# Haematological Effects of Methanolic Root and Leaf Extracts of *Thaumatococcus danielli* in Wistar Rat

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**Abstract:** The haematopoietic system which is an important index of physiological and pathological status of man and animals is one of the prime targets for toxic compounds due to the fact that all foreign compounds are distributed in the body via the blood stream. This study was undertaken to determine the phytochemical composition of dried leaves and roots of *Thaumatococcus danielli* and their effect on some haematological parameters in Wistar rats. Phytochemical analysis using GC-FID revealed that kaempferol was higher in leaf (18.75ug/g) than root (9.55ug/g). Tannin was higher in root (10.39ug/g) than leaf (8.93ug/g), while phenol was higher in leaf (6.66ug/g) than root (3.96ug/g). Saponin, rutin, phytate and catechin contents were within same range in both leaf and root. A total of 226 albino rats of weight between 180 to 220g were used for toxicity studies for 4 weeks. The $LD_{50}$ for leaf and root was 330mg/kg body weight (bw) and 250mg/kgbw respectively, upon intraperitoneal administration. Haematological result showed some alteration in red blood cells, white blood cells and its differentials but no significant effect ($P<0.05$) on haemoglobin, hematocrit and platelets concentrations. Phytochemical analyses showed significant concentration of potential phytochemicals which are of health benefit to human beings. But, sub-acute administration of leaf and root extracts of *Thaumatococcus danielli* caused noticeable alterations in haematological parameters. Thus, caution should be applied when using this plant therapeutically at medium and high dose concentrations. It is recommended that chronic toxicity studies for duration of at least 60 days be designed to explicitly define some observed alterations in haematological parameters.
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## 1. Introduction

Medicinal plants contain an array of bioactive principles that can be used for therapeutic purposes and as precursors for development of some drugs. Many plants secondary metabolites are toxic but are still considered as bioactive ingredients with therapeutic potentials (Mosihuzzaman, 2012). Blood is a body fluid that delivers necessary substances such as nutrients and oxygen to cells and transports metabolic waste products away from cells. Hematological components consist of the red blood cells; while blood cells or Leucocytes mean corpuscular volume, means corpuscular haemoglobin, mean corpuscular haemoglobin concentration and platelets.

Red blood cells serves as a carrier of haemoglobin, haemoglobin reacts with oxygen in the blood to form oxy-haemoglobin (Chineke *et al.*, 2006). The red blood cell is involved in the transports of oxygen and carbon-dioxide in the body. Thus, a reduce red blood cell count implies a reduction in oxygen levels that would be supplied to the tissues as well as the level of carbon-dioxide returned to the lung (Isaac *et al.*, 2013). The functions of the white blood cells and its differentials are to fight infections, defend the body against invasion by foreign organisms and to produce or distribute antibodies in immune response. Thus animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies for disease resistance (Soetan *et al.,* 2013) and enhance adaptability to local environment and prevalent disease conditions (Iwuji and Herbert, 2012 and Isaac *et al.*, 2013).

Blood platelets are implicated in the clothing process. Low platelet concentration suggests that in case of injury; blood clothing will be prolonged resulting in excessive loss of blood. Packed cell volume PCV also known as heamatocrit (HT) is a measure of the volume or percentage of red blood cells in blood (Isaac *et al.*, 2013).

Increased packed cell volume shows a better transportation mechanism and thus result in an increased primary and secondary polycythemia. Haemoglobin is the iron containing oxygen transport metalo- protein in the red blood cells of all vertebrates as well as tissues of invertebrates.

The physiological role of haemoglobin is to transport oxygen to tissues of animals for oxidation of ingested food so as to release energy for other body functions and to transport carbon-dioxide out of the body of animals (Soetan *et al*., 2013; Isaac *et al*., 2013). Packed cell volume, haemoglobin and mean corpuscular haemoglobin are major indices for evaluating circulating erythrocytes, and are useful in the diagnostic of anaemia as well as revealing the bone marrow capacity to produce red blood cells to mammals (Awodi *et al.,* 2005; Chineke *et al.,* 2006).

Mean corpuscular haemoglobin concentration indicates blood levels condition. A low level is an indicator of anaemia (Aster, 2004). Since all foreign compounds including herbs are distributed via the blood stream, blood and its components are constantly exposed to both essential and non-essential compounds including toxic compounds (Timbrell, 2009).

### 1.1 Review of Literature on *Thaumatococcus danielli*

*Thaumatococcus danielli* is a tropical plant found in the rain forest of West Africa particularly Nigeria, Ghana and Cote d'iviore (Yeboah *et al.,* 2003; Arowosoge and popola, 2005; Ojekale *et al.*, 2007).

It is the source of the natural sweetener, Thaumatin, regarded as a sweet protein (Chinedu *et al*., 2014). In Nigeria, this plant is used among different ethnic groups for wrapping and boiling food to add to its savour and also to preserve and extend the shelf life of the food.

With the widespread uses of the leaves of this plant in food packaging, researches have been made in to its sterility, it was reported that *Thaumatococcus danielli* leaves extracts had no significant antimicrobial activity, but has been shown to possess hypoglycaemic properties, thus, used in treatment of diabetes mellitus (Emudainohwo *et al.,* 2015).

All the plants part is rich in minerals and crude fibre. The fruit is also a good source of Calcium, Magnesium and Phosphorus (Shalom *et al.*, 2014). The high fibre content can be helpful in preventing intestinal and digestive disorders such as constipation, flatulent, pile, colon and rectum cancers (Showemimo and Olarewaju, 2004).

*Thaumatococcus danielli* has versatile uses in folk medicine and nutrition.The fruit aril contains the sweetener called Thaumatin which is used in food and confectionery industries as taste and flavour enhancer (Ojekale *et al*, 2007).

