THE EFFECT OF AQUEOUS EXTRACT OF PLANTAIN AND BANANA PETALS ON OVARIES OF FEMALE WISTAR ALBINO RAT

BY

ANAYO KAMSI DIVINE

LSC2103710

DEPARTMENT OF BIOCHEMISTRY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

BENIN CITY

OCTOBER, 2025.

THE EFFECT OF AQUEOUS EXTRACT OF PLANTAIN AND BANANA PETALS ON OVARIES OF FEMALE WISTAR ALBINO RAT

BY

ANAYO KAMSI DIVINE

LSC2103710

A PROJECT RESEARCH SUBMITTED TO THE DEPARTMENT OF BIOCHEMISTRY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN.

IN PARTIAL FULFILLMENT OF THE AWARD OF BACHELOR OF SCIENCE (B. Sc) IN BIOCHEMISTRY.

OCTOBER, 2025.

CERTIFICATION

This is to certify that this final year project work was carried out by **ANAYO KAMSI DIVINE** with matriculation number **LSC2103710** of the department of biochemistry, faculty of life science, University of Benin, Benin city, in partial fulfillment of the award of bachelor of science (B.Sc) degree in biochemistry.

____________________________ ____________________________

Prof. (Mrs.) B. O Agoreyo **Date**

Project Supervisor

____________________________ ____________________________

Dr. S. I. Ojeaburu **Date**

Project Co-ordinator

____________________________ ____________________________

Prof E. C. Onyeneke **Date**

Head of Department

DEDICATION

This project is dedicated first to God almighty the creator of the universe, and the one who have been my source of strength and wisdom all through this project and who have also crowned me with good health.

ACKNOWLEDGEMENT

This project marks a significant milestone in my academic journey, and its successful completion would not have been possible without the support, guidance, and encouragement of many remarkable individuals to whom I remain deeply grateful.

Firstly, my heartfelt appreciation goes to God Almighty, whose grace, wisdom, and strength have continually sustained and guided me throughout this endeavor. Every achievement recorded in this research reflects His unfailing presence and favor.

I extend my profound gratitude to my parents, Mr. John Anayo and Mrs. Christiana Anayo, for their sacrifices, unwavering support, and steadfast belief in my dreams. Their love, prayers, and encouragement provided the motivation required to persevere through every challenge.

Special thanks go to my siblings, Obiajulu, Ogoochukwu, and Chika, for their understanding, love, and moral support, especially during moments when this research demanded my full focus and commitment. I sincerely appreciate my wonderful friends Favour, Dora, OG, Freya, Praise, Sophia and Precious (a friend who has become a sister) for their joy, motivation, and companionship, which made this challenging journey more manageable and truly rewarding.

I am deeply indebted to my project supervisor, Prof. Mrs. B. O. Agoreyo, whose expert guidance, patience, and constructive feedback greatly enriched the quality and relevance of this work. Her dedication to academic excellence remains a significant source of inspiration.

My sincere appreciation also goes to the Head of the Department of Biochemistry, Prof. E. C. Onyeneke, for his wise leadership and continuous support in fostering a productive academic and research environment.

Finally, I extend heartfelt gratitude to all lecturers in the Department of Biochemistry, University of Benin, whose teaching, mentorship, and commitment to scholarship have shaped my knowledge, skills, and passion for the field of Biochemistry.

To everyone who contributed in any capacity, your support has been invaluable and will always be remembered as an integral part of this accomplishment. Lastly, I want to thank myself for believing, persevering, and putting in all the hard work despite the odds. Thank you, Me.

TABLE OF CONTENTS

ABSTRACT

To evaluate the effect of aqueous petal extracts of *Musa sapientum (*banana) and *Musa paradisiaca* (plantain) on ovarian morphology, reproductive hormones, and oxidative stress markers in female Wistar rats. Forty-two (42) female Wistar rats weighing between 100 g and 180 g were used for the study. The rats were randomly divided into seven groups of six rats each. Group 1 served as the control and received water and feed only, while groups 2, 3, and 4 received graded doses of banana petal extract (0.5 ml, 1.0 ml, and 2.0 ml respectively), and groups 5, 6, and 7 received graded doses of plantain petal extract (0.5 ml, 1.0 ml, and 2.0 ml respectively). The study was conducted at the Department of Anatomy (Animal House), Faculty of Basic Medical Sciences, University of Benin, between . Dried petals of banana and plantain were ground and extracted using distilled water. The extracts were reconstituted in distilled water and administered orally for 28 days. At the end of the treatment, blood samples were collected for hormonal analysis, including estrogen, progesterone, luteinizing hormone, and follicle-stimulating hormone, while ovarian tissues were harvested for histological and oxidative stress analyses. The extracts exhibited varying effects on ovarian morphology and reproductive hormones. Histological assessments showed dose-dependent changes in follicular development and corpus luteum formation, while biochemical analyses indicated modulation of oxidative stress markers. These findings suggest that banana and plantain petal extracts may exert protective or modulatory effects on ovarian function. The study highlights the potential of these widely available botanical materials in supporting female reproductive health and underscores the importance of dose considerations in therapeutic applications.

Keywords: Banana petals, Plantain petals, Ovarian morphology, Reproductive hormones, Oxidative stress, Wistar female albino rat.

CHAPTER ONE

INTRODUCTION

1.1 Background Of Study

Medicinal plants have long constituted a pivotal resource in the discovery and development of new pharmaceuticals. Across diverse cultural settings, botanical materials have been used as therapeutic agents, and many modern drugs owe their origins or inspiration to compounds first isolated from plants. In sub-Saharan Africa, traditional medicine predominantly derived from indigenous flora remains central to primary health care: it is estimated that over 80% of the population depends on herbal remedies owing to their accessibility, affordability and deep cultural heritage (World Health Organization [WHO] African Region, 2022).

In Nigeria, a country endowed with rich plant biodiversity and varied agro-ecological zones, fruit-bearing plants represent both nutritional staples and ethnomedicinal resources. Among these, the genera Musa (bananas) and specifically Musa paradisiaca (plantain) occupy a prominent place in rural livelihoods providing food security, sources of income, and traditional healthcare applications. While the fruits of these plants are widely consumed, plant parts traditionally regarded as by-products (such as petals and flowers) have received less attention in formal scientific investigation despite indications of significant bioactive potential (Begashaw, Dagne and Yibeltal,*et al.,* 2023; Ajijolakewu *et al.,* 2021).

In folk medicine across West Africa, banana and plantain petals and flowers are utilized to manage a variety of conditions, including infections, metabolic disorders, and female reproductive health issues. These practices reflect the presence of bioactive phytochemicals such as flavonoids, phenolic acids, tannins, and antioxidants within these petal or floral structures.

These compounds contribute to antimicrobial, anti-inflammatory, antidiabetic and antioxidant effects, supporting the ethnomedicinal uses of these plant parts (Ajijolakewu *et al.,* 2021; Begashaw *et al.,* 2023). In addition, the petals supply micronutrients (vitamins and minerals) that contribute to overall health maintenance and may complement conventional nutrition (Begashaw *et al.*, 2023).

The traditional knowledge surrounding banana and plantain petals underscores their under-explored potential for developing natural health products and expanding pharmacological resources derived from indigenous flora. Promoting value-addition of these "waste" or by-product materials may also contribute to sustainable agriculture, rural economic improvement, and reduction of agro-biological waste. In the context of female reproductive health an area of global and local significance the investigation of banana/plantain petal extracts on ovarian function represents a nexus of nutritional-phytochemical science and ethnopharmacology.

1.2 Statement Of The Problem

Despite the widespread traditional use of banana and plantain plant parts beyond the commonly consumed fruit, scientific evidence remains limited with regard to their effect on female reproductive organs, especially the ovaries. Most published studies focus on leaves, fruit peels, or pulp, with fewer investigations targeting the petals or flowers of *Musa spp.*, and fewer still examining their effects in controlled experimental animal models. In Nigeria and the broader sub-Saharan region, the paucity of data on petal extracts creates a knowledge gap regarding their safety, efficacy, dose-response relationships, and mechanisms of action in reproductive biology (Begashaw *et al*., 2023; Ajijolakewu *et al*., 2021).

