International Research Journal of Medical and Pharmaceutical Sciences
Volume.10, Number 3; July-September, 2025;
ISSN: 2836-8207| Impact Factor: 7.61
https://zapjournals.com/Journals/index.php/Pharmaceutical
Published By: Zendo Academic Publishing

EFFECT OF BRYOPHYLLUM PINNATUM EXTRACT ON BLOOD PARAMETERS OF MALE WISTAR ALBINO RATS EXPOSED TO KEROSENE

Edoga Cyril Onyekachi, Nnamani Chidinma Praise and Offor Amarachukwu Grace

Article Info

Keywords: *Bryophyllum pinnatum*, white blood cell differential, Haemoglobin, Packed cell volume, white blood cell, red blood cell, kerosene.

DOI
10.5281/zenodo.16909690

Abstract

This study investigated the effects of *B. pinnatum* extract on the haematological parameters of male Wistar albino rats exposed to kerosene fumes. A total of 25 male Wistar rats were divided into five groups. Groups A and B are blank and negative controls, respectively. Groups C, D, and E were exposed to 500 ml of kerosene and treated with 100, 200, and 500 mg/kg *B. pinnatum* extract, respectively. The results showed significant alterations in haematological parameters due to kerosene exposure, with significant differences ($p<0.05$) in PCV, RBC, WBC, haemoglobin, lymphocytes, neutrophils, eosinophils, monocytes, and basophils. *Bryophyllum pinnatum* increased PCV from (26.30 ± 1.00) to (43.45 ± 1.00). The same applies to other parameters, except basophil concentration, which neither kerosene exposure nor *Bryophyllum pinnatum* affects. However, treatment with *B. pinnatum* extract showed ameliorative effects, particularly at higher doses, by restoring blood parameters closer to baseline levels. These findings propose that *B. pinnatum* could serve as a natural remedy for mitigating the toxic haematological effects of environmental pollutants, including kerosene.

Introduction

Bryophyllum pinnatum, commonly known by different names cathedral bells, Goethe plant, love bush, miracle plant, “leaf of life," or "*Kalanchoe pinnata,"* has a rich history in traditional medicine across various cultures (Misra *et al*., 2011). Its traditional use spans centuries, where it was used to treat wounds, gastrointestinal issues, respiratory ailments, and liver disorders (Ojewole, 2015). The therapeutic characteristics of *B. pinnatum* are attributed to its phytochemicals, including alkaloids, flavonoids, saponins, tannins, taraxasterol, aurone, oxalic acid, ferulic acid, steroids, and phenolic compounds.

Bryophyllum pinnatum, documented with various protective properties in traditional medicine systems, warrants further investigation. This research aims to solve problems regarding human exposure to petrochemicals due to certain work, home, and environmental conditions, e.g., humans living in environments where refineries pollute the air, water, and soil. This research aims to investigate how living in such environments can affect the health of the inhabitants of such environments. The research also points to individuals whose jobs center around a

particular environment where they constantly inhale this petrochemical in places like fuel or gas stations, fuel or kerosene vendors. Understanding how *B. pinnatum* extracts interact with kerosene-induced blood toxicity can provide valuable insights into medicinal strategies. This study aims to bridge the gap between traditional knowledge and modern scientific inquiry by evaluating the effect of *Bryophyllum pinnatum* on blood function and components in a Wistar albino rat exposed to kerosene exhaust. The overarching goal of this study is to assess the potential of *Bryophyllum pinnatum* as a natural remedy for blood function distortions caused by environmental pollutants, thereby contributing to the development of preventive and therapeutic health interventions in the context of hydrocarbon exposure and beyond. It can contribute to terms of the economy.

Blood is the specialized liquid component of the human body; its main components are erythrocytes, leukocytes, and platelets. Air is taken in through the mouth and nostrils, and gases are exchanged in the alveoli. Oxygen and gases are absorbed into the bloodstream. After inhalation of air and absorption of oxygen in the lungs, the blood transports the absorbed oxygen to the parts of the body where it is needed. Inhaled foreign compounds can be found in the bloodstream. This component can distort or affect the functions of blood components, e.g., the packed cell volume, WBC, RBC, hemoglobin, and WBC differentials. Distortion of the blood components can affect the entire body's processes. The distortions can be lethal or mild. Elevated WBC could indicate that the body is fighting foreign compounds.

Kerosene contains a complex mixture of gases and particulate matter and numerous toxic components, such as polycyclic aromatic hydrocarbons (PAHs), nitrogen oxides (NO), and sulfur dioxide (SO2). Occupational exposure to petroleum fumes has toxic effects on various organs and systems, including the respiratory, immune, and nervous systems. Kerosene exposure has been associated with various adverse health effects, including respiratory disorders, nausea, increased stress levels, convulsions, irritability, drowsiness, and pneumonia (Dayasiri *et al*., 2017). Releases from the petrochemical industry are also thought to increase the incidence of cancer in fence line communities (Calvin *et al.*, 2020). Exposure to individual components, such as kerosene and petrochemical mixtures, can induce hematological effects (Zhang *et al*., 2022).