Thaumatin being a sweet protein and not carbohydrate (Arowosoge and Labode, 2006), has been shown to be very ideal for diabetic as it is non-caloric (Lim, 2012). In folk medicine, the leaf sap is used as antidote against venoms, stings and bites. Leaf and root sap are used as sedative and for treating insanity (shalom *et al.*, 2014).

The fruit is used as laxative (Adeyemi *et al*., 2014). The seed is used as an emetic and for pulmonary problems (shalom *et al*., 2014). It has been shown by research that the leaf extract of this plant contains Tannin, Saponins, anthraquinones, Terpenoids and Steroids (Adeyemi *et al*., 2014; Shalom *et al.,* 2014).

These secondary metabolites could be associated with sedative properties of this plant extract (Edewor-Kuponiyi, 2013). Plates 1 and 2 shows photographs of *Thaumatococcus danielli* root and leaves while Plate 3 is the photograph of Wistar rat.

### 1.2 Statement of the Problem

There have been some scientific reports on the potential of herbal medicine to cause injury to vital organs such as liver and kidney as well as blood parameters (Chikezie *et al*., 2015).

However, some plants that were earlier reported to be safe are now shown to be hepatotoxic, haematotoxic having mild to severe adverse side effect on the skin, biologic and metabolic functions (Ekpenyong *et al.*, 2012).

This research is undertaken to ascertain the level of safety of leaf and root extracts of *Thaumatococcus danielli on haematological components*.

**Plate 1:** *Thaumatococcus danielli root*

### Objectives of Study

To determine the phytochemical composition of root and leaf extracts of *Thaumatococcus danielli* and to assess the effect of root and leaf extract of *Thaumatococcus danielli* on some haematological parameters.

**Plate 2:** *Thaumatococcus danielli leaves*

**Plate 3:** Photograph of Wistar rat

## 2. Materials and Methods

### 2.1 Sample Collection and Extraction

Fresh leaves and roots of *Thaumatococcus danielli* were collected from the bush at Rukpokwu community of Rivers State, identified in Plant Science and Biotechnology Department, University of Port-Harcourt. The roots and leaves (samples) were shade-dried at room temperature to a constant weight, and thereafter ground to powder, packed into dark polythene bags and stored in a desiccator for subsequent uses. About 200g of each powdered sample (leaves and root) was dissolved in 1 litre of methanol at room temperature for 72 hours. This was then filtered using Whatman No. 1 filter paper and the filtrate transferred into a rotary evaporator at 40°C. Each residue obtained was further dried in a water bath at 37°C- 40°C and stored in a refrigerator at 4°C.

### 2.2 Preparation of Solutions

The vehicle used for the reconstitution of the extract was 5% of sodium carbonate ($Na_2Co_3$), it was prepared by dissolving 5g of $Na_2Co_3$ in 100ml of distilled water. On the basis of solubility of the extract in the 5% $Na_2Co_3$ solution, 40mg/ml and 50mg/ml were prepared as follows: 40mg/ml, prepared by dissolving 1g (1000mg) of extracts (roots and leaves) in 25ml of 5% $Na_2Co_3$, 50mg/ml: this was prepared by dissolving 1g (1000mg) of each extract in 20ml of 5% $Na_2Co_3$.

### 2.3 Animals and Treatment

A total of 226 Wistar rats of weighing between 180g-220g were bought from the animal house of the department of human Physiology, University of Nigeria, Enusgu and acclimatized for one week in the animal house of Biochemistry Department, University of Port Harcourt. During acclimatization, the animals were fed with rat pellets. The leaf and root extracts of *Thaumatococcus danielli* were administered based on the experimental design.

### 2.4 Collection of Blood Sample

Three animals (rats) were anaesthetized by putting in a desiccators containing cotton wool soaked in chloroform. Blood was obtained weekly after day 7, 14, 21 and on day 29 from each group by cutting the jugular vein of the rat on the neck by means of surgical blade. The blood for haematological studies was stored in EDTA bottles and analysed using automated hematology analyzer (BC-3200) to assess the following parameters: red blood cells (RBC), hemoglobin (Hgb), hematocrit (HCT), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), white blood cell count (WBC) and platelet count (PLT)

### 2.5 Qualitative and Quantitative Phytochemical Analyses

Qualitative analyses were carried out using the methods of Trease and Evans (1989) and Harborne (2008) to identify the different photochemical, while phytochemical Quantification was performed on a BUCK M910 Gas chromatography equipped with a flame ionization detector.

### 2.6 $LD_{50}$ Determination

From the results of toxicity range test, 25 Wister rats were obtained for each extract (5 animals per group), making a total of 50 animals for both extracts (leaf and root), with doses stated below. Clinical signs and symptoms of toxic effects and mortality within 24hrs were observed.

**Doses (mg/kg):**

500mg/kg = 2.5ml of 40mg/ml
400mg/kg = 2ml of 40mg/ml
300mg/kg = 1.5ml of 40mg/ml
200mg/kg = 1ml of 40mg/ml
100mg/kg = 0.5ml of 40mg/ml

For the $LD_{50}$ determination, Karber's method was used.

$$\mathbf{LD50} = LD100 - \Sigma \frac{Sum\ of\ dose\ difference\ x\ mean\ death}{\text{Number of animal per group}}$$

### 2.7 Experimental Design for Sub-Acute Toxicity Testing

A total of one hundred and forty (140) Wistar rats weighing between 180 to 220g were grouped into 7 of 20 rats in each, while group 1 served as normal control for both extract. The treatment was for a period of 4 weeks. For the roots: Group 1: Normal control treated with 1ml of distilled water daily. Group 2: Treated with 6.25mg/kg/day (Low dose). Group 3: Treated with 12.5mg/kg/day (Medium dose). Group 4: Treated with 25mg/kg/day (High dose). For the leaves: Group 2: Treated with 8.25mg/kg/day (Low dose). Group 3: Treated with 16.5mg/kg/day (Medium dose) Group 4: Treated with 33mg/kg/day (High dose).

