INVESTIGATION INTO PHYTOCHEMICAL AND ANTIOXIDANT PROPERTIES OF AQUEOUS EXTRACT OF MORINGA OLIVERA SEED

BY

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CERTIFICATION

This is to certify that this project research was **ADESHINA FARUQ MORENIKEJI** with Matriculation **HND/23/SLT/FT/0402** has been read and approved as meeting part of the requirements for award of Higher National Diploma (HND) in Science Laboratory Technology.

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DEDICATION

This project is dedicated to my beloved family, whose constant love, support, and prayers have been my greatest source of strength.

To my parents, for their sacrifices and encouragement throughout my academic journey.

And to everyone who believed in me, even when I doubted myself — this achievement is as much yours as it is mine.

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ABSTRACT

Moringa Oleifera is a highly valued plant and various parts of this plant are employed for therapeutic purposes in the indigenous system of medicine. This study was undertaken to determine the phytochemical and antioxidant constituents of the aqueous extract of Moringa Oleifera seed. The phytochemical and anti-oxidant constituents of the extracts were analyzed using standard laboratory procedures. The result of the phytochemical analysis showed that saponins, steroids and phlobatannins were absent, and some antioxidants were also present. Hence, moringa oleifera has been shown to have potential medicinal benefit.

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CHAPTER ONE

1.0 INTRODUCTION

Moringa oleifera leaf extract, particularly using ethanol as a solvent, is a subject of scientific interest due to the plant's various medicinal properties. Ethanol, a semi-polar solvent, is often chosen for its ability to extract both polar and non-polar compounds from the leaves. This contains various bioactive compounds like vitamins, minerals, and

antioxidants. It's been explored for applications in agriculture as a plant growth enhancer and in human health for its potential antioxidant, anti-inflammatory, and antimicrobial effects.

There are many reports in science that moringa has a glucose-lowering effect, cholesterol-lowering in plasma and liver, anti-obesity properties, cardioprotective, and a reduction in insulin resistance. Moringa leaves are high in flavonoids, isothiocyanates, phenolic acids, saponins, tannins, and vitamins which are mostly found in the plant's leaves.

In the present study, moringa leaves were selected because they are considered by many to be a super food and have medicinal uses. They provide a substantial source of bioactive compounds that make them a rich source of nutrition as well as having disease-fighting properties. To make moringa, which is known as a miracle tree full of vitamins and nutrients, less toxic ethanol was extracted as the binary solvent for extraction. The root, stem, and leaves were consumed as superfood despite the fact that the roots and leaves are recommended for daily consumption. The fibre and anti-oxidative properties of the plant cause laxation, erosion of the stomach, intestine, and collapse of the kidneys, the liver, and other organs in the body.

Given that moringa contains over 83 different types of bioactive compounds, consuming a large amount of the plant is required to obtain comparable nutritional value of the nutrients. Extract from moringa leaves are not medicine by themselves but they are supportive of

disease when taken with other foods and taken the right way. Furthermore, pregnant women are discouraged from consuming moringa as it hurts the unborn fetus in the womb.

Medicinal plants are known to be a rich source of bio-active phyto compounds as bio-nutrients (Nandita et al, 2006). They are described as an enriched resource that can be used in drug development and as vital deposits of nutrients and therefore recommended for their therapeutic value (Kushwaha, 2018). The leaves of M.oleifera could serve as a great benefit to people who cannot obtain proteins from meat. Many company across the world manufacture various products from moringa leaf such as tea, tablets, capsules, leaf powder made from young root of moringa plant gives a flavour similar to that of horseradish and can be used as a list seasoning base (Builder et al, 2014).

1.1 JUSTIFICATION OF THE STUDY

The overarching aim of this study is to scientifically explore, analyze, and document the medicinal properties of moringa oleifera, thereby assessing its potential as a functional food and therapeutic agent in addressing nutritional deficiencies and managing chronic disease. The nutritional richness and pharmacological versatility of moringa oleifera make it an ideal candidate for combating malnutrition, oxidative stress, and metabolic disorders. (Gopalakrishnan et al., 2016). This study also seeks to bridge the gap between traditional uses and modern scientific validation to promote the responsible and sustainable use of moringa in health and nutrition sectors globally

1.2 Aim and Objectives

The aim and objective of this study is to investigate the phytochemical and antioxidant properties of *Moringa oleifera* seed in order to assess their medicinal potential.

CHAPTER TWO

2.0 LITERATURE REVIEW

Moringa oleifera, is a fast-growing tree native to India but now grown in many parts of Africa, Asia, and South America. It is sometimes called the "miracle tree" due to its versatile uses, with almost every part—leaves, seeds, flowers, and even roots—being utilized for food, medicine, and other purposes. The tree thrives in hot climates and poor soil, making it easy to plant and care for. The leaves are particularly important because they are rich in nutrients like proteins, vitamins (such as A and D), minerals (including calcium, iron, and potassium), and antioxidants, making them useful for fighting malnutrition, especially in poor communities. Scientists have found that moringa leaves contain more vitamin A than carrots, more calcium than milk, and more iron than spinach.

Many researchers have studied the chemicals found in Moringa oleifera, known as phytochemicals, which include flavonoids, tannins, saponins, and alkaloids. These natural chemicals help the body fight diseases and infections; for example, flavonoids act as antioxidants, protecting the body from harmful substances called free radicals. These phytochemicals are usually extracted using ethanol, which helps to bring out water-based and oil-based compounds from the plant.