B. pinnatum extracts save cost in terms of production and purchase. In production, *Bryophyllum pinnatum* is natural and takes less time for extraction than synthetic drugs. *B. pinnatum* extracts are more affordable than synthesized drugs in terms of purchase. Extracts can be considered much safer than synthesized drugs in terms of allergies.

Methods

Experimental design

The study was laid on a complete randomized experimental design. A total of 25 male Wistar albino rats were obtained from the University of Nigeria, Nsukka (UNN). The animals were acclimatized for 2 weeks at the Animal House of Power Tech Analytical and Scientific Research Laboratory, where they were housed in wire-gauze cages under standard laboratory conditions. After acclimatization, the rats were randomly assigned to five groups, labeled A to E, with five rats in each group. Group A served as the blank control and received only standard feed and water, with no kerosene exposure or treatment with *B. pinnatum* extract. Group B was the negative control, in which the rats were exposed to kerosene alone, without any treatment. Group C comprised rats exposed to 500 mL of kerosene and treated with 100 mg/g of *B. pinnatum* extract. Group D rats were exposed to 500 mL of kerosene and treated with 200 mg/g of *B. pinnatum* extract. Group E rats were exposed to 500 mL of kerosene and treated with *Bryophyllum pinnatum* extract (500 mg/g).

The petroleum inhalation protocol

The method of exposure was inhalation. The rats were transferred to a ventilated exposure chamber labeled B-E. Perforated cans containing 500 mL kerosene were placed in each exposure chamber from (B-E). The Wistar rats were exposed to kerosene in the compartment for 5 h for 28 days.

Preparation of plant extracts

Fresh *Bryophyllum pinnatum* leaves were obtained from the Divine Love Sisters' Garden by Kingsway Road, Enugu State, Nigeria. The leaves were identified and authenticated by Prof. C. S. Eze in the Department of Applied Biology and Biotechnology, Enugu State University of Science and Technology, Enugu, Nigeria. The preparation method was the maceration method. Fresh *B. pinnatum* leaves were oven-dried. The leaves were then pulverized. Then, 400 g of the powder was measured, and absolute ethanol (98%) was added. The mixture was stirred thoroughly and left to sit for 48 h. The mixture was then filtered through a sieve cloth and decanted. The filtrate was then placed in a 60°C water bath. To remove the ethanol to obtain the crude sap.

Administration of the plant extract

The plant extract was administered orally through intubation. Administration was calculated and given according to the rat's body weight. Rat weight was between 120-180 g. Dosage volume was as follows: low dose (100 mg/g), medium dose (200 mg/g), and high dose (500 mg/g).

Collection of blood samples

Blood was collected through ocular puncture, as needle insertion was avoided to minimize the risk of cardiac arrest. A sterile capillary tube was carefully used to puncture the medial canthus of each eye for blood extraction. Approximately 2–3-mL blood was collected from each animal and distributed into plain and anticoagulant bottles to facilitate subsequent haematological analyses.

Haematological analysis

Estimation of the RBC

The total red blood cell counts of matured albino rats were determined using a standard haematological procedure as described by Ochei and Kolhatkar (2008). Well-mixed whole blood (0.02 ml) in EDTA mixed with 10% Na_2CO_3 in a ratio of 1:20 in a test tube was loaded into a Neubauer counting chamber, and the red blood cells were viewed under a light microscope. Appropriate squares were counted and added to determine the RBC.

Estimation of the WBC

The total white blood cell counts of mature albino rats were determined using a standard haematological procedure as described by Ochei and Kolhatkar (2008). Well-mixed whole blood (0.02 ml) in EDTA mixed with Turk's solution (2% glacial acetic acid) in a ratio of 1:20 in a test tube was loaded into a Neubauer counting chamber, and the white blood cells were counted and added up to determine the white blood cells.

Estimation of packed cell volume

The PCV was estimated as described by Ochei and Kolhatkar (2008). A blood sample was taken with a heparinized capillary tube, cleaned, and sealed with plasticine. The filled tubes were placed in a microhematocrit centrifuge and centrifuged at 12,000 g for 5 min. Spun tubes were placed into a specially designed scale, and the percentage percentage value (PCV) was read.

$$\text{PCV \%} = \frac{\text{Packed RBC column height} \times 100}{\text{Total blood volume height}}$$

Determination of haemoglobin concentration

This was performed using the cyanomethaglobin method, as described by Ochei and Kolhatkar (2008). Haemoglobin is mixed with Drabkin's solution, which contains potassium ferricyanide, potassium cyanide, and potassium dihydrogen phosphate. The ferricyanide form of methemoglobin, which is converted to cyanmethaemoglobin by cyanide. Cyanmethaemoglobin produces a color that is measured using a colorimetric

machine. Whole blood (0.02 mL) was added to 5 mL of Drabkin's solution (1:250 dilution) in a test tube. This was well mixed and allowed to stand for 10 min, and the absorbance was read colorimetrically at 540 nm with Drabkin's solution as a blank. The absorbance reading were multiplied a standard hemoglobin factor (36.8 g/dL) to obtain the actual hemoglobin value.

