

EFFECT OF ETHANOL ROOT EXTRACT OF *Moringa oleifera* LAM. ON
BLOOD SUGAR LEVEL IN NON-DIABETIC WISTAR RATS

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University of Benin

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AUGUST, 2023

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A PROJECT THESIS SUBMITTED TO THE DEPARTMENT OF PLANT
BIOLOGY AND BIOTECHNOLOGY, FACULTY OF LIFE SCIENCES,
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THE REQUIREMENTS FOR THE AWARD OF THE BACHELOR OF
SCIENCE (HONOURS) DEGREE (B.Sc.) IN PLANT BIOLOGY AND
BIOTECHNOLOGY.

AUGUST, 2023

CERTIFICATION

We certify that this research work was carried out by Amarachi Favour ONUMAJURU of the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin city, Nigeria.

Dr. Odaro Timothy

(Project Supervisor)

Signature and Date

Prof. E.D. Vwioko

(Head of Department)

Signature and Date

DEDICATION

This research work is dedicated to God Almighty in heaven for his guidance, protection, wisdom, knowledge and understanding throughout this work. This work is also dedicated to my lovely parents and siblings for their support throughout this work.

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ABSTRACT

Moringa oleifera Lam. is a tree plant specie belonging to the family Moringaceae and it is widely used for various medicinal purposes. This study is aimed at determining the effect of sub-chronic administration of ethanol root extract of *M. oleifera* on the blood sugar level of non-diabetic Wistar rats. Eighteen adult albino Wistar rats, weighing between 157 g to 292 g were used for the study. The animals were divided into four groups, namely: Groups I, II, III and IV(Control). The extract was prepared using fresh roots of the plant collected from Obe Quarters, Benin City, Edo State. The roots of the plant were shade dried and were grinded to powder form. The extract was obtained by cold maceration of the powdered roots in 99% ethanol at room temperature for 72 hours, filtered and evaporated to dryness in a drying oven at 50°C. Groups I, II and III orally received 150, 300 and 600 mg/kg of ethanol root extract of *M. oleifera* respectively for a period of 21 days while the control group was administered distilled water only. The blood sugar level of each of the treated rats was measured after 24 hours of extract administration, and subsequently on Day 7, 14 and 21 by reading a strip of blood sample collected from the tail vein using a glucometer test kit. From the results obtained, it was observed that the blood sugar levels in all the treatment groups were not significantly different ($p > 0.05$) when compared with the control. In conclusion, ethanol root extract of *M. oleifera* does not have any negative impact on normal glyceimic values in Wistar rats.

INTRODUCTION

1.1 BACKGROUND OF STUDY

Herbal medicine is the oldest form of health care which has been used for decades in developing countries and developed countries. Primitive humans have always relied on nature for their food, clothing, housing, and medical needs. These people were able to distinguish between herbs that were effective and had positive effects from those that were harmful or inert (Kunle *et al.*, 2012). The primary therapeutic component of African traditional medicine's non-conventional healthcare is herbal medicine. Some of the factors cited for the current interest in and popularity of herbal medicine include its consistent positive effects on primary healthcare, relative affordability of treatment, ease of access to herbs, herbal materials, and finished herbal medications, close relationships between patients and practitioners, lower relative side effects, and success in the management of diseases for which conventional therapies have failed and acceptable elegant dosage form presentations for finished herbal medicines (Elkordy *et al.*, 2021; Builders and Builders, 2016). While the powders are made from finely ground or pulverized plant components, the liquid combinations frequently come from infusions and decoctions of herbs (Kumadoh and Ofori-Kwsakye, 2017). *Moringa oleifera* is also known as the “tree of life” or “miracle tree”. Due to its numerous medical and non-medical benefits, it is regarded as an important herbal plant. The plant has historically been used to treat cancer, inflammation, ulcers, liver, heart, and other diseases. The roots of the plant have been found to possess several distinct pharmacological properties and root preparations are used for the cure of bronchitis, stomatitis, common cold, fever, diarrhea, anti-inflammatory, anti-diabetic and many other (Mittal *et al.*, 2007). Blood glucose levels are automatically controlled by the body as part of metabolic homeostasis. The body's cells primarily use glucose as an energy source. The hormone insulin,

which the body produces mostly in the pancreas, makes glucose available for cell absorption when it travels from the intestines or liver to the body cells through the bloodstream. The level of glucose (sugar) in the blood is determined via a blood glucose test. It is being measured using a glucometer with test strips and the results are measured in milligram per deciliter(mg/dl).

