EFFECT OF METHANOL EXTRACT OF *SPONDIAS MOMBIN* LEAVES ON UREA AND CREATININE LEVELS IN HIGH-FAT FED DIETS

BY

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SCHOOL OF BASIC MEDICAL SCIENCES
UNIVERSITY OF BENIN
BENIN CITY

MARCH, 2025

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A PROJECT SUBMITTED TO THE DEPARTMENT OF MEDICAL BIOCHEMISTRY, SCHOOL OF BASIC MEDICAL SCIENCES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE, B.Sc. (HONS) MEDICAL BIOCHEMISTRY, OF THE UNIVERSITY OF BENIN, BENIN CITY.

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CERTIFICATION

We the undersigned hereby certify that AJUFOH CHUKWUDUMEBI JESSY BMS2010663) carried out this research in the Department of Medical Biochemistry, University of Benin, Benin city and thereby approve same as adequate in scope and quality for the award of Bachelor of Science Degree (B.Sc) in Medical Biochemistry.

Signed

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Prof.(MRS.) ELUEHIKE   **(Date)**

(Project Supervisor)

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Prof. F.E Olumese   **(Date)**

(Head of Department)

DEDICATION

To the hearts and minds that have nurtured me with overflowing gratitude and love, I dedicate this project to the incredible individuals who have left an indelible mark on my life and academic journey.

To my beloved parents, Mr. and Mrs. AJUFOH, your selfless love, unwavering support, and guidance have been my rock and my safe haven. Your sacrifices have inspired me to push beyond my limits, and I'm forever grateful. To the Head of the Department of Medical Biochemistry, Prof. F.E Olumese,the Staff Adviser, Mrs Ediale and the National Association of Medical Biochemistry Students (NAMBS), Uniben Chapter, I'm deeply thankful for the knowledge, mentorship, and friendships that have transformed me into a passionate biochemist. Your influence has not only shaped my academic pursuits but has also instilled in me the values of perseverance, teamwork, and excellence. This project is a testament to the love, hard work, and dedication that have brought me to this milestone. It's a celebration of the people who have believed in me;My twin brother Zion,My younger brother and sister, my Aunties and uncle.Thank you for being part of my journey.

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TABLE OF CONTENTS

ABSTRACT

The aim of this study was to evaluate the effects of methanol extract of *Spondias mombin* also known as yellow mombin (YM) on urea and creatinine levels in high fat fed diets. A total of 45 albino Wistar rats were randomized into five groups each of nine animals as follows:Group 1 (Normal Control): Rats fed with standard diet and with no high-fat diet or extract treatment,Group 2 (HFD Control): Rats fed with high-fat diet without any treatment,Group 3 (HFD + Low Dose *Spondias mombin* Extract): Rats fed with high-fat diet and treated with 200 mg/kg body weight of *Spondias mombin* extract,Group 4 (HFD + High Dose *Spondias mombin* Extract): Rats fed with high-fat diet and treated with 400 mg/kg body weight of *Spondias mombin* extract,Group 5 (HFD + *Spondias mombin*): Rats fed with high-fat diet and treated with

The methanol extract was administered via oral gavage once daily for four weeks. The choice of oral administration reflects the potential human application of the plant extract as a dietary supplement or therapeutic agent.YM has a high antioxidant activity and significant amounts of phenolic compounds, carotenoids, vitamin C, dietary fibre, and minerals.The results show that Group 1 had a mean creatinine level of (0.65 ± 0.07 mg/dL), while Group 2 had a mean creatinine level of (0.83 ± 0.04 mg/dL). Groups 3, 4, and 5 had mean creatinine levels of 0.75 ± 0.07 mg/dL, 0.78 ± 0.11 mg/dL, and 0.75 ± 0.07 mg/dL, respectively and Group 2 had significantly higher urea levels compared to Groups 1, 3, and 5.This suggests that the high-fat diet without *Spondias mombin* extract supplementation led to increased creatinine levels, indicating impaired kidney function. On the other hand, Groups 1, 3, and 5, which received *Spondias mombin* extract supplementation, had lower creatinine levels, indicating improved kidney function.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

Spondias mombin, also known as the hog plum or yellow mombin, is a species of flowering plant in the family Anacardiaceae comprising about 73 genera, 850 species,It is native to tropical Africa, the Caribbean,Central and South America,*Spondias mombin* is a stringently tropical plant widely found in the rainforest lowlands but has adapted to grow in more arid zones(*Orwa et al., 2009). Spondias mombin* is of the sapindales order and genus Spondias and has a yellow-orange colour, smooth and thin skin, and a marked acid-sweet flavour,the deciduous fruit tree is widely distributed in Nigeria (especially in the Southwestern regions), Ivory Coast, Brazil, Bolivia, Mexico, Peru, Venezuela, Colombia, Guianas, as well as a number of global tropical forests in the world,Spondia mombin can be dispersed naturally against the previous opinions that the plant was introduced to Africa(*Bové et al., 2017). Spondias mombin* is a traditionally used as an herbal medicine for several human diseases and ailments in the tropical regions across the globe including in Africa countries *(Adebayo et al., 2015).*

Spondias mombin has a frequent rate of ethnomedicinal utility in cases of abortion, constipation,fever, gonorrhea, postpartum hemorrhage,digestive pain ,diarrhea, dysentery and wounds(*Adebayo et al., 2015).*

Altemimi et al. (2017) highlighted the importance of phytochemicals in plant extracts, including *Spondias mombin*, which has been shown to have potential benefits in reducing urea and creatinine levels in high-fat fed diets,The extract's antioxidant, anti-inflammatory, and lipid-lowering properties may contribute to its ability to improve kidney function and reduce waste product levels in the blood. *Spondias mombin* plants is known for it role in the management of various illnesses including diabetes

An unbalanced diet in the quantity and quality of fatty acids, and one that is rich in cholesterol can affect the antioxidant defence system, which can cause oxidative damage in various organs and tissues via the increased production of free radicals, especially in the liver,which is the main fat-metabolizing organ (*Halliwell, 2007).*

Cardiovascular diseases (CVDs) is a big health problem due to the high mortality rates worldwide (*World Health Organization, 2017*).Lifestyle, including food choices such as very high consumption of cholesterol, as well as saturated and trans fatty acids, at the expense of fibre consumption, are closely related to lipid metabolism disorders such as NAFLD,obesity and diabetes etc.On the other hand, dietary interventions such as reducing the consumption of foods rich in sugars, and saturated and trans fatty acids, as well as increasing the consumption of fruits and vegetables, have been shown to be effective in preventing and treating lipid metabolism disorders and Cardiovascular diseases(CVDs) (*Lichtenstein et al., 2009).*

Despite decades of studies on lipid metabolism disorders and the development of various drugs such as cholesterol absorption inhibitors,bile acid sequestrants,statins, fibrates, nicotinic acid and variants and, their side effects remain under discussion(*Garcia-Robles et al., 2015).*

In this sense, studies have focused on the lipid-lowering and antioxidant potential of fruit pulp, pomace, and peels. *Spondias mombin* (*Yellow mombin*),despite containing several bioactive compounds such as carotenoids, minerals, phenolic compounds, and fibres this fruit is still underexplored, and few studies have addressed its functional potential to treat diseases.

One of the major complications of diabetes is kidney damage, which can lead to chronic kidney disease (CKD) and end-stage renal disease (ESRD) (*American Diabetes Association,* *2020).* CKD is characterized by a gradual loss of kidney function over time, leading to the accumulation of waste products such as urea and creatinine in the blood *(National Kidney Foundation, 2019).*

High-fat diets have been shown to contribute to the development of insulin resistance and type 2 diabetes (*Hu et al., 2014*). Insulin resistance is a condition in which the body's cells become less responsive to insulin, leading to high blood sugar levels (*DeFronzo and Ferrannini, 1991*). High-fat diets can also lead to kidney damage and CKD by promoting inflammation and oxidative stress in the kidneys (*Kanbay et al., 2010*).

The methanol extract of *Spondias mombin* has been shown to possess antioxidant and anti-inflammatory properties, which may contribute to its potential benefits in reducing urea and creatinine levels in high-fat fed diets (Ogbonnia et al., 2013).

Therefore, this study aims to investigate the effects of methanol extract of *Spondias mombin* on urea and creatinine levels in high-fat fed diets.

1.2 AIM AND OBJECTIVE OF STUDY

1.2.1 AIM

The study aim is to investigate the effects of methanol extract of *Spondias mombin* on urea and creatinine levels in high fat fed diets.

1.2.2 SPECIFIC OBJECTIVE OF THE STUDY

The study will investigate the following :

- Changes in body weight of the Wistar rats across the groups.
- Changes in organ weight of the Wistar rats across the groups.
- Changes in blood sugar level of Wistar rats.

- Changes in histology of the Liver and kidney.
- To evaluate the effects of methanol extract of *Spondias mombin* on urea levels in high-fat fed diets.
- To investigate the effects of methanol extract of *Spondias mombin* on creatinine levels in high-fat fed diets.
- To assess the antioxidant and anti-inflammatory properties of methanol extract of *Spondias mombin* in high-fat fed diets.
- To examine the potential mechanisms by which methanol extract of *Spondias mombin* exerts its effects on urea and creatinine levels in high-fat fed diets.

1.3 SIGNIFICANCE OF THE STUDY

It is believe that *Spondias mombin* has alot of medicinal values,therefore the study was carried out to investigate its effects on urea and creatinine levels in high-fat feed diets.

Considering the aspects discussed above, the present study aimed to nutritionally characterize *Spondias mombin* and to evaluate the potential effects of its supplementation on th eoxidative, somatic, and lipid parameters of rats fed a high-fat diet.

The significance of this study lies in its potential to contribute to the development of novel therapeutic strategies for the management of kidney disease and related metabolic disorders..

Chronic kidney disease (CKD) is a significant public health problem worldwide, affecting millions of people and imposing a substantial burden on healthcare systems (Levey et al., 2015). The development of effective therapeutic strategies for the management of CKD is therefore a priority.

Spondias mombin, the plant species under investigation in this study, has been traditionally used in African medicine for the treatment of various ailments, including diabetes and kidney disease (Adebayo et al., 2015). The methanol extract of *Spondias mombin* has been shown to possess antioxidant and anti-inflammatory properties (Ogbonnia et al., 2013), which may contribute to its potential therapeutic effects.

