematopoietic and hypoglycemic properties.

The plant *Ipomoea batatas* is a plant crop commonly called sweet potato Udoh et al [7]. It is a specie of the morning glory family Convolvulaceae which is widely grown in tropical, subtropical, and warm temperate regions Gonzales et al. [8]; Srisuwan et al. [9] and is tolerant of many diseases and pests Islam et al. [10]. It has smooth, lightly moderate green leaves sometimes with a considerable amount of purple pigmentation especially along its veins Antia et al. [11] and the edible tuberous root is long and tapered with colour ranges from red, purple, brown to white Udoh et al. [7].

Fig. 1. Fresh leaves of *I. batatas*

1.1 Scientific Classification of *I. batatas*

Domain: Eukarya
Kingdom: Plantae
Phylum: Magnoliophyta
Class: Eudicotyledones
Family: Convolvulaceae
Genus: *Ipomoea*
Species: *Ipomoea batatas*
(Source: Austin and Huaman, [12].

1.2 Nomenclature

People around different countries of the world call sweet potato by different names. In Eastern Africa for instance, sweet potato is called "cilera abana" meaning "protector of the children, "dankali" is the common name in Hausa language, Nigeria. In Argentina, Venezuela, Puerto Rico and the Dominican Republic the sweet potato is called *batata*. In Mexico, Peru, Chile, Central America, and the Philippines, sweet potato is known as *camote* (alternatively spelled *kamote* in the Philippines), derived from the Nahuatl word *camotli*.

Phytochemicals are chemical compounds produced by plants through primary or secondary metabolism [13]; [14]. They generally have biological activity in the plant host and play a role in plant growth or defense against competitors, pathogens, or predators [13]. The effect of these foreign agents are usually harmful hence the need for the plants to develop inherent mechanisms of deterring them. Heneman and Zidenberg-Cherr [15], regarded phytochemicals as research compounds rather than essential nutrients because of lack of establishment of their possible health effects hence, their non-classification into any of the classes of food. Some phytochemicals commonly found in plants, which are of economic and therapeutic importance include; tannins, saponins, alkaloids, anthraquinones, terpenes, steroids, glycosides, cardiac glycosides, balsam, flavonoids, essential oils and many others.

Hematology is simply, the study of blood. Blood is a vital special circulatory tissue. It is composed of cells suspended in a fluid intercellular substance (plasma) with the major function of maintaining homeostasis [16]. Hematological components, which consist of red blood cells, white blood cells or leucocytes, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration are valuable in monitoring feed toxicity especially with feed constituents that affect the blood as well as the health status of farm animals [17].

In Nigeria for example, the local people are known for using natural herbs and herbal formulae in addressing various kinds of diseases including blood deficiencies, fever, cough/catarrh, malaria, obesity as they can be seen being hawked on streets in different preparations. However, little or no scientific efforts have been put in place to find out their effect on hematological parameters and lipid profile. The need to carry out a research on the effect of *I. batatas* leaves on hematological parameters and serum lipid profile considering their metabolic importance cum its use in traditional medicine is the essence of this study.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Plant material

The plant used was *Ipomoea batatas* (sweet potato) leaves which was gotten from a local farm at High-court phase II area of Keffi in Keffi local government area, Nasarawa State, Nigeria. The plant was identified by a taxonomist at the Department of Plant Science and Biotechnology, Nasarawa State University, keffi.

2.1.2 Animals

The animals used for this work were adult wistar albino rats. They were obtained from the National Veterinary Research Institute, Vom, in Plateau state - Nigeria and taken to the Animal House, Department of Biochemistry and Molecular Biology, Nasarawa State Univerity Keffi, Nasarawa State, Nigeria. They were acclimatized for seven days under standard environmental conditions and were maintained on feed and clean water *ad libitum*.

2.2 Methods

2.2.1 Preparation of plant material

The fresh *I. batatas* leaves were washed under running tap water to remove debris and shade-dried for 14 days. Dried leaves of *I. batatas* were grounded into fine powder using electric blender. A 300g of the fine powder was weighed and dissolved in 900ml of absolute ethanol (99.9%).

The mixture was allowed to stand for 72 hours after which it was filtered using Whatman filter paper no. 1. The extract was concentrated to dryness using water bath at a temperature not exceeding 40°C. The recovered extract was stored in a refrigerator at a temperature of 0 to 4°C. The extract was divided into two; one was used for phytochemical analysis while the other portion was used in administration to the rats.