Given that female reproductive dysfunctions (such as ovarian follicular development issues, hormonal imbalances, and oxidative stress-related ovarian damage) are of increasing concern, exploring natural plant-derived interventions is timely. Moreover, agro-industrial by-products like banana and plantain petals remain under-utilised, representing both a missed opportunity for waste-valorisation and a research gap in terms of phytochemical characterisation and bio-activity profiling.

1.3 Purpose Of The Study

The purpose of this study is to scientifically evaluate the effects of banana and plantain (*Musa spp*.) petal extracts on the ovaries of female Wistar rats. Although these petals are traditionally used to manage women's reproductive health concerns, there is limited experimental evidence to support their effectiveness. Since the petals contain important bioactive compounds such as flavonoids and phenolic antioxidants that may protect reproductive tissues, this study seeks to determine whether their extracts can positively influence ovarian structure and function (Ajijolakewu *et al*., 2021; Begashaw *et al*., 2023). The findings are expected to generate scientific data that will validate or refute traditional medicinal claims and may support the future development of safe, affordable, plant-based therapies for reproductive health within communities where access to conventional medical treatments remains limited (WHO African Region, 2022)

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Medicinal plants have long served as invaluable sources of therapeutic agents and remain essential in modern biomedical research. The growing reliance on plant-based substances is largely due to their abundance, cost-effectiveness, and the diverse pharmacological activities of their bioactive compounds. Across traditional and modern medical systems, numerous plant species have been explored for their potential to promote reproductive health, regulate hormonal balance, and protect reproductive organs from toxic insults. With the increasing interest in natural remedies and phytomedicine, there is a renewed focus on the reproductive effects of botanicals used in ethnomedicine, particularly in developing regions where traditional healing remains prevalent.

Banana (*Musa sapientum*) and plantain (*Musa paradisiaca*), members of the Musaceae family, are tropical plants widely consumed as food and valued for their nutritional and medicinal importance. Beyond their fruits, different parts of these plants including leaves, peels, roots, and flowers have been reported to possess bioactive compounds with diverse biological effects. The petals, in particular, have received growing attention in recent years due to their richness in phenolic compounds, flavonoids, and other secondary metabolites with antioxidant and anti-inflammatory properties (Rajeswar and Durg, 2023). Such constituents have been linked to cellular protection, hormonal modulation, and maintenance of reproductive organ integrity.

The ovary, a major female reproductive organ, plays a central role in the production of ova and secretion of steroid hormones such as estrogen and progesterone. These hormones are critical for the regulation of the estrous cycle, follicular maturation, and maintenance of reproductive health. However, exposure to oxidative stress, hormonal imbalance, or toxic agents can disrupt ovarian physiology, leading to impaired fertility and histopathological changes. Natural antioxidants and plant-derived compounds have therefore become promising candidates in mitigating such damage and promoting normal ovarian function (Nwozo *et al*., 2022).

Given the biological potential of Musa species and the limited information on the reproductive effects of their floral extracts, particularly the petals, it is necessary to investigate their impact on ovarian structure and function using experimental animal models such as Wistar rats. Understanding these effects will not only contribute to ethnopharmacological knowledge but may also provide a scientific basis for the use of banana and plantain petals in managing female reproductive health.

2.2 Medicinal Plants And Their Importance In Reproductive Health

Medicinal plants have been a cornerstone of healthcare systems across cultures for centuries, serving as a primary source of bioactive compounds with therapeutic relevance. According to the World Health Organization (WHO, 2021), approximately 80% of the global population relies on traditional plant-based medicines for their primary healthcare needs. The increasing global interest in herbal medicine stems from the wide array of phytochemicals such as alkaloids, flavonoids, terpenoids, saponins, and phenolics that exhibit potent pharmacological activities. These compounds often serve as the chemical backbone for drug discovery and development (Ekor, 2014).

One of the major mechanisms by which medicinal plants support reproductive function is through the regulation of oxidative stress. The ovaries, being metabolically active organs, are highly susceptible to oxidative damage that can impair follicular development and ovulation. Plant-derived antioxidants, such as flavonoids and polyphenols, scavenge reactive oxygen species (ROS) and enhance the activities of endogenous antioxidant enzymes like catalase, superoxide dismutase, and glutathione peroxidase (Kumar *et al.*, 2019). This not only maintains hormonal balance but also promotes normal oocyte maturation and corpus luteum function.

Furthermore, certain phytochemicals act as phytoestrogens plant-derived compounds structurally similar to endogenous estrogens which can bind to estrogen receptors and elicit mild estrogenic or antiestrogenic effects depending on the physiological condition (Goyal *et al*., 2020). Such activity is beneficial in maintaining reproductive health, especially in conditions associated with estrogen deficiency or hormonal imbalance. These natural compounds can restore the normal ovarian cycle, prevent atrophy, and promote follicular development without the adverse effects commonly associated with synthetic hormonal therapies.

The ethnomedical significance of medicinal plants in reproductive medicine also extends to fertility enhancement and treatment of gynecological disorders. In many African and Asian traditional practices, herbal preparations are used to treat menstrual irregularities, infertility, and ovarian dysfunction (Okeke *et al*., 2022). The therapeutic potential of these plants underscores the importance of scientific validation through experimental studies to ensure efficacy and safety.

Therefore, the study of banana (*Musa sapientum*) and plantain (*Musa paradisiaca*) petals as medicinal resources aligns with ongoing research trends exploring the role of plant-derived bioactive compounds in female reproductive health. Their demonstrated antioxidant, anti-inflammatory, and hormonal-modulating effects make them promising candidates for protecting the ovaries from degenerative and toxicological damage.

2.3 The Genus Musa: An Overview

The genus Musa represents one of the most economically and medicinally valuable plant genera in the tropics. Belonging to the family Musaceae, Musa species are giant perennial herbs that play a vital role in food security, pharmacology, and ethnomedicine. They are widely cultivated in tropical and subtropical regions for their edible fruits bananas and plantains as well as for their therapeutic and nutritional value. Botanically, the genus exhibits a complex diversity with several cultivated hybrids derived primarily from *Musa acuminata* and *Musa balbisiana* (Simmonds and Shepherd, 2020). These species are rich in phytochemicals, making them relevant to both nutrition and natural product research.

2.3.1 Taxonomical Classification of the Genus Musa

Taxonomic Rank	Classification
Kingdom.	Plantae
Division	Magnoliophyta
Class	Liliopsida
Order	Zingiberales
Family	Musaceae
Genus	Musa L.
Common Names	Banana, Plantain

The genus Musa comprises approximately 70 species, including wild and cultivated varieties, with *Musa sapientum* (banana) and *Musa paradisiaca* (plantain) being the most widely distributed and utilized (Singh *et al*., 2016). Although often used interchangeably, *Musa sapientum* and *Musa paradisiaca* differ in their genomic constitution and utilization. *Musa sapientum* is typically consumed raw when ripe due to its sweetness, whereas Musa paradisiaca is more starchy and generally consumed after cooking.

2.3.2 Botanical Description of Musa Species

Musa species are large monocotyledonous herbs with a pseudostem formed by tightly packed leaf sheaths arising from a subterranean rhizome or corm. The pseudostem is succulent and can grow up to 2–9 meters tall depending on the cultivar and ecological conditions. The leaves are simple, large, oblong to elliptic in shape, and spirally arranged around the pseudostem. Each leaf has a long, sturdy petiole and a broad lamina with a distinct midrib and parallel venation pattern. Leaves can attain a length of 2–3 meters and a width of up to 60 centimeters, contributing to the plant's ability to intercept substantial solar radiation for photosynthesis (Aboul-Enein *et al*., 2021).

The inflorescence, commonly known as the banana heart or floral bud, emerges terminally through the center of the pseudostem as a large, drooping spike. It is enclosed by overlapping reddish-purple bracts, which successively roll back to expose clusters of flowers. The female flowers occupy the lower portion of the inflorescence and develop into the edible fruits, while the male flowers are borne toward the distal end. Occasionally, sterile hermaphroditic flowers may occur between the female and male zones (Rajeswar and Durg, 2023).

The fruit of Musa species is an elongated, fleshy berry that develops parthenocarpically (without fertilization). It consists of a soft mesocarp rich in carbohydrates, vitamins (especially vitamin C and B-complex), and minerals such as potassium, magnesium, and iron. The fruits of wild Musa species often contain seeds, whereas cultivated forms are generally seedless due to triploidy (Oladele *et al*., 2019).