Moringa oleifera has many health benefits. It has been shown to reduce blood sugar levels, lower blood pressure, fight bacteria, and reduce inflammation. Some studies even

suggest it may help prevent certain types of cancer. Because of its healing properties, it is used in traditional medicine for treating infections, diabetes, high blood pressure, and stomach problems

In terms of food value, Moringa leaves contain a high amount of protein, fiber, and healthy fats. They also provide energy, high carbohydrates, many health experts believe that moringa can be used to help fight hunger and malnutrition, especially among children and pregnant women. Moringa is also being used in industries to make body creams, soaps, and hair products. Even the seeds are used to purify dirty water.

However, moringa is not perfect. If taken in large amounts it can cause stomach pain, vomiting, or diarrhea. Pregnant women should avoid eating the root or bark because it may cause contractions. People who have thyroid problems are also advised to take it in moderation. Because of certain compounds that can interfere with thyroid function

2.1 HISTORY OF MORINGA OLEIFERA

Moringa Oleifera is one of the oldest known plants used by humans for both food and medicine. Its history goes back thousands of years, especially in ancient India where it was first discovered.

Moringa Oleifera is a plant with a long and rich history that stretches back thousands of years. It is believed to have originated in the northern part of India, particularly around the foothills of the Himalayas. Here it was first cultivated over 2,000 years ago. From there, it spread to Africa, Asia, and the tropical parts of the world due to its many uses in food and traditional medicine (Fahey, 2005).

In ancient Indian Ayurvedic medicine, moringa was used to treat a wide variety of diseases. Historical records show that Indian healers used the leaves, bark, seeds, and pods of moringa to treat over 300 ailments, including digestive issues, skin infections, and high blood pressure (Anwar et al; 2007).

The Egyptians also used moringa in ancient times, especially for its oil, which they applied to the skin to protect against the sun and to prepare ointments and perfumes. The oil was also used in mummification. Later, the Greeks and Romans adopted moringa for its medicinal and culinary purposes (Gopalakrishnan et al; 2016).

As trade routes expanded, Arab traders and explorers helped spread moringa Oleifera to the Middle East and parts of Africa, especially along the East African Coast. African communities soon began cultivating it, using the leaves in cooking and treating illnesses such as malaria, diabetes, and malnutrition.

In Southeast Asia, especially in the Philippines and Indonesia, moringa became a common vegetable. It is known locally as "malunggay" in the Philippines and is often used in soups, stew and to increase breast milk in nursing mothers (Leone et al; 2015).

In modern times moringa oleifera has gained international attention. During the 20th Century, Scientists began studying its nutritional value. They found that it contains high level of Vitamin A, Vitamin C, Calcium, Iron, Potassium, and Protein, making it useful in fighting malnutrition in children and adults (WHO, 2018). Non- governmental Organizations (NGOs), health ministers, and international aid groups started promoting moringa in food and health programs.

Today moringa is considered a Superfood and is grown in over 80 countries around the world. It is sold in various forms such as Powders, Capsules, teas, and oils. Its journey from ancient healing plant to a modern health supplement shows how traditional knowledge and Science can work together for global health

2.2 CULTIVATION OF MORINGA OLEIFERA

Moringa Oleifera, also known as the "drumstick tree" or "miracle tree" is a fast growing drought- resistant plant that thrives in many tropical and subtropical regions of the world. Because of its high nutritional and medicinal value it is cultivated widely for both household and commercial purposes. Farmers and health Organizations are promoting the

cultivation of moringa as a tool to fight hunger, improve health and create economic opportunities.

2.2.1 CLIMATE AND SOIL REQUIREMENTS

Moringa grows best in warm climate with temperature ranging from 25°C to 35°C, but it can tolerate temperature up to 48°C. It prefers well-drained Sandy or Loamy Soil with a neutral to slightly acidic pH (6.0-7.5) although it is drought-tolerant, it performs better with regular watering during the early stages of growth. It Cannot Survive in waterlogged Conditions, as its roots are Sensitive to rot (Foidi et al; 2001).

2.2.2 PROPAGATION METHODS

Moringa Oleifera can be grown either from Seed or Cuttings:

• Seed Propagation: Seeds are Sown directly into the ground or in nursery bags. They germinate within 5 to 12 days. This method is preferred for large- Scale planting- especially for leaf and Pod production.

• Cuttings: Semi-hardwood branches about 1 meter in length and 4-5cm thick can be Planted directly into moist Soil. This method is Common when fast- establishment and early harvesting are needed, especially for Oilseed production. Both methods are easy and the plant requires minimal care compared to many other crops.

2.2.3 SPACING AND PLANTING

The Spacing for moringa depends on the purpose of Cultivation: For Leaf production: Plants are Spaced closely about 15-20 cm apart in rows. (Fuglie 2001).

Planting is usually done at the beginning of the rainy Season to help with early growth and establishment.

