EVALUATION OF EFFECTS OF AQUEOUS LEAF EXTRACT OF *Sphenocentrum jollyanum* FOLLOWING 28 DAYS ADMINISTRATION ON HAEMATOLOGICAL PARAMETERS OF WISTAR RATS

BY

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY, FACULTY OF LIFE SCIENCE, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA. IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE BACHELOR DEGREE (BSc.) IN SCIENCE LABORATORY TECHNOLOGY DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY (PHYSIOLOGY AND PHARMACOLOGY TECHNIQUES) FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY

OCTOBER, 2025

CERTIFICATION

This is to certify that this project work, titled **"EVALUATION OF EFFECTS OF AQUEOUS LEAF EXTRACT OF *Sphenocentrum jollyanum* FOLLOWING 28 DAYS ADMINISTRATION ON HAEMATOLOGICAL PARAMETERS IN WISTAR RATS"** was carried out by Hannah Esosa NWAIWU (Miss) with Matriculation Number LSC2010035 of the Department of Science Laboratory Technology, Faculty of Life Sciences, University of Benin, Benin City, Edo state under the supervision of Mr. James O. Oseyomon.

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DEDICATION

This work is dedicated to God Almighty for His all sufficient grace and mercy and also to my parents Mr. and Mrs. Celestine C. Nwaiwu.

ACKNOWLEDGEMENTS

I would love to thank God Almighty for making the completion of the project work a success. I also wish to appreciate my project supervisor, Mr. James O. Oseyomon who supported and rendered help throughout the research work. I also want to thank Prof. J. O. Osarumwense (HOD) and my other lecturers for their immense love and support.

My profound gratitude goes to my parents, Mr. and Mrs. Celestine C. Nwaiwu for their love, support, care, encouragement, and prayers throughout my stay in the university. I also want to appreciate my aunties for their love, prayers, care and support and my phenomenal siblings: Nwaiwu David and Nwaiwu Daniella for their prayers, love and care. My appreciation and heartfelt gratitude also goes to my friends: Emmanuella, Francess, Mimi, DG (Destiny), Etinosa, Akponine, Lilabel and Divine for their encouragement, support, love and care throughout my stay in the University, you guys made the toughest and most trying days endurable and enjoyable. Thank you guys for reminding me that even in chaos, there's still warmth, laughter and love.

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ABSTRACT

This study investigated the effects of 28-day oral administration of the aqueous leaf extract of *Sphenocentrum jollyanum* on haematological parameters in wistar rats. The plant which is widely used in West African traditional medicine, is known for its therapeutic benefits, yet its prolonged safety on blood indices remains scarcely explored. Twenty-four male wistar rats were randomly distributed into four groups: a control group and three treatment groups receiving 250 mg/kg, 500 mg/kg, and 1000 mg/kg of the extract, respectively. At the end of the experimental period, blood samples were analyzed for red and white blood cell indices, as well as platelet parameters, using standard hematological techniques. The results revealed a significant reduction ($p < 0.05$) in total white blood cell, monocyte, and granulocyte counts at the lowest dose (250 mg/kg), while higher doses maintained values comparable to the control. Red blood cell indices—including haemoglobin, packed cell volume, and mean corpuscular volume—remained within normal physiological limits, suggesting no adverse effect on erythropoiesis. Platelet counts were greatly unaffected, though a temporary decrease in plateletcrit and platelet distribution width was observed at low dose. Overall, the extract did not produce any clinically significant haematotoxic effect but demonstrated mild dose-dependent immunomodulatory influence. These findings suggest that aqueous extract of *Sphenocentrum jollyanum* is relatively safe on haematological profiles within the tested range, supporting its traditional use while emphasizing the need for dose regulation in prolonged administration.

CHAPTER ONE

INTRODUCTION

1.1 Background of study

Medicinal plants have been used for thousands of years in traditional medicine worldwide, with their therapeutic benefits passed down and improved over centuries through communal experience and empirical knowledge (Khan, 2014). Research has shown that medicinal plants, in their various forms, have been a longstanding source of medication, with both raw form and purified compounds being used for therapeutic purposes (Halberstein, 2005). Nature-derived compounds continue to be a crucial foundation for drug development, with numerous modern medications originating from traditional herbal medicines and still widely used in current medical treatment (Patwardhan *et al*., 2008). Herbal medicines hold significant importance globally, not only for their medicinal value but also for their economic impact, with approximately 80% of the world's population relying on traditional medicine to fulfill their healthcare requiremets (WHO, 2013), and the global herbal medicine market being valued at approximately $107 billion in 2017 (Zobayed, 2016).

Medicinal plants contain various organic compounds that have specific effects on the human body. These bioactive substances include tannins, alkaloids, carbohydrates, terpenoids, steroids, and flavonoids, which contribute to their therapeutic properties (Edeoga *et al*., 2005). Nonetheless, using an entire plant for medicine can have unpredictable effects due to the diverse range of phytochemicals it contains, which can interact in complex ways. Plants produce a broad spectrum of chemical compounds that help protect them from insects, fungi diseases, and

plant-eating mammals (Kumar, 2021).