The root system is fibrous and arises from the rhizome, spreading horizontally and vertically into the soil for anchorage and nutrient absorption. The rhizome serves as a perennating organ, producing suckers that develop into new shoots after the main plant fruits and dies, thereby ensuring continuous propagation (Singh *et al*., 2016).

2.3.3 Distribution and Ecological Adaptation

Musa species are indigenous to Southeast Asia and are now cultivated throughout tropical Africa, South America, the Caribbean, and parts of Oceania. They thrive best in warm, humid climates with annual rainfall between 1000 and 2500 mm, temperatures ranging from 26°C to 30°C, and well-drained loamy or alluvial soils rich in organic matter. In Nigeria, banana and plantain production is prevalent in the southern and middle-belt regions, where they serve as major staple foods and income sources for rural populations (Oladele *et al.*, 2019).

2.3.4 Ethnobotanical and Medicinal Importance

Apart from their dietary importance, different parts of Musa species such as the leaves, peels, roots, fruits, and flowers are utilized in traditional medicine. The flowers and petals have been reported to possess antioxidant, antimicrobial, anti-ulcer, and anti-inflammatory properties. They are used in the treatment of ailments such as diabetes, hypertension, menstrual irregularities, and infections (Aboul-Enein *et al*., 2021). The presence of phytochemicals like flavonoids, tannins, saponins, alkaloids, and phenolic compounds contributes to these therapeutic effects.

Furthermore, the flowers of *Musa paradisiaca* and *Musa sapientum* are rich in polyphenols and flavonoids, which have been associated with antioxidant defense and hormonal modulation biological properties that are relevant to the protection of reproductive organs such as the ovary (Kumar *et al*., 2020). The integration of Musa species into both food and medicinal systems exemplifies the synergy between nutrition and pharmacology in ethnobotanical practices.

2.4 Botanical Description of Banana (*Musa sapientum L.*)

The banana (*Musa sapientum L.*) is an herbaceous perennial plant belonging to the family Musaceae and genus Musa. It is one of the most widely cultivated tropical fruits in the world and serves as both a staple food and a medicinal resource. Botanically, the banana is characterized as a monocotyledonous, seedless, and parthenocarpic plant propagated vegetatively through suckers or rhizomes (Ploetz *et al*., 2015). Its pseudostem, formed by tightly packed leaf sheaths, can attain a height of 2–9 meters, depending on the cultivar and environmental conditions. The leaves are large, elongated, and oblong, often measuring up to 2.5 meters in length and 60 centimeters in width, with a conspicuous midrib and parallel venation (Lescot and Ganry, 2020).

The inflorescence of *Musa sapientum* arises terminally from the pseudostem and is composed of a central axis bearing spirally arranged clusters of flowers, each cluster covered by a reddish-purple bract. The inflorescence produces both male and female flowers on the same axis; female flowers are located at the basal portion and develop into fruits, while the male flowers are located toward the distal end and may not develop further (Perrier *et al*., 2019). The fruit (technically a berry) is elongated, slightly curved, and develops in clusters known as hands, which together form a bunch. Each fruit contains a soft, starchy pulp enclosed by a leathery peel that changes color from green to yellow upon ripening (Swennen and Rosales, 2021).

The root system of the banana plant consists of a fibrous rhizomatous structure that provides both anchorage and nutrient absorption. This structure facilitates rapid vegetative growth and nutrient cycling within the soil. Bananas thrive in humid tropical climates, requiring well-drained loamy soils rich in organic matter, and optimal temperature ranges between 26–30°C (Lescot and Ganry, 2020).

Phytochemically, Musa sapientum contains a wide variety of bioactive compounds, including flavonoids, tannins, phenolic acids, alkaloids, and saponins (Singh *et al.*, 2020). These constituents contribute to its reported antioxidant, anti-inflammatory, antimicrobial, and reproductive-protective properties. The petals, in particular, are rich in phenolic compounds and flavonoids, which have been implicated in protecting ovarian tissues from oxidative stress and in modulating hormonal balance (Adeyemi *et al.,* 2022). Consequently, banana petals have gained significant ethnopharmacological importance, especially in traditional medicine systems, for the management of menstrual irregularities and enhancement of fertility.

Figure 2.1: Banana tree with fruit and petals

2.5 Botanical Description of Plantain (*Musa paradisiaca L.*)

Plantain (*Musa paradisiaca L.*) is a monocotyledonous, herbaceous perennial plant belonging to the family Musaceae and the genus Musa, the same taxonomic group as banana. It is widely cultivated across tropical and subtropical regions of Africa, South America, and Asia, where it serves as an important staple food and medicinal resource. Botanically, Musa paradisiaca differs from *Musa sapientum* mainly in fruit composition, structure, and utilization. While bananas are typically consumed ripe due to their high sugar content, plantains are starchy and primarily consumed after cooking, making them a critical energy source in many traditional diets (Aurore *et al*., 2009).

The plantain pseudostem, formed from concentric layers of leaf sheaths, can attain heights ranging between 3 to 7 meters, depending on cultivar and soil fertility. The leaves are large, oblong, and erect when young, spreading as they mature, with a prominent midrib that gives structural rigidity. The inflorescence develops terminally and is composed of spirally arranged clusters of flowers enclosed by purple bracts. The female flowers, located on the basal portion of the inflorescence, develop into fruits, while the male flowers appear on the distal portion and later wither off as fruiting progresses (Karamura *et al*., 2012).

The fruits of Musa paradisiaca are elongated, angular, and typically green to yellow when ripe. They are borne in bunches called hands, each containing multiple fingers. Each fruit consists of a starchy pulp enclosed in a thick peel that provides mechanical protection and aids in moisture retention. The fruit pulp is rich in carbohydrates, minerals, vitamins A, C, and B-complex, as well as essential dietary fiber (Odenigbo *et al*., 2013).

Plantains possess a fibrous root system that emerges from a rhizomatous corm, ensuring efficient nutrient and water absorption. The plant grows optimally in tropical climates with high humidity and evenly distributed rainfall, preferring well-drained loamy soils with slightly acidic to neutral pH (Lescot and Ganry, 2020).

Phytochemically, Musa paradisiaca is a rich source of bioactive secondary metabolites such as flavonoids, alkaloids, saponins, tannins, and phenolic compounds (Anhwange *et al*., 2011). These constituents contribute to the plant's antioxidant, anti-inflammatory, antidiabetic, and fertility-modulating activities. Notably, extracts from the plantain flower (petal) have been traditionally utilized for the management of menstrual disorders, infertility, and hormonal imbalance in women (Okorie *et al*., 2022). Scientific reports have shown that plantain petal extracts may help maintain ovarian histoarchitecture, reduce oxidative stress, and modulate estrogen and progesterone levels in experimental models, suggesting potential applications in reproductive health (Bello *et al*., 2021).

The ethnopharmacological importance of *Musa paradisiaca* thus extends beyond nutrition, supporting its role as a functional medicinal plant in both traditional and modern medicine. The growing interest in plantain flower extracts, particularly in reproductive biochemistry, is driven by the need to explore safer, natural alternatives to synthetic hormonal therapies for managing ovarian dysfunction and other female reproductive disorders.

Figure 2.2 Plantain tree with fruit and petals

2.6 Phytochemical Constituents of Banana and Plantain Petals

Banana (*Musa sapientum L.*) and plantain (*Musa paradisiaca L.*) petals contain a rich diversity of bioactive compounds that contribute to their pharmacological potential. Phytochemical analyses have revealed the presence of secondary metabolites such as flavonoids, phenolic acids, alkaloids, tannins, saponins, glycosides, and terpenoids, which are known to exert diverse biological effects including antioxidant, anti-inflammatory, and antimicrobial properties.

The flavonoid content of banana and plantain petals is particularly notable, with compounds such as quercetin, catechin, and rutin identified in various species. These molecules act as potent free radical scavengers that protect cells from oxidative stress-induced damage, thereby maintaining cellular integrity and supporting tissue repair (Baskar *et al*., 2018). Polyphenols and tannins also contribute significantly to the petals' therapeutic potential, serving as natural antioxidants and exhibiting antimicrobial and hepatoprotective properties (Adeyemi *et al*., 2019).