2.2.4 FERTILIZATION AND MAINTENANCE

Moringa requires little fertilizer, but Organic compost or manure can be added to improve yield. In poor Soils, adding phosphorus and nitrogen help boost leaf growth. Regular weeding, Pruning and thinning are important to maintain healthy growth. Pruning encourages the plant to grow more branches, which results in more leaves and Pods. For leaf production, harvesting can begin as early as 60days after planting, and leaves can be harvested every 2-3 weeks.

2.2.5 PEST AND DISEASE MANAGEMENT

Moringa is naturally resistant to many pest and disease due to its Strong Phytochemical Composition. However, it can Sometimes be affected by:

• Caterpillars

• Aphids

• Grasshoppers and Root rot (in poorly drained Soil)

Organic Pest Control methods: Such as neem oil or ash can be used. proper drainage and Crop rotation help prevent root and fungal diseases.

2.2.6 HARVESTING

Leaves can be harvested multiple times a year, especially in densely planted areas.

The leaves are dried under Shade and crushed into powder for Storage.

2.2.7 COMMERCIAL AND ECONOMIC POTENTIAL

Due to increasing global demand for health food and natural products, moringa is now Cultivated on a commercial Scale in many Countries, including India, Nigeria, Ghana, Kenya, Philippines and Thailand. It is used in many nutritional Supplements, teas, Oils Cosmetics, animal feed, and bio-fertilizers.

Government and NGOs are also promoting Moringa as low- cost, high- nutrition Crop for fighting malnutrition and boosting local economics

2.3 IMPORTANCE OF MORINGA OLEIFERA

The leaves of Moringa Oleifera, also known as the "miracle tree", are among the most valuable parts of the plant for centuries. They have been used in traditional medicine and nutrition across Asia and Africa. In modern times, scientific research has confirmed what many traditional cultures already knew - that Moringa leaves are a powerhouse of nutrient and healing properties.

2.3.1 RICH NUTRITIONAL VALUE

One of the greatest importance of Moringa leaves lie in their nutrient density. They are an excellent source of:

* Protein (including all essential amino acids)

* Vitamins (such as A, B1 (Thiamine), B2 (Riboflavin), B3 (Niacin))

* Minerals (including Calcium, Potassium, Magnesium, Iron, Zinc)

* Antioxidants (such as Quercetin and Chlorogenic acid)

* Dietary Fiber

It is reported that Moringa leaves contain:

* 7 times more Vitamin C than Oranges

* 4 times more Vitamin A than Carrots

* 3 times more Potassium than Bananas

* 17 times more Calcium than milk

* 2 times more Protein than yogurt (Fuglie, 2001; Anwar et al., 2007)

These nutrient make the leaves especially useful in combating malnutrition, particularly among children and pregnant women in low-resource areas.

2.3.2 IMMUNE SYSTEM SUPPORT

Moringa leaves are rich in Vitamin C and antioxidants which strengthen the Immune System and help the body fight off infections. Flavonoids such as Quercetin and Kaempferol also reduce inflammation and Support Immune health (Gopalakrishnan et al., 2016).

2.3.3 ANTIOXIDANT AND ANTI-AGING EFFECTS

The leaves contain powerful antioxidants that protect the body from Oxidative Stress, a major cause of aging and chronic diseases like cancer, heart disease and diabetes. Chlorogenic acid, for example, helps regulate blood sugar while Quercetin help reduce blood pressure (Leone et al., 2015).

2.3.4 BLOOD SUGAR AND DIABETES MANAGEMENT

Studies have shown that regular intake of Moringa leaf powder can help reduce blood glucose levels, making it useful for people with type 2 diabetes. The presence of compound like Isothiocyanates and polyphenols may help improve Insulin Sensitivity and lower Blood Sugar Spikes after meals (Jaiswal et al., 2009).

2.3.5 Blood Pressure and Heart Health

Moringa Oleifera leaves help lower blood pressure due to their high potassium and antioxidant content. They also reduce cholesterol levels, improving Overall Cardiovascular health and reducing the risk of heart diseases (Fahey, 2005).

2.3.6 ANTIBACTERIAL AND ANTIMICROBIAL PROPERTIES

The leaves have been found to have antibacterial, antifungal, and antiviral effects, making them helpful in treating or preventing infections. Research shows that extracts of Moringa leaves can inhibit the growth of E. coli, Staphylococcus aureus, Salmonella, and Candida albicans (Anwar et al., 2007).

2.3.7 SKIN AND HAIR HEALTH

Because of their high content of Vitamins A and E, Moringa leaves are widely used in skincare and haircare. They promote healthy skin, fight acne, improve hair growth, and protect against dandruff and dryness. Many cosmetic companies now include Moringa extracts in soaps, creams, and shampoos.

2.3.8 BRAIN HEALTH AND MENTAL CLARITY

The leaves are rich in iron and Vitamin B6, which help improve brain function. Antioxidants also protect nerve cells and may reduce the risk of neurodegenerative diseases like Alzheimer’s. Some users report better focus, memory, and mental energy after using Moringa regularly (KoppalaKrishnan et al., 2016).

2.3.9 SUPPORT DURING PREGNANCY AND LACTATION

In many cultures, Moringa leaves are given to pregnant and breastfeeding women to increase nutritional intake and boost milk production. The high content of calcium, iron, and folate helps support both mother and child's health (Figue 2001).