Medicinal plants can be used as a substitute for conventional medicine or alongside it, offering an alternative or supplementary option for managing health (Zimmerman and Thompson, 2002). Some individuals seek more holistic treatment approach, while others prefer alternative medicines due to their perceived lower risk of side effects. Additionally, many people with chronic mental health issues are dissatisfied with conventional treatments that seem ineffective, driving them to explore alternative options (Werneke *et al*., 2006). Medicinal plants have become a valuable complement to conventional treatments for psychosis due to their diverse chemical composition, targeted biochemical effects, and other beneficial properties, making them promising leads for managing various mental health conditions, including psychosis (Chatterjee *et al*., 2012).

The growing global interest in medicinal plants is driven by the rising issues of antibiotic resistance and the adverse effects of synthetic pharmaceuticals. Herbal medicines are considered a safer option or complement to conventional treatments (Rates, 2001). Phytochemicals with antioxidant properties, for instance, can nullify harmful free radicals that contribute to oxidative stress and chronic conditions like diabetes, cardiovascular diseases, and cancer (Gulcin, 2020; Halliwell & Gutteridge, 2015). In Africa, traditional medicine continues to be a vital part of cultural heritage and healthcare management. In Nigeria, herbal remedies are commonly used across communities to treat prevalent conditions like malaria, infections, and inflammation (Sofowora *et* al., 2013). These traditional practices are transmitted through generations and constitute a significant aspect of native knowledge systems.

Researchers have extensively studied the effects of phytochemicals found in local medicinal

plants on promoting sustainable health and well-being, revealing a complex synergy of biochemical, metabolic, and physiological processes (Nyakudya *et al*., 2020). One of such medicinal plants is *Sphenocentrum jollyanum* Pierre, a perennial shrub native to the tropical regions of West Africa, specifically in Nigeria, Ghana and Cote d'Ivoire. This plant is widely used in traditional medicine due to its efficacy in treating a range of health issues such as malaria, fever, inflammation, including various gastrointestinal and reproductive issues (Aderibigbe *et al*., 2011). Nearly all parts of the plant, including its roots, leaves, and seeds, have been utilized in traditional medicine, typically prepared as water-based or alcoholic concoctions.

The haematopoietic system, which generates and regulates blood cells, is a vital indicator of physiological and pathological health. Assessing haematological parameters like haemoglobin levels, packed cell volume, red and white blood cell counts, and platelet count is crucial for understanding the effects of bioactive substances on the body (Yakubu and Akanji, 2010). Changes in these parameters can signal toxicity, anaemia, infection, or immune system modulation.

1.2 Statement of problems

While *Sphenocentrum jollyanum* has been reported to exhibit antioxidant, anti-inflammatory, and hepatoprotective properties, limited studies have evaluated its long-term safety profile on blood indices, especially after repeated daily admnistration.

1.3 Aim of study

The main aim of this study is to evaluate the effect of 28 days of daily administration of the aqueous extract of *Sphenocentrum jollyanum* on haematological parameters in Wistar rats.

1.4 Objectives

The specific objectives of the study are to:

1. Determine the effect of aqueous extract of *Sphenocentrum jollyanum* on red blood cell count, haemoglobin concentration, and packed cell volume.

2. Assess its effect on total and differential white blood cell counts.

3. Evaluate changes in platelet count following daily administration for 28 days.

4. Compare haematological responses across different extract doses to determine dose-dependent effects.

CHAPTER TWO

LITERATURE REVIEW

2.1 Sphenocentrum jollyanum

Sphenocentrum jollyanum Pierre is a medicinal shrub that belongs to the Menispermaceae family. It is native to the tropical regions of West Africa, particularly Nigeria, Ghana, and Côte d'Ivoire, where it is found in rainforests and secondary growth vegetation (Adesina, 2005). Locally, it is called "Ajo" in Yoruba, "Okpoho" in Igbo, and "Aduro kokoo" in Ghanaian Twi. The plant habitually grows to about 1–2 meters in height, with slender stems and deep yellow roots that emit a characteristic pungent aroma (Olorunnisola *et al*., 2017). Morphologically, *Sphenocentrum jollyanum* possesses alternate leaves that are elliptic to oblong, simple, and glabrous. The plant bears small yellowish flowers and produces fleshy fruits containing seeds used traditionally for medicinal purposes. Its roots and seeds are the most therapeutically relevant parts, used in decoctions, infusions, or powders for treating fever, jaundice, inflammation, and reproductive dysfunctions (Iwu, 2014).