### 2.8 Statistical Analysis

Results were analyzed using SPSS (IBM-SPSS). Data obtained were expressed using descriptive statistic. Significant difference between the treatment groups and the control was determined using one way analysis of variance (ANOVA).

## 3. Results and Discussion

Results of phytochemical analyses are presented in Tables 1 and 2 while Tables 3 and 4 gave results of $LD_{50}$ of leaf and root extract respectively. Phytochemical analyses indicated that flavonoids were significantly present in both leaves and roots.

The flavonoids in the leaves were Kaempferol-(18.57ug/g), Rutin (11.25ug/g), Catechin (5.51ug/g), Anthocyanin (2.49ug/g) and Epicatechin (1.80ug/g), while the root showed 9.55ug/g, 11.35ug/g, 5.67ug/g, 1.37ug/g and 1.87ug/g respectively. Saponin concentration was between 14.00ug/g to 14.33ug/g in roots and leaves respectively.

Phytate content of both leaves and roots was low (0.23ug/g – 0.29ug/g). Phenol concentration was higher in the leaves (6.66ug/g) than in the root (3.96ug/g), while tannin was more in the roots (10.39ug/g) than the leaves (8.93ug/g). Lunamarine and Ribalinidine (Alkaloids) were higher in the roots (2.08ug/g and 4.76ug/g) than the leaves (1.98ug/g and 3.09ug/g) respectively.

This report agrees with findings of Ojekale *et al*. (2007) and Chinedu *et al*. (2014) that the leaf extract of *Thaumatococcus danielli* contains alkaloids, saponins, flavonoids, tannins, but cardiac glycoside, phenol were absent.

Flavonoids are important group of polyphenols widely distributed among the plant flora. Kaempferol, a member of flavonoids is a potent promoter of apoptosis (Ramos, 2007). It also modifies a host of cellular signalling pathways and has numerous anticancer properties.

Flavonoid (Anthocyanin) have many health promoting effects which include anti-oxidant, anti-inflammatory, anticancer, enzyme inhibition, anti-allergic and anti-viral effects (Chikezie *et al*., 2015). Several studies have shown that certain flavonoids can protect low density lipoprotein from being oxidized (Donald and Cristobal, 2006).

**Table 1: Phytochemical Screening Results**

| Parameters | Leaves | Root |
|---|---|---|
| Alkaloids | + | + |
| Flavonoids | ++ | ++ |
| Steroids | - | - |
| Tannins | ++ | ++ |
| Resins | - | - |
| Proteins | + | + |
| Saponins | ++ | ++ |
| Cardiac glycosides | + | + |
| Terpenoids | - | - |

**Key: (+)** trace amount, (++) significantly present, (-) Absence

The oxidation of low density lipoproteins have been recognized to play an important role in atherosclerosis, hypertension and excessive cholesterol in the blood (Middleton and Kandaswami, 1993; Ojekale *et al*., 2007; Ramawat *et al*., 2009). The leaves and roots extracts of *Thaumatococcus danielli* contain appreciable concentrations of Lunamarine (1.98ug/g in the leaves and 2.08ug/g in the roots), Ribalinidine in the leaves (3.09ug/g) and Roots (4.76ug/g) and negligible concentration of spartein (0.0002ug/g) in both leaves and roots.

**Table 2: Result of Phytochemical Analysis using GC-FID**

| Phytochemicals | Leave ug/g | Root ug/g |
|---|---|---|
| Phytate | 0.23 | 0.29 |
| Epidcatechin | 1.80 | 1.87 |
| Oxalate | 1.20 | 0.84 |
| Anthocyanin | 2.49 | 1.37 |
| Tannin | 8.93 | 10.39 |
| Phenol | 6.66 | 3.96 |
| Lunamarine | 1.98 | 2.08 |
| Ribalinidine | 3.09 | 4.76 |
| Catechin | 5.51 | 5.67 |
| Rutin | 11.25 | 11.35 |
| Kaempferol | 18.57 | 9.55 |
| Saponin | 14.33 | 14.00 |
| Spartein | 0.0002 | 0.0002 |

Alkaloids are potential bioactive compounds which have been used as CNS stimulant, topical anaesthetic in ophthalmology, powerful pain relievers and are known to exert antipuretic action (Ramawat *et al*., 2009). According to Okwu (2004), the basis for use of Alkaloids as therapeutic agents is due to their analgesic, anti-spasmodic and bactericidal effects.

Saponins have been reported to possess both beneficial (lowering of blood cholesterol) and

deleterious effects (cytotoxic, haemolysis and permeabilization of the intestine (Wink, 2010). Saponin content in both leaves (14.33uglg) and Roots (14.00ug/g) may be suggested to exert beneficial effect.

Saponins also have antimicrobial and anti-inflammatory activities but high concentration of saponins in the body can reduce uptake of certain nutrients including glucose and cholesterol, leading to hypercholesterolemia effect (Price *et al*., 1987; Sparg *et al*., 2004). The knowledge of phytate levels in plants and food is necessary because high concentration of phytate can cause indigestion of food and flatulence (Nwoko and Bragg, 1977).

Phytic acid intake of 4.00 – 9.00mg/100g reduces iron absorption by 4-5 folds in human (Grases *et al.*, 2001). But phytate in moderate levels has an anti-oxidant effect and can also prevent colon cancers by reducing stress in the lumen of intestinal tracts. Phenol was significantly present in both samples: leaves (6.66ug/g) and roots (3.96ug/g).