2.2.2 Qualitative phytochemical analysis

The preliminary phytochemical screening of the ethanol extract was carried out in order to ascertain the presence of some plant secondary metabolites. These were carried out by utilizing standard conventional protocols as illustrated by Harborne [14]; Trease and Evans [18] and Sofowara [19], thus;

Test for alkaloids: A quantity (0.2 g) of extract was mixed with 10 ml 2% HCl, heated for 5 minutes then filtered. To 1 ml filtrate was added 1 ml of Wagner's reagent. A creamy white precipitate indicated the presence of alkaloids.

Test for glycosides: A quantity (0.2 g) of extract was mixed with distilled water (10 ml), boiled for 5 minutes before it was filtered. To 2 ml of filtrate, dilute ammonia (2 ml) was added and the solution was then added 400 µl of Fehling's solutions A and B. The solution was heated for 10 minutes in a water bath. A change of coloration to brick red gave the presence of glycoside.

Test for steroids: To 0.2 g of methanol extract was added 2 ml of acetic anhydride. The solution was subsequently added 2 ml of concentrated H_2SO_4 carefully. A colour change from violet to green or bluish green in sample indicates the presence of steroids.

Test for flavonoids: A quantity of the sample (0.2g) was heated with 10ml ethyl acetate in boiling water for 3 minutes. The mixture was filtered. 4ml of the filtrate was shaken with 1ml of dilute ammonium solution to obtain two layers. The layers were allowed to separate. A yellow precipitate observed in the ammonium layer indicated the presence of flavonoids.

Test for tannins (Ferric chloride Method): To 0.2 g of extract was added 10 ml of 45% ethanol, boiled for 5 minutes and then filtered. To 1 ml filtrate, 200 µl of ferric chloride was added. An observation of brownish green precipitate indicated the presence of tannins.

Test for saponins: A quantity (0.2 g) of extract was dissolved with 10ml distilled water, warmed for a minute and then filtered. To 1 ml filtrate was added 4 ml of distilled water, shaken thoroughly for 5 minutes before allowing to stand for 1 minute. Persistence of foam indicated the presence of saponins.

Test for terpenoids: A quantity (0.2g) of the extract was dissolved in ethanol and 1 ml of acetic anhydride was added to the solution. A few drops of concentrated H_2SO_4 was then added to the solution. A change in colour from pink to violet showed the presence of terpenoids.

Test for phenolics: To 0.2g of the extract was added 2 ml of distilled water. Then 0.5 ml Na_2CO_3 and 0.5 ml Folin Ciocalteau reagent was subsequently added. Formation of a blue-green colour indicated the presence of phenols.

2.2.3 Quantitative phytochemical analysis

The quantitative phytochemical analysis was done using the method of Harborne, [14]; Trease and Evans [18].

The concentration of the various phytochemical constituents was calculated from the formla:

$$\text{Concentration} \left(\frac{\text{mg}}{100\text{g}} \right) = \frac{Absorbance\,of\,sample}{Absorbance\,of\,standard} \, x \, Dilution\,factor$$

Dilution factor = (total volume/weight) of extract

Quantitative Determination of Flavonoids: A quantity (0.2 g) of the extract was macerated with 20ml of ethylacetate for 10 minutes and centrifuged for 5 minutes. 5 ml of the supernatant was transferred into triplicate test tubes and to each of them were added 5 ml of 1 M ammonium. The mixture was shaken vigorously for 2 to 5 minutes, centrifuged for 5 minutes and the upper layer discarded. The absorbance of the lower layer was then taken at wavelength of 470 nm against the corresponding blank.

Quantitative Determination of Tannins: A quantity (0.2 g) of extract was macerated with 20 ml of methanol for 10 minutes and centrifuged for 5 minutes. 2 ml of the supernatant was then transferred into triplicate test tubes and to the

tubes were added 3ml of methanol, 0.3 ml of 0.1M ferric chloride in 0.1 M HCl and 0.3 ml of 0.0008 M potassium ferricyanide. The solution was shaken thoroughly and the absorbance was taken against the corresponding blank at 720 nm after 5 minutes but below 30 minutes.

Quantitative Determination of alkaloids: A known quantity of the extract (0.2 g) was macerated with 10 ml of ethanol and 10 ml of 20 % sulphuric acid for 10 minutes. The macerated sample was then centrifuged for 5 minutes and 0.5 ml of the supernatant transferred into triplicate test tubes. To the triplicate test tubes were added 2.5 ml of 60% sulphuric acid and 2.5ml of 0.5% formaldehyde in 60% sulphuric acid. The solution was then mixed thoroughly and allowed to stand for 3 hours. The absorbance was taken at wavelength of 565 nm against the corresponding blank.

Quantitative Determination of Steroids: A quantity of extract (0.2 g) was macerated in 7 ml of ethanol. It was filtered and 1 ml of chromagen solution was added to 1 ml of the filtrate and made to stand for 30 minutes. The absorbance was thereafter read at 550 nm.