2.3.10 SUSTAINABLE FOOD SECURITY

Moringa leaves grow fast, require little water, and can be harvested multiple times a year. This makes them an ideal crop for food security, especially in drought-prone and impoverished areas. They can be cooked fresh, added to soups, or dried and ground into powder for long-term storage.

2.4. USES AND EFFECTIVENESS OF MORINGA OLEIFERA

Moringa Oleifera, often called the "miracle tree," is widely known for the medicinal and nutritional benefits by its leaves. These leaves have been used for centuries in traditional healing systems like Ayurveda, Unani, and African herbal medicine. In recent years, modern science has begun to confirm the many uses and proven health effects of moringa leaves.

2.4.1 NUTRITIONAL SUPPLEMENT

One of the most common uses of moringa leaves is as a natural food supplement. The leaves are rich in:

- Protein (contain all 9 essential amino acids),

- Vitamins (A, B-complex, C, E),

- Minerals (Calcium, Iron, Potassium, Magnesium),

- Fiber and antioxidants.

Due to its rich profile, moringa is used to combat malnutrition in children and pregnant women. It is often made into powder or capsules and added to meals or taken as a daily supplement.

Studies show that moringa leaf powder significantly improves nutritional status and immune function when consumed regularly (Fuglie 2001; Gopalakrishna et al. 2016).

2.4.2 ANTIOXIDANT AND ANTI-AGING AGENT

The leaves are rich in natural antioxidants like Quercetin, Chlorogenic acid, and Vitamin C. These compounds help protect the body from oxidative stress, which causes aging and chronic diseases.

clinical research confirms that moringa leaf extract reduces oxidative damage and may help slow down aging and prevent diseases such as cancer and heart disease (Fahey, 2005; Anwar et al., 2007).

2.4.3 BLOOD SUGAR CONTROL (ANTIDIABETIC USE)

Moringa leaves are commonly used to help manage diabetes. The plant compounds help improve insulin function and lower blood glucose levels.

Several animal and human studies have shown that moringa leaf extract lowers fasting blood sugar and reduces post-meal sugar spikes (Jaiswal et al; 2009).

2.4.4 ANTI-INFLAMMATORY AND PAIN RELIEF

In traditional medicine, moringa leaves are boiled or crushed to make teas and poultices to treat joint pain, wounds, and swelling. The anti-inflammatory effect comes from compounds like isothiocyanates and flavonoids.

Scientific studies have confirmed its ability to reduce inflammation in both internal and external conditions, such as arthritis, asthma, and ulcers (Gopalakrishna et al; 2016).

2.4.5 ANTIMICROBIAL AND ANTIBACTERIAL USES

Moringa leaves are used to treat infections caused by bacteria, fungi, and viruses. In many cultures, leaf decoctions are used to treat diarrhea, wounds, and skin infections.

Lab tests have shown that moringa leaf extract inhibits harmful microbes like E. coli, Candida albicans (Anwar et al; 2007).

2.4.6 IMMUNE SYSTEM BOOSTER

Moringa leaves help boost the immune system due to their high levels of Vitamin C, beta-Carotene, Zinc, and other immune-supporting nutrients.

Regular use has been linked with fewer infections and stronger resistance to diseases, especially in malnourished individuals (Cleone et al; 2015).

2.4.7 SUPPORTS HEART HEALTH

By lowering cholesterol, triglycerides, and blood pressure, Moringa leaves are used to maintain a healthy heart. The leaves are also known to improve blood flow and reduce the risk of atherosclerosis (hardening of arteries).

Research confirms that Moringa leaf extract significantly reduces cholesterol levels and improves blood vessel health (Fahey 2005).

2.4.8 ENHANCES MILK PRODUCTION: (GALACTAGOGUE)

In many cultures, Moringa leaves are given to breastfeeding mothers to increase milk supply and improve the nutrient content of the milk.

Scientific studies and clinical trials in the Philippines and India support the use of Moringa as an effective galactagogue (Estrella et al; 2000).

2.4.9 USED IN SKINCARE AND COSMETICS

Moringa leaf extracts are added to lotions, creams, and shampoos to help treat acne, dry skin, scalp infections, and promote healthy hair growth.

Its antimicrobial and antioxidant effects make it useful in protecting skin cells and reducing signs of aging (Gopalakrishna et al; 2016).

2.4.10 MENTAL CLARITY AND BRAIN FUNCTION

Traditional healers have used moringa leaves to improve memory, mood, and mental focus. Its nutrient support brain health and may help prevent neurodegenerative diseases.

Animal studies suggest that moringa leaf extract improves learning and memory due to its antioxidant and anti-inflammatory properties (Ganguly & Guha, 2008).

2.5 SIDE EFFECTS OF MORINGA OLEIFERA

Moringa Oleifera, widely known to as the "miracle tree," are particularly praised for their rich content of Vitamins, minerals, proteins, and bioactive compounds. They have been traditionally used to treat malnutrition, inflammation, infections, diabetes, and other chronic diseases (Anwar et al, 2007; Fahey 2005).

Despite these health-promoting properties, it is essential to recognize that moringa oleifera leaves are not entirely free from adverse effects. Like many medicinal plants, improper or excessive consumption, contamination, or interactions with medications can lead to undesirable side effects. While moderate use of moringa leaves is considered safe for most

individuals, awareness of potential risks is crucial, especially for vulnerable populations such as pregnant women, individuals with pre-existing health conditions, and those on long-term medication.