1.2 *Moringa oleifera*

The *Moringa oleifera* Lam. is a tropical tree that belongs to the Moringaceae family, which includes about 13 different species (Vaknin *et al.*, 2017). *M. oleifera* is the most well-known, though. Although it is also grown in the Red Sea region and/or other parts of Asia and Africa, including Madagascar, this crop originates from northern India and some regions of northern Europe. It has been given various names, such as "benzolive tree, drumstick tree, horseradish tree, mulangay, moonga, saijhan, marango, sajna, mlonge, or Ben oil tree" (Zainab *et al.*, 2020), due to its widespread distribution throughout the world (Asia, Africa, Central, and South America) (Singh *et al.*, 2019).

1.2.1 TAXONOMIC CLASSIFICATION

Kingdom - Plantae

Sub kingdom - Tracheobionta

Super Division – Spermatophyta

Division -Magnoliophyta

Class -Magnoliopsida

Subclass – Dilleniidae

Order – Capparales

Family – Moringaceae

Genus – *Moringa*

Species – *oleifera*

Binomial – *Moringa oleifera* Lam.

BOTANICAL DESCRIPTION

The *Moringa oleifera* tree is a small, quickly-growing evergreen or deciduous tree that typically reaches a height of 9 meters. Its wood is soft and white, and its bark is corky and sticky. Horseradish is the flavor of roots. The leaves are longitudinally cracked, 30-75 cm long, with a jointed main axis and branch, glandular at the joint, and whole, glabrous leaflets. The leaflets have whole (not toothed) borders, are rounded or blunt-pointed at the apex, and are short-pointed at the base. They are coarsely hairy, green on the upper surface, and nearly hairless beneath. The mid-veins have a reddish tint. The twigs are green and have tiny hairs. Flowers are white, scented in large axillary down panicles, pods are pendulous, ribbed, seeds are 3-angled (Garima *et al.*, 2011).



Plate 1: *Moringa oleifera* tree

Photo Credit: Amarachi Favour Onumajuru

1.2.3 DISTRIBUTION AND CULTIVATION

Moringa Oleifera is native to the southern Himalayan slopes and was widely dispersed by migrating Asian communities into tropical and subtropical regions (Bosch, 2004; Radovich, 2009). Ancient Egypt, Ancient Greece, and the Roman Empire all valued the seed oil for making perfumes (Orwa *et al.*, 2009; Bosch, 2004). In the majority of African nations, the Caribbean Islands, and Central America, the species has now been naturalized. It is a significant crop in India, Ethiopia, the Philippines, and the Sudan (FAO, 2014). It can be found up to 1000m in the

Himalayas, 1350 m in East Africa, and as high as 2000 m in Zimbabwe, however it only grows up to an altitude of 600 m from sea level (Bosch, 2004; Radovich, 2009). When the average temperature is high, between 25 and 30°C, it thrives. Frost and low temperatures can destroy plants down to the ground, but if the temperature rises, regeneration happens quickly. Where there is an average yearly rainfall of 1000–2000 mm, the species thrives. Although the amount of foliage produced under such circumstances is reduced, it is resilient to drought and may live where rainfall is as low as 400 mm. It also has a limited tolerance for waterlogging. It works well in full sunlight and tolerates a variety of soils with pH values ranging from 4.5 to 9, as long as they are well-drained (Bosch, 2004; Radovich, 2009). Additionally, it can tolerate some salt (up to 3 d S/m) during germination and 8 d S/m if well-established. (Oliviera *et al.*, 2009; Nouman *et al.*, 2014). The primary exporter of moringa is India, which also produces fresh fruits (1.2 million t in India), oil, and leaf powder (Radovich, 2009). The primary item traded locally in Africa is leaves (Bosch, 2004).