Quantitative Determination of Terpenoids: A known quantity of extract (0.2 g) was macerated in 10 ml of ethanol and then filtered. To 0.5 ml of filtrate was added 0.5 ml of phosphomolybdic acid, 0.5 ml of concentrated sulphuric acid and 5 ml of ethanol. The absorbance was subsequently read at 700 nm.

Test for total Phenolics: A known quantity of extract (1 g) was macerated with 20 ml of 80 % ethanol for 10 minutes and centrifuged for 5 minutes. 2 ml of the supernatant was transferred into triplicate test tubes to which was added 3 ml of water, 0.5 ml of folin-ciocalteu, mixed and allowed to stand for 5 minutes. 2 ml of 20 % sodium carbonate was later added; the solution mixed thoroughly by shaking and allowed to stand for another 30 minutes. The absorbance of the resulting solution was then determined at wavelength of 760 nm against the corresponding blank.

Quantitative Determination of Saponins: The extract (0.5g) was macerated with 10 ml of methanol for 10 minutes and centrifuged for 5 minutes. 2 ml of the supernatant was then transferred into triplicate tubes, evaporated to dryness and the residue re-dissolved by adding 2 ml of ethylacetate, 1ml of 0.5 % anysaldehyde in ethylacetate and 1ml of 50% sulphuric acid in ethylacetate. The solution was mixed thoroughly, incubated at 60ºC for 20 minutes, cooled for 10 minutes in a cold water bath and the absorbance determined at wavelength of 430 nm against the corresponding blank.

2.2.4 Administration of the extract to the animals

Sixteen (16) albino rats weighing between 100-150g were used as the experimental animals. They were randomly distributed into 4 groups of 4 rats each. Animals in group 1 served as the control group and were given feed and water only while animals in groups 2, 3, and 4 served as the test groups and were administered 200, 300 and 400g/kg body weight respectively of ethanol leaf extract of *I batata* along with the feed and water. The administration of the extract lasted for a period of fourteen (14) days.

2.2.5 Blood and preparation of blood sample

At the end of the 14th day, the administration of the extract was terminated and the animals hasted for a period of 10 hours. The animals were anesthetized with CCl_4 and blood was collected from each rat via the ocular veins using capillary tubes. Permanent slides were made using whole blood collected in EDTA bottle to prevent clotting and stained with Giemsa stain for determination of some hematological parameters such as white blood cells, red blood cells, platelet count while for packed cell volume, whole blood was collected into capillary tubes. Blood used for lipid profile analysis was collected in plain sample bottles and allowed to clot. It was spun using a centrifuge machine at 3200 rpm for 7 minutes and the serum was used for the analysis.

2.2.6 Determination of haematological parameters

2.2.6.1 Packed Cell Volume (PCV)

The packed cell volume was determined using the standard method described by Ochei and Kolhatkar [20].

Principle: The principle is based on the sedimentation of higher molecular weight red cells and other blood contents leaving the supernatant plasma at the top which can be separated.

Procedure: Blood samples from the rats were collected into heparinized PCV hematocrit tubes using capillary action. One end of the tube was sealed with plasticine after the collection of the blood and then centrifuged using the hematocrit centrifuge for 5 minutes at 3000 rpm. The test result was read using a PCV hematocrit reader.

Haemoglobin Estimation (Hb): The Hb was determined using the method of Miale [21].

Principle: Drapkin's solution is able to hydrolyze the red blood cells leaving haemoglobin to be counted.

Procedure: To a 4ml Drabkins solution in a test tube was added 20µl of well mixed anti-coagulated whole blood. The tube was mixed by inversion and incubated at 25°C for 5 minutes. Absorbance of the solution was read at 540 nm against a reagent blank. The concentration of haemoglobin was calculated by multiplying the absorbance with a factor of 36.8

$$Hb = A_{540} \times 36.8$$

Determination of Total White Blood Cell (WBC) Count: White blood cell count was determined using the method of Dacie and Lewis [22].

Principle: Turk's solution (2% glacial acetic acid) hydrolyzes the red blood cells except white blood cells, leaving it to be counted.

Procedure: The blood sample was diluted (1:20) with Turk's solution (2% glacial acetic acid). The diluted sample was loaded into a Neubaer counting chamber with the aid of Pasteur pipette. The total WBC was calculated by counting the required number of squares on the counting chamber under a microscope using the (×1000) magnification.

2.2.6.2 Determination of red blood cell count

This was done using the standard hematological procedure described by Ochei and Kolhatkar, [14].

Principle: Red blood cells are large and conspicuous when viewed through the microscope, making it easily to be counted in the Neubaeur counting chamber.