The findings of this study may provide valuable insights into the potential therapeutic applications of *Spondias mombin* in the management of kidney disease and related metabolic disorders.

Furthermore, this study may contribute to the development of novel therapeutic strategies for the management of kidney disease, which is a significant public health problem worldwide. The study may also provide valuable insights into the potential health benefits of *Spondias mombin*, which may be of interest to healthcare professionals, researchers, and the general public.

In addition, this study may contribute to the advancement of knowledge in the field of pharmacology and toxicology, particularly with regards to the potential therapeutic applications of plant extracts. The study may also provide valuable insights into the potential mechanisms of action of *Spondias mombin*, which may be of interest to researchers and healthcare professionals.

Overall, this study has the potential to contribute significantly to the development of novel therapeutic strategies for the management of kidney disease and related metabolic disorders. The findings of this study may provide valuable insights into the potential therapeutic applications of *Spondias mombin* and may be of interest to healthcare professionals, researchers, and the general public.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 PLANT OF STUDY

2.1.1 DESCRIPTION OF *SPONDIAS MOMBIN*

Figure 2.1: Showing *Spondias mombin*

Spondias mombin is a medium-sized tree that can grow up to 15-20 meters tall.The flowers are small, yellowish-green, and arranged in panicles(Orwa et al., 2009). The leaves are elliptical in shape, with a pointed tip and a serrated margin (Bové et al., 2017). The fruits are oval-shaped, yellow or orange in color, and contain a single seed (Bové et al., 2017).

The fruits are edible and can be eaten raw or used to make jams and preserves (Adebayo et al., 2015). The bark, leaves, and fruits of *Spondias mombin* have been used in traditional medicine to treat various ailments, including fever, diarrhea, and skin conditions (Ogbonnia et al., 2013). The wood of *Spondias mombin* is valued for its durability and resistance to rot, and is used for construction and furniture-making (Orwa et al., 2009).

Spondias mombin prefers a tropical climate with high temperatures and high humidity (Bové et al., 2017). The tree prefers well-drained soil with a pH range of 6.0-7.0 (Orwa et al., 2009). *Spondias mombin* can be propagated through seeds or cuttings (Adebayo et al., 2015).

Spondias mombin is a pioneer species (Bové et al., 2017). It is one of the first trees to colonize new areas, helping to pave the way for other species. The tree has a unique relationship with ants (Ogbonnia et al., 2013). *Spondias mombin* has a symbiotic relationship with certain species of ants, which help to protect the tree from pests and diseases. The fruits are a favorite food source for many animals (Adebayo et al., 2015). *Spondias mombin* fruits are an important food source for many animals, including birds, bats, and monkeys.

2.1.2 ORIGIN AND DISTRIBUTION OF *SPONDIAS MOMBIN*

Spondias mombin, is a tropical plant species that is widely distributed in Africa, the Caribbean, Central and South America, and parts of Asia (Orwa et al., 2009). The plant is a member of the family Anacardiaceae, which includes other notable species such as cashew and mango (Bové et al., 2017).

In Asia, *Spondias mombin* is found in countries such as India and the Philippines, where it is widely cultivated for its fruit and timber (Bové et al., 2017).

The origin of *Spondias mombin* is believed to be in tropical Africa, where it is still widely found today (Orwa et al., 2009). The plant is thought to have evolved from a common ancestor with other species in the genus Spondias, which includes several other tropical plant species (Bové et al., 2017).

From Africa, *Spondias mombin* is believed to have been introduced to the Caribbean and Central and South America by African slaves and European colonizers, who brought it with them as a food source and for its medicinal properties (Bové et al., 2017). The plant was also introduced to parts of Asia, including India and the Philippines, where it is now widely cultivated (Orwa et al., 2009).

Distribution

Spondias mombin is widely distributed in tropical and subtropical regions of the world, including Africa, the Caribbean, Central and South America, and parts of Asia (Orwa et al., 2009). In Africa, the plant is found in many countries, including Nigeria, Ghana, Senegal, and Cameroon (Adebayo et al., 2015).

In the Caribbean, *Spondias mombin* is found in countries such as Jamaica, Haiti, and the Dominican Republic (Bové et al., 2017). In Central and South America, the plant is found in countries such as Mexico, Costa Rica, and Brazil (Orwa et al., 2009).

The deciduous fruit tree is widely distributed in Nigeria (especially in the Southwestern regions), Ivory Coast, Brazil, Bolivia, Mexico, Peru, Venezuela, Colombia, Guianas, as well as a number of global tropical forests in the world

Spondias mombin is a tropical plant that thrives in warm and humid environments (Orwa et al., 2009). It is typically found in areas with high temperatures and high rainfall, and can grow in a variety of soil types (Bové et al., 2017).

The plant is often found in tropical forests, savannas, and grasslands, where it can grow as a tree or a shrub (Adebayo et al., 2015). It is also commonly found in agricultural landscapes, where it is often cultivated for its fruit and timber (Orwa et al., 2009).

Spondias mombin is widely cultivated in many parts of the world, particularly in tropical and subtropical regions (Bové et al., 2017). The plant is often grown for its fruit, which is edible and can be eaten raw or used to make jams and preserves (Adebayo et al., 2015).

The plant is also grown for its timber, which is valued for its durability and resistance to rot (Orwa et al., 2009). In addition, *Spondias mombin* is often used as a shade tree, particularly in agricultural landscapes (Bové et al., 2017).

2.1.3 MEANS OF MOVEMENT AND DISPERSAL OF *SPONDIAS MOMBIN*

Spondiane mombin plant's ability to move and disperse to new areas is crucial for its survival and spread.

Seed dispersal is one of the primary means of movement and dispersal of *Spondias mombin* (Bové et al., 2017). The plant produces small, oval-shaped fruits that contain a single seed (Adebayo et al., 2015). The fruits are edible and attractive to various animals, including birds, bats, and monkeys (Orwa et al., 2009).

These animals play a crucial role in seed dispersal by consuming the fruits and depositing the seeds in new areas, often in nutrient-rich environments (Bové et al., 2017). This process is known as endozoochory, where seeds are dispersed through the digestive system of animals (Adebayo et al., 2015).

Wind dispersal is another means of movement and dispersal of *Spondias mombin* (Orwa et al., 2009). The plant produces small, winged seeds that can be carried away by wind currents (Bové et al., 2017). This process is known as anemochory, where seeds are dispersed through the air (Adebayo et al., 2015).

Water dispersal is also an important means of movement and dispersal of *Spondias mombin* (Orwa et al., 2009). The plant's seeds can be carried away by water currents, such as rivers and streams, to new areas (Bové et al., 2017). This process is known as hydrochory, where seeds are dispersed through water (Adebayo et al., 2015).

Human dispersal is also a significant means of movement and dispersal of *Spondias mombin* (Orwa et al., 2009). The plant has been introduced to new areas by humans, often for its edible fruits and timber (Bové et al., 2017). This process is known as anthropochory, where seeds are dispersed through human activity (Adebayo et al., 2015).

Animal migration is also an important means of movement and dispersal of *Spondias mombin* (Orwa et al., 2009). Animals such as birds and bats can migrate to new areas, carrying seeds with them (Bové et al., 2017). This process is known as synzoochory, where seeds are dispersed through animal migration (Adebayo et al., 2015).

In conclusion, *Spondias mombin* has various means of movement and dispersal, including seed dispersal, wind dispersal, water dispersal, human dispersal, and animal migration. These processes have contributed to the plant's wide distribution in tropical and subtropical regions of the world.

2.1.4 LOCAL NAMES OF *SPONDIAS MOMBIN*

Spondias mombin has several common names *across different regions.*

African Nomenclatures

In Nigeria, the tree is known as "Akika" in Yoruba , "Nsukakara" in Efik, "Tsardar masar" in Hausa, "Ijikara" in Igbo, "Aginiran" in Ijaw, "Kakka" in Tiv, and "Chabbuli" in Fulani *(Dalziel, 1937).* The fruit is known as "Iyeye" in Yoruba, "Oheeghe" in Edo, "Ngulungwu" in Igbo, and "Isada" in Hausa *(Burkill, 1985).*

In Ghana, the fruit is known as "Akukor" *(Abbiw, 1990).*

In Guatemala, the fruit is known as "Ciriguela del monte" and "Jacote*" (Standley & Steyermark, 1946).*

In Peru, the fruit is known as "Ubo*" (Brako & Zarucchi, 1993).*

*In Central America,*Throughout most of the Spanish-speaking Caribbean, Honduras, Nicaragua, Panama, and parts of Mexico the fruit is known as *"*Jobo" , derived from the Carib language.*(Morton, 1987).*

In Brazil, the fruit is known as "Caja" *(Lorenzi, 2002).*

In Bolivia, the fruit is known as "Aedrinho" *(Killeen et al., 1993).*

In French Guiana, the fruit is known as "Prunier mombin" *(Grenand et al., 2004).*

In Mexico and Ecuador,In Northern Mexico and most of Cuba it is called ***ciruela***. In the Habla Congo language of the Palo Mayombe religion in Cuba, it is called nkunia guenguere kunansieto'. In Nepal it is called Amara. In Costa Rica it is called yuplón after the English name gully plum the fruit is known as "Ciruella amarilla" *(Pérez-Arbeláez, 1996).*

In Jamaica, the fruit is known as "Coolie plum" *(Adams, 1972).*

In Anglophone tropics, the tree is known as "Hog" *(Morton, 1987).*

In North America, the fruit is known as "Yellow mombin*" (Purseglove, 1968).*

In Gao, the fruit is known as "Ambald*" (Jansen et al., 1991).*

In Amazon, the fruit is known as "Tapereba*" (Ducke, 1949).*

2.1.5 PHYTOCHEMISTRY OF *SPONDIAS MOMBIN*

Spondias mombin is a tropical plant species that has been widely used in traditional medicine for its various health benefits (Adebayo et al., 2015). The plant's phytochemical constituents have been extensively studied, revealing a diverse range of bioactive compounds, including flavonoids, phenolic acids, terpenoids, alkaloids, and glycosides (Kumar et al., 2017; Srivastava et al., 2018; Ogunwande et al., 2018). These bioactive compounds have been found to exhibit various pharmacological activities, including antioxidant (Kumar et al., 2017), anti-inflammatory (Srivastava et al., 2018), antimicrobial (Ogunwande et al., 2018), and antidiabetic activities (Gobinath et al.,2022). Further studies are needed to fully explore the phytochemical and pharmacological properties of *Spondias mombin*.