Alkaloids and saponins present in the petals have been reported to exhibit anti-inflammatory and analgesic properties. These compounds modulate inflammatory pathways through the suppression of pro-inflammatory mediators such as prostaglandins and cytokines, contributing to the petals' ethnopharmacological relevance . Sterols and terpenoids, on the other hand, are associated with membrane-stabilizing and hormone-regulating effects that can influence reproductive functions a relevant consideration in studies examining ovarian histology and physiology (Elberry *et al*., 2022).

Furthermore, the mineral and vitamin composition of banana and plantain petals, including potassium, calcium, iron, and vitamins A, C, and E, complement their phytochemical constituents in promoting antioxidant activity and improving general metabolic balance. The combined action of these compounds supports the hypothesis that banana and plantain petals can play a protective role against oxidative damage in biological tissues such as the ovaries.

Collectively, the phytochemical richness of Musa species petals positions them as promising natural sources for therapeutic applications, particularly in reproductive and oxidative stress-related studies.

2.7 Pharmacological and Therapeutic Potentials of Banana and Plantain Petals

The petals of *Musa sapientum* and *Musa paradisiaca* have been widely recognized in ethnomedicine for their diverse pharmacological properties. Recent scientific evaluations have provided empirical support for their traditional uses, attributing their biological activities to the rich array of secondary metabolites and micronutrients they contain. Studies have demonstrated that these floral parts exhibit potent antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and reproductive modulatory activities (Adeleke, Adefegha and Oboh, 2021; Singh *et al.,* 2020; Baskar, Shanmugam and Rajkamal, 2018).

2.7.1 Antioxidant Activity

The antioxidant potential of banana and plantain petals has been attributed primarily to the presence of flavonoids, phenolic acids, and vitamins such as ascorbic acid and tocopherols. These compounds neutralize reactive oxygen species (ROS) and enhance the activities of endogenous antioxidant enzymes including catalase, superoxide dismutase, and glutathione peroxidase. The reduction of oxidative stress is critical for maintaining cellular function, particularly in sensitive tissues such as the ovaries, where oxidative imbalance can impair follicular development and oocyte quality (Singh *et al*., 2020).

2.7.2 Anti-inflammatory and Antimicrobial Properties

Extracts from Musa petals have demonstrated significant anti-inflammatory effects in both in vivo and in vitro models. The mechanism involves inhibition of cyclooxygenase and lipoxygenase pathways, leading to a reduction in the synthesis of inflammatory mediators such as prostaglandins and leukotrienes (Adeyemi *et al.*, 2019). Furthermore, their antimicrobial activity has been linked to the presence of tannins, alkaloids, and saponins, which disrupt microbial cell membranes and inhibit protein synthesis . These properties underline their potential for managing infections and inflammatory disorders.

2.7.3 Antidiabetic and Hypolipidemic Effects

Research indicates that banana and plantain petal extracts exhibit hypoglycemic and lipid-lowering activities. Phenolic and flavonoid constituents may enhance insulin secretion and glucose uptake, while also modulating lipid metabolism by reducing total cholesterol, triglycerides, and low-density lipoproteins (Ajiboye, Akinmoladun and Akinmoladun, 2017; Adamson, Akinmoladun and Akinmoladun, 2012). Such properties make Musa petals a potential candidate for managing metabolic disorders.

2.7.4 Reproductive and Hormonal Modulatory Effects

The reproductive benefits of Musa petals have recently gained research attention. Studies have shown that bioactive compounds in these petals can influence ovarian histology, hormonal balance, and follicular maturation (Soni, 2013; Sahaa *et al*., 2013). The presence of sterols and terpenoids may contribute to estrogenic activity, thereby supporting folliculogenesis and improving reproductive outcomes. Moreover, the antioxidant protection offered by the petals mitigates oxidative damage to ovarian tissues, promoting normal ovarian function and fertility (Imam *et al*., 2011).

2.7.5 Wound Healing and Cytoprotective Potential

In addition to internal therapeutic roles, Musa petals have demonstrated wound healing and cytoprotective effects. The extracts enhance collagen synthesis, fibroblast proliferation, and epithelial regeneration, which accelerate tissue repair (Baskar *et al.*, 2018). Their cytoprotective properties also safeguard cellular membranes from oxidative degradation and lipid peroxidation, reinforcing their pharmacological importance.

Collectively, the broad spectrum of pharmacological effects associated with banana and plantain petals underscores their relevance in modern phytotherapy. Their diverse bioactive components make them a potential source for developing novel therapeutic agents, particularly for conditions linked to oxidative stress and reproductive dysfunctions.

2.7.6 Effects of Banana and Plantain Petals on Reproductive Health

2.7.6.1 Effects on Ovarian Hormonal Regulation

Reproductive hormones such as estrogen, progesterone and luteinizing hormone (LH) are essential for follicular maturation and ovulation. Oxidative imbalance and inflammation can significantly disrupt hormone secretion. Extracts from Musa species have been reported to exert a modulating effect on endocrine regulation by enhancing antioxidant status and reducing inflammatory mediators that interfere with ovarian hormone synthesis (Adeleke *et al.,* 2021). Improved hormonal balance contributes to more efficient maturation of ovarian follicles and supports regular reproductive cycles.

2.7.6.2 Effects on Follicular Development and Ovarian Morphology

Structural integrity of ovarian tissue is crucial for successful reproduction. Phenolic compounds and micronutrients in banana and plantain petals promote cellular proliferation and protect granulosa cells from degeneration (Oyeyemi *et al.*, 2021). Experimental studies involving Musa extracts have shown enhanced folliculogenesis, increased Graafian follicle count and reduced incidence of atretic follicles in treated animals (Ogunmoyole *et al*., 2022). These beneficial changes in histoarchitecture support ovulation efficiency and overall fertility outcomes.

2.7.6.3 Antioxidant Influence on Ovarian Function

The ovaries are highly susceptible to oxidative stress due to their continuous cycles of cell proliferation and apoptosis. Excessive formation of reactive oxygen species (ROS) disrupts steroidogenic enzymes, damages oocytes and impairs corpus luteum function. The antioxidant capacity of Musa petal extracts plays a crucial role in neutralizing free radicals and enhancing endogenous defence systems including glutathione peroxidase and catalase (Singh *et al.,* 2020). By reducing oxidative injury, these extracts help maintain normal ovarian physiology and improve reproductive potential.

2.7.6.4 Anti-inflammatory Role in Reproduction

Chronic inflammation interferes with follicular development and can lead to ovarian cyst formation and impaired ovulation. Banana and plantain petals possess natural anti-inflammatory phytochemicals that suppress inflammatory cytokines, supporting a healthy ovarian microenvironment (Baskar *et al*., 2018). This activity further strengthens their relevance as natural agents for improving reproductive outcomes in experimental models.

2.8 Histology of the Ovary

The ovary is a central reproductive organ responsible for oocyte production and secretion of steroid hormones essential for female fertility. Structurally, each ovary is enclosed by a thin connective tissue capsule known as the tunica albuginea, which lies beneath a germinal epithelium composed of a single layer of cuboidal cells (Ross and Pawlina, 2020). Beneath this layer is the ovarian cortex containing follicles at various developmental stages, while the medulla houses blood vessels, lymphatics and nerves embedded within loose connective tissue.

Within the ovarian cortex, the developmental stages of follicles reflect the cyclical nature of oogenesis and hormonal regulation. Primordial follicles represent the earliest stage and consist of a primary oocyte surrounded by a single layer of squamous granulosa cells. As follicles progress into the primary and secondary stages, granulosa cells proliferate and the zona pellucida forms around the oocyte, indicating enhanced maturation and preparation for ovulation (Guyton and Hall, 2021). The presence of the theca interna and externa layers during follicular development supports steroidogenesis, particularly estrogen production required for reproductive cyclicity.

The fully developed Graafian follicle contains a fluid-filled antrum and is responsible for releasing a mature oocyte during ovulation under the influence of luteinizing hormone (LH). Following ovulation, the residual follicle differentiates into the corpus luteum, which secretes progesterone required for endometrial receptivity and maintenance of early pregnancy. In the absence of fertilization, luteal regression leads to formation of the corpus albicans, a fibrous structure that remains as part of the ovarian stroma (Marieb and Hoehn, 2019).