Estimation of the WBC differential

The WBC differential cell counts of matured albino rats were determined using an automated hematological system. Whole blood (0.02 mL) in EDTA was mixed with 2 mL of Turk's solution (2% glacial acetic acid) and introduced into the automated hematological system through a sucker. Total platelet, neutrophil, basophil, eosinophil, and lymphocyte counts were recorded.

Results

PCV count

The mean PCV levels of the rats exposed to kerosene at baseline showed no significant difference ($p > 0.05$) between the experimental groups (low-dose, medium-dose, and high-dose) (44.00 ± 0.40, 44.46 ± 0.70, 44.20 ± 0.40) when compared with the controls (42.41, ± 0.80, 43.47 ± 0.60) (Table 1). After 14 days of exposure to kerosene, a significant difference ($p<0.05$) between the negative control (26.30 ± 1.00) and blank control (44.46 ± 1.10). When the treatment groups were compared (39.60 ± 1.60, 39.58 ± 1.00, 43.45 ± 1.20) with the negative control (26.30 ± 1.00), a significant increase was observed. This indicates that *Bryophyllum pinnatum can* reduce the hematological effects of PCV levels. In addition, a significant difference was observed when the low-dose (39.60 ± 1.60) and medium-dose (39.48 ± 1.01) groups were compared with the blank control (44.46 ± 1.10). However, the high dose (43.45 ± 1.20) was not significantly different ($p > 0.05$) from the blank control. This indicates that a high dose could return the parameter to the blank control level. The mean PCV count maintained a similar trend as in week 2 after 28 days post-exposure. This propose that exposure to kerosene decreased PCV levels, and the increase was dose-dependent in *Bryophyllum pinnatum*.

Table 1: Effect of *Bryophyllum pinnatum* extract on PCV (%) in male Wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	42.41 ± 0.80^{a1}	44.46 ± 1.10^{a1}	43.47 ± 1.20^{a1}
B (Negative control)	43.47 ± 0.60^{a1}	26.30 ± 1.00^{b2}	25.31 ± 1.20^{b2}
C (low-dose extracts)	44.00 ± 0.40^{a1}	39.60 ± 1.60^{c2}	38.62 ± 1.80^{c2}
D (Medium-dose Extracts)	44.46 ± 0.70^{a1}	39.58 ± 1.00^{c2}	39.48 ± 1.01^{c2}
E (high-dose extracts)	44.20 ± 0.40^{a1}	43.45 ± 1.20^{a1}	42.42 ± 1.10^{a1}

Data are presented as mean ± SEM. In a column, mean values with the same letter as superscript are not significantly different ($p > 0.05$). In a row, the mean values with the same number as a superscript are not significantly different ($p > 0.05$).

RBC COUNT

The baseline mean RBC levels of the experimental group (6.46 ± 0.24, 6.49 ± 0.32, 6.52 ± 0.20) were not significantly different ($p > 0.05$) from the controls (6.48 ± 0.12, 6.51 ± 0.23) (Table 2). After 14 days of exposure to kerosene, a significant difference ($p<0.05$) between the negative control (4.00 ± 0.04) and blank control (6.50 ± 0.22). When treatment groups (Low-dose, medium-dose dose and high-dose extracts were compared (5.45 ± 0.10, 5.62 ± 0.20, 6.53 ± 0.02) with negative control (4.00 ± 0.04), there was a significant increase. This indicates that *Bryophyllum pinnatum* can reduce the hematological effects of RBC levels. In addition, a significant difference was observed when the low-dose (5.45 ± 0.10) and medium-dose (5.62 ± 0.20) groups were compared with the blank control (6.50 ± 0.22). However, the high dose (6.53 ± 0.02) was not significantly different ($p >$

0.05) from the blank control. This indicates that the high-dose treated group could return the RBC count to the level of the blank control. At 28 days post-exposure, the mean RBC count maintained a similar trend as that at week 2.

Table 2: Effect of *Bryophyllum pinnatum* extract on RBC ($X10^6/mm^3$) of male wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	6.48 ± 0.12^{a1}	6.50 ± 0.22^{a1}	6.53 ± 0.08^{a1}
B (Negative control)	6.51 ± 0.23^{a1}	4.00 ± 0.04^{b2}	4.02 ± 0.12^{b2}
C (low-dose extracts)	6.46 ± 0.24^{a1}	5.45 ± 0.10^{c2}	5.49 ± 0.14^{c2}
D (medium-dose extracts)	6.49 ± 0.32^{a1}	5.62 ± 0.20^{c2}	5.60 ± 0.24^{c2}
E (high-dose extracts)	6.52 ± 0.20^{a1}	6.53 ± 0.02^{a1}	6.50 ± 0.26^{a1}

Data are presented as mean± SEM. In a column, mean values with the same letter as superscript are not significantly different (p > 0.05). In a row, the mean values with the same number as a superscript are not significantly different (p > 0.05).