Plate 1: A picture of *Sphenocentrum jollyanum* plant (Ajayi *et al*., 2019)

2.1.1 Taxonomic hierarchy of *Sphenocentrum jollyanum*

Kingdom- Plantae

Subkingdom- Tracheobionta

Superdivision- Spermatophyta

Division- Tracheophyta

Class- Magnoliopsida

Subclass- Magnoliidae

Order- Ranunculales

Family- Menispermaceae

Genus- Sphenocentrum

Species- *Sphenocentrum jollyanum* Pierre (Olorunnisola *et al*., 2017)

2.1.2 Description of Sphenocentrum jollyanum

Sphenocentrum jollyanum perpetually grows as a shrub or small understorey tree, attaining an average height of 1–1.5 m under natural forest conditions (Ekpono *et al*., 2018). The bark is woody, grey to brown in colour, and may have a slightly rough or flaky texture, which helps in identification during field collection (Olorunnisola *et al*., 2017). The leaves of *Sphenocentrum jollyanum* are simple, alternate, and broad, with an entire (smooth) margin. They are usually dark green and glossy on the upper surface, and slightly paler below (Olorunnisola *et al*., 2017). The leaves vary in size, ranging from 8–20 cm in length and 5–12 cm in width, with petioles

approximately 2–5 cm long (Ekpono *et al*., 2018). The leaf apex is wedge-shaped or sometimes cordate (heart-shaped), with a prominent midrib and lateral veins visible on both surfaces (Akinwumi and Sonibare, 2022). The flowers of *Sphenocentrum jollyanum* are small, bisexual, and bell-shaped, occurring singly or in small clusters (Ekpono *et al*., 2018). They are pale yellow to cream in colour, and though not highly fragrant, they attract small pollinators. The fruit is a yellowish drupe that becomes orange upon ripening and contains a single oval seed approximately 1 cm long (Olorunnisola *et al*., 2017). The fruiting phase occurs primarily during the rainy season in tropical regions. *Sphenocentrum jollyanum* thrives in tropical rainforest ecosystems and is habitually found along shaded forest floors and riverbanks where the soil is loamy and rich in organic matter (Akinwumi and Sonibare, 2022). In various regions of West Africa, *Sphenocentrum jollyanum* is known by different local names. In Nigeria (Yoruba), it is called “Akerejupon”, in Ghana it is referred to as “Aduro kokoo” or “Oban abe”, and among the Ibo tribe it is known as “Nkpukpu-ogwu” (Olorunnisola *et al*., 2017).

2.2 Ethnomedicinal uses of *Sphenocentrum jollyanum*

The traditional use of *Sphenocentrum jollyanum* is deeply rooted in African herbal medicine. The plant is valued for its ability to treat malaria, fever, gastrointestinal disorders, and inflammatory conditions (Aderibigbe *et al*., 2011). The root decoction is consumed to enhance appetite, alleviate constipation, and relieve menstrual pain. In Ghana and Nigeria, the seeds are chewed as stimulants and to manage sexual weakness (Amegbor *et al*., 2020). Furthermore, extracts of the plant are employed as adjunct therapies for liver disorders, hypertension, and diabetes. Its use as a postpartum tonic and lactation enhancer has also been reported among rural populations in

West Africa (Iwu, 2014). The extensive traditional application of *Sphenocentrum jollyanum* has spurred scientific interest in validating its pharmacological efficacy and safety.

In folkloric medicine, various plant parts are utilized by traditional medical practitioners. Specifically, some traditional healers and herb vendors in Southwestern Nigeria utilize the fruit and root of *Sphenocentrum jollyanum* to treat gastric ulcers by grinding them into powder and consuming with pap or water (Akinwumi and Sonibare, 2019). *Sphenocentrum jollyanum* is used in Sub-Saharan Africa to treat sexual dysfunction and act as an aphrodisiac (Ajao *et al*., 2019).

2.3 Phytochemical composition of *Sphenocentrum jollyanum*

A study on the ethanol root extract of *Sphenocentrum jollyanum* found it contains terpenoids and flavonoids, with alkaloids being the most prevalent compounds, according to a detailed phytochemical analysis (Olorunnisola *et al*., 2017).

Phytochemical investigation of *Sphenocentrum jollyanum* has revealed a rich profile of bioactive secondary metabolites responsible for its diverse biological activities. These metabolites include alkaloids, flavonoids, saponins, tannins, terpenoids, steroids, glycosides, and phenolic compounds (Amegbor *et al*., 2020; Adebayo et al., 2023).

Alkaloids such as berberine, columbamine, magnoflorine, and jatrorrhizine have been isolated from its root and seed extracts. These compounds are known for their antimicrobial, anti-inflammatory, and neuroactive effects (Adesina, 2005).

Flavonoids and phenolics are potent antioxidants that neutralize reactive oxygen species and protect cellular components from oxidative injury (Yakubu & Akanji, 2010). Saponins contribute

to cholesterol regulation and immune enhancement, while tannins possess antimicrobial and anti-ulcer properties (Edeoga *et al*., 2005).

The diversity of phytochemicals in *Sphenocentru jollyanum* enhances its pharmacological potential. However, these same compounds may exert hematotoxic or cytotoxic effects at high doses or during prolonged use, making toxicological assessment crucial (Adebayo et al., 2023).

2.4 PHARMACOLOGICAL ACTIVITIES

2.4.1 Antioxidant Activity

The antioxidant potential of *Sphenocentrum jollyanum* has been demonstrated through both in vitro and in vivo models. Its extracts search for free radicals such as DPPH (2,2-Diphenyl-1-Picrylhydrazyl) and nitric oxide, inhibit lipid peroxidation, and enhance the activity of endogenous antioxidant enzymes including catalase (CAT) and superoxide dismutase (SOD) (Amegbor *et al*., 2020). This antioxidant property is mainly due to flavonoids and phenolic acids, which donate hydrogen atoms to stabilize reactive oxygen species.