1.2.4 PHYTOCHEMISTRY

Moringa plants provide large and rare combination of zeatin, quercetin, beta – sitosterol, kaempferol, and caffeoylguinic acid. Vital minerals present in the plant include iron, potassium, calcium, copper, zinc, magnesium, manganese etc. Other most important and valuable species of the plant are *M. oleifera*, *M. arborea*, *M. drouhardii*, *M. ovalifolia*, *M. longituba*, *M. rivaie*, *M. borziana*, *M. corcanensis*, *M. hildebrandtii*, *M. ruspoliana*, *M. astenopetala*, *M. peregrine*, *M. pygmaea*. The bark, leaves, seeds, flowers, roots, and immature pods of the plant contain a great number of essential phytoconstituents such as terpenoids, alkaloids, tannins, steroidal aglycones, and reducing sugars. The leaves include necessary amino acids that aid in the development of robust, healthy bodies. Because of its ability to purify water and have a high nutritional value, *M.*

oleifera leaves have been employed in traditional medical systems for ages. This includes the ayurveda system of medicine, which is linked to the treatment or prevention of ailments. Despite being small and challenging to harvest, plant leaves have a complex nutritional profile that includes vitamins, minerals, and vital amino acids. One hundred grams of dried *M. oleifera* leaf provide 25 times the iron in spinach, 15 times the potassium in bananas, 12 times the vitamin C in oranges, and 9 times the vitamin A in carrots. Antioxidants abound, and the leaves of the plant are a rich source of antioxidants, including quercetin, chlorogenic acid, beta-carotene, and vitamin C. Blood sugar levels have been shown to be lowered by chlorogenic acid (Vaidya *et al.*, 2007). The leaves and seeds may protect against some of the consequences of arsenic toxicity, which is especially noteworthy in light of recent developments. Arsenic contamination of ground water has also become a source of global public health concern. The seeds have even been proven to be more effective in water purification (Gupta *et al.*, 2010). The roots have antibacterial qualities and are used to treat illnesses such as asthma, digestive issues, gastritis, inflammation, and skin disorders. *M. oleifera* is notable for its isothiocyanates, which have antibacterial activity and may help to rid your body of *H. pylori*, a bacteria linked to gastritis, ulcers, and gastric cancer. It is also noteworthy for its high fiber content, which, as the epoch times put it, acts like a mop in your intestines to clean up any extra grime left over from a greasy diet (Tangkiatkumjai *et al.*, 2020.)

1.2.5 ETHNOMEDICINAL USES

Since ancient times, people have consumed *M. oleifera* because of its essential healing properties. The plant is reported to have been used for generations to make a variety of medications that contain ethnomedicinal characteristics for treating ailments. Almost all of this plant's parts,

including the leaf, pod, bark, gum, flower, seed, seed oil, and root, have been used to treat various illnesses (Stohs *et al.*, 2015). The plant has been used as a diuretic (Tahkur *et al.*, 2016), anti-diarrheal agent (Misra *et al.*, 2014), antihypertensive agent and anti-anxiety agent (Bhat and Joy, 2014) in pathological changes. Additionally, it is used to treat colitis and dysentery. Inflammatory disorders like bronchitis, headaches, and glandular inflammation can be treated quickly using a poultice made from the leaves (Posmontier, 2011). The pods alleviate joint discomfort and treat hepatitis (Gopalakrishnan *et al.*, 2016). The roots are traditionally used to treat kidney stones, liver diseases (Ghasi, 2000), inflammation (Paliwal *et al.*, 2001), ulcers (Debnath *et al.*, 2007), as well as pain in the ear and tooth. To cure wounds and skin infections, the stem's bark is used (Rathi, 2006). The gum that is derived from this plant is used by Indians to treat fever and to cause abortions. The plant's seeds have laxative properties and are used to treat tumors, prostate issues, and bladder issues. By modifying oxidative stress and lowering inflammation, the seeds demonstrate potential for the treatment of arthritis (Meireles *et al.*, 2020). Preparations made from the plant's leaves aid nursing women, undernourished infants, and the population's overall health. *M. oleifera* leaves have been effective in treating wounds and helping individuals with insomnia (Liu *et al.*, 2022). The ancient Egyptians also prepared skin ointments using moringa, which is currently utilized incredibly widely in the beauty business (Toma *et al.*, 2014).