WBC Count

The baseline mean WBC levels showed no significant difference (p > 0.05) between the experimental group (10.30 ± 0.40, 10.20 ± 0.60, 10.06 ± 0.24) and the control group (95.11 ± 0.52, 10.22 ± 0.40) (Table 3). After 14 days of exposure to kerosene, a significant difference (p<0.05) between the negative control (10.22 ± 0.40) and blank control (95.11 ± 0.52). When treatment groups were compared (6.85 ± 0.62, 7.30 ± 0.400, 9.80 ± 0.60) with negative control (5.60 ± 0.40), there was a significant increase. This indicates that *Bryophyllum pinnatum* can reduce the hematological effects of WBC levels. In addition, a significant difference was observed when the low-dose (6.85 ± 0.62) and medium-dose (7.30 ± 0.400) groups were compared with the blank (10.10 ± 0.30). However, the high dose (9.80 ± 0.60) was not significantly different (p > 0.05) from the blank control. This indicates that a high dose could return the parameter to the blank control level. At 28 days post-exposure, the mean WBC count maintained a similar trend as that at week 2. This result implies that exposure to kerosene decreased WBC levels, and the increase was dose-dependent for *Bryophyllum pinnatum*.

Table 3: Effect of *Bryophyllum pinnatum* extract on WBC ($X10^3/mm^3$) of male wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	95.11 ± 0.52^{a1}	10.10 ± 0.30^{a1}	10.00 ± 0.42^{a1}
B (Negative control)	10.22 ± 0.40^{a1}	5.60 ± 0.40^{b2}	5.68 ± 0.50^{b2}
C (low-dose extracts)	10.30 ± 0.34^{a1}	6.85 ± 0.62^{c2}	6.98 ± 0.68^{c2}
D (medium-dose extracts)	10.20 ± 0.60^{a1}	7.30 ± 0.400^{c2}	7.25 ± 0.60^{c2}
E (high-dose extracts)	10.06 ± 0.24^{a1}	9.80 ± 0.60^{a2}	9.98 ± 0.70^{a2}

Data are presented as mean± SEM. In a column, mean values with the same letter as superscript are not significantly different (p > 0.05). In a row, the mean values with the same number as a superscript are not significantly different (p > 0.05).

Hb count.

The mean hemoglobin levels of the baseline showed that the experimental group (low-dose, medium-dose and high-dose) (14.20 ± 0.06, 14.30 ± 0.12, 14.20 ± 0.12) was not significantly different (p > 0.05) from the controls (14.16 ± 0.08, 14.30 ± 0.10) (Table 4). After 14 days of exposure to kerosene, a significant difference (p<0.05) between the negative control (11.12 ± 0.08) and blank control (14.26 ± 0.04). When experimental groups (12.62

± 0.32, 13.60 ± 0.10, 13.68 ± 0.22) were compared with the negative control (11.12 ± 0.08), there was a significant increase. This indicates that *Bryophyllum pinnatum* can reduce the hematological alterations of the Hb levels. The mean values of the medium-dose (13.60 ± 0.10) and high dose groups (13.68 ± 0.22), was not significantly different ($p > 0.05$) compared with the blank group. The low-dose group was significantly different ($p<0.05$) from the blank group (14.26 ± 0.04). After 28 days of exposure, the mean Hb count maintained a similar trend as that at week 2. This result implies that exposure to kerosene decreased Hb levels, and an increase was dose-dependent in *Bryophyllum pinnatum*.

Table 4: Effect of *Bryophyllum pinnatum* extract on hemoglobin levels (g/dL) of male wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	14.16 ± 0.08^{a1}	14.26 ± 0.04^{a1}	14.20 ± 0.06^{a1}
B (Negative control)	14.30 ± 0.10^{a1}	11.12 ± 0.08^{b2}	11.22 ± 0.05^{b2}
C (low-dose extracts)	14.20 ± 0.06^{a1}	12.62 ± 0.32^{a2}	12.70 ± 0.42^{a2}
D (medium-dose extracts)	14.30 ± 0.12^{a1}	13.60 ± 0.10^{a1}	13.68 ± 0.02^{a1}
E (high-dose extracts)	14.20 ± 0.14^{a1}	13.68 ± 0.22^{a1}	13.78 ± 0.12^{a1}

Data are presented as mean± SEM. In a column, mean values with the same letter as superscript are not significantly different (p > 0.05). Mean values with the same figure or number as a superscript are not significantly different (p > 0.05).

Lymphocyte count

The mean lymphocyte levels at baseline were not significantly different ($p > 0.05$) between the experimental groups (low-dose, medium-dose, and high-dose) (66.20 ± 0.26, 65.40 ± 0.24, 66.00 ± 0.22) and the controls (65.61 ± 0.16, 64.80 ± 0.16) (Table 5). After 14 days of exposure to kerosene, a significant difference ($p<0.05$) between the negative control (50.24 ± 0.14) and blank control (65.70 ± 0.12). When the treatment groups were compared (52.74 ± 0.22, 60.68 ± 0.26, 64.72 ± 0.30) with the negative control (50.24 ± 0.14), a significant increase was observed. This indicates that *Bryophyllum pinnatum* can reduce the hematological effects on lymphocyte levels. There was also a significant difference between the low dose groups and the medium dose (52.74 ± 0.22, 60.68 ± 0.26) groups and the blank control (65.70 ± 0.12). However, the high dose (64.72 ± 0.30) was not significantly different ($p > 0.05$) from the blank control. This indicates that a high dose could return the lymphocyte level to that of the blank control. At 28 days post-exposure, the mean lymphocyte count maintained a similar trend as that at week 2. This result implies that exposure to kerosene decreased lymphocyte levels, and the increase was dose-dependent.