Procedure: Well mixed anti-coagulated blood was diluted 1:20 with 10% Na_2CO_3 solution. The

mixture was then loaded into an improved Neubauer counting chamber. Appropriate squares were counted and added up to determine the total red cell count.

2.2.6.3 Determination of platelets count

This was done according to the method described by Uramani and Shashidhar [23].

Principle: Platelets are easily stained by Leishman stain, making them visible enough to be counted.

Procedure: Air-dried thin smears were made from all samples and stained with Leishman stain. These PBS (Platelets blood stains) were examined under light microscope using x100 oil immersion lens. In a monolayer zone of the smear, platelets were counted simultaneously with RBC till 1000 RBC were counted. The number of platelets per 1000 RBC thus obtained was multiplied by 15000

Mean Cell Volume (MCV) $=$ $(Haematocrit\ x\ 10)/RBC$

Mean Cell Haemoglobin (MCH) $=$ $(Haemoglobin\ x\ 10)/RBC$

Mean Cell Haemoglobin Concentration (MCHC) $=$ $(Haemoglobin\ x\ 100)/HTC$

2.2.7 Determination of lipid profile

2.2.7.1 Cholesterol determination

The method of Abell et al. [24] was followed. Cholesterol was determined after enzymatic hydrolysis and oxidation. The indicator quinoneimine is formed from hydrogen peroxidase and 4-aminoantipyrine in the presence of phenol and peroxidase.

Test procedure: Three (3) test tubes were set up in a test tube rack and labeled blank, standard and sample respectively. To the blank, was added (10ul) distilled H_2O, 10ul standard specimen to the standard test tube and 10µl sample (serum) to the sample test tube. To each of these test tubes was added 1000µl of the cholesterol reagent. It was thoroughly mixed and incubated for 10minutes at room temperature (20-25°C). The absorbance of the sample (A sample) against the blank was taken within 60 minutes at 500nm.

2.2.7.2 Estimation of low density lipoprotein (LDL-C)

Principle: LDL-C can be determined as the difference between total cholesterol and the cholesterol content of the supernatant after precipitation of the LDL-C fraction by polyvinyl sulphate (PVS) in the presence of polyethyleneglycol monomethyl ether.

Procedure: The serum samples were kept at 2-8^{0}C. The precipitant solution (0.1ml) was added to 0.2ml of the serum sample and mixed thoroughly and allowed to stand for 15 min. This was centrifuged at 2,000 x g for 15 min. The cholesterol concentration in the supernatant was determined. The concentration of the serum total cholesterol as described by Kameswara et al. [25] was used.

2.2.8 Calculation

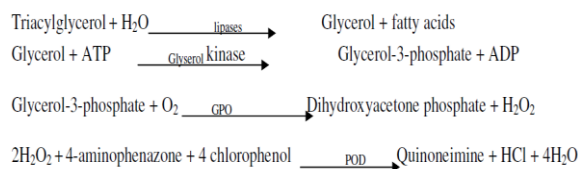**LDL-C** (mmol/L) = Total Cholesterol (mmol/L) − 1.5 x Supernatant Cholesterol (mmol/L).

2.2.8.1 Estimation of High density lipoprotein (HDL-C)

Principle: LDL-C and VLDL-C (low and very low density lipoproteins) are precipitated from serum by the action of a polysaccharide in the presence of divalent cations. Then, high density lipoproteins (HDL-C) present in the supernatant is determined.

Procedure: The precipitant solution 0.1ml was added to 0.3ml of the serum sample and mixed thoroughly and allowed to stand for 15 min. This was centrifuged at 2,000 x g for 15 min. The cholesterol concentration in the supernatant was determined. Determination of the concentration of the serum total HDL-C as described by Kameswara et al. [25] was used.

2.2.8.2 Estimation of triacylglycerol

Principle: The triacylglycerols are determined after enzymatic hydrolysis with lipases. The indicator is a quinoneimine formed from hydrogen peroxide, 4-aminophenazone and 4-chlorophenol under the catalytic influence of peroxidase.

$$\text{Triacylglycerol} + H_2O \xrightarrow{\text{lipases}} \text{Glycerol} + \text{fatty acids}$$

$$\text{Glycerol} + \text{ATP} \xrightarrow{\text{Glycerol kinase}} \text{Glycerol-3-phosphate} + \text{ADP}$$

$$\text{Glycerol-3-phosphate} + O_2 \xrightarrow{\text{GPO}} \text{Dihydroxyacetone phosphate} + H_2O_2$$

$$2H_2O_2 + \text{4-aminophenazone} + \text{4 chlorophenol} \xrightarrow{\text{POD}} \text{Quinoneimine} + HCl + 4H_2O$$

Method: A quantity of the sample (0.1 ml) was pipetted into a clean labelled tube and 1.0 ml of trichloroacetic acid (TCA) was added to it, mixed and then centrifuged at 250 rpm for 10 minutes. The supernatant was decanted and reserved for use.