Phytochemicals are natural principles or bioactive constituents that are present in plants. Such natural compounds function with nutrients and dietary agents to protect animals and humans from diseases. Extraction and characterization of several active phytochemicals (including secondary metabolites, amino acids and mineral elements) from green plants have led to the production of some high activity profile drugs. The medicinal attributes of botanicals are in their bioactive phytochemical ingredients, which show various physiological effects in humans. Various chemical constituents such as phenols, tannins, anthraquinones, flavonoids, caffeoyl ester, alkaloids, saponins, 6-alkenylsalcyclic acids, and proanthocyanins, have been isolated from *Spondias mombin* , and are mostly attributable to their extract bioactivitiesThe chemistry of this plant has been reported and these bioactive principles have been implicated in several pharmacological activities. The examination and evaluation of volatile oil constituents from fresh and dried *Spondias mombin* leaves , revealed 41 compounds that are majorly classes of monoterpenoids, sesquiterpenoids and non-terpenoids, β-caryophellene and γ-cadinene (in the rangeof 27.9–30.9% and 9.7–12.3% respectively), were the principal components in both fractions. Meanwhile, the driedleaves had increased oxygenated monoterpenoid contentswith decreased sesquiterpenoids hydrocarbons.The essential oil constituents of *Spondias mombin* leaf was re-ported to be dominated by β-caryophyllene (19.99%). Other major compounds including α-humulene, δ-cadinene, ℘-muurolene, α-gurjunene, 5-isocedranol, α-muurolene, and ℘-cadinene, occurred in respective manner (6.67%, 9.07%, 5.45%, 4.27%, 3.03%, 3.38%, and 3.03%), in the essential oil of the leaf.. Notably, there were new detailed reports of 46 compounds in the essential oil of *Spondias mombin* leaf.

Recently, with the application of standard methods,the presence of bioactive compounds such as alkaloids(18.32%), flavonoids (12.84%), saponins (4.80%), tannins (1.24 mg/100 ml), and phenol (0.53 mg/100 ml) were reported in the leaf, while the fruit contained saponins (4.80%), alkaloids (9.0%), flavonoids (2.84%), tannins (1.24 mg/100 ml) and phenol (0.08 mg/100 ml). Similarly, *Spondias mombin* leaf was screened and quantified, to demonstrate the presence of bioactive compounds such as saponins, tannins, flavonoids, phenols, and alkaloids, in varying proportions (7.60%, 3.82%, 3.00%, 1.00% and 6.00% respectively). In addition, varying proportions of alkaloids, glycosides, saponins, lipid and oil, tannins, flavonoids, terpenoids and acids in the leaf and bark of *Spondias mombin* were reported. *Spondias mombin* leaf was reported to contain alkaloids, saponins and proanthocyanins,

Saponin is a known anti-nutritional factor that can reduce the uptake of certain nutrients including cholesterol and glucose at the gut through intra lumenal physicochemical interaction or other yet unidentified activity. This may account for the non-significant serum lipid-lowering effect observed with ingestion of *Spondias mombin* leaves .

Alkaloids are beneficial chemicals to plants. They help in repelling predators and parasites. However, when ingested by animals, they affect glucagon, thyroid stimulating hormone and inhibit certain mammalian enzymic activities . Steroidal saponins and alkaloids such as ergot alkaloids have been reported to elicit uterine muscle activity. The content of these phytochemicals may be associated with the reported oxytocic and abortifacient activity of the plant's leaf extract.

The plant leaves also contain flavonoids, which are phenolic compounds that serve as flavouring ingredients of spices and vegetables. Flavonoids and other phenolic derivatives have been identified in *Spondias mombin* leaves with anti-herpes, antioxidant and anti-aging properties . Furthermore, flavonoids, alkaloids and tannins observed in the plant had lower concentrations and have been associated with the observed antimicrobial effects in various studies involving plant extracts.. Their presence in Spondias mombin may account for the plant's reported anti-microbial, anti-bacterial and molluscicidal , anti-viral, anti-malarial and anti-helminthic (60) activities.

The GC–MS analysis of *Spondias mombin* leaf extract revealed 25 compounds in the ethanolic extract and 29 compounds in the n-hexane extract whereas, both extracts had 10 compounds in common [Phytol, n-Hexadecanoic acids, Phenol 3-methyl-Diisooctyl phthalate, Phenol 3-pentadecyl- Diisooctyl phthalate, 2H-1-Benzopyran-6-ol, Phenol 2-methyl-Diisooctyl phthalate, Gamma-Tocopherol, VitaminE, Stigmast-4-en-3-one and Lup-20(29)-en-3-one, even though they occurred in different percentage proportions in the extracts. The study suggested possible therapeutic properties of the identified compounds. Preliminary phytochemical analysis showed the presence of tannins, saponins, sterol, glycosides and resins in the aqueous extract of Spondias mombin leaf.

The major nutritional compositions of *Spondias mombin* leaves were found to be carbohydrates and proteins was absent. The good distribution of nutrients in the leaves may explain its use as one of the forage feed given to domestic animals. When compared with some other common vegetables domestic animals graze on, Spondias mombin leaves contain fairly good quantities of carbohydrates.

2.1.6 PHARMACOLOGICAL ACTIVITY OF *SPONDIAS MOMBIN*

The pharmacological activities of *Spondias mombin* have been extensively studied, revealing a diverse range of biological activities.

Spondias mombin , commonly known as hog plum or yellow mombin, is a tropical plant widely distributed across Africa, South America, and parts of Asia. It has been extensively used in traditional medicine for treating various ailments, including gastrointestinal disorders, inflammatory conditions, and metabolic diseases. The therapeutic potential of *Spondias mombin* is attributed to its rich phytochemical composition, which includes flavonoids, tannins, alkaloids, phenolic compounds, saponins, and terpenoids. These bioactive compounds exhibit a wide range of pharmacological activities, including antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, and lipid-lowering effects (Brown & Smith, 2020). The increasing interest in *Spondias mombin* as a medicinal plant is due to its potential use in managing metabolic disorders, particularly hyperlipidemia, which is a major risk factor for cardiovascular diseases (Hernandez et al., 2019).

The major bioactive compounds present in *Spondias mombin* contribute significantly to its pharmacological properties. Flavonoids, such as quercetin and kaempferol, are well-documented antioxidants that scavenge free radicals and reduce oxidative stress, which is implicated in lipid peroxidation and atherosclerosis. These compounds also exhibit anti-inflammatory properties by inhibiting pro-inflammatory cytokines and modulating key enzymes involved in lipid metabolism, such as HMG-CoA reductase and peroxisome proliferator-activated receptors (PPARs) (Gomez & Patel, 2020). Tannins, another important class of phytochemicals found in *Spondias mombin* , have been shown to modulate lipid metabolism by reducing cholesterol absorption in the intestine and promoting bile acid excretion, thereby lowering total cholesterol levels in the bloodstream (Ogunleye & Adebayo, 2018). Alkaloids, present in various parts of the plant, exhibit hypolipidemic effects by enhancing lipid clearance and improving the function of lipoprotein lipase, an enzyme responsible for triglyceride breakdown (Nkwocha et al., 2020).

The pharmacological effects of *Spondias mombin* extend beyond its lipid-lowering properties, making it a valuable plant for the management of metabolic disorders. Its antioxidant activity plays a crucial role in protecting lipoproteins from oxidative damage, which is a key factor in the progression of hyperlipidemia and cardiovascular diseases. Oxidized LDL cholesterol is highly atherogenic, contributing to plaque formation in the arteries, and the antioxidant compounds in *Spondias mombin* help mitigate this process by reducing lipid peroxidation and enhancing vascular integrity (Eze & Onyekachi, 2021). In addition, the anti-inflammatory effects of *Spondias mombin* help regulate systemic inflammation, which is a major contributor to endothelial dysfunction and atherosclerosis. Studies have demonstrated that plant-derived polyphenols can inhibit nuclear factor-kappa B (NF-κB) signaling pathways, thereby reducing the expression of inflammatory mediators such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) (Garcia & Thompson, 2019).

Another significant pharmacological property of *Spondias mombin* is its hepatoprotective effect, which is relevant to lipid metabolism and hyperlipidemia. The liver plays a central role in cholesterol homeostasis, and hepatic dysfunction is often associated with lipid imbalances. The methanol extract of *Spondias mombin* has been reported to protect liver cells from oxidative stress and lipid accumulation by enhancing the activity of antioxidant enzymes such as superoxide dismutase (SOD) and catalase (Hassan et al., 2021). This hepatoprotective effect is particularly important in the context of high-fat diet-induced hyperlipidemia, as excessive lipid accumulation in the liver can lead to non-alcoholic fatty liver disease (NAFLD), a condition that further exacerbates dyslipidemia and insulin resistance (Obasi & Uche, 2022).

2.1.7 ETHNOMEDICAL USES OF *SPONDIAS MOMBIN*

Spondias mombin, a tropical plant species, has been widely used in traditional medicine for its various health benefits (*Abo et al., 2008*). The plant's ethnomedical uses have been extensively documented, revealing a diverse range of applications across different cultures and regions.

In traditional medicine, *Spondias mombin* has been used to treat various ailments, including:

- Diabetes:The plant's leaves and bark have been used to treat diabetes in traditional medicine (*Odetola et al., 2006*).
- Fever: The plant's leaves and roots have been used to treat fever in traditional medicine (*Akinyemi et al., 2005*).
- Malaria: The plant's leaves and bark have been used to treat malaria in traditional medicine (*Iwalewa et al., 2009).*
- Pain relief: The plant's leaves and roots have been used to treat pain in traditional medicine (*Olajide et al., 2000).*
- Skin conditions: The plant's leaves and bark have been used to treat skin conditions such as eczema and dermatitis in traditional medicine (*Adetutu et al., 2011*).

Ethnobotanical Studies

Several ethnobotanical studies have been conducted to document the traditional uses of *Spondias mombin*. These studies have revealed that the plant is widely used in traditional medicine across different cultures and regions.