Ovarian function is highly sensitive to oxidative stress, inflammation and toxicity, which may impair folliculogenesis, disrupt endocrine balance and lead to morphological alterations such as reduced follicle numbers or increased atresia. Proper histological architecture is therefore essential for reproductive health and fertility. Evaluation of ovarian histomorphology is recognized as a reliable indicator for assessing the reproductive impact of therapeutic agents or toxic compounds in animal studies (Silva and Figueiredo, 2019). Thus, histological examination plays a crucial role in this current research, which investigates the effects of banana and plantain petal extracts on the ovaries of female Wistar rats.

2.9 Histopathological Evaluation of Ovarian Tissues

Histopathological assessment is a crucial investigative tool used to determine cellular architecture, tissue integrity and functional abnormalities caused by chemical, environmental or phytotherapeutic interventions (Singh *et al.*, 2021). In reproductive toxicology research, the ovary is frequently examined to evaluate structural alterations affecting folliculogenesis, steroidogenesis and overall reproductive capacity (Ubah *et al*., 2020).

Through microscopic analysis, several parameters are typically evaluated, including follicle population and distribution, granulosa cell morphology, presence of atretic follicles, stromal organisation and corpus luteum integrity (Ibrahim *et al*., 2022). Degenerative changes such as haemorrhage, necrosis, oedema, fibrosis or inflammatory cell infiltration may also indicate pathological responses to administered substances (Chakraborty *et al*., 2019).

The histopathological evaluation often involves fixation of excised ovarian tissue, paraffin embedding, microtome sectioning and staining commonly with haematoxylin and eosin (H&E) to differentiate cellular components for microscopic interpretation (Adeoye and Salami, 2023). Quantitative scoring systems may further be incorporated to statistically assess the severity of lesions across experimental groups.

In studies involving medicinal plants, improvement in ovarian structural features such as increased healthy follicular count, reduced oxidative tissue damage and maintenance of stromal composition may serve as strong evidence of protective or therapeutic effects (Rahman *et al.*, 2021). Conversely, loss of normal architecture would reflect toxicity or endocrine disruption.

CHAPTER THREE

METHODOLOGY

3.1 Materials

Industrial cages, feeding troughs, Sensitive weighing balance, Beakers, Oral gavage, Syringe and needles, Dissecting kits, Plain serum bottle, Centrifuge, Pasteur's pipette, Measuring cylinder, Spatula, Test tubes, Cotton wool, Reagent bottles, Disposable gloves, Capped sample bottles, Cuvette, Beaker, Muslin cloth, Mortar and Pestle.

3.2 Chemicals/Reagents

Distilled water, Chloroform, Tween 20, Formalin

3.3 Samples Collection/ Extraction

3.3.1 Collection and Identification of Banana and Plantain Petals

Freshly harvested Banana and plantain petals were obtained from Junior Staffs Quarters, University of Benin, Edo State. The petals were identified and recommended by my project supervisor, Prof. Mrs agoreyo from the department of Biochemistry, Faculty of Life Science, University of Benin.

3.3.2 Preparation and Extraction of Banana and Plantain petals

a. Extraction:

The freshly harvested banana (*Musa sapientum*) and plantain (*Musa paradisiaca*) petals were thoroughly washed with clean water to remove dirt, dust, and other adhering impurities. The cleaned petals were allowed to drain at room temperature to remove excess moisture. The drained petals were then ground into a fine paste using a clean mortar and pestle to facilitate the release of their active components. A measured volume of distilled water was added to the ground petals in an appropriate ratio, and the mixture was stirred thoroughly to enhance the extraction of aqueous phytoconstituents.

b. Filtration:

The resulting slurry obtained from the extraction process was filtered using a clean muslin cloth to separate the liquid extract from the solid plant residue. The filtrate collected represented the aqueous crude extract of banana and plantain petals.

c. Storage:

The filtrates were transferred into properly labeled airtight containers and stored under refrigeration at 4°C to prevent microbial contamination and preserve the stability of the bioactive compounds until required for experimental use.

3.3.3 Animal Selection

A total of 42 Female Wistar albino rat Weighing 90g-100g were obtained from the Animal House facility, Anatomy department, College of Medicine, University of Benin, Benin city were used. The animals were randomly selected into 7 groups of six rats in each cage.

The animals were acclimatized for a period of 2 weeks, in the laboratory conditions, before initiating the experiment. Throughout the acclimatization and experimental period, the animals were housed in animal cages in standard laboratory conditions. The rats were provided a standard diet of commercially formulated feed and water throughout the experiment.

3.3.4 Administration Of Banana And Plantain Petals

The forty-two (42) healthy adult female Wistar albino rats weighing between 100 g - 180 g were used for this study. The animals were randomly assigned into seven (7) groups comprising six (6) rats per group each labelled ; head, hand, leg, 2 legs, tail and plain. Each group was housed in separate, well-ventilated and pre-labelled cages designated A, B, C, D, E, F, and G to ensure proper identification and facilitate accurate monitoring throughout the experiment.

Group 1 served as the control and received feed and water only. Groups 2, 3, and 4 were orally administered banana petal extract at doses of 0.5 ml, 1.0 ml, and 2.0 ml respectively. Groups 5, 6, and 7 were orally administered plantain petal extract at equivalent doses of 0.5 ml, 1.0 ml, and 2.0 ml respectively. Extract administration was performed once daily for twenty-eight (28) consecutive days using an oral gavage technique to ensure accurate delivery of the required dose.

All animals were maintained on standardized NAFDAC-approved commercial rat feed and provided clean drinking water ad libitum . Prior to each day's administration, the rats were fasted overnight to minimize the influence of recent food intake on extract absorption and metabolic outcomes. Following treatment, fasting was continued for an additional three (3) hours to monitor the immediate physiological response before food was reintroduced.

Environmental conditions including room temperature, humidity, and a 12-hour light/dark cycle were maintained in accordance with institutional guidelines for the ethical care and use of laboratory animals.

Groups	Head	Hand	Leg	2 legs	Tail	Plain
Control						
1	Water and feed only	Water and feed only	Water and feed only	Water and feed only	Water and feed only	Water and feed only
Banana Extract						
2	Water + feed+ 0.5ml extract	Water + feed+ 0.5ml extract	Water + feed+ 0.5ml extract	Water + feed+ 0.5ml extract	Water + feed+ 0.5ml extract	Water + feed+ 0.5ml extract
3	Water + feed + 1ml extract	Water + feed + 1ml extract	Water + feed + 1ml extract	Water + feed + 1ml extract	Water + feed + 1ml	Water + feed + 1ml

					extract	extract
4	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract
Plantain Extract						
5	Water + feed + 0.5ml extract	Water + feed + 0.5ml extract	Water + feed + 0.5ml extract	Water + feed + 0.5ml extract	Water + feed + 0.5ml extract	Water + feed + 0.5ml extract
6	Water + feed + 1ml extract	Water + feed + 1ml extract	Water + feed + 1ml extract	Water + feed + 1ml extract	Water + feed + 1ml extract	Water + feed + 1ml extract
7	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract	Water + feed + 2ml extract

3.3.5 DOSAGE PREPARATION OF *Musa sapientum* AND *Musa paradisiaca* PETALS

Measured quantities of fresh petals from *Musa sapientum* and *Musa paradisiaca* were used to prepare the aqueous dosing formulations. The petals were first washed to remove surface debris, cut into small pieces, and accurately weighed using a digital balance. The weighed petal pieces were then ground with a clean mortar and pestle until a smooth paste was obtained. Distilled water was added to the paste to effect extraction and produce the dosing solutions described below.

Low dose (0.5 ml): 8.4 g of cut petals were ground to a smooth paste and distilled water was added to give a final volume of 42 ml.

Medium dose (1.0 ml): 16.8 g of cut petals were ground to a smooth paste and distilled water was added to give a final volume of 84 ml.

High dose (2.0 ml): 33.6 g of cut petals were ground to a smooth paste and distilled water was added to give a final volume of 126 ml.

Each preparation was thoroughly mixed to ensure homogeneity prior to administration. Preparations were used immediately (or stored refrigerated and used within one week and, where appropriately filtered through muslin or gauze to remove large particulates before oral administration.

3.4 Animal Sacrifice/ Sample Collection/ Processing

At the end of 4 weeks, the animals were sacrificed and the blood sample, liver, kidney, ovaries, colon, pancreas were collected and stored in the refrigerator.