Phenolic compounds are secondary metabolites with a wide range of biological activities including increase bile secretion, reduction of blood lipid and cholesterol level, antioxidant and antimicrobial activity against bacterial strains staphylococcus (Wink, 2010). The concentration of oxalate in the leaves (1.20ug/g) and roots (0.84ug/g) was quite low compared to values reported for okra (61.5mg/100g), sweet potato (29.1mg/100g), Tomato (6.5mg/100g), orange (2.2mg/100g), onion (2.9mg/100g), carrot (7.7mg/100g). Oxalate is often referred to as anti-nutrient.

If consumed in large amounts may be harmful to health (Noonan and Savage, 1999) and can increase risk of kidney stone development because of increased concentration in urine. At moderate intake levels, about 40% of the total oxalate is excreted in the urine (Kohlmeier, 2003) as minute crystals. In the body oxalic acids combine with divalent metal cations such as $Ca^{2+}$ and iron (II) $fe^{2+}$ to form crystals and has been reported to interfere with calcium absorption (Kohlmeier, 2003).

**Table 3: Result of $LD_{50}$ of Leaf Extract**

| Doses (mg/kg) | No of Death | Mean Death | Dose Diff. | Mean Death x Dose Diff. |
|---|---|---|---|---|
| 100 | 0 | 0 | 0 | 0 |
| 200 | 1 | 0.5 | 100 | 50 |
| 300 | 2 | 1.5 | 100 | 150 |
| 400 | 3 | 2.5 | 100 | 250 |
| 500 | 5 | 4 | 100 | 400 |
| **Total** | | | | **850** |

Now by applying Karber's method for the determination of the $LD_{50}$,

$$\mathbf{LD50} = LD100 - \Sigma\frac{Sum\ of\ dose\ difference\ x\ mean\ death}{\text{Number of animal per group}}$$

$LD_{50}$ = 500 – (850/5) = 500 – 170 = 330, :. $LD_{50}$ = 330mg/kg

**Table 4: Result of $LD_{50}$ of Root Extract**

| Dose (mg/kg) | No of Death | Mean Death | Dose Diff. | Mean Death x Dose Diff. |
|---|---|---|---|---|
| 100 | 0 | 0 | 0 | 0 |
| 200 | 2 | 1 | 100 | 100 |
| 300 | 4 | 3 | 100 | 300 |
| 400 | 4 | 4 | 100 | 400 |
| 500 | 5 | 4.5 | 100 | 450 |
| **Total** | | | | **1250** |

$$\mathbf{LD50} = LD100 - \Sigma\frac{Sum\ of\ dose\ difference\ x\ mean\ death}{\text{Number of animal per group}}$$

$LD_{50}$ = 500 – (1250/5) = 500 – 250 = 250, :. $LD_{50}$ = 250mg/kg.

The effect of methanol leaf extract of *Thaumatococcus danielli* on haematological parameters after one week of treatment revealed no significant difference ($p<0.05$) in white blood cells, neutrophils and lymphocytes of the rats at all tested doses except monocyte of medium dose treated rats

that showed a significant increase compared to the control (Table 5). The effect of methanol root extract of *Thaumatococcus danielli* showed no significant difference ($p<0.05$) in the concentration of white blood cells, neutrophils, lymphocytes and monocyte of the treated animals at all tested doses compared to the control (Table 6)

After two weeks of treatment with the leaf extract, there was no significant difference ($p<0.05$) in the concentration of white blood cells, neutrophils, lymphocytes and monocyte of the treated animals at all tested doses compared to the control (Table 7).

**Table 5: Haematological parameters of Wistar rats after one week of treatment with Methanol leaf extract of *Thaumatococcus danielli*.**

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | $6.44\pm1.15^{ns}$ | $4.17\pm1.77^{ns}$ | $1.93\pm1.01^{ns}$ | $0.30\pm0.06^{ns}$ |
| Medium Dose | 15.00±3.85* | $1.93\pm0.62^{ns}$ | $6.30\pm1.36^{ns}$ | $1.00\pm0.04^{ns}$ |
| High Dose | $7.12\pm0.49^{ns}$ | $1.37\pm0.92^{ns}$ | $5.31\pm0.55^{ns}$ | $0.35\pm0.03^{ns}$ |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

Values are mean of five replicate ± Standard error of the mean (SEM)
*Significant ($p<0.05$) compared to the control, ns: not significant.

**Table 6: Haematological parameters of Wistar rats after one week of treatment with Methanol Root extract of *Thaumatococcus danielli*.**

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | $11.00\pm2.09^{ns}$ | $2.26\pm1.01^{ns}$ | $7.42\pm+1.43^{ns}$ | $0.58\pm0.56^{ns}$ |
| Medium Dose | $8.35\pm2.67^{ns}$ | $1.86\pm0.32^{ns}$ | $5.65\pm2.58^{ns}$ | $0.81\pm0.20^{ns}$ |
| High Dose | $9.37\pm2.39^{ns}$ | $0.63\pm0.23^{ns}$ | $6.30\pm0.65^{ns}$ | $0.50\pm0.20^{ns}$ |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

**Table 7: Haematological parameters of Wistar rats after Two weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli*.**

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | $5.60\pm1.16^{ns}$ | $2.24\pm0.48^{ns}$ | $3.03\pm0.61^{ns}$ | $0.40\pm0.12^{ns}$ |
| Medium Dose | $6.67\pm0.64^{ns}$ | $2.40\pm0.06^{ns}$ | $4.10\pm0.61^{ns}$ | $0.27\pm0.03^{ns}$ |
| High Dose | $6.03\pm0.12^{ns}$ | $2.47\pm0.09^{ns}$ | $4.20\pm0.53^{ns}$ | $0.33\pm0.03^{ns}$ |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

similarly, week 2 treatment with the root extract revealed no significant difference ($p<0.05$) in white blood cells, neutrophils and lymphocytes of the rats at all tested doses except monocyte of medium dose treated rats that showed a significant increase compared to the control.(Table 8)