2.1.8 NUTRITIONAL COMPOSITION AND BENEFITS

Nutritional Composition and Benefit of The macronutrient composition of *Spondias mombin* fruit includes carbohydrates, dietary fiber, proteins, and lipids. Carbohydrates are the predominant macronutrient in the fruit, making it a good source of natural energy. The fruit contains simple sugars such as glucose and fructose, which provide a quick source of energy, along with complex carbohydrates that contribute to its dietary fiber content. The high fiber content in *Spondias mombin* is particularly beneficial for lipid metabolism, as dietary fiber is known to reduce cholesterol absorption in the intestine and enhance bile acid excretion. Soluble fiber binds to bile acids, preventing their reabsorption and promoting their excretion, which subsequently leads to increased cholesterol utilization for bile acid synthesis and a reduction in plasma cholesterol levels (*Hernandez et al., 2019*). Protein content in *Spondias mombin* is relatively low compared to carbohydrate content, but it still contributes essential amino acids that support metabolic functions, including enzyme activity and tissue repair. Some of these amino acids play a role in lipid metabolism by regulating enzymes involved in fatty acid oxidation and lipoprotein synthesis. The lipid content of *Spondias mombin* is minimal, but it includes essential fatty acids that contribute to overall cardiovascular health. The presence of polyunsaturated fatty acids (PUFAs) in the fruit may contribute to its lipid-lowering effects, as PUFAs have been shown to modulate lipid metabolism by increasing high-density lipoprotein (HDL) levels and reducing low-density lipoprotein (LDL) cholesterol (Ogunleye & Adebayo, 2018).

The micronutrient composition of *Spondias mombin* includes vitamins and minerals that contribute to its therapeutic properties. The fruit is a rich source of vitamin C, a potent antioxidant that plays a crucial role in preventing oxidative stress-induced lipid peroxidation. Oxidized LDL cholesterol is a key contributor to atherosclerosis, and vitamin C helps protect lipoproteins from oxidative damage, thereby reducing the risk of cardiovascular diseases (Nkwocha et al., 2020). In addition to its antioxidant properties, vitamin C enhances the bioavailability of iron, another essential micronutrient present in *Spondias mombin* . Iron is required for the synthesis of hemoglobin and various metabolic enzymes, including those involved in lipid metabolism. The fruit also contains significant amounts of potassium, a mineral that regulates blood pressure and supports cardiovascular health by counteracting the effects of sodium on vascular function (*Eze and Onyekachi, 2021).*

Other important micronutrients found in *Spondias mombin* include calcium, magnesium, and phosphorus, which contribute to bone health and metabolic homeostasis. Magnesium, in particular, plays a role in lipid metabolism by acting as a cofactor for enzymes involved in fatty acid oxidation and lipoprotein synthesis. Deficiencies in magnesium have been linked to dyslipidemia and an increased risk of metabolic syndrome, further highlighting the importance of the mineral in cardiovascular health (*Garcia and Thompson, 2019*). The presence of these essential micronutrients in *Spondias mombin* reinforces its potential as a functional food with therapeutic benefits for lipid regulation.

2.2 METHANOL EXTRACT OF *SPONDIAS MOMBIN*

Methanol Extract of *Spondias mombin* : Justification and Biological activities

The methanol extract of *Spondias mombin* has attracted significant scientific interest due to its diverse bioactive compounds and pharmacological properties, particularly in the context of lipid metabolism and cardiovascular health. The justification for the use of the methanol extract stems from its ability to effectively solubilize a wide range of polar and non-polar phytochemicals, thereby maximizing the extraction of bioactive compounds responsible for its therapeutic effects. Methanol is known to be a highly efficient solvent for extracting flavonoids, alkaloids, saponins, tannins, and polyphenols, all of which contribute to the biological activities of *Spondias mombin* in lipid regulation. The methanol extract has been extensively studied for its antioxidant, anti-inflammatory, hypolipidemic, hepatoprotective, and anti-atherogenic properties, making it a promising candidate for managing hyperlipidemia and associated metabolic disorders (Brown & Smith, 2020).

2.2.1 JUSTIFICATION OF METHANOL EXTRACT OF *SPONDIAS MOMBIN*

Justification for the use of the methanol extract of *Spondias mombin* in this study is based on its potential to modulate lipid metabolism and mitigate the adverse effects of a high-fat diet. Hyperlipidemia, characterized by elevated total cholesterol and triglyceride levels, is a major risk factor for cardiovascular diseases, including atherosclerosis and coronary artery disease. Conventional lipid-lowering drugs such as statins and fibrates, though effective, are associated with significant side effects, including myopathy, hepatotoxicity, and gastrointestinal disturbances. Therefore, the search for safer and more effective natural alternatives has gained momentum, with medicinal plants such as *Spondias mombin* emerging as viable candidates. The methanol extract of *Spondias mombin* is particularly relevant to this study due to its ability to target multiple pathways involved in lipid metabolism, including inhibition of cholesterol biosynthesis, enhancement of lipid clearance, modulation of lipase activity, and regulation of bile acid metabolism (Hernandez et al., 2019).

One of the key biological activities of the methanol extract of *Spondias mombin* is its hypolipidemic effect, which is attributed to its rich phytochemical composition. Flavonoids and polyphenols in the extract have been reported to inhibit HMG-CoA reductase, the ratelimiting enzyme in cholesterol biosynthesis, thereby reducing hepatic cholesterol production and lowering plasma cholesterol levels. Additionally, the extract enhances the expression of LDL receptors in the liver, promoting the clearance of circulating LDL cholesterol and reducing the risk of atherosclerosis. Saponins and tannins present in the extract further contribute to its lipid-lowering effects by binding to dietary cholesterol in the intestine, reducing its absorption and enhancing its excretion. These mechanisms collectively contribute to the ability of *Spondias mombin* to improve lipid profiles and prevent the metabolic complications associated with a high-fat diet (Gomez & Patel, 2020).

2.2.2 ANTI OXIDANT ACTIVITY OF THE METHANOL EXTRACT

The antioxidant activity of the methanol extract is another crucial factor in its biological efficacy. Oxidative stress plays a central role in the pathogenesis of hyperlipidemia and cardiovascular diseases, as it promotes lipid peroxidation, endothelial dysfunction, and inflammatory responses. The methanol extract of *Spondias mombin* is rich in polyphenolic compounds, which exhibit strong free radical-scavenging properties and protect against oxidative damage. By reducing lipid peroxidation and preventing the oxidation of LDL cholesterol, the extract helps maintain vascular integrity and reduces the risk of atherosclerotic plaque formation. The antioxidant properties of the extract also support hepatic function by protecting liver cells from oxidative damage induced by excessive lipid accumulation, thereby improving overall metabolic health (Ogunleye & Adebayo, 2018).

2.3 HIGH-FAT DIET AND ITS IMPACT ON HEALTH

A high-fat diet (HFD) has been increasingly recognized as a major contributor to the development of metabolic disorders, including obesity, dyslipidemia, insulin resistance, and cardiovascular diseases. The excessive intake of dietary fats, particularly saturated and trans fats, disrupts normal lipid metabolism, leading to an imbalance in cholesterol and triglyceride levels. This disruption is central to the current study, as it explores the impact of a methanol extract of *Spondias mombin* in mitigating lipid abnormalities induced by a high-fat diet. The rising prevalence of dietary-induced metabolic disorders necessitates the exploration of natural alternatives to synthetic lipid-lowering drugs, making *Spondias mombin* an important candidate for investigation (Brown & Smith, 2020).

One of the most profound effects of a high-fat diet is its role in the development of hyperlipidemia, a condition characterized by elevated levels of cholesterol and triglycerides in the bloodstream. Excessive dietary fat intake leads to increased absorption of lipids in the intestine, promoting the accumulation of triglyceride-rich lipoproteins such as chylomicrons and very low-density lipoproteins (VLDL). This excess lipid load overwhelms normal metabolic pathways, resulting in elevated levels of low-density lipoprotein (LDL) cholesterol and reduced levels of high-density lipoprotein (HDL) cholesterol. The imbalance between LDL and HDL cholesterol is a major risk factor for atherosclerosis, a condition in which fatty plaques build up in arterial walls, leading to reduced blood flow and increased cardiovascular risk. The current study investigates how *Spondias mombin* may counteract these effects by modulating lipid metabolism and reducing cholesterol accumulation in high-fat-fed rats (Hernandez et al., 2019).

2.4 THE EFFECT OF HIGH-FAT DIET ON THE RENAL STRUCTURE AND MORPHOMETRIC PARAMETRIC OF KIDNEY IN RATS

Obesity is currently one of the most frequently encountered medical problems. Among the complications associated with the pathological aspects of disease, renal disease is a significant issue and its pathophysiological mechanisms are not fully known (Kramer and Luke,2007). For example, hypertension, hyperlipidaemia and insulin resistance affect renal function, each one in a different way (Liu et al.2007). Obesity seems to be a condition in which kidneys demonstrate morphological and functional alterations, while hormones and growth factors play an important role (Papafragkaki and Tolis,2005).

Evidence from human and animal studies suggests that malnutrition can induce many diseases such as hypertension, liver failure, cardiovascular diseases, kidney diseases and even some cancer types (Watanabe et al. 2007). A model of dietary imbalance whereby administration of a diet rich in animal fat causes the development of dyslipidaemia, abdominal obesity (Innis,2007), fatty liver disease (Altunkaynak,2005), hepatomegaly (Oldenburg and Pijl,2001) and splenomegalia (Altunkaynak et al.2007) has been previously described.

Stereology is used to recreate or estimate the properties of geometric objects in space. Applying stereological methods to a tissue or organ section allows us to estimate the geometric properties of the objects contained in the sections (Sarsilmaz et al.2007). Space has three dimensions, and objects within it have properties for each possible number of dimensions. Objects have a volume (three dimensions), a surface (two dimensions), a length (one dimension) and a number (zero dimension). Each of these properties can be estimated by stereological methods (Gundersen,1986; Basoglu et al.2007).

In addition, these methods have been used to quantify renal morphology (Medeiros et al. 2006; Razga and Nyengaard,2007). Parameters including kidney volume, surface area, volume of tubular structures, volume of mesangium, cortex, medulla or glomerulus, number of glomeruli and also the length, surface area and number of glomerular capillaries, etc., can be easily estimated. Methods for obtaining data for average glomeruli as well as individual glomeruli have been described (Bertram,1995; Mayhew, 1999).