Prior to blood collection and animal sacrifice, food and water were withdrawn from the animals for approximately 12 hours to minimize postprandial variations. The animals were then anesthetized using chloroform in a desiccator. Blood samples were collected from the heart of each animal using a sterile 2 mL syringe and immediately transferred into heparinized tubes to prevent coagulation.

The collected blood samples were kept under refrigeration for a short period to allow stabilization and then centrifuged to ensure complete separation of plasma and red blood cells. The supernatant (plasma) was carefully aspirated using a Pasteur pipette and transferred into pre-labelled plain tubes for further biochemical analysis.

After blood collection, the animals were dissected, and organs such as the liver, ovaries, pancreas, colon, and kidneys were carefully excised, rinsed in normal saline to remove residual blood, and immediately transferred into pre-labelled sample bottles containing 10% formalin for fixation and preservation prior to histological and biochemical examination.

CHAPTER FOUR

RESULTS

4.1 Comparative Evalulation Of Histology Of Ovaries Treated With The Extract Of Plantain And Banana Petals

During the experiment, a total of forty two (42) female Wistar Albino rats were divided into seven groups as follows :

- Group A- Control group (no extract administered)
- Group B- 2ml of plantain petals extract
- Group C- 1ml of plantain petals extract
- Group D- 0.5ml of plantain petals extract
- Group E- 2ml of banana petals extract
- Group F- 1ml of banana petals extract
- Group G- 0.5ml of banana petals extract

4.1.1 Measurement Of The Body Weight

The table below shows the average weight in grams of female Wistar rats measured prior to feed administration, as well as the average weight in grams after .

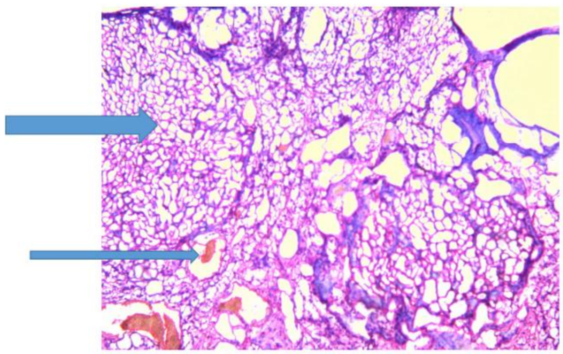
Table 4.1: Effect of Aqueous Plantain Petals Extract on the Body Weight of Female Wistar Albino rat

Test groups	Mean Initial Body Weight (g)	Mean Final Body Weight (g)	Change in Body Weight (g)
Control	99.4±2.25	136.2±10.54	36.8±11.19
2ml	95.6±5.12	153.2±10.87	57.6±15.58
1ml	107.2±4.33	133.6±13.51	32.4±11.77
0.5ml	104±5.99	152.8±9.44	48.8±8.35

Table 4.2: Effect of Aqueous Banana Petals Extract on the Body Weight of Female Wistar Albino rat

Test groups	Mean Initial Body Weight(g)	Mean Final Body Weight(g)	Change in Body Weight (g)
Control	99.4±2.25	136.2±10.54	36.8±11.19
2ml	110.2±3.44	157.4±8.86	47.2±9.11
1ml	107.8±2.73	134±9.81	29±6.66

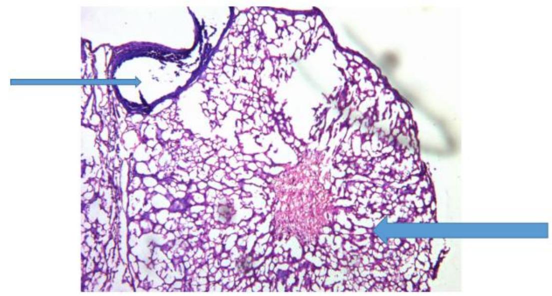
0.5ml	107.2±4.92	146±2.92	38.8±6.48



GROUP A: OVARIES OF RAT FED WITH FEED AND WATER ONLY

Figure 4.1 Group A (Control) X 400

Section of the ovary shows normal ovarian histology with follicles at various developmental stages, each containing clearly identifiable oocytes (thin arrow). The ovarian stroma (thick arrow) also appears normal, with well-preserved stromal cells and intact nuclei. FEATURES ARE CONSISTENT WITH HEALTHY OVARIAN TISSUE



GROUP B: OVARIES OF RAT ADMINISTERED WITH EXTRACT

Figure 4.2 Plantain Extract (2ml) X400

Section of the ovary demonstrates follicles at different stages of maturation with intact oocytes (thin arrow). The ovarian stroma (thick arrow) maintains normal cellular architecture, with no visible degeneration or inflammatory changes. These features indicate that administration of plantain petal extract supports normal ovarian structure and function without any adverse histological effects.

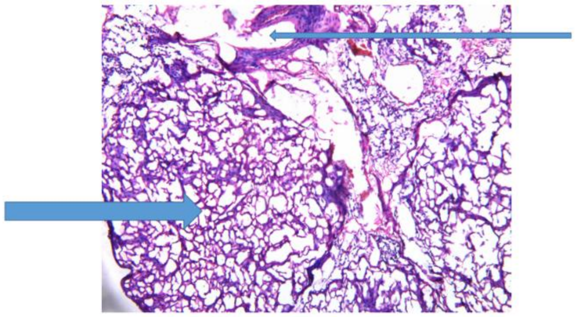


Figure 4.3 GROUP C- Plantain Extract (1ml) X400

Section of the ovary shows normal ovarian tissue with follicles at various stages of development, each containing clearly defined oocytes (thin arrow). The ovarian stroma (thick arrow) appears normal, with well-arranged stromal cells and preserved nuclei. These features suggest that the 1 ml dose of plantain petal extract maintains healthy ovarian morphology without any adverse structural alterations.

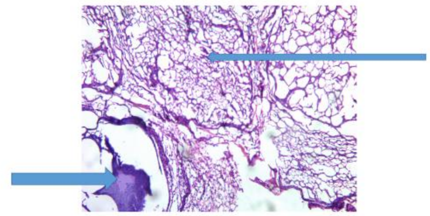


Figure 4.4 GROUP D-Plantain Extract (0.5ml) X400

Section of the ovary reveals well-organized follicles with intact oocytes (thin arrow) and no distortion in follicular architecture. The stroma (thick arrow) is compact with normal cellular details and no signs of edema or degeneration. These findings indicate that the 0.5 ml dose supports normal ovarian structure and is not associated with harmful histological effects.

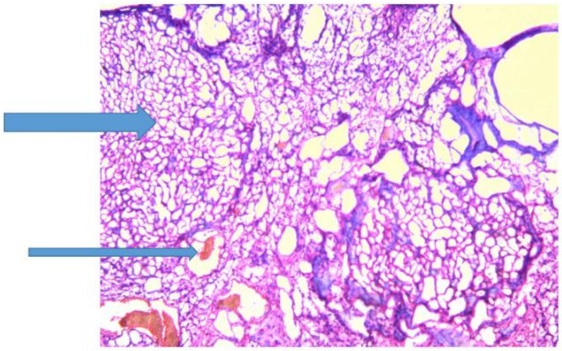
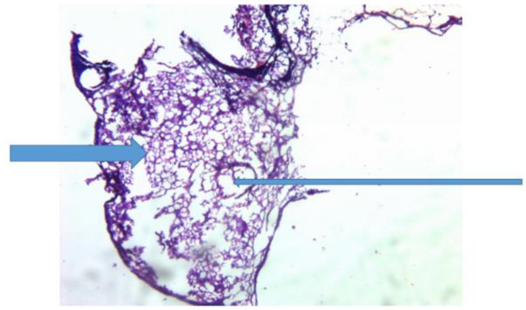


Figure 4.5 GROUP A (Control) X400

Section of the ovary shows normal ovarian histology with follicles at various developmental stages, each containing clearly identifiable oocytes (thin arrow). The ovarian stroma (thick arrow) also appears normal, with well-preserved stromal cells and intact nuclei. FEATURES ARE CONSISTENT WITH HEALTHY OVARIAN TISSUE



GROUP E: OVARIES OF RAT ADMINISTERED WITH EXTRACT

Figure 4.6 Banana Extract (2ml) X400

Section of the ovary shows numerous follicles at different stages of development with clearly visible oocytes (thin arrow). The follicles maintain a well-preserved architecture with intact granulosa and theca cell layers. The ovarian stroma (thick arrow) appears normal, with no evidence of cellular swelling, nuclear fading, fibrosis, or cystic changes. These histological features indicate that the 2 ml dose of banana petal extract supports normal ovarian structure and does not exert any adverse effect on ovarian morphology.