2.5.1 GASTROINTESTINAL SIDE EFFECTS:

Gastrointestinal discomfort is among the most frequently reported side effects of moringa oleifera leaf consumption. Scientific studies and anecdotal evidence have documented the following:

2.5.1.1 Diarrhea: Due to the presence of bioactive compounds with laxative properties, excessive intake of moringa leaves can lead to frequent bowel movements or diarrhea (Cleone et al; 2015).

2.5.1.2 Nausea and Vomiting: Some individuals experience nausea and vomiting, especially when large quantities of raw moringa leaves or concentrated extracts are consumed (Anwar et al; 2007).

2.5.2 REPRODUCTIVE AND PREGNANCY-RELATED RISKS

The use of moringa Oleifera leaves during pregnancy has generated significant concern due to potential risks associated with certain bioactive compounds found in the plant.

Uterine Contractions: Several studies have reported that compounds present in the roots bark, and to a lesser extent the leaves of moringa may induce uterine contraction, increasing the risk of miscarriage or premature labor (Fahey 2005; Fuglie 2001).

Some evidence suggests that excessive consumption of moringa leaves could interfere with hormonal balance during pregnancy, posing risks to fetal development.

2.5.3 BLOOD PRESSURE AND BLOOD SUGAR COMPLICATIONS

Moringa oleifera leaves possess antihypertensive and antidiabetic properties, making them beneficial for managing high blood pressure and diabetes (Jaiswal et al; 2009).

Individuals already taking blood pressure-lowering medications may experience dangerously low blood pressure if moringa leaves are consumed excessively.

Diabetic individuals on insulin or oral hypoglycemic drugs are at risk of developing hypoglycemia when moringa leaves are combined with the medication.

2.5.4 TOXICITY FROM OVERCONSUMPTION

Several animal studies have indicated that extremely high doses of moringa oleifera leaf extract may lead to toxicity, particularly affecting the liver and kidney (Anwar et al., 2007). While human studies remain limited, excessive intake of moringa leaves or their concentrated extracts may overwhelm the body with bioactive compounds, resulting in:

- Liver & Kidney Stress

- Gastrointestinal Irritation

- Electrolyte Imbalance

Moderate consumption and proper preparation of moringa leaves significantly reduce the risk of toxicity.

2.5.5 ANTI-NUTRITIONAL FACTORS

Raw Moringa Oleifera leaves contain anti-nutritional compounds such as:

2.5.5.1 Phytate: Which can bind to minerals like iron, zinc, reducing their absorption.

2.5.5.2 Oxalate: Which may interfere with calcium absorption and contribute to kidney stone formation in susceptible individuals.

2.5.5.3 Tannins and Saponins: Which, in high concentrations, can cause digestive disturbances and reduce nutrient availability (Saini et al., 2016).

Cooking, drying, or fermenting Moringa leaves significantly reduces these anti-nutritional factors, making them safer for human consumption.

2.6 BENEFITS OF MORINGA

2.6.1 COGNITIVE FUNCTION AND MOOD REGULATION

Moringa's high content of Vitamins E and C may help slow neural degeneration and improve brain function. These vitamins are known to act as neuro-enhancers, potentially benefiting individuals with migraines or learning headaches. Additionally, moringa may help regulate the production of neurotransmitters like serotonin, dopamine, and noradrenaline, which are important for memory and mood stabilization.

2.6.2 MUSCLE HEALTH AND ENERGY LEVELS

Moringa leaves are rich in protein, providing approximately 6-7 grams per 100 grams. This makes them beneficial for muscle health and energy. The leaves also contain carbohydrates and fats, which can contribute to increased energy levels. Regular consumption may help combat fatigue and enhance overall stamina.

2.6.3 HEART HEALTH

Moringa has been shown to lower cholesterol levels, which may reduce the risk of heart disease. Its potassium content also promotes healthy blood pressure. These effects are

attributed to the presence of compounds like quercetin and chlorogenic acid, which help fight oxidative stress and inflammation.

2.6.4 BONE HEALTH

The presence of calcium and phosphorus in moringa contributes to maintaining bone density and strength. These minerals are essential for bone health and may help prevent conditions like osteoporosis (bone density loss).

2.6.1 HEALTH BENEFITS OF MORINGA FOR MEN

2.6.1.1 TESTOSTERONE, LIBIDO, AND SEXUAL HEALTH

- Boosts testosterone production in vitro: in mouse Leydig TM3 cells, moringa leaf extract increased testosterone by 34-45% under hCG stimulation.

- Animal studies show improved sexual function.

- Male rats treated with moringa had higher follicle-stimulating hormone and increased sperm quality, and testes antioxidants protection.

- Stress-exposed rats given moringa extract showed enhanced sexual performance.

2.6.1.2. NATURAL APHRODISIAC EFFECTS

- Moringa polyphenols support nitric oxide-mediated blood flow, improving erectile function.

2.6.1.3 FERTILITY AND SPERM QUALITY

- Enhances sperm parameters: Animal data highlighted improvements in motility, morphology, and sperm DNA protection.

2.6.1.4 BLOOD SUGAR CONTROL

- Helps regulate blood glucose: Rodent studies show moringa leaf extracts lower blood sugar by enhancing insulin production or uptake.