The methanolic stem extract showed dose-dependent antioxidant activity, effectively neutralizing superoxide radicals and hydrogen peroxide. Its IC50 values were 13.11 μg/mL and 30.04 μg/mL, comparable to ascorbic acid's values of 15.34 μg/mL and 35.44 μg/mL, respectively (Olorunnisola *et al*., 2017).

2.4.2 Anti-inflammatory and Analgesic Effects

Extracts of *Sphenocentrum jollyanum* possess strong anti-inflammatory effects by inhibiting cyclooxygenase and lipoxygenase pathways, leading to reduced synthesis of inflammatory mediators such as prostaglandins and leukotrienes (Aderibigbe *et al*., 2011). Its analgesic properties further support its use in traditional medicine for pain relief.

The methanol fruit extract (200 mg/kg) showed significant anti-inflammatory effects, inhibiting edema formation by 79.58%, while the root extract inhibited by 53.75%. Furanoditerpenes (columbin, isocolumbine, and fibleucin) isolated from the fruit extract also demonstrated notable anti-inflammatory properties. Additionally, columbin and a flavonoid-rich fraction (both at 200 mg/kg) exhibited 67.08% and 76.25% anti-inflammatory activity, comparable to acetylsalicylic acid (Olorunnisola *et al*., 2017).

2.4.3 Antimicrobial and Antiparasitic Activity

Methanolic and aqueous extracts of *Sphenocentrum jollyanum* exhibit broad-spectrum antimicrobial activity against both Gram-positive and Gram-negative bacteria, including Escherichia coli, Staphylococcus aureus, and Pseudomonas aeruginosa (Adesina, 2005). The plant also demonstrates antimalarial effects through the inhibition of Plasmodium falciparum growth, likely due to its alkaloid content (Adebayo *et al*., 2023).

2.4.4 Hepatoprotective Effect

Several studies have reported that *Sphenocentrum jollyanum* mitigates hepatic oxidative injury and normalizes liver enzyme markers such as alanine aminotransferase (ALT) and aspartate

aminotransferase (AST). Its antioxidant properties contribute to this protective effect by reducing lipid peroxidation and enhancing detoxification enzyme systems (Amegbor *et al*., 2020).

Research on *Sphenocentrum jollyanum* stem bark extract's hepatoprotective potential found that it effectively protected the liver from damage in rats exposed to carbon tetrachloride (CCl4). The extract significantly reversed elevated liver enzymes (AST, ALP, ALT) and total bilirubin levels while also improving total serum protein levels in a dose-dependent manner (Olorunnisola *et al*., 2011).

2.4.5 Aphrodisiac and Fertility-Enhancing Activity

Root extracts of *Sphenocentrum jollyanum* have been shown to increase serum testosterone levels, enhance sperm motility, and promote mating behavior in male rats (Yakubu & Akanji, 2010). The mechanism is believed to involve modulation of the hypothalamic–pituitary–gonadal axis and stimulation of testicular steroidogenesis.

2.4.6 Haematological Activity

Methanolic extracts from the roots and leaves of *Sphenocentrum jollyanum* were evaluated for their potential hematopoietic effects in Wistar mice infected with chloroquine-resistant Plasmodium berghei NK67. The extracts were administered orally for seven consecutive days. Results showed a notable increase in packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), and hemoglobin (Hb) levels. Additionally, red and white blood cell counts rose significantly, except for monocytes and neutrophils. These findings indicate that the extract may have the capacity to stimulate hematopoietic stem cell activity (Olorunnisola *et al.*, 2011; Mbaka *et al*., 2010).

2.4.7 Antidiabetic activity

An evaluation of various extracts from the morphological parts of *Sphenocentrum jollyanum* demonstrated its potential to lower blood glucose levels. Administration of 1 g/kg petroleum ether seed extract 30 minutes prior to a glucose load in oral glucose tolerance tests (OGTT) and alloxan-induced diabetic rabbits significantly reduced blood glucose levels by about 20% compared to the untreated control group. The study further confirmed the extract's anti-hyperglycemic effect in alloxan-induced diabetic rabbits (Mbaka *et al*., 2010).

Observation carried out on the methanol root extract exhibited significant hypoglycemic activity in streptozotocin-induced diabetic Wistar rats. Oral administration of 200 mg/kg of the extract for two weeks markedly reduced blood glucose levels to 6.62 mmol/L, compared to 16.3 mmol/L in the untreated control group. These findings support the traditional use of the plant for lowering blood glucose and suggest its potential as a source of effective anti-diabetic agents (Alese *et al*., 2014).