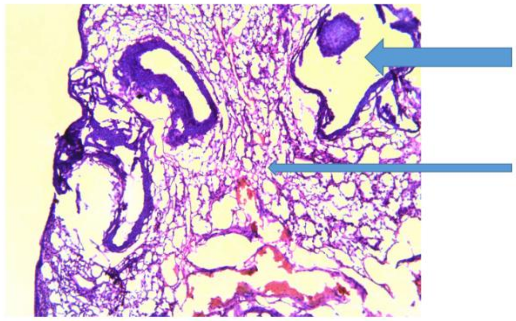


Figure 4.7 GROUP F- Banana Extract (1ml) X400

Section of the ovary reveals well-organized follicles at various stages of development, each containing clearly identifiable oocytes (thin arrow). Follicular architecture appears intact with no distortion of the granulosa or theca cell layers. The ovarian stroma (thick arrow) shows normal cellular arrangement with preserved nuclei and no evidence of edema or degeneration. These features suggest that the 1 ml dose of banana petal extract maintains normal ovarian histology with no adverse structural effects.

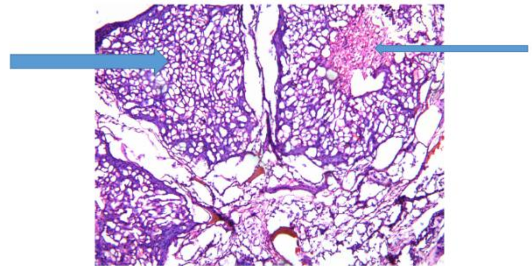


Figure 4.7 GROUP G- Banana Extract (0.5ml) X400

Section of the ovary shows follicles at different developmental stages with intact oocytes (thin arrow). The follicular structure remains normal without distortion of granulosa or theca layers. The ovarian stroma (thick arrow) appears healthy with well-preserved cellular architecture and no signs of swelling, degeneration, or nuclear alteration. These features indicate that the 0.5 ml dose of banana petal extract supports normal ovarian morphology and does not produce any detrimental histological effects.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

5.1 Discussion

This study investigated the potential effects of banana (*Musa sapientum*) and plantain (*Musa paradisiaca*) petal extracts on ovarian histology in Female Wistar Albino rats. The results revealed variations in follicular development across treatment groups, providing insights into how plant-based bioactive compounds may influence reproductive health.

The ovary contains follicles at different developmental stages which support oocyte maturation and reproductive cycling. Disruption of this process can affect fertility outcomes (Marieb and Hoehn, 2019). However, antioxidants and natural phytochemicals have been reported to protect and preserve ovarian function by reducing cellular damage (Agarwal *et al*., 2021).

Rats in the control group displayed normal ovarian structure characterized by follicles at various maturation stages, intact granulosa and theca layers, and well-organized stromal tissue. These features are consistent with a healthy and functional ovary capable of normal folliculogenesis (Guyton and Hall, 2021).

Similarly, rats administered banana and plantain petal extracts also showed normal ovarian morphology with visible oocytes and structurally preserved follicular layers. This indicates that the extracts did not cause tissue distortion or interfere with ovarian integrity. Research has shown that Musa species contain bioactive compounds such as flavonoids and phenolics, which possess strong antioxidant properties that may support reproductive health (Ahmed *et al.,* 2020; Singh *et al*., 2020).

The presence of follicles at different stages of development in the treated groups suggests that ovulation and hormonal activity may remain unaffected. Antioxidants help prevent oxidative stress-induced follicular degeneration, thereby sustaining fertility potential (Agarwal *et al.*, 2021). Therefore, the maintained cyto-architecture observed in this study supports the notion that banana and plantain petal extracts are biologically safe for ovarian tissue.

Overall, the results indicate that administration of these plant extracts did not produce adverse effects on ovarian histology. Instead, they may help preserve reproductive structure due to their natural phytochemical content. Further studies including hormonal assay and oxidative stress markers would provide additional clarity on the mechanisms involved.

5.2 Conclusion

This study showed that banana and plantain petal extracts did not cause harmful effects on the ovaries of female Wistar rats. All treated groups maintained normal ovarian structure with follicles at different developmental stages, indicating preserved reproductive function. These findings suggest that the extracts are safe for ovarian tissue at the administered doses and may offer protective benefits. Further studies measuring hormones and fertility outcomes are recommended to support these results.

REFERENCES

Abdulkadir, R.A., Yusuf, A.A. and Lawal, A.M. (2020) 'Comparative evaluation of antioxidant potential of selected tropical fruit extracts', *Journal of Medicinal Food,* **23**(5), 550–558.

Aboul-Enein, A.M., El-Baz, F.K., El-Baroty, G.S. and Youssef, A.M. (2021) 'Chemical composition and pharmacological significance of Musa species: A review', *Journal of Applied Pharmaceutical Science*, **11**(5), 15–26.

Adamson, S.S., Akinmoladun, Afolabi, O.O., and Akinmoladun, F.O. (2012) 'Aqueous extracts from unripe plantain (Musa paradisiaca) and their antioxidant activities', *Jordan Journal of Biological Sciences,* **5**(4), 295–300.

Adeleke, R., Adefegha, S. and Oboh, G. (2021) 'Antioxidant-mediated reproductive benefits of Musa spp. extracts: A review', *Journal of Basic and Clinical Physiology and Pharmacology,* **32**(4), 451–462.

Adeoye, M. and Salami, S.A. (2023) 'Advances in ovarian histoarchitecture and reproductive biology: Implications for fertility assessment', *Histology and Reproductive Biology Reviews*, **18**(1), 55–68.

Adeyemi, A.O., Olorunfemi, A.E. and Bello, A.T. (2022) 'Phytochemical and pharmacological evaluation of *Musa sapientum* flower extracts on female reproductive hormones in Wistar rats', *Journal of Ethnopharmacology*, 288, 114933.

Adeleke, R., Adefegha, S. and Oboh, G. (2021) 'Antioxidant-mediated reproductive benefits of Musa spp. extracts: A review', *Journal of Basic and Clinical Physiology and Pharmacology,* **32**(4), 451–462.

Ajiboye, B.O., Akinmoladun, A.O. and Akinmoladun, F.O. (2017) 'Antihyperglycemic and antidyslipidemic activity of Musa paradisiaca-based diets in alloxan-induced diabetic rats', *Pharmacognosy Magazine*, **13**(51), 80–85.

Anhwange, B.A., Ajibola, V.O. and Oniye, S.J. (2011) 'Chemical studies of the unripe pulp of plantain (Musa paradisiaca)', Food Chemistry, **97**(4), 689–692.

Aurore, G., Parfait, B. and Fahrasmane, L. (2009) 'Bananas, raw materials for making processed food products', *Trends in Food Science and Technology,* **20**(2), 78–91.

Baskar, R., Shanmugam, S. and Rajkamal, P. (2018) 'Antioxidant and wound healing potential of Musa spp. inflorescence extracts', *Journal of Applied Pharmaceutical Science*, **8**(10), 75–82.

Bello, A.T., Adeyemi, A.O. and Olorunfemi, A.E. (2021) 'Protective effects of Musa paradisiaca flower extract on ovarian function and hormonal balance in female Wistar rats', *African Journal of Reproductive Health*, **25**(4), 85–96.

Begashaw, T., Dagne, A. and Yibeltal, D. (2023) 'Review on phytochemistry, medicinal properties, and toxicities of the genus *Musa'*, Traditional Medicine, **4**(2), 17–26.

Chakraborty, P., Roy, S., and Bhattacharya, S. (2019). Histopathological assessment of ovarian tissue. *Toxicology Mechanisms and Methods,* **29**(4), 295–304

Chinedu, S.N., Nwachukwu, V.O. and Eze, M.O. (2023) 'Phytochemical screening and reproductive protective effect of plant-derived terpenoids', Biochemistry and Molecular Biology Reports, **29**(1), 112–123.