Table 5: Effect of *Bryophyllum pinnatum* extract on Lymphocyte ($X10^3/mm^3$) of male Wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	64.80 ± 0.16^{a1}	65.70 ± 0.12^{a1}	66.60 ± 0.16^{a1}
B (Negative control)	65.61 ± 0.16^{a1}	50.24 ± 0.14^{b2}	51.20 ± 0.24^{b2}
C (low-dose extracts)	66.20 ± 0.26^{a1}	52.74 ± 0.22^{b2}	54.70 ± 0.20^{b2}
D (medium-dose extracts)	65.40 ± 0.24^{a1}	60.68 ± 0.26^{c2}	59.68 ± 0.20^{c2}
E (high-dose extracts)	66.00 ± 0.22^{a1}	64.72 ± 0.30^{a1}	64.78 ± 0.38^{a1}

Data are presented as mean± SEM. In a column, mean values with the same letter as a superscript are not significantly different (p > 0.05). Mean values with the same figure or number as a superscript are not significantly different (p > 0.05).

Neutrophils count

The baseline mean neutrophil levels showed no significant difference ($p > 0.05$) between the experimental group (low-dose, medium-dose, and high-dose) (23.50 ± 0.14, 23.45 ± 0.24, 23.62 ± 0.12) and the control group (23.50 ± 0.22, 23.20 ± 0.10) (Table 6). After 14 days of exposure to kerosene, a significant difference ($p<0.05$) between the negative control (15.00 ± 0.12) and blank control (22.30 ± 0.16). When treatment groups were compared (18.60 ± 0.12, 19.00 ± 0.20) with negative control (15.00 ± 0.12), a significant increase was observed. This indicates that *Bryophyllum pinnatum* could mitigate the hematological effects of neutrophil levels. There was also a significant difference between the low-dose (18.60 ± 0.20) and medium-dose (19.00 ± 0.20) groups and the blank control (22.30 ± 0.16). However, the high dose (21.88 ± 0.31) did not significantly differ from the blank control. This indicates that a high dose could return the parameter to the blank control level. At 28 days post-exposure, the mean neutrophil count maintained a similar trend as that at week 2. This result implies that exposure to kerosene decreased lymphocyte levels, and the increase was dose-dependent.

Table 6: Effect of *Bryophyllum pinnatum* extract on Neutrophils ($X10^3/mm^3$) of male Wistar albino rats exposed to kerosene.

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	23.50 ± 0.22^{a1}	22.30 ± 0.16^{a1}	23.60 ± 0.18^{a1}
B (Negative control)	23.20 ± 0.10^{a1}	15.00 ± 0.12^{b2}	15.20 ± 0.32^{b2}
C (low-dose extracts)	23.50 ± 0.14^{a1}	18.60 ± 0.20^{c2}	18.84 ± 0.22^{c2}
D (medium-dose extracts)	23.45 ± 0.24^{a1}	19.00 ± 0.20^{c2}	19.18 ± 0.24^{c2}
E (high-dose extracts)	23.62 ± 0.12^{a1}	21.88 ± 0.31^{a1}	22.78 ± 0.30^{a1}

Data are presented as mean± SEM. *In a column, mean values with the same letter as a superscript are not significantly different ($p > 0.05$). In a row, the mean values with the same figure or number as a superscript are not significantly different ($p > 0.05$).*

Eosinophil count

The baseline eosinophil levels showed no significant difference ($p > 0.05$) between the experimental group (low-dose, medium-dose, and high-dose) (3.74 ± 0.12, 3.71 ± 0.08, 3.69 ± 0.20) and the control group (3.70 ± 0.20, 3.68 ± 0.20) (Table 7). After 14 days of exposure to kerosene, a significant difference ($p<0.05$) between the negative control (2.30 ± 0.01) and blank control (3.72 ± 0.08). When the experimental groups were compared (2.80 ± 0.04, 2.98 ± 0.06, 3.65 ± 0.06) with the negative control (2.30 ± 0.01), a significant increase ($p<0.05$). This indicates that *B. pinnatum can* reduce the hematological effects of eosinophil levels. The low-dose (2.80 ± 0.04) and medium-dose (2.98 ± 0.06) groups were significantly different ($p<0.05$) compared to the blank control (3.72 ± 0.08). However, the high dose (3.65 ± 0.06) was not significantly different ($p > 0.05$) from the blank control. This indicates that a high dose could return the parameter to the blank control level. At 28 days post-exposure, the mean eosinophil count maintained a similar trend as that at week 2. This result implies that exposure to kerosene decreased eosinophil levels, and an increase in eosinophil levels was dose-dependent in *B. pinnatum*.