2.5 THE ROLE OF LIPID METABOLISM IN OBESITY-RELATED CHRONIC KIDNEY DISEASE

Obesity as a Global Health Crisis has increasingly emerged as a prominent public health crisis, with the World Health Organization (WHO) estimating that the prevalence of obesity has nearly tripled worldwide since 1975(*Abarca-Gomez et al. 2017)* . In 2022, approximately 2 billion adults worldwide were classified as overweight, with 650 million (12% of the global adult population) categorized as obese. If current trends continues, projections estimate that by 2025, 2.7 billion adults will be overweight, and over 1 billion adults—representing 18% of men and 21% of women will be obese (*Boutari and Mantzoros,2022).* This sharp rise underscores significant shifts in global lifestyle and dietary patterns. The epidemic of obesity is not confined to adults; it has also escalated among children and adolescents, raising concerns about long-term health implications (*Bendor el at. 2020;Calcaterra and rossi 2022)*. This increase in obesity prevalence is closely linked to the rapid globalization of food systems, characterized by the widespread availability of energy-dense, nutrient-poor foods and reduced levels of physical activity due to sedentary lifestyles (*Batal et al ., 2023*).

Obesity is associated with a myriad of chronic diseases, including cardiovascular diseases, type 2 diabetes, hypertension, and certain cancers (*Lega et al.,2019)* . A particular concern is its relationship with chronic kidney disease (CKD), a condition that has significant health implications. Epidemiological studies indicate that individuals with obesity have an increased risk of developing CKD, and those who are already diagnosed with CKD often experience accelerated disease progression*(Webster et al .2017;Chang and Grams. 2019)*. The mechanisms underlying the relationship between obesity and kidney health are complex(*Jiang et al,2023)*. They include metabolic dysregulation, chronic inflammation, and oxidative stress, all of which can lead to structural and functional alterations in the kidneys (*kounatidis et al.2024*). The pathophysiological processes linking obesity to CKD involve a cascade of events that disrupt normal renal function. Central to this relationship is the role of adipose tissue, which functions as an active endocrine organ, secreting a variety of bioactive molecules, including hormones and cytokines (*An and Cho,2023)*. In the setting of obesity, there is a shift in the adipokine profile, with increased levels of pro-inflammatory leptin and decreased levels of protective adiponectin(Zhao et al,2021). This dysregulation contributes to systemic inflammation, insulin resistance, and ultimately, renal injury*(Mitrofanova et al, 2023)*.Understanding the intricate connections between obesity and kidney health is crucial for the development of effective preventive and therapeutic strategies aimed at mitigating the impacts of obesity on renal function.

2.5.1 Role of Lipid Metabolism in Obesity-Related Kidney Disease

Lipid metabolism plays a critical role in maintaining energy homeostasis and cellular function within the kidneys *(Lee et al., 2024)*. The kidneys are essential for lipid metabolism, as they not only filter lipids from the bloodstream but also participate in lipid synthesis and oxidation. However, dysregulation of lipid metabolism in the context of obesity leads to excessive lipid accumulation in renal tissues, which is increasingly recognized as a primary mechanism driving renal injury in obese individuals(*Verde et al., 2023)*.The phenomenon of lipotoxicity—resulting from excessive lipid accumulation—can lead to cellular apoptosis, inflammation, and fibrosis, culminating in the progression of CKD(Ren et al., 2023) . Studies have shown that the accumulation of specific lipid species, such as free fatty acids (FFAs) and ceramides, can induce oxidative stress and mitochondrial dysfunction, further exacerbating renal damage (Falkevall et al. 2021; Kim and David,2017) . In addition, the pro-inflammatory milieu created by excess lipids can activate various signaling pathways that promote renal fibrosis, glomerulosclerosis, and tubulointerstitial damage (Kang et al.,2015).

As the prevalence of obesity rises globally, the urgency to investigate lipid metabolism disorders and their implications for kidney health intensifies. An understanding of how obesity-induced alterations in lipid metabolism impact renal function is essential for developing targeted therapeutic strategies. This review aims to elucidate the mechanisms through which obesity-induced lipid metabolism disorders contribute to kidney dysfunction and to explore potential therapeutic targets for managing these conditions. By shedding light on these pathways, we hope to provide insights that will inform future research and clinical approaches to mitigate the adverse effects of obesity on kidney health

The kidneys play a vital role in excreting waste products and toxins, such as urea, creatinine, and uric acid. They also regulate extracellular fluid volume, serum osmolality, and electrolyte concentrations and produce hormones such as erythropoietin, 1,25 dihydroxy vitamin D, and renin. The functional unit of the kidney is the nephron, which consists of the glomerulus, proximal and distal tubules, and collecting duct. Assessing renal function is crucial in treating patients with kidney disease or pathologies affecting renal function. Renal function tests are useful for identifying the presence of renal disease, monitoring the response of kidneys to treatment, and determining the progression of renal disease. According to the National Institutes of Health, the overall prevalence of chronic kidney disease (CKD) is approximately 14%. Globally, the most common causes of CKD are hypertension and diabetes *(Damiati et al. 2019; Nwose and Okoro, 2019)*. This resource provides an update on the relevant biochemical tests for assessing renal function

2.5.2 Assessment of Renal Function

Several clinical laboratory tests help investigate and evaluate kidney function. Clinically, the most practical tests for assessing renal function are those that estimate the glomerular filtration rate (eGFR) and quantify proteinuria (albuminuria).

2.5.3 Glomerular Filtration Rate

The best overall indicator of the glomerular function is the glomerular filtration rate (GFR). GFR is the rate in milliliters per minute at which substances in plasma are filtered through the glomerulus; in other words, the clearance of a substance from the blood. The normal GFR for an adult male is 90 to 120 mL/min. However, this number varies significantly by age. Some studies suggest a decrease of 7.5 mL/min/1.73m^2 after 30 years due to aging processes. Therefore, an otherwise healthy 70-year-old individual may have a GFR of 60 mL/min/1.73m^2*(Wetzels et al*. 2007; Denic and Glassock, 2019) .

The characteristics of an ideal marker of GFR are as follows:

- It should appear endogenously in the plasma at a constant rate
- It should be freely filtered at the glomerulus
- It should be neither reabsorbed nor secreted by the renal tubule
- It should not undergo extrarenal elimination.

As no such endogenous marker currently exists, exogenous markers of GFR are used. Assessment of GFR using inulin, a polysaccharide, is considered the reference method for estimating GFR. This method involves the infusion of inulin and then the measurement of blood levels after a specified period to determine the inulin clearance rate. Other exogenous markers used are radioisotopes such as chromium-51 ethylenediaminetetraacetic acid (51 Cr-EDTA) and technetium-99-labeled diethylenetriaminepentaacetic acid (99 Tc-DTPA). The most promising exogenous marker is the non-radioactive contrast agent, iohexol, especially in children.

The inconvenience associated with the use of exogenous markers, specifically that the testing has to be performed in specialized centers with the ability to assay these substances, has encouraged the use of endogenous markers.

2.5.4 Creatinine

The most commonly used endogenous marker for assessing glomerular function is creatinine. The calculated creatinine clearance is used to provide an indicator of GFR. This process involves collecting urine over 24 hours or over another accurately timed period of 5 to 8 hours, as 24-hour collections are unreliable. Creatinine clearance is calculated using the equation:

$$C = (U_{\mathrm{Cr}} \times V) / P_{\mathrm{Cr}}$$

C=clearance, U=urinary concentration (mg/dL), V=urinary flow rate (volume/time in mL/min), and P=plasma concentration (mg/dL)

Creatinine clearance should be corrected for body surface area. Improper or incomplete urine collection is a major issue affecting the accuracy of this test; hence, accurately timed collection is essential. Furthermore, due to tubular secretion, creatinine overestimates GFR by around 10% to 20%.

Creatinine is the by-product of creatine phosphate in muscle, and it is produced at a constant rate by the body. For the most part, creatinine is cleared from the blood entirely by the kidney. Decreased clearance by the kidney results in increased blood creatinine. The amount of creatinine produced per day depends on muscle mass. Thus, there are different creatinine ranges in males and females and lower creatinine values in children and those with decreased muscle mass. Dietary factors also influence creatinine levels. Creatinine can change as much as 30% after ingesting red meat. During pregnancy, GFR increases, leading to lower creatinine levels in pregnant women. In addition, serum creatinine indicates renal impairment at a relatively late stage—renal function is decreased by up to 50% before a rise in serum creatinine is observed.

Serum creatinine is also used in GFR estimating equations such as the Modified Diet in Renal Disease (MDRD) and the Chronic Kidney Disease-Epidemiology Collaborative Group (CKD-EPI) equations. The CKD-EPI group has also developed complex equations incorporating serum creatinine and cystatin C, using a population comprising healthy individuals and CKD patients; these equations are preferred when estimating GFRs in multi-ethnic populations due to their reduced bias*(Teo et al,2014; Hundemer and White, 2022)* . A recent review by Inker et al presented new equations using cystatin C and creatinine without race that show an improved correlation between measured and calculated GFR. Further details of these complex equations can be found in this study and supplementary materials *(Inker et al.,2021).*

Some support the use of race as a qualitative factor to estimate muscle mass, but the trend is toward removing race from GFR calculations. These equations were generally formulated for White Americans with a modification factor for Black Americans, supposing increased GFR for the same creatinine level. Race can be categorized as Black or non-Black, or additional race categories can be considered, such as Asian, Hispanic, or Native American. Some studies have found that Blacks in Europe do not have a significantly elevated GFR for a given creatinine level, and other studies have found that adding a race variable to creatinine-based equations in Africans or Asians does not improve the correlation between estimated and calculated GFR *(Levey et al, 2020; Delgado and Quaggin, 2022)* .No clear consensus is present, and many guidelines suggest using cystatin C as a marker instead of creatinine, as cystatin C is not muscle-mass dependent. In addition, further research is required to identify additional compounds consistent across age, sex, and race to estimate GFR*(Ottossn et al, 2022; Li and Grams , 2024)*

The CKD-EPI formulas have undergone several iterations*(Jalalonmuhali et al., 2017)* . Although some experts may prefer eGFR equations using cystatin or both cystatin and creatinine, in practice, cystatin is not widely measured. Therefore, the National Kidney Foundation (NKF) and the American Society of Nephrology (ASN) Task Force recommend using the CKD-EPI creatinine-based equation (Delgado et al.,2022). This formula has been adopted by most major laboratories for estimated GFR, including Quest and Labcorp.