1.2.6 BIOLOGICAL ACTIVITY

The antioxidant, anti-inflammatory, anti-cancer, and anti-hyperglycemic properties of moringa species are widely documented. Their abundance of flavonoids, glucosides, and glucosinolates accounts for the majority of their biological activity. (Abdel-Rahman *et al.*, 2010)

Antioxidant Activity: Bioactive substances from Moringa pods such as glycosylates, isothiocyanates, thiocarbamate, flavonoids, and several other chemicals have been studied for reactive oxygen species (Nunthanawanich *et al.*, 2016). The aqueous extract has been found to be an effective free radical scavenger. Previous research suggests that the antioxidant capacity is related to kaempferol, which is found primarily in plant leaves. The plant has a synergistic effect with piperine and curcumin on oxidative stress caused by beryllium poisoning in Wistar rats (Agrawal *et al.*, 2015). The plant's alcoholic extract inhibited glucose-induced cataractogenesis in isolated goat eye lenses by regulating GSH levels. Myricetin, obtained from seed extract, has been shown to be more effective as an antioxidant than BHT (butylated hydroxytoluene) and alpha-tocopherol. In HEK-293 cells, *M. oleifera* leaf extract and components such as isoquercetin, astragalins, and cryptochlorogenic acid help decrease ROS (Vongsak *et al.*, 2015). Moringa also helps to lower plasma monoaldehyde (MDA) levels in fasting plasma glucose (FPG) concentrations in healthy volunteers when compared to persons fed warm water. A dose-dependent increase in GSH and a decrease in MDA levels were reported with the plant's alcoholic extract up to 100 mg/kg.

Anti-diabetic Activity: *M. oleifera* leaves improved glucose tolerance in Wistar and Goto-Kakizaki rats and also reduced blood glucose levels. In rats, the aqueous extract showed an anti-diabetic effect by reducing blood glucose levels, protein, sugar, and hemoglobin (Sing *et al.*, 2018). The plant's leaves were found to lower glucose levels within three hours of consumption, but not more than the standard drug glibenclamide. When administered orally, the seeds contain insulin-like proteins with antigenic epitopes similar to insulin and exhibit antihyperglycemic activity (Al-maliki *et al.*, 2015). The plant's leaf extracts also exhibit anti-diabetic potential, as

they boosted CAT and MDA levels, decreased FPG levels, hemoglobin levels, LDL-C, and VLDL-C levels in type 2 diabetes patients, and, most crucially, increased insulin levels in healthy individuals (Villarruel-López *et al.*, 2018). The plant's seed extract reduced LPO levels and amplified the antioxidant effect in streptozotocin-induced mice. It was also able to reduce IgG, IgA, and IL-6 parameters, as well as pancreatic β -cell activity, and it was suggested that the bioactive compounds responsible for this effect were quercetin, kaempferol, glucomoringin, chlorogenic acid, and isothiocyanates (Azad *et al.*, 2017).

Antimicrobial and Antifungal Activity: The chemical N-benzylethyl thioformate (an aglycone of deoxyniazimincin) in *M. oleifera* ethanolic root extract is responsible for the antibacterial and antifungal impact against a wide range of microorganisms and fungi (Upadhyay *et al.*, 2015). Its methanolic leaf extract may prevent Gram-negative and Gram-positive bacterial infections of the urinary tract, including *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Escherichia coli*, and *Staphylococcus saprophyticus* (Maurya and Singh, 2014). The inhibitory effect of extracts from leaves, seeds, and stems of *M. oleifera* has been specified in various fungal strains such as *Aspergillus flavus*, *Aspergillus terreus*, *Aspergillus nidulans*, *Rhizoctonia solani*, *Aspergillus niger*, *Aspergillus oryzae*, *Fusarium solani*, *Penicillium sclerotigenum*, *Cladosporium cladosporioides*, *Trichophyton mentagrophytes*, *Penicillium species*, *Pullarium species* (Upadhyay *et al.*, 2015). The active components of the seeds, 4-(alpha-L-rhamanosyloxy) benzyl isothiocyanates, are thought to be responsible for their antibacterial action (Padla *et al.*, 2012). The juice of the leaves also shown antibacterial activity against human pathogenic microorganisms (Mishra *et al.*, 2011). The methanolic leaf extract inhibits *Botrytis cinerea* (a necrotrophic plant fungus) by approximately 99% (Ahmadua *et al.*, 2020).