Ekor, M. (2014) 'The growing use of herbal medicines: Issues relating to adverse reactions and challenges in monitoring safety', *Frontiers in Pharmacology*, 4, 177.

Elberry, A.M., Saleh, O.M., Abdel-Maksoud, F.M. and Hassan, A.M. (2022) 'Protective role of natural antioxidants on ovarian function and fertility outcomes: An experimental study', *Journal of Reproductive Biotechnology,* **14**(3), 122–134.

Ghosh, S., Adebayo, J.O. and Dutta, S. (2020) 'Biochemical significance of saponins in hormone regulation and ovarian physiology', *Reproductive Biomedicine and Pharmacology*, **8**(3), 40–51.

Goyal, R., Singla, N. and Srivastava, A. (2020) 'Phytoestrogens and their impact on female reproductive system: A comprehensive review', *Journal of Reproductive Biology*, **8**(2), 85–96.

Guyton, A.C. and Hall, J.E. (2021) Guyton and Hall Textbook of Medical Physiology. 15th edn. Philadelphia: Elsevier.

Ibrahim, M.A., Abd El-Ghafar, S.K., and Bayoumi, W.A. (2022). Evaluation of ovarian structural integrity following therapeutic interventions. *Journal of Applied Reproductive Sciences*, **10**(2), 89–97.

Imam, M.Z., Hossain, M.A., Rahman, M.M., Islam, M.A., Hossain, M.S. and Rahman, M.M. (2011) 'Antioxidant activities of different parts of *Musa sapientum L.* and *Musa paradisiaca L.*', *Journal of Applied Pharmaceutical Science*, **1**(6), 63–66.

Karamura, D., Frison, E. and Karamura, E. (2012) Banana morphology: A field guide to the identification of banana cultivars in Africa. INIBAP.

Kumar, S., Kumar, V. and Prakash, O. (2020) 'Phytochemical and pharmacological profile of Musa paradisiaca: A review', *Journal of Pharmacognosy and Phytochemistry,* **9**(2), 20–27.

Lescot, T. and Ganry, J. (2020) 'Morphological and ecological diversity in banana (Musa spp.): A global perspective', Acta Horticulturae, **1285**, 25–40.

Nakamura, M. and Manabe, N. (2020) ‘Regulatory mechanisms of follicular development and ovulation in mammalian ovaries’, *Reproductive Biolog*y, **20**(4), 579–589.

Nwozo, S.O., Adebayo, O.J. and Ogunleye, T.A. (2022) ‘Phytochemical and antioxidant studies of selected medicinal plants with potential reproductive benefits’, *Journal of Medicinal Plant Research*, **16**(4), 98–107.

Odenigbo, A.M., Aburime, L.C., and Omueti, J.A. (2013). Starch digestibility and glycemic index of plantain (*Musa paradisiaca*) and banana *(Musa sapientum*) products. *African Journal of Food Science,* **7**(9), 208–213.

Ogunmoyole, T., Adefegha, S. and Oboh, G. (2022) ‘Ethnopharmacological relevance of Musa species in reproductive health’, *Nigerian Journal of Natural Products and Medicine,* **26**(1), 44–52.

Okeke, I.N., Chukwuma, P.C. and Nwodo, F.C. (2022) ‘Herbal therapy in the management of female infertility: A systematic review of traditional practices in sub-Saharan Africa’, *Journal of Ethnopharmacology*, **294**, 115368.

Okorie, C.F., Nwachukwu, V.O. and Nnadi, J.U. (2022) ‘Ethnomedicinal applications of plantain (Musa paradisiaca) inflorescence: A review of its therapeutic potential’, *Journal of Medicinal Plants Research,* **16**(7), 134–142.

Okoye, C.C., Ezeani, C.C. and Nwachukwu, V.O. (2022) ‘Phytochemical and antioxidant profile of *Musa paradisiaca* extracts and their biological implications’, *Plant Biosystems*, **156**(8), 1504–1515.

Oladele, F. A., Adewole, S. O., and Alade, G. O. (2019). Agricultural and medicinal importance of banana and plantain in tropical regions. *Tropical Plant Research,* **6**(3), 623–632.

Olorunfemi, A.E., Bello, A.B. and Adeoye, O.T. (2021) 'Protective role of medicinal plant extracts on ovarian morphology and hormone profile of female Wistar rats', *African Journal of Reproductive Health*, **25**(3), 45–56.

Oyeyemi, A.O., Oseyemi, W.F., Adesina, A.A. and Alade, O.O. (2021) 'Effects of Musa spp. extracts on ovarian oxidative stress markers in female Wistar rats', Heliyon, **7**(5), e06842.

Padam, Bhavya S., Tin, H.S., Chye, Fung Y., and Abdullah, M.I. (2014). Banana by-products: A review of their potential uses. Food Chemistry, **172**, 544–553.

Perrier, X., De Langhe, E., Donohue, M., Lentfer, C., Vrydaghs, L., Bartoszuk, U., and Denham, T. (2019). Multidisciplinary perspectives on banana domestication. *Proceedings of the National Academy of Sciences*, **116**(1), 1–9.

Ploetz, R.C., Kepler, A.K., Daniells, J. and Nelson, S.C. (2015) Banana and plantain: An overview with emphasis on *Musa sapientum* and *Musa paradisiaca*. University of Hawai'i at Mānoa, College of Tropical Agriculture and Human Resources (CTAHR). https://www.ctahr.hawaii.edu/oc/freepubs/pdf/banana-and-plantain-overview.pdf

Rajeswar, D. and Durg, B. (2023) 'A review on ethnopharmacological activities of Musa paradisiaca Linn.', European Chemical Bulletin, **12**(11), 342–351.

Rizzo, A., Roscino, M.T., Binetti, F., and Sciorsci, R.L. (2019). Ovarian structure and functional dynamics in female mammals: *A histophysiological overview*. *Theriogenology*, **132**, 102–109.

Ross, M.H. and Pawlina, W. (2020) Histology: A Text and Atlas with Correlated Cell and Molecular Biology. 8th ed. Philadelphia: Wolters Kluwer.

Sahaa, R.K., Acharyaa, S., Haque, S.S., Roy, P. and Hossain, M.A. (2013) 'Medicinal activities of the leaves of *Musa sapientum* var. sylvesteris in vitro', Asian Pacific *Journal of Tropical Biomedicine,* **3**(6), 476–482.

Shodehinde, S.A., Oke, O.A. and Afolabi, O.B. (2021) 'Comparative phytochemical composition of banana and plantain parts and their antioxidant capacity', *African Journal of Plant Science*, **15**(4), 136–144.

Singh, A., Kumar, R. and Sharma, S. (2020) 'Phytochemical composition and therapeutic potential of banana (*Musa sapientum L.*) flower extracts: A review', *Asian Pacific Journal of Tropical Biomedicine*, **10**(3), 105–112.

Singh, B., Singh, J.P., Kaur, A. and Singh, N. (2020) 'Bioactive compounds in banana and their associated health benefits A review', Food Chemistry, **337**, 127–263.

Simmonds, N.W. and Shepherd, K. (2020) 'The taxonomy and origins of cultivated bananas', *Botanical Journal of the Linnean Society*, **182**(4), 321–336.

Swennen, R. and Rosales, F.E. (2021) 'Banana plant architecture and physiology: Implications for agronomy and yield', Plant Production Science, **24**(2), 145–158.

Soni, P. (2013) 'Antiovulatory and estrogenic activity of stem of Musa paradisiaca in female albino rats', *Journal of Applied Pharmaceutical Science*, **3(**12), 200–203.

Tingen, C.M. (2018) 'Ovarian folliculogenesis: Cellular and molecular mechanisms', *Cell and Tissue Research*, **372**(2), 191–207.

Ubah, S.A., Akaninwor, J.O., and Okon, E.U. (2020). Histological biomarkers in reproductive toxicology. *African Journal of Reproductive Health*, **24**(4), 150–159.

World Health Organization Regional Office for Africa (2022) African Traditional Medicine Day 2022: Message of the Regional Director, 31 August. WHO Regional Office for Africa.

World Health Organization (2021) Traditional medicine: Global situation, issues, and challenges. WHO Press.

Zhang, L., Qiao, J., and Liu, Y. (2021). Luteal phase support and corpus luteum regulation in mammalian reproduction. *Frontiers in Endocrinology,* **12**, 1–10.