Procedure: Three test tubes were labelled Blank, Standard and sample respectively, 0.5 ml of distilled water was added in the blank, and 0.5 ml of standard solution in the standard, then 1ml of the sample in the sample tube. 1 ml of reagent mixture was added into each test of the tubes. The mixtures were allowed to stand for 20 minutes at 25 ^{0}C and the absorbance of the sample and standards read against the blank was taken at 540 nm.

Calculation: The concentration of triacylglycerol in serum was calculated as follows:

$$\frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \times \text{Standard concentration (mmol/l)} = \text{mmol/l}$$

2.3 Statistical Analysis

The data obtained were analyzed using one-way analysis of variance (ANOVA) in SPSS package, version 20.0 and the results were expressed as mean ± standard deviation. The Duncan test was used to determine the levels of significance. The acceptance value of significance was $P = 0.05$.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Qualitative and quantitative phytochemical composition of ethanol extract of *Ipomoea batatas*

The ethanol leaf extract of *Ipomoea batatas* was found to be a rich source of bioactive compounds with the highest mean concentration of terpenoids, followed by flavonoids and alkaloids which were present in moderate amounts, and glycosides, phenolics and steroids present in low concentrations as shown in Table 1.

3.1.2 Effects of ethanol leaf extract of *I. batatas* on Haematological parameters of rats

Table 2 shows significant ($P = 0.05$) increase of PCV in all the test groups (2, 3 and 4) administered with the extract, when compared to control. Haemoglobin increased significantly ($P = 0.05$) in all the test groups when compared to the control group. WBC counts also showed a similar result, increasing significantly across the test groups compared to the control. PLT decreased significantly ($P = 0.05$) in all the test groups when compared to the control group. MCV increased significantly ($P = 0.05$) in all the test groups when compared to the control group. MCH increased significantly ($P = 0.05$) in group but decreased significantly in groups 3 and 4 when compared to the control group. MCHC concentrations across all the test groups (2, 3 and 4) were observed to increase significantly ($P = 0.05$) when compared to the control group.

3.1.3 Effects of ethanol extract of *I. batatas* on lipid profile of rats

Table 3 shows a non-significant alteration in triglycerides (TAG), total cholesterol (TC), high density lipoprotein (HDL-C) and low density lipoprotein (LDL-C) in all test groups compared to control but a significant decrease ($P = 0.05$) in HDL-C was observed in group 4 when compared to the control.

3.2 Discussion

This study determined the phytochemical composition of the ethanol extract of *I. batatas* and determined its effect on the haematology and lipid profile using albino rats as the animal models.

The concentrations of terpenoids was found to be high, followed by flavonoids and alkaloids, in moderate amounts, while glycosides, phenolics and steroids were present in low amounts which in consonance with Pochapski et al. [26], which found that the major phytochemicals present in the leaves of sweet potato are triterpenes/steroids, alkaloids, anthraquinones, flavonoids, saponins, tannins, and phenolic acids. The extract had the highest mean concentration of terpenoids (744.33±9.07) which was found to be significantly (p = 0.05) higher than the other detected phytochemicals. Terpenoids are used for their aromatic qualities and play a role in traditional herbal remedies.

This was followed by flavonoids (203.67±8.50) and alkaloids (209.33±8.50) respectively. Flavonoids are known to possess antioxidant activities and have been reported to inhibit lipid peroxidation processes on cells, they are known to scavenge free radicals and reactive oxygen species (ROS), and inactivate lypoxygenase [27]. Alkaloids have bitter taste and are employed in medicine in the production of drugs which include Heroin, Morphin, Quinine, and anti-malaria; all obtained from plants [19]. Glycosides had a mean concentration of (97.33±3.21) in this study, followed by phenolics (34.00±2.00), while steroids concentration was found to be significantly (p < 0.05) low in the extract (14.33±4.04) compared to the other phytochemicals. Glycosides contain special sugar constituents and aglycones (non-sugar portion) that have the property of stimulating the heart muscles. These are referred to as cardiac active or cardiac glycosides [28].