2.4.8 Antibacterial Activity

Investigation was carried out on the essential oil composition of the root extract of *Sphenocentrum jollyanum* and its antibacterial activity against Bacillus subtilis, Salmonella typhi, Staphylococcus aureus, Bacillus cereus, Proteus mirabilis, and Pseudomonas aeruginosa. The study revealed that the essential oil showed notable effectiveness against Bacillus subtilis and Pseudomonas aeruginosa, producing inhibition zones of 10 mm and 9 mm, respectively, at a concentration of 1000 µg/mL (Aboaba and Ekundayo, 2010). The plant extract was found to strongly inhibit S. typhi. Its moderate antimicrobial activity further supports the traditional use of

the root as a laxative that promotes healthy bowel movement and improves digestion (Koleosho *et al*., 2013).

2.4.9 Anti-Allergy Activity

The anti-allergic activity was evaluated using a milk-induced leukocytosis and eosinophilia model in mice. The ethanolic fruit extract produced a significant, dose-dependent reduction in eosinophil and lymphocyte counts. These findings indicate that the fruit extract possesses anti-allergic properties, likely mediated through multiple mechanisms arising from the interaction of its phytochemical constituents (Olorunnisola *et al*., 2017).

2.5 Toxicity Studies

Although widely regarded as safe in traditional medicine, toxicological evaluations are necessary to confirm the safety of *Sphenocentrum jollyanum*, especially with prolonged use. Studies have reported that the plant is relatively non-toxic at moderate doses but may induce hepatocellular alterations or haematological changes at higher concentrations (Adebayo *et al*., 2023).

Acute toxicity studies using aqueous and ethanolic extracts revealed LD_{50} values greater than 2000 mg/kg, suggesting low acute toxicity (Amegbor *et al*., 2020). However, sub-chronic studies over 28–60 days have shown mild alterations in liver enzymes and blood indices, emphasizing the need for controlled dosing and further evaluation.

2.6 Haematological Parameters

Haematological parameters serve as essential biomarkers for evaluating the physiological and pathological condition of organisms. They provide information on the functional integrity of the bone marrow, blood cells, and the overall health condition of animals exposed to test substances (Ali *et al*., 2021). The assessment of these parameters is therefore crucial in toxicological and pharmacological studies to determine the safety and efficacy of medicinal plant extracts (Oladipo *et al*., 2020). Variations in haematological indices such as red blood cell count (RBC), haemoglobin (Hb), packed cell volume (PCV), and white blood cell count (WBC) are used to detect anaemia, infection, immune stimulation, or immune suppression (Eze *et al*., 2019).

In studies involving repeated daily administration of plant extracts, including *Sphenocentrum jollyanum*, monitoring haematological indices helps to reveal any adverse or beneficial effects on the blood and related organs (Ekpono and Wopara, 2019). Haematological parameters are broadly divided into red blood cell indices, white blood cell indices, and platelet indices.

Red blood cells (RBC), haemoglobin (Hb), and packed cell volume (PCV):

These parameters are direct indicators of the oxygen-carrying capacity of the blood. A significant reduction in these parameters may suggest anaemia or bone marrow suppression, while an increase could indicate haemoconcentration or erythropoietic stimulation (Afolabi et al., 2021). According to Eze *et al*. (2019), alterations in Hb(Haemoglobin) and PCV(Packed Cell Volume) levels following extract administration may reflect the plant's potential to promote or inhibit erythropoiesis.

Red cell indices (MCV, MCH, MCHC, RDW):

Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW) help to classify anaemia and assess red blood cell morphology. Abnormalities in these indices often indicate deficiencies in essential nutrients such as iron or folate (Abdullahi *et al*., 2020).

White blood cells (WBC) and differential counts:

White blood cell count is a marker of immune response and infection. An increase in total WBC or neutrophils often signifies inflammation or immune stimulation, while a reduction may indicate immunosuppression or toxicity (Azeez *et al*., 2020). Differential counts such as lymphocytes, monocytes, and eosinophils provide further insight into immune modulation (Oladipo *et al*., 2020).

Platelet count and platelet indices (MPV, PDW):

Platelets are responsible for blood clotting and wound healing. Alterations in platelet count, mean platelet volume (MPV), or platelet distribution width (PDW) may reflect bone marrow suppression or hyperactivity (Nwankwo *et al*., 2021).

2.6.1 Measurement and Interpretation of Haematological Parameters

Haematological parameters are typically measured using automated haematology analyzers, which provide precise readings of complete blood count (CBC). According to Olorunfemi and Adeyemi (2021), EDTA-treated blood samples are preferred for accurate haematological analysis. In a 28-day sub-chronic toxicity study, samples are usually collected at baseline and on day 28 to assess cumulative effects (World Health Organization, 2020). Comparison between control and treated groups provides evidence of either haematotoxic or haematoprotective effects.

2.6.2 Haematological Parameters in Toxicological and Botanical Studies

In toxicological assessments, alterations in haematological indices are early indicators of systemic toxicity (Azeez *et al*., 2020). For example, repeated administration of plant extracts has been reported to cause significant changes in red blood cell (RBC), white blood cell (WBC), and platelet levels depending on the phytochemical composition and dosage (Abdullahi *et al*., 2020).