Anti-Inflammatory Activity: Different sections of *M. oleifera* (leaves, pods, flowers, and roots) showed a substantial anti-inflammatory impact. The isolated chemical (4 - [2-o-Acetyl-alpha -l-rahannoslyoxy) benzyl] thiocynate from *M. oleifera* was discovered to have nitric oxide inhibitory action and was later demonstrated to be efficacious in Raw264.7 cell lines (Tan *et al.*, 2017). TNF- production was suppressed by a substance produced from *M. oleifera* roots known as aurnatiamide acetate and 1,3-dibenzylurea (Cuellar-Nez *et al.*, 2021). Active substances with anti-inflammatory characteristics include tannins, phenols, alkaloids, flavanoids, carotenoids, -sitosterol, vanillin, and moringin (Bhattacharya *et al.*, 2018). The fruit extract inhibited nuclear factor kappa B (NF κ B) translocation, and the chloroform extract was shown to be cytotoxic at high doses (500-1000 g/mL) (Abdel-Daim M.M *et al.*, 2020). The leaves extract was reported to be successful in lowering the expression of mannose receptor mRNA, thymic stromal lymphopietin, and retinoic acid-related orphan receptor γ T in ear tissues when administered in mice to treat atopic dermatitis in human keratinocytes (Choi *et al.*, 2016).

Anti-Cancer Activity: Several *M. oleifera* components (fruits, leaves, flowers, and stems) have been proved to be useful against cancer, a terrible illness. The isolated plant chemicals thiocarbamate and isothiocyanate suppress tumor cell growth (Parvathy *et al.*, 2007). The dichloromethane fraction was reported to be cytotoxic for MCF7 breast cancer cells (Mohd *et al.*, 2021). Niazimincin has been proposed as an effective chemopreventive drug in chemical carcinogenesis. In the melanoma mouse model, alcoholic and hydro-methanolic extracts of fruits and leaves significantly slowed tumor development. Soluble cold distilled water from *M. oleifera* suppressed tumor cell proliferation and lowered ROS (reactive oxygen species) in cancer cells (Singh and Navneet, 2018). A recent research based on computer modeling reveals that the plant

has rutin with the greatest binding affinity to BRAC-1 (Breast Cancer Gene-1) (Balogun *et al.*, 2021).

Anti-Allergic Activity: The ethanolic seed extract lowered histamine release while also suppressing anaphylaxis caused by anti-immunoglobulin G. The mechanism behind this action may be the membrane-stabilizing potential of mast cells in an oval albumin sensitization model (Bhattacharya *et al.*, 2018).

Anti-Venom Effect: The leaves of the plant extract were shown to be effective against the venom of *Naja Nigricollis* (a snake species) in rats. This snake's venom contains potent neurotoxins that cause the degradation of phospholipids at the plasma membrane, affecting the normal neurotransmission process and causing hemolysis and hemorrhage. The results showed that *M. oleifera* extract effectively cured acute anemia, and a remarkable increase in micronucleated polychromatic erythrocytes was observed in rats treated with the plant. (Adeyi *et al.*, 2020).

Hepatoprotective Activity: Among the various flavonoids (quercetin, kaempferol, isoquercetin, rhamnetin, and so on) found in *M. oleifera*, quercetin in the flowers of the plant is assumed to be responsible for the hepatoprotective action. Methanolic extract at modest doses changed the hepato-renal and hematological profiles, with substantial alterations in serum aminotransferase concentration, plasma cholesterol level, alkaline phosphate, bilirubin, and serum LPO levels. However, a greater dose of the extract increased total bilirubin, blood urea nitrogen, and non-protein nitrogen levels while decreasing clotting time (Mishra *et al.*, 2011). *M. oleifera* demonstrated comparable hepatoprotective qualities in these rats by reducing the levels of AST, ALT, and ALP after acetaminophen-induced liver damage in Sprague-Dawley rats, while the