This study showed an increasing trend for the hematocrit, RBC, hemoglobin count, WBC, MCHC, and MCV. WBC counts also showed a similar result, increasing significantly across the test groups compared to the control. PLT decreased significantly ($P = 0.05$) in all the test groups when compared to the control group. MCH increased significantly ($P = 0.05$) in group but decreased significantly in groups 3 and 4 when compared to the control group in healthy rats after treatment with *I. batatas* (sweet potato) leaves extract. These animals remained healthy throughout the duration of the experiment and no adverse effects (especially death of animals) were recorded during the duration of the treatment. An increase in RBC count can be attributed to the direct stimulation on hemopoietic tissues such as the liver and bone marrow [29]. An increase in the RBC count is similar with the study of Islam et al. [30], where the hemoglobin, RBC and WBC counts were restored to normal after the administration of sweet potatoes to mice [30]. Significant difference in hematocrit is expected since there was a significant difference in the RBC count [31]. This is also similar with a study on the effect of sweet potato extract on hematocrit levels in rabbit [32]. Sweet potatoes could cause a significant increase in the hemoglobin concentration in rats because it is rich in phytochemicals. There was significant decrease among groups with regards to the platelet counts in this study. This contradicts the study on rabbits in which sweet potato extracts were able to increase platelet count [32].

Table 1. Qualitative and quantitative composition of *Ipomoea batatas*

Phytochemical	Qualitative	Quantitative (mg/100 g)
Alkaloids	++	209.33 ± 8.50^a
Flavonoids	++	203.67 ± 8.50^a
Terpenoids	+++	744.33 ± 9.07^b
Steroids	+	14.33 ± 4.04^c
Phenolics	+	34.00 ± 2.00^d
Glycosides	+	97.33 ± 3.21^e

Results are expressed in Means ± SD (n = 3). Mean values with different letters as superscripts down the column are considered significant at P < 0.05. +++ = Present in abundance, ++ = present in moderate quantity, + = present in trace quantity

Table 2. Effect of ethanol extract of *I. batata* on the Haematological parameters of rats

	PCV (%)	Hb (g/l)	RBC ($\times 10^{12}$/l)	WBC ($\times 10^9$/l)	PLT ($\times 10^9$/l)	MCHC (g/l)	MCV (fl)	MCH (pg)
GROUP 1	41.0 ± 1.8^a	135.8 ± 25^a	1.3 ± 0.0^a	$1.47 \pm .4^a$	303.75 ± 5.1^a	315.75 ± 1.7^a	0.33 ± 0.35^a	102.95 ± 1.4^a
GROUP 2	51.5 ± 1.3^b	164.3 ± 1.2^b	1.5 ± 0.2^b	$2.9 \pm .2^b$	161.5 ± 2.1^b	325.25 ± 3.6^b	0.48 ± 0.43^a	109.77 ± 1.2^b
GROUP 3	45.3 ± 1.7^c	158.0 ± 1.8^c	3.2 ± 0.0^c	$2.4 \pm .1^b$	113.3 ± 4.4^c	330.25 ± 2.6^b	0.18 ± 0.02^b	$50.44 \pm .8^b$
GROUP 4	44.7 ± 3.5^c	150.0 ± 2.0^d	$3.9 \pm .0^d$	$3.7 \pm .6^n$	173.3 ± 6.7^d	334.00 ± 5.6^b	0.17 ± 0.1^b	38.05 ± 1.3^c

Results are expressed in Means ± SD (n = 4). Mean values with different letters as superscripts down the column are considered significant at p < 0.05. Group 1 = Control, Group 2 = 200 mg/kg body weight of I. batatas extract, Group 3 = 300 mg/kg body weight of I. batatas extract, Group 4 = 400 mg/kg body weight of I. batatas extract

Table 3. Effect of ethanol extract of *I. batatas* on Lipid profile of albino rats

	TAG (mg/dl)	TC (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)
Group 1	106.89 ± 8.20^a	84.19 ± 4.78^b	65.99 ± 4.43^c	16.71 ± 1.35^e
Group 2	106.42 ± 5.71^a	88.21 ± 2.15^b	64.59 ± 5.03^c	16.29 ± 2.58^e
Group 3	111.67 ± 5.97^a	94.79 ± 10.79^b	63.26 ± 8.86^c	$18.35 \pm .69^e$
Group 4	109.95 ± 1.35^a	88.30 ± 5.29^b	54.14 ± 5.15^d	17.84 ± 2.52^e

Results are expressed in Means ± SD (n = 4). Mean values with different letters as superscripts down the column are considered significant at p = 0.05. Group 1 = Control, Group 2 = 200 mg/kg body weight of I. batatas extract, Group 3 = 300 mg/kg body weight of I. batatas extract, Group 4 = 400 mg/kg body weight of I. batatas extract

Lipids and lipoprotein abnormalities are well known risk factors for heart diseases. Elevated level of triglycerides, cholesterol, and low density lipoprotein-cholesterol are documented as risk factors for atherogenesis [33]. The serum concentration of high density lipoprotein-cholesterol in contrast bears an inverse relationship to the risk of atherogenesis and coronary heart disease [34]. Genetic factors and diet play a major role in regulating cholesterol and triacylglycerol level in the blood. High level of cholesterol, particularly LDL-$_c$, is mainly responsible for hypercholesterolemia [35]. Dietary factors such as continuous ingestion of high amount of saturated fats and cholesterol are believed to be directly related to hypercholesterolemia and susceptibility to atherosclerosis [36]. he results of this study showed that all doses of the plant extract had non-significant ($P > 0.05$) effects on the mean LDL-C, HDL-C, TG and TC levels of the animals, implying that the extract does not alter lipid profile in the administered rats within the period of the study.