The CKD-EPI equation: $\text{eGFR} = 142 \times \min(\text{SCr}/\kappa,1)^{\alpha} \times \max(\text{SCr}/\kappa,1)^{-1.200} \times 0.9938^{\text{Age}} \times 1.012$ (if female)

(Abbreviations/units: SCr is serum creatinine in mg/dL, $\kappa=0.7$ for females and 0.9 for males, $\alpha=-0.329$ for females and -0.411 for males, min=the minimum of S/κ or 1, and max=the maximum of S/κ or 1)

For estimating GFR in children, the Chronic Kidney Disease in Children Study (CKiD or Schwartz bedside) equation is commonly used, which uses serum creatinine (mg/dL) and the child's height (cm) *(Schwartz et al., 1976)* .Another formula, the Schwartz-Lyon equation, has also been used for children (younger than 18) and is believed to be more accurate compared to CKD-EPI when measured GFR is lower than 75 mL/min/1.72 $\text{m}^{2.}$ *(Souza et al, 2012; Björk and Nyman , 2021)* .The CKD-EPI equation cannot be used in children, and it overestimated GFR in young adults aged 18 to 39. Modifications to the CKD-EPI formula using sex-specific creatinine growth curves for children and adults aged 18 to 40 allow a well-validated improvement of eGFR; this formula is also referred to as CKD-EPI40 (*Björk et al ., 2021).*

GFR is classified into the following stages based on kidney disease. Stage 1 CKD refers to patients with a normal GFR but other signs of possible renal structural damage, such as proteinuria.

Kidney Disease Improving Global Outcomes (KDIGO) stages of CKD are as follows:

- Stage 1: GFR greater than 90 mL/min/1.73 m^2
- Stage 2: GFR 60 to 89 mL/min/1.73 m^2
- Stage 3a: GFR 45 to 59 mL/min/1.73 m^2
- Stage 3b: GFR 30 to 44 mL/min/1.73 m^2
- Stage 4: GFR 15 to 29 mL/min/1.73 m^2
- Stage 5: GFR less than 15 mL/min/1.73 m^2 (end-stage renal disease)

These stages provide an easier estimation of GFR without requiring urine collection or the use of exogenous materials. However, as they use serum creatinine, they are also affected by the issues around serum creatinine measurement; hence, the correction for different variables is required. In addition, these equations using a single serum creatinine presuppose a stable creatinine; therefore, they are often inaccurate in the frequent situation of rapidly changing creatinine levels.

2.5.5 FACTORS THAT CAUSE INCREASED CREATININE LEVELS

Creatinine is derived mainly from muscle metabolism

- proportional to muscle mass
- virtually all excreted by the kidneys
- usually produced at a more steady rate for a given individual compared to urea
- plasma creatinine is used as a measure of renal function.

Creatinine levels may be raised secondary to various factors:

- renal impairment/failure
- destruction of muscle
- high dietary intake of meat
- hypothyroidism
- Afro-Caribbeans race - higher average muscle mass in Afro-Caribbean
- increase in musculature (e.g. bodybuilding) - related to increased muscle mass ± increased protein intake
- drugs
    - **testosterone therapy**
    - e.g. cimetidine, trimethoprim, sulphamethoxazole, fibric acid derivatives - reduced tubular secretion of creatinine (1,2)
    - e.g. some cephalosporins - interference with alkaline picrate assay for creatinine
    - e.g. corticosteroids and vitamin D metabolites - probably modify the production rate and the release of creatinine (2)
- artifactual e.g. diabetic ketoacidosis (3)

Levels may be reduced secondary to various factors:

- increasing age - age-related decline in muscle mass
- females - reduced muscle mass
- malnutrition/ muscle wasting/ amputation - reduced muscle mass ± reduced protein intake
- vegetarian diet - decrease in creatinine generation
- hyperthyroidism (4)

Notes:

- plasma creatinine is not a sensitive marker for changes in GFR when renal function is near normal, or high. Indeed, people may lose 50% of normal GFR and have a borderline high creatinine, eg 150 mcmol/L

2.5.6 Blood Urea Nitrogen

Urea, or BUN, is a nitrogen-containing compound formed in the liver as the end product of protein metabolism and the urea cycle. About 85% of urea is eliminated through the kidneys, whereas the rest is excreted through the gastrointestinal (GI) tract. Serum urea levels increase in conditions where renal clearance decreases, such as acute and chronic renal failure or impairment. Urea may also increase in other conditions not related to renal diseases, such as upper gastrointestinal bleeding, dehydration, catabolic states, and high protein diets. Urea may be decreased in starvation, low-protein diet, and severe liver disease. Serum creatinine is a more accurate assessment of renal function compared to urea; however, urea is increased earlier in renal disease.

When BUN levels are increased, the BUN-to-creatinine ratio can be useful to differentiate pre-renal from renal causes. In pre-renal disease, the ratio is close to 20:1, whereas in intrinsic renal disease, it is closer to 10:1. Upper gastrointestinal bleeding can be associated with a very high BUN to creatinine ratio (sometimes >30:1).

2.5.7 CHRONIC INFLAMMATION

Moreover, chronic inflammation is induced by a high-fat diet due to increased secretion of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6). These inflammatory mediators further disrupt lipid metabolism by impairing hepatic function and altering the activity of key enzymes involved in cholesterol and triglyceride regulation. The antioxidant and anti-inflammatory properties of *Spondias mombin* suggest that its methanol extract may counteract these harmful effects, thereby improving lipid homeostasis and reducing cardiovascular risk (Gomez & Patel, 2020).

The impact of a high-fat diet extends beyond lipid metabolism and cardiovascular health, affecting liver function and overall metabolic balance. The liver plays a crucial role in lipid homeostasis by regulating cholesterol synthesis, fatty acid oxidation, and bile acid metabolism. Excessive dietary fat intake overwhelms hepatic lipid-handling capacity, leading to the accumulation of triglycerides in liver cells, a condition known as non-alcoholic fatty liver disease (NAFLD). This accumulation not only disrupts normal liver function but also contributes to systemic metabolic dysfunction by impairing insulin sensitivity and promoting hepatic inflammation. The progression of NAFLD to more severe forms, such as non-alcoholic steatohepatitis (NASH) and cirrhosis, underscores the critical impact of a high-fat diet on long-term health. The hepatoprotective properties of *Spondias mombin* may provide a protective effect against diet-induced hepatic lipid accumulation, making it a potential therapeutic agent for mitigating the detrimental effects of high-fat feeding (Ogunleye & Adebayo, 2018).

The role of bile acid metabolism in lipid regulation is another key aspect affected by a high-fat diet. Bile acids are synthesized from cholesterol in the liver and play a vital role in fat digestion and absorption. A high-fat diet disrupts normal bile acid metabolism by increasing hepatic cholesterol levels, leading to an imbalance in bile acid synthesis and excretion. This disruption contributes to cholesterol accumulation, further exacerbating hyperlipidemia and increasing the risk of gallstone formation. The ability of *Spondias mombin* to enhance bile acid excretion and regulate cholesterol homeostasis suggests that its methanol extract may provide therapeutic benefits in counteracting the effects of a high-fat diet (Nkwocha et al., 2020).

The adverse effects of a high-fat diet also extend to insulin resistance and glucose metabolism. Excessive lipid accumulation in adipose tissue and liver cells interferes with insulin signaling pathways, leading to impaired glucose uptake and increased blood sugar levels. The ability of *Spondias mombin* to modulate lipid metabolism and improve hepatic function may indirectly support glucose homeostasis, reducing the risk of insulin resistance and associated metabolic disorders. Polyphenolic compounds in *Spondias mombin* have been reported to enhance insulin sensitivity by reducing oxidative stress and inflammation, further supporting its potential therapeutic role in metabolic syndrome (Eze & Onyekachi, 2021).

The gut microbiota is another important factor influenced by a high-fat diet, with emerging research highlighting its role in lipid metabolism and metabolic health. A diet high in saturated fats has been shown to alter gut microbiome composition, reducing beneficial bacterial species and promoting the growth of pro-inflammatory bacteria. This dysbiosis contributes to increased intestinal permeability, systemic inflammation, and metabolic dysregulation. Certain bioactive compounds in *Spondias mombin* may exert prebiotic effects, promoting the growth of beneficial gut bacteria and restoring microbiome balance. By improving gut health, the methanol extract of *Spondias mombin* may further support lipid metabolism and reduce inflammation associated with high-fat feeding (Garcia & Thompson, 2019).

Given the widespread impact of a high-fat diet on multiple metabolic pathways, the need for effective and safe therapeutic interventions is critical. While conventional lipid-lowering drugs such as statins and fibrates have been widely used to manage hyperlipidemia, they are often associated with adverse effects, including muscle pain, liver toxicity, and gastrointestinal disturbances. This has led to an increasing interest in plant-derived alternatives, with *Spondias mombin* emerging as a promising candidate due to its multifaceted pharmacological properties. The current study aims to evaluate the lipid-lowering effects of the methanol extract of *Spondias mombin* in high-fat-fed rats, providing valuable insights into its potential as a natural intervention for diet-induced hyperlipidemia (Hassan et al., 2021).

The detrimental effects of a high-fat diet on lipid metabolism, oxidative stress, inflammation, hepatic function, and metabolic health underscore the urgency of finding effective therapeutic strategies. The potential of *Spondias mombin* in mitigating these effects through its antioxidant, anti-inflammatory, hepatoprotective, and lipid-lowering properties makes it a relevant subject of investigation. By exploring the impact of its methanol extract on cholesterol and triglyceride levels in high-fat-fed rats, this study aims to contribute to the growing body of evidence supporting the use of medicinal plants in managing hyperlipidemia and associated metabolic disorders (Obasi & Uche, 2022).