Table 7: Effect of *Bryophyllum pinnatum* extract on Eosinophils ($X10^3/mm^3$) of male Wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	3.68 ± 0.20^{a1}	3.72 ± 0.08^{a1}	3.70 ± 0.10^{a1}
B (Negative control)	3.70 ± 0.20^{a1}	2.30 ± 0.01^{b2}	2.20 ± 0.00^{b2}
C (low-dose extracts)	3.74 ± 0.12^{a1}	2.80 ± 0.04^{c2}	2.84 ± 0.02^{c2}

D (medium-dose extracts)	3.71 ± 0.08^{a1}	2.98 ± 0.06^{c2}	3.18 ± 0.04^{c2}
E (high-dose extracts)	3.69 ± 0.20^{a1}	3.65 ± 0.06^{a1}	3.64 ± 0.08^{a1}

Data are presented as mean ± SEM. *In a column, mean values with the same letter as superscript are not significantly different (p > 0.05). Mean values with the same figure or number as superscript are not significantly different (p > 0.05).*

Monocyte count

The mean monocyte levels at baseline were not significantly different (p > 0.05) between the experimental groups (low-dose, medium-dose, and high-dose) (3.49 ± 0.11, 3.52 ± 0.12, 3.50 ± 0.08) and the controls (3.51 ± 0.06, 3.52 ± 0.10) (Table 8). After 14 days of exposure to kerosene, a significant difference (p<0.05) between the negative control (2.42 ± 0.01) and blank control (3.50 ± 0.08). When treatment groups were compared (2.82 ± 0.02, 3.02 ± 0.02, 3.47 ± 0.06) with negative control (2.42 ± 0.01), there was a significant increase. This indicates that *Bryophyllum pinnatum* can reduce the hematological effects of monocyte levels. There was also a significant difference between the low-dose (2.82 ± 0.02) and medium-dose (3.02 ± 0.02) groups and the blank control (3.50 ± 0.08). However, the high dose (3.47 ± 0.06) did not significantly differ from the blank control. This indicates that a high dose could return the parameter to a level close to that of the blank control. After 28 days of exposure, the mean eosinophil count maintained a trend similar to that observed at week 2. This result implies that exposure to kerosene decreased eosinophil levels, and an increase in eosinophil levels was dose-dependent in *B. pinnatum*.

Table 8: Effect of *Bryophyllum pinnatum* extract on Monocyte ($X10^3/mm^3$) of male Wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	3.52 ± 0.10^{a1}	3.50 ± 0.08^{a1}	3.54 ± 0.10^{a1}
B (Negative control)	3.51 ± 0.06^{a1}	2.42 ± 0.01^{b2}	2.40 ± 0.00^{b2}
C (low-dose extracts)	3.49 ± 0.11^{a1}	2.82 ± 0.02^{c2}	2.84 ± 0.02^{c2}
D (medium-dose extracts)	3.52 ± 0.12^{a1}	3.02 ± 0.02^{c2}	3.04 ± 0.04^{c2}
E (high-dose extracts)	3.50 ± 0.08^{a1}	3.47 ± 0.06^{a1}	3.48 ± 0.08^{a1}

Data are presented as mean± SEM. *In a column, mean values with the same letter as superscript are not significantly different (p > 0.05). Mean values with the same figure or number as a superscript are not significantly different (p > 0.05).*

Basophils count

The mean basophils of the baseline between the experimental groups (low-dose, medium-dose, and high-dose extracts) (1.00 ± 0.00, 1.00 ± 0.00, 1.00 ± 0.00) and the controls (1.00 ± 0.00, 1.00 ± 0.00) show no significant difference (p > 0.05). No significant difference was observed across the groups and throughout the experiment. It can be concluded that neither exposure nor the introduction of *B. pinnatum* extract has no effect on basophil levels.

Table 9: Effect of *Bryophyllum pinnatum* extract on Basophil ($X10^3/mm^3$) of male Wistar albino rats exposed to kerosene

Groups	Wk 0	Wk 2	Wk 4
A (Blank Control)	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}
B (Negative control)	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}
C (low-dose extracts)	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}
D (medium-dose extracts)	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}
E (high-dose extracts)	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}	1.00 ± 0.00^{a1}

Data are presented as mean± SEM. *In a column, mean values with the same letter as a superscript are not significantly different (p > 0.05). In a row, the mean values with the same figure or number as a superscript are not significantly different (p > 0.05).*

Discussion and Conclusion

Discussions

This study showed a significant decrease in the concentration of packed cell volume due to kerosene exposure. There was also a dose-dependent increase in PCV after the introduction of *B. pinnatum* extract. This study is consistent with the previous research carried out by Khan *et al*. (2016), who documented significant reductions in PCV due to kerosene exposure. This also supports Patel *et al*. (2023), who stated that *Bryophyllum pinnatum* improves blood profiles.