4. CONCLUSION

The data obtained from this study indicated that the ethanol leaf extract of *I. batatas* contain appreciable amount of phytochemicals which include; terpenoids, flavonoids, alkaloids, glycosides, phenolics and steroids. The results also showed a significant increase in the hematological parameters which suggests that *I. batatas* has hematopoietic effect and can be a useful remedy in the treatment and management of anaemia. The study however showed a non-significant alteration in lipid profile which suggests that the plant may not be effective in the treatment and management of hyperlipidemia.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

FUNDING

This study did not have funding from any external source.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sofowora AO. Medicinal plants traditional medicine in West Africa. Second Edition, John Willey and Sons Limited. New York. 2008;289.
2. Dhanalakshmi R, Manavalan R. Bioactive compounds in leaves of *Corchorus trilocularis* L by GC-MS Analysis. International Journal of Pharmtech Res. 2014;6:1991-1998.
3. Sowmya S, Gopalakrishnan VK, Poornima K. Enzymatic and nonenzymatic antioxidant activity of *Tabernaemontana divaricate* R.Br. against DEN and Fe-NTA induced renal damage in wistar albino rats. Journal of Applied Pharmacological Sciences. 2015;5: 33-37.
4. Ebeye OA, Ekundina VO, Ekele CM, Eboh DO. The histological effect of *Cnidoscolus* aconitifolius aqueous leaf extracts on the archetecture of the ovary, testis and sperm cells of adult wistar rats. Intr J Herbs and Pharmcol Res. 2015;4: 7-17.
5. Oluwatosin AA, Adekunbi A, Ademola AO. *Cnidoscolus aconitifolius* leaf extract protects against hepatic damage induced by chronic ethanol administration in wistar rats. Alcohol, 2011:46: 445-451.
6. Ludvik B, Pancini G. Efficacy of Ipomoea batatas (Caiapo) on diabetes control in type 2 diabetic subjects treated with diet. Diabetes Care. 2004;25:239 - 240.
7. Udoh F, Udoh P, Umoh E. Effect of Ipomoea batatas leaf extract on the thyroid gonadal axis of male wistar rats. Journal of medical Sciences. 2010;7:78 – 84.
8. Gonzalez RG, Sanchez DS, Guerra ZZ, Campos JM, Quesada AL, Valdivia RM. Efficient regeneration and *Agrobacterium tumefaciens* mediated transformation of recalcitrant sweet potato (*Ipomea batatas* L.) cultivars. Asia Pacific Journal of Molecular Biology and Biotechnology. 2008;16(2):25–33.
9. Srisuwan S, Sihachakr D, Siljak-Yakovlev S. The origin and evolution of sweet potato (*Ipomoea batatas* Lam.) and Its Wild Relatives through the Cytogenetic Approaches. Plant Science. 2006; 171:424–433.

10. Islam S, Yoshimoto M, Terahara N, Yamakawa O. Anthocyanin compositions in sweetpotato (*Ipomea batatas* L.) leaves. Bioscience, Biotechnology, Biochemistry. 2002;66 (11): 2483–2486.

11. Antia BS, Akpan EJ, Okon PA, Umuren IU. Nutritive and anti-nutritive evaluation of sweet potatoes (*Ipomea batatas*) leaves. Pakistan Journal of Nutrition. 2006;5(2):166–168.

12. Austin DF, Huaman Z. A synopsis of Ipomoea (Convolvulaceae) in the Americas. Taxon. 1996;45:3 - 38.

13. Molyneux MD, Mbaeyi-Nwaoha IE, Emejulu VN. Evaluation of phytochemical composition and antimicrobial activity of sweet potato (*Ipomoea batatas*) leaf. Pakistan Journal of Nutrition. 2007;12: 575.

14. Harborne JB. Phytochemical Methods: A Guide to Modern Technique of Plant Analysis. 1st ed. Chapman and Hall, London. 1999;107-150.

15. Heneman DE, Zidenberg CH. Phytochemicals and vitamin contents of indigenous species of Southern Eastern Nigeria. Journal Suustain Agriculture. Environ. 2008;6(1):259 - 269.