**Table 8: Haematological parameters of Wistar rats after Two weeks of treatment with Methanol Root extract of *Thaumatococcus danielli*.**

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | $6.83\pm0.33^{ns}$ | $3.07\pm0.35^{ns}$ | $3.63\pm0.15^{ns}$ | $0.27\pm0.03^{ns}$ |
| Medium Dose | $6.87\pm0.29^{ns}$ | $4.73\pm1.92^{ns}$ | $6.67\pm0.93^{ns}$ | 1.87±0.90* |
| High Dose | $6.80\pm0.29^{ns}$ | $2.70\pm0.26^{ns}$ | $3.73\pm0.09^{ns}$ | $0.33\pm0.03^{ns}$ |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

Week 3 treatment with the leaf extract showed significant decrease ($p<0.05$) in the concentration of lymphocyte (medium and high dose treated groups) and a significant increase in monocyte (low dose treated group) when compared to normal control. The concentrations of white blood cells and neutrophils were not significantly affected at $P<0.05$ (Table 9) Also, the methanol root extract of *Thaumatococcus danielli* (Table 10) after three weeks treatments showed a significant decrease ($p<0.05$) in the concentration of lymphocyte (medium and high dose treated groups) but a significant increase in monocyte (high dose treated group) when compared to normal control. The concentrations of white blood cells and neutrophils were not significantly affected at $P<0.05$.

**Table 9: Haematological parameters of Wistar rats after Three weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | 9.03±0.09$^{ns}$ | 2.47±1.03$^{ns}$ | 5.57±0.90$^{ns}$ | 0.60±0.06* |
| Medium Dose | 5.30±0.62$^{ns}$ | 2.43±0.09$^{ns}$ | 2.43±0.46* | 0.27±0.09$^{ns}$ |
| High Dose | 6.73±1.21$^{ns}$ | 2.70±0.12$^{ns}$ | 1.50±0.06* | 0.33±0.09$^{ns}$ |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

**Table 10: Haematological parameters of Wistar rats after Three weeks of treatment with Methanol Root extract of *Thaumatococcus danielli*.**

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | 3.53±1.20$^{ns}$ | 2.57±0.94$^{ns}$ | 2.90±0.74$^{ns}$ | 0.40±0.06$^{ns}$ |
| Medium Dose | 5.03±0.75$^{ns}$ | 1.60±0.12$^{ns}$ | 1.43±0.09* | 0.30±0.12$^{ns}$ |
| High Dose | 9.33±2.61$^{ns}$ | 2.00±0.21$^{ns}$ | 1.93±0.45* | 0.77±0.23* |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

As shown in Table 11, the methanol leaf extract of *Thaumatococcus danielli* after Four weeks treatment caused significant decrease ($p<0.05$) in the concentrations of white blood cells and lymphocyte in all groups treated, Neutrophils was significantly affected in low dose treated group when compared to normal control.

The concentration of monocyte was not affected. It was observed that after four weeks treatment with the root extract there was significant decrease ($p<0.05$) in the concentration of white blood cells (low and medium dose treated groups) but no significant difference ($p<0.05$) in neutrophils, lymphocytes and monocyte of the animals at all tested doses compared to the control (Table12).

The methanol leaf extract of *Thaumatococcus danielli* after one week treatment showed no significant ($p<0.05$ ) difference in the concentrations of red blood cells, haemoglobin, haematocrit and mean cell volume of all the tested doses compared to the control (Table 13).

**Table 11: Haematological parameters of Wistar rats after Four weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | 4.64±0.32* | 0.27±0.03* | 2.03±0.03* | 0.97±0.68$^{ns}$ |
| Medium Dose | 4.49±0.51* | 0.68±0.36$^{ns}$ | 1.23±0.19* | 0.13±0.03$^{ns}$ |
| High Dose | 5.75±0.11* | 2.53±9.23$^{ns}$ | 2.80±0.15* | 0.20±0.06$^{ns}$ |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

**Table 12: Haematological parameters of Wistar rats after Four weeks of treatment with Methanol Root extract of *Thaumatococcus danieli.***

| Group | WBC ($x10^9$/l) | Neu ($x10^9$/l) | Lym ($x10^9$/l) | Mon ($x10^9$/l) |
|---|---|---|---|---|
| Low Dose | 4.93±0.06* | 1.60±0.06$^{ns}$ | 2.77±0.23$^{ns}$ | 0.47±0.18$^{ns}$ |
| Medium Dose | 5.27±1.24* | 1.53±0.17$^{ns}$ | 3.43±0.9$^{ns}$ | 0.73±0.32$^{ns}$ |
| High Dose | 5.48±0.03$^{ns}$ | 1.43±0.55$^{ns}$ | 2.73±0.15$^{ns}$ | 0.97±0.48$^{ns}$ |
| Normal | 8.23±1.28 | 2.00±0.70 | 6.03±1.94 | 0.24±0.12 |

**Table 13: Haematological parameters of Wistar rats after one week of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | 7.92±0.87$^{ns}$ | 15.87±0.30$^{ns}$ | 49.33±2.40$^{ns}$ | 61.93±6.32$^{ns}$ |
| Medium Dose | 9.15±1.69$^{ns}$ | 17.00±1.85$^{ns}$ | 51.00±5.51$^{ns}$ | 57.73±5.73$^{ns}$ |
| High Dose | 8.84±1.49$^{ns}$ | 16.53±1.62$^{ns}$ | 49.67±4.84$^{ns}$ | 57.80±5.04$^{ns}$ |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

But the root extract of *Thaumatococcus danielli* showed significant increase ($p<0.05$) in the concentration of haemoglobin in medium and high dose treated groups but no significant difference

($p<0.05$) in red blood cells and haematocrit of the albino rats at all tested doses compared to the control. However, the mean cell volume showed significant ($p<0.05$) decrease in low dose treated group. Other alterations observed were not statistically significant at $p<0.05$ (Table 14).