2.6.1.5 PROSTATE HEALTH

- May support prostate wellness: Animal studies found glucosinolates in moringa might reduce prostate size and PSA levels.

2.6.1.6 CARDIOVASCULAR HEALTH AND ENERGY

- Heart-friendly and cholesterol-lowering: Animal studies suggest moringa protects the heart, lowers LDL cholesterol, and supports healthy weight.

- Boosts energy: High B-vitamins and iron content help combat fatigue and enhance stamina.

2.6.1.7 MENTAL HEALTH AND MOOD

- Supports mood and cognition: Moringa's tryptophan, magnesium, and antioxidants may enhance mood and reduce anxiety.

2.6.2 HEALTH BENEFITS OF MORINGA FOR WOMEN

2.6.2.1 MAY HELP PROMOTE LACTATION

Moringa has been traditionally used to increase milk supply for lactating mothers for many years. Still today, women may use moringa to potentially support their milk supply. Because it is packed with nutrients like calcium, vitamin C, B, beta-carotene, and amino acids, moringa may contribute to lactation. However, it’s important that new mothers purchase their moringa from a trusted source, as some products may be filled with cheap fillers or harmful chemicals.

2.6.2.2 MAY SUPPORT LIBIDO

Research studies have shown that the vitamins and minerals in moringa seeds can offer potential sexual health benefits. Vitamin C can aid in immune system health and regulate circulation, leading to increased stamina. Vitamin D can assist with balancing sex hormones in both women and men. Minerals like calcium, iron, and zinc may also support libido.

2.6.2.3 MAY AID IN WEIGHT MANAGEMENT

For women, maintaining a healthy body weight can be incredibly challenging, as they tend to have slower metabolism than men. Studies suggest that moringa powder may support a weight management plan through the breakdown of fats, known as lipolysis.

2.6.2.4 SUPPORTS BONE HEALTH

Calcium and phosphorus are essential nutrients for maintaining strong and healthy bones. Moringa is a fantastic source of both minerals, providing about 17 times more calcium than milk and is high in vitamins K and D. Many studies have linked these years following age-related hormonal changes to a loss of bone density in some women. Because of this, calcium-dense foods may provide potential health benefits.

2.7 NUTRIENTS IN MORINGA

2.7.1 Macronutrients in Moringa

2.7.1.1 Proteins

- Moringa leaves are a rich source of plant-based protein. They contain essential amino acids such as leucine, isoleucine, valine, threonine, and phenylalanine, which are crucial for body growth and repair. On a dry weight basis, moringa leaves may contain up to 27% protein, which is comparable to the protein content in milk and eggs. (Gopalakrishnan et al., 2016).

2.7.1.1.2 Carbohydrates and Fats

- Moringa leaves contain a moderate amount of carbohydrates. They are low in fat. The fats present include beneficial fatty acids such as omega-3 and omega-6. Moringa seed oil, extracted from its seeds, is known for its high monounsaturated fat content, particularly oleic acid, which supports heart health.

2.7.2 Micronutrients in Moringa

Moringa is considered a rich source of various essential vitamins:

2.7.2.1 Vitamin A (as beta-carotene): Important for vision and immune function. Moringa leaves provide up to 7,500 mg of beta-carotene per 100g of dried leaves.

2.7.2.2 Vitamin C: Supports immunity and acts as an antioxidant. Fresh moringa leaves can provide 220 mg of vitamin C per 100g, which is more than most citrus fruits.

2.7.2.3 Vitamin E: Present in moringa seed oil, it contributes to skin and cell health. (Mayo et al., 2011).

Moringa is considered a rich source of various Minerals

2.7.2.4 Moringa leaves are exceptionally rich in minerals which are critical for various body functions:

2.7.2.5 Calcium Important for bone health. Moringa contains 440 mg of calcium per 100g of fresh leaves, which is more than in milk.

2.7.2.6 Iron: Vital for red blood cell production. Moringa contains up to 7 mg of iron per 100g, aiding in combating anemia.

Potassium Moringa leaves provide 2591 mg of potassium per 100g, which supports nerve function and fluid balance.

Magnesium and Zinc Present in smaller quantities but important for enzyme functions and immune health.

2.7.3 Phytochemicals and Antioxidants

Besides macro- and micronutrients, moringa contains powerful phytochemicals such as:

2.7.3.1 Quercetin A: natural antioxidant that helps in lowering blood pressure.

2.7.3.2 Chlorogenic acid: Helps regulate blood sugar levels.

2.7.3.3 Isothiocyanates: Known for their anti-inflammatory and anti-cancer properties. (Fahey, J.W. (2005)).

2.8 MEDICINAL PROPERTIES OF MORINGA OLEIFERA

Moringa oleifera, commonly known as the "drumstick tree,""miracle tree," or "horseradish tree," is a fast-growing, drought-resistant tree native to India and now widely cultivated in tropical and subtropical regions. It has been used for centuries in traditional medicine systems such as Ayurveda and Unani for its vast therapeutic benefits. Modern

scientific studies have validated many of these uses, demonstrating that it possesses a wide range of medicinal properties, largely due to its rich content of bioactive compounds, vitamins, minerals, and antioxidants.