reference medication used was silymarin (Sharifudin *et al.*, 2013). The seeds were also shown to be beneficial against carbon tetrachloride-induced liver fibrosis, as demonstrated by a decrease in serum aminotransferase activity and globulin levels (Hamza, 2010). When silymarin was used as the usual treatment for acetaminophen-induced liver damage in Sprague-Dawley rats, Moringa demonstrated comparable hepatoprotective qualities by lowering the levels of AST, ALT, and ALP in these animals. (Sharifudin *et al.*, 2013). A decrease in blood aminotransferase activity and globulin levels showed that the seeds were also beneficial in preventing carbon tetrachloride-induced liver fibrosis (Hamza, 2010). This plant's alkaloid, quercetin, kaempferol, flavonoids, ascorbic acid, and benzyl glucosinolates were discovered to have the effect that treatment with this plant extract for around 21 days on a daily basis as diet greatly decreased liver damage.

Toxicity: Several experimental methods were carried out in order to assess the plant's hazardous potential. An oral dosage of 2000 mg/kg aqueous methanol solution was administered to a random sample of female non-pregnant Wistar albino rats. Blood samples were taken, and the levels of ALT, AST, and total bilirubin were determined. The study's findings revealed that the fatal dosage of the aqueous extract in female rats was greater than 2000 mg/kg (Zhang *et al.*, 2011). Experiments for acute and subacute toxic tests revealed that the stem bark extract had no hazardous impact in acute and subacute toxic trials up to 2000 mg/kg. As a result, the researchers determined that the stem bark of *M. oleifera* is non-toxic when taken orally (Reddy *et al.*, 2013). The subacute toxicity test was carried out for 60 days at doses of 250, 500, and 1500 mg/kg. The fatal dosage was determined to be 1585 mg/kg, with no significant changes in sperm quality, biochemical, or hematological parameters as compared to the control group (Suzana *et al.*, 2017).

1.3 AIM OF STUDY

To determine the blood sugar level in Wistar rats due to sub-chronic administration of the ethanol extract of *Moringa oleifera* root.

1.4 OBJECTIVE OF STUDY

The specific objectives shall include:

- To evaluate the effect of the ethanolic root extract of *Moringa oleifera* on blood sugar level.
- To observe the effect of the various doses on the blood sugar level.

CHAPTER TWO

MATERIALS AND METHODS

2.1 MATERIALS

2.1.1 CHEMICAL REAGENTS

Absolute ethanol (99%) from fharmatrend limited Nigeria and Distilled water.

2.1.2 EQUIPMENT AND APPARATUS

Digital weighing balance, Jars, Drying oven, Syringes, needle, Glucometer, test strips, orogastric tube, mortar and pestle, spatula, feed, cage, beddings.

2.1.3 COLLECTION OF PLANT MATERIALS

Fresh *Moringa oleifera* roots were taken from mature trees of the specific plant species found in the Obe Quarters, Benin City, Edo State, Nigeria. The Department of Plant Biology and Biotechnology at the University of Benin conducted the authentication of the species. In the herbarium, specimens were labeled and placed.

2.1.4 EXPERIMENTAL ANIMALS

The animal section of the Biochemistry Department at the University of Benin provided a total of 18 young male albino Wistar rats. They were kept in a plastic cage at the Department of Plant

Biology and Biotechnology, University of Benin. The animals varied in weight from 157 g – 292 g. They were housed and maintained in a standard laboratory setting with a 12-hour light/dark cycle, humidity, and room temperature. Before the experiment began, a seven-day acclimatization time to the new environment was permitted. They were fed a conventional pellet meal, had access to clean water, and had their cages cleaned every day.

2.2 METHODS

2.2.1 EXTRACTION

The roots of *Moringa Oleifera* were shade dried under room temperature. The shade dried roots were now being ground to powder form. The powdered roots (600 g) were now macerated in 99% ethanol at room temperature for 72 hours. It was then filtered using a filter paper and the filtrate evaporated to dryness in a drying oven. A brownish residue was obtained and stored in air tight bottle and kept in the refrigerator for preservation before being administered to the Wistar rats.