**Table 14: Haematological parameters of Wistar rats after one week of treatment with Methanol Root extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | $11.01\pm0.97^{ns}$ | $18.77\pm0.77^{ns}$ | $56.33\pm2.33^{ns}$ | 50.93±3.65* |
| Medium Dose | $8.27\pm2.06^{ns}$ | 19.13±1.37* | $57.33\pm4.10^{ns}$ | $66.20\pm6.66^{ns}$ |
| High Dose | $8.37\pm1.65^{ns}$ | 19.33±1.33* | $56.67\pm5.36^{ns}$ | $65.00\pm7.20^{ns}$ |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

Weeks 2 treatment with leaf extract of *Thaumatococcus danielli* showed no significant ($p<0.05$ ) difference in the concentrations of red blood cells, haemoglobin, haematocrit and mean cell volume of all the treated groups compared to the control (Table 15).

**Table 15: Haematological parameters of Wistar rats after Two weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | $4.67\pm0.60^{ns}$ | $11.93\pm0.41^{ns}$ | $36.33\pm1.20^{ns}$ | $78.77\pm7.34^{ns}$ |
| Medium Dose | $9.38\pm2.04^{ns}$ | $14.03\pm0.69^{ns}$ | $41.33\pm2.03^{ns}$ | $42.37\pm12.29^{ns}$ |
| High Dose | $5.87\pm0.28^{ns}$ | $14.50\pm0.29^{ns}$ | $45.33\pm1.76^{ns}$ | $53.80\pm12.27^{ns}$ |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

Similarly, after two weeks of treatment with root extract, there was no significant ($p<0.05$ ) difference in the concentrations of red blood cells, haemoglobin, haematocrit and mean cell volume of all the tested groups compared to the control.

**Table 16: Haematological parameters of Wistar rats after Two weeks of treatment with Methanol Root extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | $5.88\pm0.47^{ns}$ | $13.97\pm0.41^{ns}$ | $42.00\pm1.15^{ns}$ | $65.77\pm0.29^{ns}$ |
| Medium Dose | $7.19\pm1.19^{ns}$ | $14.47\pm0.69^{ns}$ | $44.00\pm2.08^{ns}$ | $60.20\pm8.06^{ns}$ |
| High Dose | $5.62\pm0.28^{ns}$ | $13.84\pm0.29^{ns}$ | $41.67\pm0.88^{ns}$ | $75.10\pm1.59^{ns}$ |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

The methanol leaf extract of *Thaumatococcus danielli* (Table 17) after three weeks of treatment showed significant decrease ($p<0.05$) in the concentration of red blood cells of medium dose treated groups, but no significant difference ($p<0.05$) in haemoglobin and haematocrit of the albino rats at all tested doses compared to the control. mean cell volume also showed significant ($p<0.05$) decrease in low and high dose treated groups. Other alterations observed were not statistically significant at $p<0.05$

**Table 17: Haematological parameters of Wistar rats after Three weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | $6.66\pm0.58^{ns}$ | $12.13\pm0.66^{ns}$ | $37.00\pm2.08^{ns}$ | 54.30±2.51* |
| Medium Dose | 4.89±0.46* | $14.30\pm0.21^{ns}$ | $43.00\pm0.58^{ns}$ | $72.67\pm1.13^{ns}$ |
| High Dose | $5.61\pm0.02^{ns}$ | $11.87\pm0.09^{ns}$ | $35.33\pm0.33^{ns}$ | 61.93±2.17* |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

The methanol root extract of *Thaumatococcus danielli* after three weeks of treatment showed no significant ($p<0.05$ ) difference in the concentrations of red blood cells, haemoglobin, haematocrit and mean cell volume of all the tested groups compared to the control (Table 18)

**Table 18: Haematological parameters of Wistar rats after Three weeks of treatment with Methanol Root extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | $5.14\pm0.28^{ns}$ | $13.53\pm1.53^{ns}$ | $40.67\pm4.63^{ns}$ | $81.13\pm11.71^{ns}$ |
| Medium Dose | $6.24\pm0.35^{ns}$ | $12.57\pm0.72^{ns}$ | $38.67\pm2.03^{ns}$ | $66.70\pm3.91^{ns}$ |
| High Dose | $7.01\pm1.42^{ns}$ | $15.07\pm0.98^{ns}$ | $45.00\pm2.89^{ns}$ | $68.93\pm9.33^{ns}$ |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

The methanol leaf extract of *Thaumatococcus danielli* after four weeks of treatment showed significant decrease ($p<0.05$) in the concentration of red blood cells with marked increase in mean cell volume in all treatment groups, but no significant difference ($p<0.05$) in haemoglobin and haematocrit concentrations (Table 19).

**Table 19: Haematological parameters of Wistar rats after Four weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | 4.61±0.26* | $13.30\pm0.58^{ns}$ | $40.00\pm1.73^{ns}$ | 87.53±0.73* |
| Medium Dose | 4.58±0.18* | $12.97\pm0.03^{ns}$ | $38.67\pm0.33^{ns}$ | 85.47±3.72* |
| High Dose | 4.92±0.03* | $14.37\pm0.20^{ns}$ | $43.00\pm0.58^{ns}$ | 90.07±0.35* |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

Effect of methanol leaf extract of *Thaumatococcus danielli* after four weeks of treatment showed significant decrease ($p<0.05$) in the concentration of red blood cells (low and high dose treated groups) but no significant difference ($p<0.05$) in haemoglobin, haematocrit and mean cell volume when compared to the normal control. Other alterations observed were not statistically significant at $p<0.05$ (Table 20).