This study showed a significant decrease in the red blood cell count concentration due to kerosene exposure. There was also a dose-dependent increase in RBC after the introduction of *B. pinnatum* extract. This study aligns with the previous work of Abdel-Rahman *et al*. (2016), who documented that a decrease in RBC may be due to hematological alterations caused by kerosene exposure. This supports Singh *et al*. (2018), who stated that *B. pinnatum* can improve blood health.

This study showed a significant decrease in the WBC count concentration due to kerosene exposure. There was also a dose-dependent increase in WBC after the introduction of *B. pinnatum* extract. This study is consistent with the previous research carried out by Aprioku and Igbe (2020), who documented significant reductions in PCV due to kerosene exposure. This also supports Patel *et al*. (2023), who stated that *Bryophyllum pinnatum* improves blood profiles.

This study showed a significant decrease in the concentration of hemoglobin count due to kerosene exposure. There was also a dose-dependent increase in hemoglobin after the introduction of *B. pinnatum* extract. This study is consistent with the previous research carried out by Abdel-Rahman *et al*. (2016), who documented that kerosene exposure reduced Hb levels. This supports Singh *et al*. (2018), who stated that *B. pinnatum* can improve blood health.

This study showed a significant decrease in the neutrophil count concentration due to kerosene exposure. There was also a dose-dependent increase in neutrophils after the introduction of *B. pinnatum* extract. This study is not in agreement with the previous research carried out by Baryshnikova *et al*. (2016), who documented significant increases in neutrophils after kerosene exposure. It also agrees with the research of Patel *et al*. (2023), who stated the improvement of blood profiles by *Bryophyllum pinnatum.*

This study showed a significant decrease in the eosinophil count due to kerosene exposure. There was also a dose-dependent increase in eosinophils after the introduction of *B. pinnatum* extract. This study is not in agreement with the previous research carried out by Baryshnikova *et al*. (2016), who documented significant increases in eosinophils after kerosene exposure. It also agrees with the research of Patel *et al*. (2023), who stated the improvement of blood profiles by *Bryophyllum pinnatum.*

This study showed a significant decrease in the monocyte count concentration due to kerosene exposure. There was also a dose-dependent increase in monocytes after the introduction of *Bryophyllum pinnatum* extract. This study is consistent with the previous research carried out by Abdel-Rahman *et al*. (2016), who documented that kerosene exposure reduced monocyte levels. This also supports Patel *et al*. (2023), who stated that *Bryophyllum pinnatum* improves blood profiles.

This study showed that there was no significant decrease or increase in the concentration of basophils due to kerosene exposure or introduction to *B. pinnatum*. Studies and findings concerning basophils are limited. The present study conflicts with the study by Kaur *et al*. (2013), who stated that there was an increase in the basophil

count, which indicated an allergic or inflammatory response. This supports Singh *et al*. (2018) who stated that *B. pinnatum* can improve blood health.

Conclusion

The results confirm that *B. pinnatum* possesses protective properties that can counteract the haematological disruptions caused by kerosene exposure.

Declaration

We, the authors, declare that this manuscript titled "Effects of *Bryophyllum Pinnatum* Extract on Blood Parameters of Male Wistar Albino Rats Exposed to Kerosene" is original and has not been published or submitted elsewhere for publication. All data were collected and analyzed following the ethical guidelines for animal research. There are no conflicts of interest to declare, and all authors have approved the final version of the manuscript for submission.

Acknowledgements

The authors sincerely appreciate the support of the Department of Applied Biology and Biotechnology, Enugu State University of Science and Technology (ESUT) for providing the necessary facilities for this study. We extend our gratitude to Mr. Aneke Rowland Jachike for his technical assistance. Special thanks to Dr. Cyril Onyekachi Edoga for his valuable guidance and insightful contributions. We thank our families and friends for their encouragement throughout this research period.

Funding

The research was fully funded and carried out by the authors.

Conflict of Interest

The authors declare no conflict of interest regarding the manuscript titled *Effects of Bryophyllum Pinnatum Extract on Blood Parameters of Male Wistar Albino Rats Exposed to Kerosene.*

References

Abdel-Rahman, M. S., El-sayed, E. M., & Ali, S. A. (2019). "Kerosene-induced oxidative stress and inflammation in the liver and kidney of rats." *Environmental Toxicology and Pharmacology*, **68**:104-113.

Abou-ElWafa HS, Albadry AA, El-Gilany AH. (2015). some biochemical and hematological parameters among petrol station attendants: *A comparative study. BioMed Res Int,* **41**(8):7-24.

Adebayo, J. O., O. O. Olanrewaju, and A. O. Fadare. (2012). "Triterpenoids from *Bryophyllum pinnatum* and their effects on hematological parameters in rats." Journal of Natural *Products*, **75**(4): 523-530.

Aprioku, J. S., & Igbe, I. (2020). Effects of *Bryophyllum pinnatum* on rat hematological parameters and oxidative stress *Journal of Medicinal Plant Research*, **14**(8): 123-129.