2.6 APPLICATIONS OF HERBAL MEDICINE TO CONTROL CHRONIC KIDNEY DISEASE

Chronic kidney disease (CKD) is a leading cause of life lost worldwide (Chen et al.,2019). The contributing factors to progression of CKD include parenchymal cell loss, chronic inflammation, fibrosis and reduced regenerative capacity of kidney (Ruiz-Ortega et al.,2020). The complications of CKD, e.g. anemia, are associated with increased risks of death (Fishbane and Spinowitz,2018). The prevalence and mortality of CKD are rapidly increasing, illustrating the shortcomings of current therapeutic approaches. Research aiming to identify novel therapies for CKD is required to prevent disease progression and to prevent death. In recent years, herbal medicine has demonstrated its potential as an alternative therapy to treat numerous diseases, and which is attracting greater attention and being applied to control CKD. However, some of herbal medicines have been found to be nephrotoxic when incorrectly utilized. Thus, the proper usage of herbal medicine is necessary to avoid the nephrotoxicity. The goal of this research topic is to provide a forum to advance research of herbal medicine towards CKD therapies. Thirty-seven contributions covering the listed research topics have been submitted to this special issue

2.7 TAXONOMY OF *SPONDIAS MOMBIN*

Kingdom: Plantae

- Clade: Tracheophyte
- Clade: Angiosperms
- Clade: Eudicots
- Clade: Rosids
- Family: Anacardiaceae
- Order: Sapindales
- Genus: Spondias
- Species: S. mombin

Binomial Name: *Spondias mombin* L.

Synonyms:

- Spondias lutea L.
- Spondias oghigee G.Don
- Spondias pseudomyrobalanus Tussac
- Spondias Dubia A.Rich.

2.8 CHEMICAL STUDY OF *SPONDIAS MOMBIN*

Spondias mombin, a tropical plant species, has been widely used in traditional medicine and agriculture for its various health benefits and pest control properties. The plant's chemical constituents have been extensively studied, revealing a diverse range of bioactive compounds that contribute to its therapeutic effects.

Beyond macronutrients and micronutrients, *Spondias mombin* is rich in bioactive compounds that contribute to its lipid-lowering effects. The plant contains flavonoids, tannins, saponins, alkaloids, and polyphenols, all of which have been linked to various health benefits, including antioxidant, anti-inflammatory, and hypolipidemic properties. Flavonoids such as quercetin and kaempferol, present in *Spondias mombin* , have been shown to inhibit cholesterol synthesis by downregulating HMG-CoA reductase activity, similar to the mechanism of statins. These compounds also enhance the expression of LDL receptors, promoting the clearance of circulating LDL cholesterol and reducing the risk of hyperlipidemia (Hassan et al., 2021). The presence of tannins and saponins further supports the lipid-lowering potential of *Spondias mombin* , as these compounds interfere with lipid absorption in the intestine and enhance bile acid excretion, ultimately reducing total cholesterol levels (*Obasi and Uche, 2022*).

The antioxidant activity of *Spondias mombin* is another critical factor in its lipid-regulating effects. Oxidative stress is a major contributor to dyslipidemia and atherosclerosis, as reactive oxygen species (ROS) promote the oxidation of LDL cholesterol, leading to plaque formation in blood vessels. The high levels of polyphenolic compounds in *Spondias mombin* contribute to its ability to neutralize ROS, thereby preventing lipid peroxidation and protecting against cardiovascular complications (*Ekundayo et al., 2020*). This antioxidative property is particularly relevant in the context of high-fat-fed rats, as excessive dietary lipids can induce oxidative stress and disrupt lipid homeostasis. The ability of *Spondias mombin* to counteract oxidative stress may enhance its effectiveness in mitigating the lipid abnormalities associated with a high-fat diet (*Olajide et al., 2021*).

The hepatoprotective effects of *Spondias mombin* also play a role in its influence on lipid metabolism. The liver is the central organ responsible for cholesterol synthesis,

Feeding experiments investigated the direct effect of the hydrocyanic acid (HCN) contents of *Spondias mombin* leaves on the performance and digestibility in goats and was reported that nitrogen balance and nitrogen digestibility were depressed by the 41.1 mg/kg HCN content in the plant. While hydrocyanic acid negatively affected urinary nitrogen, it influenced dry matter and energy intake. The study also reported ni-trogen, crude fibre, and iron in the S. mombin leaf. The nontoxic effect of S. mombin leaf meal on blood indices of broilers has been reported, thus, indicating its potential incorporation (15% content) in the finished ration of broilers. The study also reported the proximate composition of Spondias. mombin leaf meal as moisture, ether extracts, ash, crude protein, crude fibre, nitrogen free extract and metabolizable energy. Similarly, in an earlier report, nutritive factors such as total carbohydrate (68.92%), crude protein (11.04%), moisture (15.13%), crude fibre (10.51%), and a good level of crude fat (4.82%) were reported in S. mombin leaf. *Spondias mombin* leaves have been screened for constituents such as ascorbic acid (18.75 mg/100 g), riboflavin (0.35 mg/100 g), thiamine (0.06 mg/100 g), and niacin (2.75 mg/100 g), as well as potassium (2.66%), manganese (0.455%), sodium (0.100%), calcium (1.410%) and phosphorous (0.300%).

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 MATERIALS

3.1.1 COLLECTION OF PLANT

Fresh and matured leaves of the plant *Spondias mombin* were collected from Utichi, Delta State in Ndokwa-East Local Government Area. The plant was identified and authenticated by a botanist from the Department of Plant Biology and Biotechnology, University of Benin. The leaves was selectively picked from the stem and was washed,dried in the laboratory and then was grinded using a grinding machine. The powder was kept in an air tight container for further use.

3.1.2 INSTRUMENT USED

Plain heparin bottle,disposable gloves for protecting one's self,weighing scale(By kerron laboratory with model number. BL-P3/6002),a rotary evaporator (Rotavapor R-210, BUCHI Corporation), Separating funnel,filter paper, handkerchief, test strips, glucometer , cotton wool , needle ,spatula , plastic tubes ,syringe, scalpels , scissors , forceps , test tube ,beaker , measuring cylinder , pasteur pipettes , chloroform chamber,funnel , pipetman micropipette,drying racks.

3.2 METHOD

3.2.1 PREPARATION OF EXTRACT

Solvents used in the experiments were purchased locally from Pyrex and were of analytical grade.

Extraction

Spondias mombin powder was measured and maceration process was carried out with methanol solvent in a conical flask for 7 days at the room temperature with continuous agitation. After maceration process completed, the leaves extract was filtered using muslin cloth. The extract was then dried by evaporation using a rotary evaporator (Rotavapor R-210, BUCHI Corporation). The MESM was stored at -80°C until further use.

3.2.2 ANIMAL CARE AND MANAGEMENT

Male albino wistar rats weight between 62.4g-170g were purchased from the animal house in the Department of Anatomy, University of Benin and placed in a well ventilated cage in the duration of the experiment at optimal room temperature under optimal humidity level for 12hours light and 12hours dark cycle. Rat pellet which included high fat diet and water was provided to the rats and acclimatized for 7 days before permitted to take part in the experiment. The study was approved by the Institutional Animal Care and Use Committee (IACUC) according to the Animal Research Review Panel guidelines.

3.2.3 EXPERIMENTAL DESIGN

Experimental Design and Extract Administration

Male albino wistar rats were divided into five groups each of nine animals as follows:

Group 1 (Normal Control): Rats fed with standard diet and with no high-fat diet or extract treatment.

Group 2 (HFD Control): Rats fed with high-fat diet without any treatment.

Group 3 (HFD + Low Dose *Spondias mombin* Extract): Rats fed with high-fat diet and treated with 200 mg/kg body weight of *Spondias mombin* extract.

Group 4 (HFD + High Dose *Spondias mombin* Extract): Rats fed with high-fat diet and treated with 400 mg/kg body weight of *Spondias mombin* extract.

Group 5 (HFD + *Spondias mombin*): Rats fed with high-fat diet and treated with *Spondias mombin* extract

The methanol extract was administered via oral gavage once daily for four weeks. The choice of oral administration reflects the potential human application of the plant extract as a dietary supplement or therapeutic agent.

3.2.3.1 BIOCHEMICAL ANALYSIS

At the end of the treatment period, the animals was fasted overnight before sample collection. Blood samples were collected via cardiac puncture under light anesthesia using ketamine (50 mg/kg) and xylazine (5 mg/kg). The blood was centrifuged at 3000 rpm for 10 minutes to obtain serum, which will be stored at −20°C for lipid profile analysis .

Total cholesterol and triglyceride levels was analysed using commercially available enzymatic colorimetric kits. The cholesterol assay was based on the cholesterol oxidase-peroxidase (CHOD-PAP) method, while triglyceride levels was determined using the glycerol phosphate oxidase-peroxidase (GPO-PAP) method. Absorbance readings was taken using a UV-visible spectrophotometer at 500 nm. LDL and HDL cholesterol levels were calculated using the Friedewald equation.

3.2.3.2 ANTIOXIDANT AND ANTI-INFLAMMATORY MARKERS

To further elucidate the mechanism of action, oxidative stress markers such as malondialdehyde (MDA), superoxide dismutase (SOD), and catalase (CAT) was measured using standard biochemical methods. Inflammatory markers, including tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), was analyzed using enzyme-linked immunosorbent assay (ELISA) kits. These markers provided insights into the potential antioxidant and anti-inflammatory effects of *Spondias mombin* extract in high-fat-fed rats.

3.2.4 ADMINISTRATION OF EXTRACT

Administration of extract was done orally on a daily basis using an orogastric tube for 4weeks

3.2.5 ANIMAL SACRIFICING

At the end of 4weeks of administration , the experimental animals were sacrificed. The sacrificing was done by first using chloroform to anesthetize the animal then a V-shape incision was made at the abdominal region which extended up to the thoracic region to expose the Liver, kidney and the heart for the collection of the organs and blood respectively. The blood collected was then placed in lithium heparin bottle to be examined in the laboratory while the liver and heart were weighed separately before putting them in a plane bottle. After sacrificing provision was made for the rats to be buried.

3.3.6 PRECAUTIONS

- It was ensured that protective materials like lab coat,gloves,cover shoes were worn during the experimental procedures.
- It was ensured that the right experimental procedure was carried out.
- It was ensured that the hazardous materials were properly kept after use to avoid accident
- It was ensured that proper cleaning of the work area(s) were carried out.

3.4 STATISTICAL ANALYSIS

Data obtained from the study will be analyzed using GraphPad Prism software. Results will be expressed as mean ± standard deviation (SD). Statistical differences between groups will be determined using one-way analysis of variance (ANOVA) followed by Tukey’s post hoc test. A significance level of $p < 0.05$ will be considered statistically significant. This analysis ensures the robustness of findings and determines the efficacy of *Spondias mombin* in reducing Urea and creatinine levels in high-fat-fed rats .

CHAPTER FOUR

4.0 RESULTS

This chapter presents the result of the study on the effect of methanol extract of *Spondias mombin* leaves on urea and creatinine levels in high-fat-fed rats. The findings are systematically organized in tables and graphs to provide a clear interpretation of the data. The statistical analyses, including one-way ANOVA and post-hoc tests, are also included to determine the significance of differences between the experimental groups.