**Table 20: Haematological parameters of Wistar rats after Four weeks of treatment with Methanol Root extract of *Thaumatococcus danielli.***

| Group | RBC ($x10^{12}$/L) | HGB (g/dL) | HCT (%) | MCV (fL) |
|---|---|---|---|---|
| Low Dose | 4.19±0.04* | $12.73\pm0.55^{ns}$ | $39.67\pm0.88^{ns}$ | $83.33\pm3.19^{ns}$ |
| Medium Dose | $5.66\pm0.57^{ns}$ | $13.20\pm0.10^{ns}$ | $39.67\pm0.33^{ns}$ | $75.37\pm8.58^{ns}$ |
| High Dose | 5.21±0.39* | $14.73\pm0.15^{ns}$ | $44.33\pm0.33^{ns}$ | $81.00\pm3.69^{ns}$ |
| Normal | 7.97±1.28 | 14.47±1.92 | 43.33±5.78 | 72.20±0.00 |

The leaf extract of *Thaumatococcus danielli* on haematological parameters after one week of treatment showed no significant difference ($p<0.05$) in mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and total platelet count of the albino rats when compared to the normal control (Table21).

**Table 21: Haematological parameters of Wistar rats after one week of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | MCH (pg) | MCHC (g/dL) | PLT ($x10^{9}$/L) |
|---|---|---|---|
| Low Dose | $18.33\pm1.69^{ns}$ | $29.63\pm0.60^{ns}$ | $214.67\pm48.60^{ns}$ |
| Medium Dose | $17.23\pm1.90^{ns}$ | $29.77\pm0.47^{ns}$ | $428.67\pm63.33^{ns}$ |
| High Dose | $16.97\pm0.98^{ns}$ | $29.67\pm2.12^{ns}$ | $419.33\pm6.35^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

The root extract of *Thaumatococcus danielli* after one week of treatment also showed no significant difference ($p<0.05$) in mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and total platelet count of the albino rats when compared to the normal control. In week 2 , treatment with the leaf extract of *Thaumatococcus danielli* showed no significant difference ($p<0.05$) in mean corpuscular haemoglobin concentration and total platelet count, but mean corpuscular haemoglobin significantly increased in low and high dose treated rats when compared to the normal control (Table 23).

**Table 22: Haematological parameters of Wistar rats after one week of treatment with Methanol Root extract of *Thaumatococcus danielli*.**

| Group | MCH (pg) | MCHC (g/dL) | PLT (x10$^9$/L) |
|---|---|---|---|
| Low Dose | 14.27±1.39$^{ns}$ | 27.37±1.39$^{ns}$ | 381.67±91.72$^{ns}$ |
| Medium Dose | 21.87±5.43$^{ns}$ | 28.33±1.97$^{ns}$ | 380.00±6.07$^{ns}$ |
| High Dose | 22.80±8.16$^{ns}$ | 30.43±2.83$^{ns}$ | 250.67±29.38$^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

**Table 23: Haematological parameters of Wistar rats after Two weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli*.**

| Group | MCH (pg) | MCHC (g/dL) | PLT (x10$^9$/L) |
|---|---|---|---|
| Low Dose | 24.70±2.29* | 30.77±0.09$^{ns}$ | 268.00±31.09$^{ns}$ |
| Medium Dose | 20.63±0.64$^{ns}$ | 30.60±0.06$^{ns}$ | 344.00±0.58$^{ns}$ |
| High Dose | 26.67±1.85* | 30.53±0.28$^{ns}$ | 306.33±20.35$^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

The root extract of *Thaumatococcus danielli* after two weeks of treatment revealed no significant difference ($p<0.05$) in total platelets count in all doses of treatment, but there was a significant increase in mean corpuscular haemoglobin level in high dose treated group, while mean corpuscular haemoglobin concentration (MCHC) in low and medium dose treated groups showed significant differences ($p<0.05$) from the normal control (Table 24).

**Table 24: Haematological parameters of Wistar rats after Two weeks of treatment with Methanol Root extract of *Thaumatococcus danielli*.**

| Group | MCH (pg) | MCHC (g/dL) | PLT (x10$^9$/L) |
|---|---|---|---|
| Low Dose | 18.27±0.17$^{ns}$ | 27.17±0.13* | 358.00±74.22$^{ns}$ |
| Medium Dose | 20.47±1.98$^{ns}$ | 33.60±1.14* | 271.33±14.4$^{ns}$ |
| High Dose | 21.50±0.50* | 30.83±0.12$^{ns}$ | 441.67±10.4$^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

In week 3, treatment with the leaf extract of *Thaumatococcus danielli* showed no significant difference ($p<0.05$) in total platelets count, but there were significant increases ($p<0.05$) in the level of mean corpuscular haemoglobin in medium and high dose groups and an in mean corpuscular haemoglobin concentration of high dose treated albino rats when compared to normal control (Table 25).