Botanical extracts rich in alkaloids, saponins, and flavonoids are known to modulate haematological indices due to their antioxidant and immune-modulatory activities (Eze et al., 2019). Some plant extracts demonstrate erythropoietic stimulation, thereby improving haemoglobin (Hb) and packed cell volume (PCV) values, while others may suppress marrow function at high concentrations (Ali *et al*., 2021).

2.6.3 Effects of Medicinal Plants on Haematological Parameters

Numerous medicinal plants influence haematological profiles either positively or negatively depending on dosage, phytochemical composition, and exposure duration. For instance, *Telfairia occidentalis* and *Vernonia amygdalina* stimulate erythropoiesis and elevate haemoglobin levels, while excessive use of *Azadirachta indica* or *Jatropha curcas* may suppress bone marrow function (Adedapo *et al*., 2014).

Plant-derived alkaloids, flavonoids, and saponins often modulate erythropoietin production, immune function, and platelet aggregation (Yakubu & Akanji, 2010). Antioxidant-rich plants protect erythrocytes from oxidative lysis, thereby maintaining cell membrane stability. Conversely, certain tannins and phenolic compounds may cause haemolysis at high concentrations.

2.7 *Sphenocentrum jollyanum* and Its Haematological Effects

Sphenocentrum jollyanum is a medicinal plant belonging to the family Menispermaceae and widely used in West African ethnomedicine for treating malaria, pain, and inflammation (Ekpono and Wopara, 2019). Phytochemical screening has shown that its root and stem contain alkaloids, saponins, flavonoids, and terpenoids that may influence blood formation and immune responses (Ajayi, 2019).

Ekpono and Wopara (2019) investigated the effect of ethanolic root extract of *Sphenocentrum jollyanum* on haematological parameters in Plasmodium berghei-infected mice. The results showed significant increases in haemoglobin (Hb), red blood cell (RBC), and packed cell volume (PCV) levels, suggesting repair of anaemia and stimulation of erythropoiesis. Also, Ekpono and Wopara (2019) reported that treatment with *Sphenocentrum jollyanum* improved haematological indices altered by infection, indicating its potential as a haematoprotective agent.

However, data on the aqueous extract of *S. jollyanum*, particularly under prolonged exposure such as 28-day daily administration, remain scarce. Since aqueous extraction mimics the traditional method of preparation, it is essential to investigate its effects on haematological indices to evaluate safety and therapeutic relevance (Ajayi, 2019; Addai-Mensah *et al*., 2019).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Equipment and Materials

Animal cages, Chloroform, Oral-gastric tubes, Feeding materials, Gloves, Microscope, Spectrophotometer, Dissecting set, Slides, Distilled water, Marker pens, Sample containers, Weighing balance, Needle syringe, Cotton wool, Aqueous extract of *Sphenocentrum jollyanum.*

3.2 Collection of Plant Samples, Identification and Authentication

Fresh leaves of *Sphenocentrum jollyanum* were collected from farm land of the Faculty of Agriculture, University of Benin, in Ovia North East Local Government Area, Edo State, Nigeria. The plant's authenticity was verified by Prof. H. A. Abkinnibosun of the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City, where herbarium number UBHG347 of the plant was deposited.

3.3 Extraction of Plant Material

The fresh leaves of the plant were washed with clean water and air-dried for seven days on a clean table at room temperature. The dried leaves were cut and pulverized, using an electrical blender. About 1000g of pulverized *S. jollyanum* leaves were macerated in distilled water and allowed to stand for 72 hours for proper extraction of the active ingredients. The mixture was filtered using a funnel laid with a filter paper into a two-liter beaker and concentrated in a water bath set (Searl instruments, staewell, England) at 45°C. The paste-like gel extract obtained was

further dried in a desiccator between 28 to 33°C to eliminate any remaining water content in the extract. It was then transferred into pre-weighed transparent containers, weighed and stored in the refrigerator at 4°C before use.

3.4 Experimental Animals

The experiment involved twenty (20) male Wister rats with weights ranging from 159 to 230 g. The rats were purchased from the Laboratory Animal House of the Department of Pharmacology and Toxicology, Faculty of Pharmacy, University of Benin, Benin City, Nigeria and kept at the same Animal House of the Department of Pharmacology and Toxicology, Faculty of Pharmacy, University of Benin, Benin City, Nigeria, where they were used for the experiment. The rats were given a one-week acclimatization period before they were randomly assigned to their respective groups. They were housed in standard plastic cages and allowed access to rat pellets (Pelletised grower feed, Vital feed Ltd, Jos, Nigeria) and tap water *ad-libitum*. Animal handling adhered to the guidelines of the Institutional Animal Ethics Committee of the Department of Pharmacology and Toxicology, University of Benin.

3.5 Experimental Design

For the acute phase, after 14 days of acclimatization, nine mice were divided into three groups, each consisting of three mice. The first group received the extract orally at a dose of 10 mg/kg, the second group at a dose of 100 mg/kg, and the last group at a dose of 1000 mg/kg body weight. These animals were observed for general signs and symptoms of toxicity, including mortality, over a period of 24 hours. In the second phase, three mice were divided into three groups of one

mouse each. The extract was administered at doses of 500, 7500, and 10,000 mg/kg orally to the respective groups. The final LD_{50} was calculated as the square root of the geometrical mean of the highest non-lethal dose and the lowest lethal dose.