2.8.1 Antioxidant Properties

Moringa contains powerful antioxidants such as Vitamin C, beta-carotene, quercetin, and chlorogenic acid. These compounds help neutralize free radicals in the body, which are responsible for oxidative stress, a major contributor to aging and chronic diseases such as cancer and cardiovascular diseases. (Sreelatha and Padma, 2009).

2.8.2 Anti-Inflammatory Effects

Chronic inflammation is associated with many serious health problems, including arthritis, heart disease, and metabolic syndrome. Moringa contains isothiocyanates, flavonoids, and phenolic acids, which have been shown to significantly reduce inflammation. (Mehta and Mehta, 2010).

2.8.3 Anti-Diabetic and Antihyperglycemic Properties

Moringa leaf extracts have demonstrated a blood sugar-lowering effect. This is attributed to the presence of chlorogenic acid, which helps regulate blood glucose levels by slowing

down the absorption of sugar in the intestines and enhancing insulin secretion. (Jaiswal et al., 2007).

2.8.4 Antimicrobial and Antibacterial Activity

Moringa extracts exhibit broad-spectrum antimicrobial activity against bacteria and viruses. The isothiocyanates and pterygospermin in moringa leaves are effective against pathogens such as Staphylococcus aureus E.Coli, salmonella, and pseudomonas aeruginosa(Saadabi et al.,2011).

2.8-5 Hepatoprotective (Liver Protecting) Activity

Moringa leaf extract has been shown to protect the liver from damage caused by toxins and heavy metals. This is due to its antioxidant action and ability to reduce lipid peroxidation and enhance detoxifying enzymes in the liver (Anwar and Bhanger, 2003).

2.8.6 Cardiovascular Health

- The high antioxidant and anti-inflammatory profile of moringa helps protect against heart disease. Studies have shown that moringa leaf extract can reduce cholesterol, lower blood pressure, and prevent the buildup of arterial plaque. (Ghasi et al., 2000).

2.8.7 Anti-Cancer Potential

- Preliminary studies suggest that moringa may have anti-cancer properties, especially against cancers such as breast, colon, and prostate. The plant contains niazimmin and other bioactive compounds that may suppress the development of cancer cells and induce apoptosis (programmed cell death). (Sreelatha et al., 2011).

2.8.8 Neuroprotective Effects

- Moringa has shown neuroprotective potential, particularly in conditions like Alzheimer's disease. The antioxidants in moringa reduce oxidative stress in the brain and improve memory and cognitive function. (Yisa and Dixit, 2003).

2.8.9 Wound Healing and Skin Health

- Topical application of moringa leaf extract aids in wound healing due to its antimicrobial and anti-inflammatory properties. Moringa oil, rich in fatty acids and vitamin E, also promotes healthy skin by moisturizing and protecting against infections. (Anwar et al., 2007).

CHAPTER THREE

3.0 MATERIALS

3.1.1 COLLECTION AND PREPARATION OF MORINGA OLEIFERA SEED

The seed of moringa oleifera was purchased at Oja Oba Market Ilorin, Kwara State.

The seeds were de-shelled, air dried for two weeks and pulvirized using an electric

grinder. 25 g of pulverized sample was macerated with distilled water for ½ h. The aqueous extract was concentrated to dryness using water bath. The extracts of the sample M. oleifera was used for the phytochemical screening and determination of the antioxidant activity.

3.1.2 APPARATUS

- Beaker

- Test tube

- Funnel

- Measuring cylinder

- Conical flask

- Weighing balance

- Pipette

- Burette

- Tripod stand

- Weighing balance

- Water baths

- Bucket centrifuge

- Best Rotator evaporator

- Laboratory oven

3.3 REAGENTS

- Copper sulphate (Cu^{2+})

- Sodium sulphate

- Hydrochloric Acid (HCl)

- H_2SO_4

- Sucrose

- Sodium Nitroprusside

- n - hexane

- Sulphuric acid

- NaOH

- APPH:2,2-diphenyl, 1-picryl hydrazine reagent

3.2 METHODS

3.2.1 PHYTOCHEMICAL ANALYSIS

The phytochemical components of leaves extracts were analyzed using standard protocol (Cukoba et al., 2011; Shah, 2012; Hossan et al., 2013).

3.2.4 Antioxidant Analysis

3.2.4.1 DPPH:

0.1mM working solution of ΔPPH in methanol was prepared. 1mg/ml of the sample was prepared in appropriate solvent; the concentration of the sample was varied to 100-500µl by serial dilution; the reaction mixture contained 100µl of the sample and 500µl of ΔPPH reagent; the mixture was allowed to incubate at room temperature for 30 min in dark; the absorbance of the reaction mixture was taken at 517nm against the reagent blank, methanol;

the control involved methanol and ΔPPH reagent. Ascorbic acid was used as standard to compare the % inhibition.

Calculation:

% Inhibition = Absorbance Ctrl - Absorbance Sample / Absorbance Ctrl × 100 (Adamoye et al., 2018)

3.2.4.2 NO (Nitric oxide) Free Radical Scavenging Activity

Nitric oxide (NO) is an important physiological messenger and effector molecule in many biological systems including immunological, neuronal and cardiovascular tissues. Due to its involvement in these diverse systems

Preparation of Griess reagent: Equal volume of 0.1% N-(1-naphthyl)ethylenediamine dichloride (NED) water and 1% Sulfanilamide in 5% phosphoric acid was used to obtain Griess reagent.