Baryshnikova N, Yakovleva, T., & Kim, I. (2016). "Effects of hydrocarbons on the immune system." *Toxicology Reports*, **3**:1-9.

Gupta, A., Sharma, S., & Singh, R. (2019). Medicinal properties of B. pinnatum. *Journal of Ethnopharmacology*, **242**:112-120...

Isirima, J., & Angalabiri-Owei (2014). Hematologic and biochemical implications of inhalation of fumes of petroleum products. *African J Cell Pathology*, **2014**(2):45

Jephcote C, Brown D, Verbeek T, Mah A. A (2020). Systematic review and meta-analysis of hematological malignancies among residents living near petrochemical facilities *Environmental Health*, **19**(1):53.

Kaur, S., Kaur, M., Sharma, S., & Gupta, R. (2013). "Effects of kerosene exposure on rat hematological parameters." *Toxicology Reports*, **1**: 546-550.

Khan, M. F., Hussain, S. S., & Anwar, S. (2016). "Oxidative stress and its role in kerosene toxicity." *Journal of Applied Toxicology*, **36**:1514-1521.

Kumar, A., Singh, S., & Pantley, S. K. (2015). "Metabolic effects of kerosene in the liver: A review." *Toxicology Reports*, **2**:1028-1036.

Kumar, V., Kumar, A., Sharma, M., 2018. Hematological effects of kerosene exposure in Wistar rats. *Environmental Toxicology and Pharmacology*, **59**:1-8.

M. B. Kavinda Chandimal Dayasiri, Shaluka F. Jayamanne and Chamilka Y. Jayasinghek (2017). Risk Factors for Acute Unintentional Poisoning among Children Aged 1–5 Years in the Rural Community of Sri Lanka: *Wiley online library*, 2.

Mishra, S. S., Moharana, S. K., & Dash, M. R. (2011). Review of cleome gynandra. *Int. J. Res. Pharm. Chem*., **1** (3): 681-689.

Ochei, J., & Kolhatkar, A. (2008). *Medical Laboratory Science, Theory and Practices*. Tata McGraw-Hill, New York, 311-347.

Ojewole, J.A. (2005) Antinociceptive, anti-inflammatory and antidiabetic effects of Bryophyllum pinnatum (Crassulaceae) leaf aqueous extract. *Journal of Ethnopharmacology*, **99**:13-19.

Patel, D. P., Shah, S. M., & Choksi, A. H. (2023). Protective Effects of *Bryophyllum pinnatum* Extracts on Toxicology. *Toxicology Reports*, **10**:15-23.

Mule, P., Upadhye, M., Taru, P., & Dhole, S. (2020). A review on Bryophyllum pinnatum:Research Journal of Pharmacognosy and Phytochemistry. **12**(2):111-112.

Rao, K. R., Suryaprakash, R., & Patil, A. S. (2021). *Bryophyllum pinnatum* as a potential antioxidant: implications in toxicology *Journal of Medicinal Plants Research*, **15**(2), 121-130.

Rothman, N., Li, G.L., Dosemeci, M., Bechtold, W.E., Marti, G.E., Wang, Y.Z., Linet, M., Xi, L.Q., Lu, W., Smith, M.T., Titenko-Holland, N., Zhang, L.P., Blot, W., Yin, S.N., Hayes, R.B. (1996). Hematotoxicity among Chinese workers exposed to benzene. *Am J Ind Med*., **29**(3):5.

Sharma, A., Gupta, P., & Singh, N. (2020). Effects of Hydrocarbon Exposure on Animal Hematological Parameters *Toxicology Letters*, **333**:15-24.

Sies, H. (2015). "Oxidative stress: A concept in redox biology and medicine." *Redox Biology*, **4**:180-183.

Singh, A., Sharma, R., Rao, S., and Babu, P. R. (2019). “Kerosene toxicity and its impacts on blood parameters: A review” [Remark 1]. *Journal of Environmental Science and Health*, **54**(3):244-259.

Singh, R., Pal, M., Kumar, R., Kumar, V. (2018). “Erythropoietic effect of bryophyllum pinnatum in rats with experimental anemia.” *Journal of Ethnopharmacology*, **214**:99-104

Szkudlarek J, Karczewski J, Jarocka J. and Karpowicz, I. (2018). "The role of oxidative stress in kerosene toxicity." *Toxicology and Applied Pharmacology*, **339**:57-64.

Valko M, Leibfritz D, Moncol J, Cronin MT, Mazur, M., & Telser, J. (2007). "Free radicals and antioxidants in normal physiological functions and human disease." The *International Journal of Biochemistry & Cell Biology*, **39**:44-84.

Zhang, Z., Liu, X., Guo, C., Zhang, X., Zhang, Y., Deng, N., Lai, G., Yang, A., Huang, Y., Dang, S., Zhu, Y., Xing, X., Xiao, Y., and Deng, Q. (2022). Hematological Effects and Benchmark Doses of Long-Term Co-Exposure to Benzene, Toluene, and Xylenes in a Follow-Up Study on Petrochemical Workers. *Toxics*, **10**(9):502.