16. Isaac LJ, Abah G, Akpan B, Ekaette IU. Haematological properties of different breeds and sexes of rabbits. Proceedings of the 18th Annual Conference of Animal Science Association of Nigeria, 2013;24-27.

17. Oyawoye BM, Ogunkunle HN. Biochemical and haematological reference values in normal experimental animals, New York: Masson. 2004;212-218.

18. Trease GE, Evans WC. Pharmacognosy. 13th ed. Bailliere Tindall Books Publishers. By Cas Sell and Collines Macmillan Publishers., Ltd. London. 1989;1-105.

19. Sofowara AO. Medicinal Plants and Traditional Medicine in Africa.University of Ife Press 2nd Edtn. 1993;320.

20. Ochei J, Kolhatkar A. Medical Laboratory Sciences: Theory and Practice. Tata McGraw Hill, New York. 2008;663-665.

21. Miale JB. Laboratory Medicine: Hematology. 4th Edn., C.V. Mosby Company, St. Louis, M.O., USA. 1972: 494.

22. Dacie JV, Lewis SM. Practical Haematology. 7th Edn., ELBS with Churchill Livingston, England. 1991;37-85.

23. Uramani MK, Shashidhar HB. Estimation of platelet count from peripheral blood smear based on platelet: red blood cell ratio: A prospective study in a tertiary care hospital, Indian Journal of Pathology and Oncology, 2016;3(2):351-353.

24. Abell LL, Levey BB, Brodie BB, Kendall, FE. Extraction of Cholesterol. Journal of Biological Chemistry, 1952;195(1): 357-366.

25. Kameswara RB, Kesavulu MM, Giri CH. Anti-diabetic and hypolipidemic effects of Momordica cymbalania Hook fruit powder in alloxan-induced diabetic rats. Journal of Ethnopharmacology, 1999; 67: 103 -109.

26. Pochapski MT, Fosquiera EC, Esmerino LA, Santos EB, Farago PV, Santos FA. Phytochemical screening, antioxidant, and antimicrobial activities of the crude leaves' extract from *Ipomoea batatas* (L.) Lam. Pharmacognistic Mag. 2011: 7:165–170.

27. Porter G. Polyphenols: antioxidants and beyond. American Journal of Clinical Nutrition; 1988;81: 215-217.

28. Godwin A, MMercer J. Comparative analysis of phytochemicals and polar metabolites from colored sweet potato (*Ipomoea batatas* L.) tubers. Food Science Biotechnology, 1983:25: 283-291.

29. Osime EO, Ediale GE, Omoti CE, Famodu AA. Effect of sweet potato leaf (*Ipomoea batatas*) extract on some hematological parameters using rabbits. Journal of Medicine, Biomedical Resource. 2008;7(1-2):12-15.

30. Campbell K, El-Choufani SE, Bolin P, Waien S, Christiano CR, Holbert D, Bode AP. Platelet adhesion testing may predict early hemodialysis arteriovenous graft and fistula failure in end-stage renal disease patients. Clinical and Applied Thrombosis/Hemostasis. 2012;14(4): 399–409.

31. Turner R, Shepard N, Frazer G. Formulating and evaluating cardiological test protocols. Journal of Medical Health. 1984;9:177-189.

32. Carroll JA, Dorward DW, Gherardini FC.Identification of a transferrin-binding protein from *Borrelia burgdorferi.* Infection and Immunity. 1996:2911-2916.
DOI: 10.1128/iai.64.8.2911-2916.1996

33. Krieger H. "Polyisoprenoids: structure, biosynthesis and function". Progress

in Lipid Research. 1998;44(4):235–58.

34. Asashima E, Doucet C, Flament C, Sautier C, Lemonnies D. Effect of an hypercholesterolemic diet on the level of several serum lipids and apolipoproteins rat strains. Reproductive Nutritional Development. 2005;27:897-906.

35. He B, Kang S, Chen Z, Liu X, Wang J, Li X, Liu X, Zheng L, Luo M, Wang Y. Hypercholesterolemia risk associated Abca6 does not regulate lipoprotein metabolism in mice or hamster. Biochimica et Biophysica Acta (BBA)-Molecular and Cell Biology of Lipids. 2021; 1866(11):159006.

36. Laguzzi F, Maitusong B, Strawbridge RJ, Baldassarre D, Veglia F, Humphries SE, Rauramaa R, Kurl S, Smit AJ, Giral P, Silveira A. Intake of food rich in saturated fat in relation to subclinical atherosclerosis and potential modulating effects from single genetic variants. Scientific reports. 2021;11(1):1-9.