It should be noted that the 10mM Sodium nitroprusside is prepared to 10mM phosphate buffer

Nitric oxide generated from sodium nitroprusside to aqueous solution at physiological pH interacts with oxygen to produce nitrite ions which was measured by Griess reaction; the reaction mixture contained 2ml of 10mM Sodium nitroprusside prepared to 10mM phosphate buffered saline (pH 7.4) and 0.5ml of different concentration of sample (100-

500µg/ml). The mixture was incubated at 25°C for 1hr ± 0.5 ml of the incubated again at room temperature for 30min in the dark and its absorbance measured at 540nm against blank; the blank contained phosphate buffered saline only while the Control was all reagent without sample. Ascorbic acid or rutin was used as Standard. The concentration of nitrite formed was derived from regression analysis using serial dilutions of sodium nitrite as a standard. The percentage inhibition of NO radical was calculated as follows:

% Inhibition of NO radical = $[(A_0 - A_1) / A_0] \times 100$

where A_0 is the absorbance of the control and A_1 is the absorbance in the presence of the extract or standard.

The mixture was incubated at room temperature for 6min after which the absorbance was taken at 593nm against reagents blank. Distilled water was used in place of sample for blank. Aqueous ascorbic acid solution at 100, 250, 500, and 1000pm (equivalent at 200, 500, 1000, and 2000µM FRAP) was used as standard or Ferrous sulphate ($FeSO_4 \cdot 7H_2O$) of same concentration. The FRAP value of the sample was calculated from the formula: FRAP (µM) Value = (Abs test sample / Abs standard) × FRAP std (µM)

It should be noted that if Fe(II) standards are used for the calculation of ascorbic acid concentration, 1000µM of FRAP value to only 500µM of ascorbic acid. Similarly, if ascorbic acid standards are used for the calculation of FRAP values, these values are double

the ascorbic acid concentration; 1-2, 1000µM ascorbic acid is equivalent to 2000µM FRAP (Benzie and strain, 1996)

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1.1 THE RESULT OF PHYTOCHEMICAL TEST IN SAMPLED PARTS OF MORINGA OLEIFERA

Phytochemical	Presence
Alkaloids	++
Flavonoids	++
Tannins	+
Phenols	+
Saponins	–
Steroids	–
Phlobatannins	–
Reducing Sugar	+
Anthraquinones	+

Key: ++ Moderately Present

+ Slightly Present

– Absent

4.1.2 THE RESULT OF VARY CONCENTRATION OF ANTIOXIDANT ACTIVITIES OF MORINGA OLEIFERA SEED

Assay Type	100 µg/mL	200 µg/mL	300 µg/mL	400 µg/mL	500 µg/mL
DPPH	78.43 ±4.43	88.85 ±4.43	82.13 ±3.63	83.03 ±1.82	84.81 ±2,21
Nitric Oxide (NO)	85.35 ±1.93	85.80 ±1.12	92.50 ±1.90	78.52 ± 1.50	39.60 ± 0.56

4.2 DISCUSSION

The phytochemical assay revealed that Moringa oleifera seed contain various components such as alkaloids, anthraquinone, flavonoids, phenols, reducing sugars, tannins, saponins, steroids, in varying concentrations with the absence of phlobatannins as shown in Table 4.1.1. This is similar to the results reported by Nepolean et al., (2009); Fowoyo and Oladoja, (2015), and Nkot et al., (2018) on M. oleifera.

Literatures have it that medicinal plants containing alkaloids, flavonoids and phenols as bioactive metabolites have good antibacterial properties and the presence of these metabolites in Moringa oleifera could make it a potent antibacterial agent (Akintelu et al., 2021). Flavonoids are responsible for the medicinal qualities accorded in the leaf. Foye et al. (2008) reported that they also induce mechanisms that may kill cancer cells and inhibit

tumor invasion. Saponins are also used as an adjuvant in the production of vaccines and also possess antioxidant, anti-inflammatory, anti-apoptosis and immune-stimulant as reported by Woods et al. (2017). Alkaloids are nitrogen-containing naturally occurring compounds, commonly found to have antimicrobial properties and are used as antimalarial, pesticides, tranquilisers and stimulants (Galeotti et al., 2008).

The antioxidant potential of Moringa oleifera extracts revealed increase in reductive potential with increasing concentration of the extracts while the aqueous extract was observed to have the least scavenging activity as shown in Table 4.1,2

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Moringa oleifera is one of the medicinal plants reported in folklore to have been explored for its beneficial purposes. The presences of various phytochemicals and high antioxidant activities as asserted in this study lay credence to the fact the seed of M. oleifera may be a good source of therapeutic material to treat a number of diseases.

5.2 RECOMMENDATION

Moringa leaves can be consumed as a dietary supplement in the form of capsules, powder or tea. It can also be added to soups, salads, and other dishes for an extra nutritional boost. For powdered Moringa leaves, a common recommendation is 1-3 teaspoons per day, mixed with food or drinks. It can be consumed in various forms, including fresh leaves in salads, dried leaves in tea or as a powder added to food or drinks. Moringa may interact with certain medication particularly those for diabetes, blood pressure and thyroid disorders.

Further studies may be employed to ascertain the medicinal properties of moringa oleifera leaf.

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