For the sub-acute phase, 24 Wistar rats were divided into four groups, each consisting of six rats. The first group served as the control, the second group received 500 mg/kg of plant extract, and the third group received 2500 mg/kg of plant extract orally using an oral gastric tube.

3.6 SAMPLE COLLECTION

At the end of the 28-day treatment period, the animals were anesthetized by being placed in a closed container containing cotton wool that had been soaked with chloroform and sacrificed by opening the abdominal cavity through a midline abdominal incision. Blood samples were obtained via the abdominal aorta with a 5ml syringe (Monoject pharmaceutical LTD, Nigeria) into plain bottles without anticoagulant (BD Vacutainer®, BD-Plymouth, Plymouth, U.K) (Ozolua *et al*., 2009). The blood samples were allowed to clot and the serum was obtained by centrifuging at 3000 revolutions per minute (rpm) for ten minutes using a table top centrifuge (90(1) Alpin Medical, England) (Ozolua *et al*., 2010). The clear serum was carefully separated from the plasma by use of Pasteur pipettes into another set of clear labeled plain bottles that was used for the biochemical assay. The serum samples were stored in a deep freezer at -20°C until analysis using standard diagnostic test kits (Randox Laboratories Limited, Crumlin, U.K.) on an automated spectrophotometer.

3.7 Hematological Analysis

For the hemaetological test, blood samples obtained into the EDTA bottles (BD Vacutainer®, BD-Plymouth, Plymouth, U.K), was thoroughly mixed by gentle rolling of the bottle for haematological assays. The following parameters: White blood cells (WBC), platelet count (PC), packed cell volume (PCV), hemoglobin concentration (HB), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), monocytes (MON), lymphocytes (LYM), and granulocytes (GRAN), were analyzed using an automated hematological analyzer (Dymind, 2021 model), at the University of Benin Teaching Hospital (UBTH), Benin City, Nigeria.

3.8 STATISTICAL ANALYSIS

The data were expressed as means ± standard error of mean. Significance of mean values of different parameters between the treatment groups and control group were analysed using one-31 way analysis of variance (ANOVA) after ascertaining the homogeneity of variances between the groups. Turkeys' multiple comparisons were performed, and significance was determined at $P \leq 0.05$. Graph Pad Prism 8.2.1 was used to conduct the analysis.

CHAPTER FOUR

RESULTS

4.1 HAEMATOLOGICAL PARAMETERS

Table 4.1 Haematological values of rats in sub- chronic treatment with aqueous leaf extract of *Sphenocentrum Jollyanum* (ALESJ)

PARAMETERS	CONTROL	250MG/KG	500MG/KG	1000MG/KG
WBC (10^{-3}/µL)	12.50±0.915	6.20±0.545**	12.18±0.613	11.30±1.628
LYM (10^{-3}/µL)	8.450±0.483	5.140±0.443	9.350±0.748	9.333±1.527
MON (10^{-3}/µL)	2.350±0.537	0.560±0.114**	1.683±0.218	1.133±0.192*
GRAN (10^{-3}/µL)	1.675±0.539	0.320±0.066*	1.167±0.306	0.850±0.160
LYM (%)	66.88±6.384	85.78±0.966	76.75±4.597	79.82±3.868
MON (%)	18.20±3.055	9.080±0.434*	13.58±1.835	9.667±0.977*
GRAN (%)	12.93±3.405	5.140±0.836	9.667±2.831	10.40±4.634
RBC (10^{-6}/µL)	6.393±0.142	7.040±0.268	6.062±0.074	5.712±0.325
HBG (g/dl)	14.08±0.319	13.44±0.601	13.73±0.377	13.72±0.325

HCT (%)	39.73±1.118	40.92±1.052	37.82±0.990	37.27±0.732
MCV (μM^{-3})	62.18±1.320	58.36±1.520	62.35±1.135	66.70±4.665
MCH (Pg)	22.05±0.419	19.04±0.143	22.62±0.427	24.47±1.4722
MCHC (g/dl)	35.45±0.185	32.76±1.084*	36.30±0.242	36.78±0.413
RDWC (%)	16.68±0.413	17.44±0.789	16.73±0.246	15.78±0.402
RDWS (%)	36.43±1.544	37.16±2.507	37.32±0.817	38.37±2.910
PLT ($10^{-3}/\mu L$)	684.0±73.51	686.6±104.1	892.8±101.1	685.0±101.8
MPV (μM^{-3})	7.775±0.193	7.740±0.344	7.517±0.224	7.667±0.173
PCT (%)	0.529±0.052	0.510±0.073***	0.661±0.055	0.617±0.035
PDW (%)	14.90±0.349	9.080±0.292**	15.32±0.145	16.22±0.411
PLCR (%)	10.98±1.243	2.980±1.300	9.462±1.318	10.97±1.154

Values are mean ± SEM, n =5. Statistically, the parameters WBC, MON, GRAN, MCHC, PDW and PLCR analyzed were significant while the other parameters were not significant when compared to the control at $p<0.05$.