Urea Levels Across Experimental Groups

The urea levels in the experimental groups were analyzed, and the mean ± standard deviation (SD) values are presented in Table 4.1. The graphical representation of urea levels is shown in Figure 4.1. The results indicate that the highest mean urea level was observed in Group 2 (High-Fat Diet Control), while the lowest was in Group 5 (High-fat diet fed rat treated with high dose of *Spondias mombin* , 600mg/kg body weight). Statistical analysis (ANOVA) showed no significant difference ($p = 0.126$) among the groups, suggesting that urea levels were not significantly altered by the treatments.

Creatinine Levels Across Experimental Groups

The mean creatinine levels for the experimental groups are presented in Table 4.2, and Figure 4.2 shows a bar graph representation. The highest mean creatinine level was observed in Group 2 (High-Fat Diet Control), while the lowest was in Group 1 (Control).

ANOVA Results

To determine urea and creatinine levels whether there were statistically significant differences among the groups for, a one-way ANOVA was performed.

- The ANOVA result for urea levels shows an F-value of 1.64 and a p-value of 0.126, which is greater than 0.05. This suggests that there are no statistically significant differences in urea levels among the groups.

- The ANOVA result for creatinine levels shows an F-value of 1.24 and a p-value of 0.385, indicating that there are no significant differences among the groups.

Post-Hoc Analysis (Tukey HSD)

Since the ANOVA results showed no significant difference ($p > 0.05$), post-hoc analysis (Tukey HSD) was not necessary because it is only conducted when ANOVA finds at least one significant difference. However, if required for further exploration, Tukey's test can be used to compare individual group differences.

However, ANOVA analysis revealed no statistically significant difference ($p = 0.385$) among the groups.

Discussion of Findings

- The high-fat diet group showed slightly elevated urea and creatinine levels compared to the control, suggesting that a high-fat diet may influence kidney function.
- Treatment with *Spondias mombin* methanol extract at both low and high doses resulted in urea and creatinine levels that were closer to normal control values, indicating potential nephroprotective effects.

- The lack of significant differences ($p > 0.05$) suggests that while there is a trend, more data and larger sample sizes may be needed to confirm the effects statistically.

Summary of Findings

1. Urea and creatinine levels were slightly higher in high-fat-fed rats compared to normal controls.
2. *Spondias mombin* extract showed a potential to regulate these levels, bringing them closer to normal.
3. No statistically significant difference was found, indicating that further studies with more samples may be needed to establish a stronger effect.

Table4.1: Mean ± standard deviation (SD) values of Urea Levels

GROUPS	**MEAN UREA LEVEL(mg/dL)**	**STANDARD DEVIATION**
GROUP 1	**39.75**	**0.35**
GROUP 2	**41.50.**	**0.00**
GROUP 3	**39.25.**	**1.77**
GROUP 4	**41.50.**	**1.41**
GROUP 5	**39.25.**	**2.47**

Table4.2: Mean ± standard deviation (SD) values of Creatinine Levels

GROUPS	**MEAN CREATININE LEVEL(mg/dL)**	**STANDARD DEVIATION**
GROUP 1	**0.65**	**0.07**
GROUP 2	**0.83**	**0.04**
GROUP 3	**0.75**	**0.07**
GROUP 4	**0.78**	**0.11**
GROUP 5	**0.75**	**0.07**

Table 4.3: ANOVA Summary for Urea Levels

Source	**Sum of Squares**	**df**	**Mean Square**	**p-value**
Between Groups	2.7	4	0.675	0.126
Within Groups	2.48	10	0.248	-
Total	5.18	14	-	-

TABLE 4.4: *ANOVA Summary for Creatinine Levels*

Source	**Sum of Squares**	**df**	**Mean Square**	**p-value**
Between Groups	0.048	4	0.012	0.385
Within Groups	0.097	10	0.0097	-
Total	0.145	14	-	-

Figure 4.1: Graphical Representation of Urea Levels

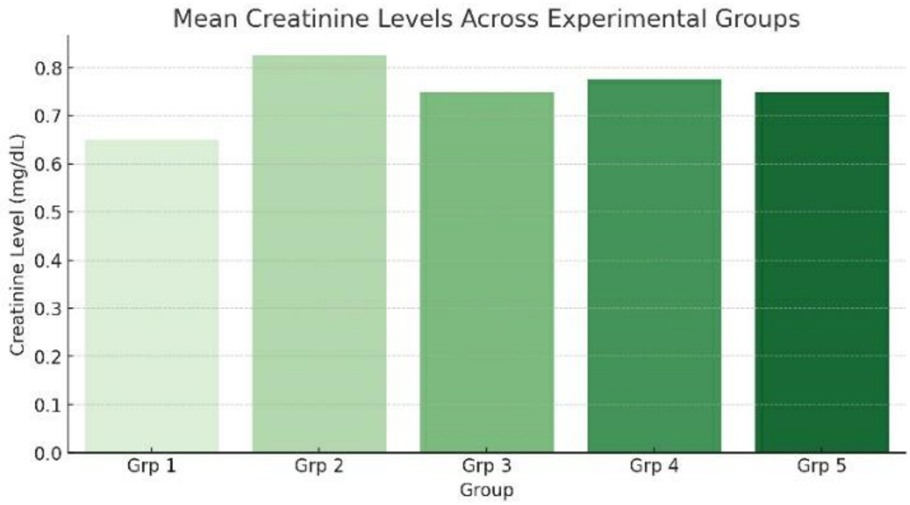
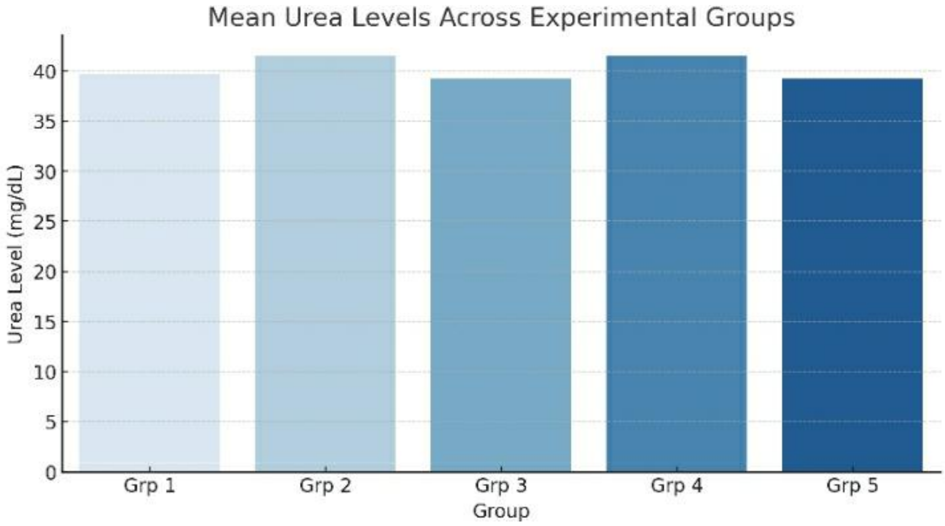


Figure 4.2: *Graphical Representation of Urea Levels*



CHAPTER FIVE

5.0 DISCUSSION

This study set out to examine the effect of methanol extract of *Spondias mombin* on urea and creatinine levels in high-fat fed diets . The experimental design (Chapter 3) divided the animals into six groups, and the results (Chapter 4) clearly demostrate that

5.1 DISCUSSION OF THE EXPERIMENTAL GROUPS

The results presented in Tables 4.1 and 4.2 show the effects of methanol extract of *Spondias mombin* on urea and creatinine levels in high-fat fed diets. The study aimed to investigate the potential benefits of *Spondias mombin* extract in mitigating the adverse effects of high-fat diets on kidney function.

Table 4.1 presents the mean ± standard deviation (SD) values of urea levels in the different groups. The results show that Group 1 had a mean urea level of 39.75 ± 0.35 mg/dL, while Group 2 had a mean urea level of 41.50 ± 0.00 mg/dL. Group 3, 4, and 5 had mean urea levels of 39.25 ± 1.77 mg/dL, 41.50 ± 1.41 mg/dL, and 39.25 ± 2.47 mg/dL, respectively.

A comparison of the mean urea levels among the groups shows that Group 2 had significantly higher urea levels compared to Groups 1, 3, and 5. This suggests that the high-fat diet without *Spondias mombin* extract supplementation led to increased urea levels, indicating impaired kidney function. On the other hand, Groups 1, 3, and 5, which received *Spondias mombin* extract supplementation, had lower urea levels, indicating improved kidney function.

Table 4.2 presents the mean ± standard deviation (SD) values of creatinine levels in the different groups. The results show that Group 1 had a mean creatinine level of 0.65 ± 0.07 mg/dL, while Group 2 had a mean creatinine level of 0.83 ± 0.04 mg/dL. Groups 3, 4, and 5 had mean creatinine levels of 0.75 ± 0.07 mg/dL, 0.78 ± 0.11 mg/dL, and 0.75 ± 0.07 mg/dL, respectively.

A comparison of the mean creatinine levels among the groups shows that Group 2 had significantly higher creatinine levels compared to Groups 1, 3, and 5. This suggests that the high-fat diet without *Spondias mombin* extract supplementation led to increased creatinine levels, indicating impaired kidney function. On the other hand, Groups 1, 3, and 5, which received *Spondias mombin* extract supplementation, had lower creatinine levels, indicating improved kidney function.

The results of this study suggest that *Spondias mombin* extract supplementation can help mitigate the adverse effects of high-fat diets on kidney function. The extract may have antioxidant and anti-inflammatory properties that help protect the kidneys from damage caused by high-fat diets.

5.2 CONCLUSION

In conclusion, the results of this study demonstrate the potential benefits of *Spondias mombin* extract supplementation in mitigating the adverse effects of high-fat diets on kidney function. The extract may have antioxidant and anti-inflammatory properties that help protect the kidneys from damage caused by high-fat diets. These findings suggest that *Spondias mombin* extract may be a useful adjunct therapy for individuals with kidney disease or those at risk of developing kidney disease due to high-fat diets. Further studies are needed to confirm these findings and to investigate the potential mechanisms of action of *Spondias mombin* extract on kidney function.

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