2.2.2 ANIMAL GROUPING AND EXTRACT ADMINISTRATION

Twelve rats were randomized into four groups of three animals each

Group 1 rats received 150 mg/kg b. wt. of root extract

Group 2 rats received 300 mg/kg b. wt. of root extract

Group 3 rats received 600 mg/kg b. wt. of root extract

Group 4 rats (control) received oral administration of distilled water.

Treatments were administered orally once daily for a period of 21 days and observations were made within the period for morbidity and mortality. Health conditions and weight of the animals were recorded based on the observation. On the 21st day, the organs were tested for histological analysis.

2.2.3 DETERMINATION OF BLOOD GLUCOSE LEVEL

The blood glucose levels were measured after every 7 days for a period of 21 days. Each measurement was obtained by use of a glucometer test device with test strips in blood samples obtained from the tail vein of the experimental rats. The results were being expressed in mg/dl.

2.2.4 DATA ANALYSIS

Values obtained from the experimental tests were subjected to statistical analysis, using statistical package for the social sciences (SPSS) version 16.0, with determination of mean and standard error of mean. Analysis of variance (ANOVA) and Tukey's post-hoc test were conducted to separate the means. The result obtained were expressed as Mean \pm SEM and values were considered to be significant at $p > 0.05$.

CHAPTER THREE

3.0 RESULT

Table 1 shows the highest blood sugar level at 150 mg/kg and lowest at 600 mg/kg. However, the values show no significant difference ($p > 0.05$) in the sugar level between the various treatments compared with the control after 24 hours following the administration of ethanolic root extract of *Moringa oleifera*.

Table 1: Fasting blood sugar level of Wistar rats after 24 h of oral administration of ethanol extract of *Moringa oleifera* root.

TREATMENT	SUGAR LEVEL (mg/dl)
Plant extract (150 mg/kg)	70.6667±4.0961 ^a
Plant extract (300 mg/kg)	66.3333±4.0552 ^a
Plant extract (600 mg/kg)	59.6667±3.3333 ^a
Control (Distilled water)	59.6667±1.7638 ^a

Values are expressed as mean \pm SEM for 4 replications; Means with similar superscript within a column are not significantly different ($P > 0.05$) based on Tukey post hoc test.

Figure 1 shows the highest blood sugar level at 150mg/kg and lowest at 600mg/kg. However, the values show no significant difference ($p > 0.05$) in the sugar level between the various treatments compared with the control after following 7 days after the administration of ethanolic root extract of *Moringa oleifera*.

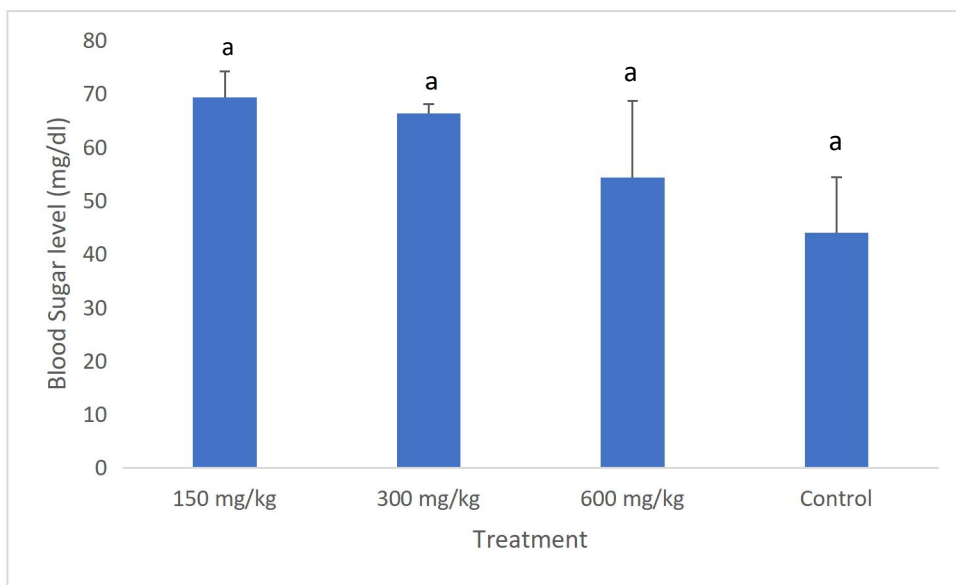


Figure 1: Fasting blood sugar level of Wistar rats following 7 days after administration ethanol extract of *Moringa oleifera* root.