Key: **WBC**- white blood cells, **MON**- monocyte, **GRAN**- granulocytes, **RBC**- red blood cell, **HBG**-haemoglobin, **HCT**- haematocrit, **MCH**- mean corpuscular hemoglobin, **MCV**- mean corpuscular volume, **MCHC**- mean corpuscular hemoglobin concentration, **RDWS**- red cell distribution width, **PLT**- platelet count, **MPV**- mean platelet volume, **PCT**- procalcitonin, **PDW**- platelet distribution width, **PLCR**- platelet- large cell ratio.

CHAPTER FIVE

DISCUSSION

Table 4.1 presents the hematological profile of rats following 28-day oral administration of aqueous leaf extract of *Sphenocentrum jollyanum* (ALESJ) at doses of 250, 500, and 1000 mg/kg. The parameters evaluated include white blood cell (WBC) indices, red blood cell (RBC) indices, and platelet-related parameters, which serve as important indicators of the extract's potential effects on the hematopoietic and immune systems.

5.1 White Blood Cell and Differential Counts

There was a significant ($p < 0.05$) reduction in total WBC count at the 250 mg/kg dose ($6.20 \pm 0.55 \times 10^3/\mu L$) compared to the control ($12.50 \pm 0.92 \times 10^3/\mu L$), while values at 500 and 1000 mg/kg remained statistically comparable to control. Similarly, monocyte (MON) and granulocyte (GRAN) counts were significantly reduced at 250 mg/kg, suggesting a transient or dose-specific suppressive effect on leukopoiesis or immune cell proliferation.

However, lymphocyte (LYM) percentages were elevated at all doses, particularly at 250 mg/kg (85.78%), indicating a compensatory lymphocytic response possibly linked to immunomodulation rather than immunosuppression. This observation aligns with previous reports that *Sphenocentrum jollyanum* contains bioactive compounds such as alkaloids and flavonoids capable of modulating immune function (Bafor & Igbinuwen, 2009; Woode *et al*., 2011).

The reduction in monocyte and granulocyte counts at low doses may reflect the anti-inflammatory or immune-suppressive activity of the extract at that concentration, consistent

with findings by Boakye-Gyasi *et al*. (2008), who reported leukocyte suppression following administration of *S. jollyanum* extracts in rodents. At higher doses (500 and 1000 mg/kg), the near-normalization of WBC and differential counts suggests that the extract does not induce prolonged bone marrow suppression or systemic immune toxicity.

5.2 Red Blood Cell (RBC) Indices

Red cell indices—including RBC count, hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH)—did not differ significantly ($p > 0.05$) between treated and control groups. RBC counts ranged between $5.71 \pm 0.33 \times 10^6/\mu L$ and $7.04 \pm 0.27 \times 10^6/\mu L$, while hemoglobin values were between 13.44 ± 0.60 and 14.08 ± 0.32 g/dL.

These values are within normal physiological limits for healthy rats (Etim *et al*., 2014), suggesting that the extract did not adversely affect erythropoiesis or oxygen-carrying capacity. The stability of HCT and MCV values further supports the absence of anemia or hemolytic effects, indicating that *Sphenocentrum jollyanum* did not interfere with red blood cell production or morphology during sub-chronic exposure.

The observed mild increase in MCH and MCHC values at 1000 mg/kg could indicate improved hemoglobin synthesis or erythrocyte integrity, possibly due to the antioxidant and iron-conserving effects of phytochemicals in the plant (Togna *et al*., 2013; Odugbemi *et al*., 2008).

5.3 Platelet Parameters

Platelet count (PLT), mean platelet volume (MPV), and platelet distribution width (PDW)

showed minor, non-dose-dependent variations. However, a significant decrease ($p < 0.05$) in PDW and plateletcrit (PCT) was observed at 250 mg/kg, alongside a reduction in platelet large cell ratio (PLCR). These transient changes may reflect an early adaptive response to the extract or a mild alteration in platelet production or turnover.

Since platelet counts remained within normal physiological range (Etim *et al*., 2014), the overall hematopoietic system appears uncompromised. The non-significant differences at higher doses (500 and 1000 mg/kg) suggest that *S. jollyanum* does not exert cumulative or toxic effects on thrombopoiesis. This finding aligns with previous studies demonstrating that the plant exhibits hematopoietic support and immunoregulatory effects in rats and mice (Oluwole *et al*., 2013; Iwu *et al*., 1993).

5.4 Conclusion

The sub-chronic administration of aqueous leaf extract of *Sphenocentrum jollyanum* for 28 days produced dose-dependent but largely non-adverse hematological effects. The extract appeared to exert mild, transient effects on leukocyte distribution at low doses, while higher doses preserved normal hematological integrity. The absence of significant anemia, leukocytosis, or thrombocytopenia indicates that the extract is relatively safe on the hematopoietic system within the tested range.

The mild modulation of white blood cell profiles may reflect the immunomodulatory and anti-inflammatory properties of the plant's secondary metabolites, consistent with its traditional use in treating inflammatory and immune-related disorders (Bafor & Igbinuwen, 2009; Woode *et al*., 2011).

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