**Table 25: Haematological parameters of Wistar rats after Three weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli*.**

| Group | MCH (pg) | MCHC (g/dL) | PLT (x10$^9$/L) |
|---|---|---|---|
| Low Dose | 17.30±0.43$^{ns}$ | 31.80±1.08$^{ns}$ | 293.00±14.80$^{ns}$ |
| Medium Dose | 26.27±1.73* | 29.07±1.18$^{ns}$ | 299.33±42.81$^{ns}$ |
| High Dose | 21.67±0.69* | 34.87±0.09* | 251.33±7.66$^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

The root extract of *Thaumatococcus danielli* after three weeks of treatment showed no significant difference ($p<0.05$) in mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and total platelet count of the treated rats when compared to the normal control (Table 26)

**Table 26: Haematological parameters of Wistar rats after Three weeks of treatment with Methanol Root extract of *Thaumatococcus danielli*.**

| Group | MCH (pg) | MCHC (g/dL) | PLT (x10$^9$/L) |
|---|---|---|---|
| Low Dose | 26.07±4.03$^{ns}$ | 26.80±6.12$^{ns}$ | 226.33±31.87$^{ns}$ |
| Medium Dose | 20.30±1.70$^{ns}$ | 29.67±0.84$^{ns}$ | 279.67±9.39$^{ns}$ |
| High Dose | 23.60±4.85$^{ns}$ | 31.40±2.42$^{ns}$ | 254.67±45.70$^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

It was observed that the leaf extract of *Thaumatococcus danielli* after four weeks of treatment showed no significant difference ($p<0.05$) in total platelets count, but there were increases in the level of mean corpuscular haemoglobin in all treated groups and in mean corpuscular haemoglobin concentration of medium and high dose treated rats which were statistically significant at $p<0.05$ (Table 27)

**Table 27: Haematological parameters of Wistar rats after Four weeks of treatment with Methanol leaf extract of *Thaumatococcus danielli.***

| Group | MCH (pg) | MCHC (g/dL) | PLT ($x10^9$/L) |
|---|---|---|---|
| Low Dose | 28.93±0.97* | 32.17±1.19$^{ns}$ | 237.33±32.54$^{ns}$ |
| Medium Dose | 29.20±1.19* | 34.00±0.58* | 240.00±8.08$^{ns}$ |
| High Dose | 29.53±0.37$^{*}$ | 33.97±0.35* | 266.33±17.52$^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

The root extract of *Thaumatococcus danielli* after four weeks of treatment showed no significant difference ($p<0.05$) in total platelets count, but there were increases in the level of mean corpuscular haemoglobin in all treated groups and in mean corpuscular haemoglobin concentration of medium and high dose treated albino rats which were statistically significant at $p<0.05$ (Table 28).

**Table 28: Hematological parameters of Wistar rats after Four weeks of treatment with Methanol Root extract of *Thaumatococcus danielli.***

| Group | MCH (pg) | MCHC (g/dL) | PLT ($x10^9$/L) |
|---|---|---|---|
| Low Dose | 28.93±0.97* | 32.17±1.19$^{ns}$ | 237.33±32.54$^{ns}$ |
| Medium Dose | 29.20±1.19* | 34.00±0.58* | 240.00±8.08$^{ns}$ |
| High Dose | 29.53±0.37* | 33.97±0.35* | 266.33±17.52$^{ns}$ |
| Normal | 17.57±1.02 | 30.57±1.02 | 306.33±32.83 |

Values are mean of five replicate ± Standard error of the mean (SEM)
*Values are significant ($p<0.05$), ns: not significant as compared to the control.

The effects of the leaf extract on red blood cells manifested in week 3 (medium dose group) and week 4 in all doses of administration with a significant decrease ($p<0.05$), while a significant decrease ($p<0.05$) on mean cell volume was observed in week 3 (low and high dose groups) and week 4 in all doses of administration.

Similarly, there was a significant decrease in week 4 treatment with the root extracts in low and high dose treated rats, while a reduction in mean cell volume was noted only in week 1 of low dose treated group. Red blood cells serve as a carrier of haemoglobin; haemoglobin reacts with oxygen in the blood to form oxyhemoglobin (Johnston and Morris, 1996; Chineke *et al*., 2006).

The red blood cell is involved in the transports of oxygen and carbon-dioxide in the body. Thus, a reduce red blood cell count implies a reduction in oxygen levels that would be supplied to the tissues as well as the level of carbon-dioxide returned to the lung (Isaac *et al*., 2013).

When the mean cell volume is lower than normal, it is an indication that the average volume of red blood is lower than normal and sometimes may result in microcytic anemia (Chineke *et al*., 2006). Other possibilities for a low MCV blood test result include low intake of vitamin B6, excess of heavy metals, low intake of iron and gastrointestinal malabsorption such as in gluten sensitivity (Medlineplus Medical Encyclopedia, 2002).

The mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) indicates blood level conditions. They are diagnostic tools used to determine the type, cause and severity of anaemia, a low level is an indicator of anaemia (Aster, 2004).

In this study, the effect of both leaf and root extracts of *Thaumatococcus danielli* on the level of MCH started manifesting in week 2 of administration and became more pronounced in week 4 of all the treated groups with significant ($p<0.05$) increases compared to normal control. Increased MCH could indicate macrocytic anemia (Longe *et al*., 2015).

It was also observed that both extracts caused significant increase ($p<0.05$) in the value of mean corpuscular haemoglobin concentration (MCHC) which could suggest hereditary spherocytosis or homozygous haemoglobin C diseases (Longe *et al*., 2015).

It is pertinent to note that MCHC can be artifactually elevated when there is agglutination of red blood cells which can falsely lower the measured

RBC and when there are free haemoglobin in the plasma due to hemolysis (Medlineplus Medical Encycopedia, 2002).

Reduction in white blood cells was observed in week 4 treatment with both extracts across all doses of administration. This implies that both extracts can lower the immune system on prolong usage.

## 4. Conclusion

Plant materials ingested as food or as herbal extract have been reported to cause some alterations in hematological component which could be positive or negative effects. Therapeutic potential of herbal extract is due to the array of phytochemicals that they contain.

Phytochemical analyses showed significant concentration of flavonoids which is a powerful antioxidant with other phytochemicals which are of health benefit. But, sub-acute administration of leaf and root extracts of this plant caused some alterations in haematological parameters which could be suggested to be negative impact.

### 4.1 Recommendations

Thus, caution should be applied when plants are used therapeutically at medium and high dose concentrations. It is recommended that chronic toxicity studies for duration of at least 60 days be designed to explicitly define some observed alterations in haematological parameters.

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