^a $p > 0.05$ based on Tukey post hoc test. Control was given distilled water.

Table 2 shows the highest blood sugar level at 150mg/kg and lowest at 300mg/kg. However, the values show no significant difference ($p > 0.05$) in the sugar level between the various treatments compared with the control following 14 days after the administration of ethanolic root extract of *Moringa oleifera*.

Table2: Fasting blood sugar level of Wistar rats following 14 days after administration ethanol extract of *Moringa oleifera* root.

TREATMENT	SUGAR LEVEL (mg/dl)
150 (mg/kg)	70.0000 ± 4.0415 ^a
300 (mg/kg)	61.0000 ± 5.6826 ^a
600 (mg/kg)	78.6667 ± 3.1798 ^a
Control (dw)	59.6667 ± 3.1798 ^a

Values are expressed as mean ± SEM for 4 replications; Means with similar superscript within a column are not significantly different ($P > 0.05$) based on Tukey post hoc test; Control (distilled water).

Figure 2 shows the highest blood sugar level at 600 mg/kg and lowest at 150 mg/kg. However, the values show no significant difference ($p > 0.05$) in the sugar level between the various treatments compared with the control after following 21 days after the administration of ethanolic root extract of *Moringa oleifera*.

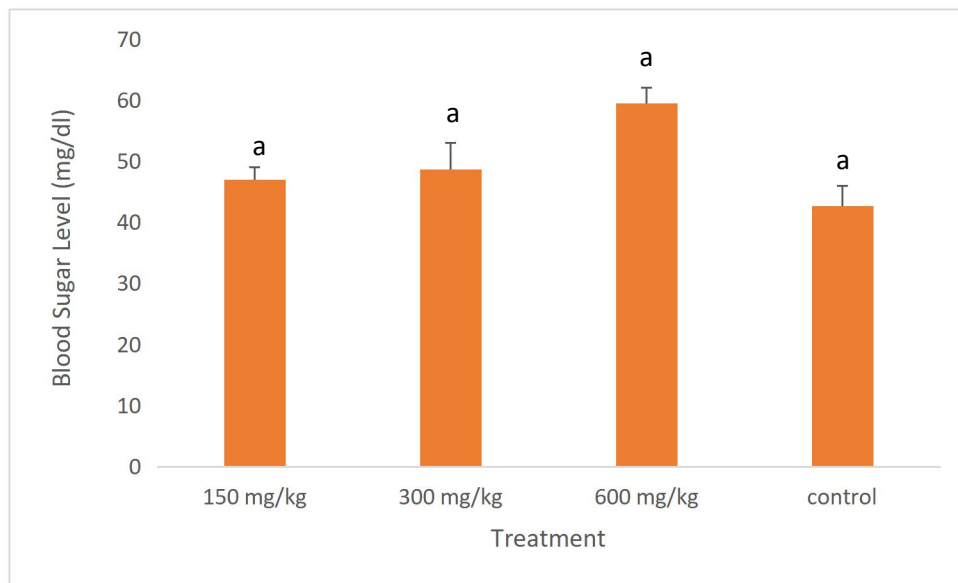


Figure 2: Fasting blood sugar level of Wistar rats following 21 days after administration ethanol extract of *Moringa oleifera* root.

^a $p > 0.05$ based on Tukey post hoc test. Control was given distilled water.

DISCUSSION

Moringa oleifera possesses bioactive compounds, the qualities of which have been studied in recent years to establish a more scientific basis for its use and to elucidate its biological activity. The leaves have been used as an antidiabetic, antibacterial and anti-inflammatory herbal drugs (Akinlolu *et al.*, 2014; Sidney and Hartman, 2015; Anudeep *et al.*, 2016;). The growing number of diabetic cases coupled with the harsh side effects of some synthetic drugs has led to the increasing search for alternatives, which are relatively cheap, and with minimal side effects (Airaodion *et al.*, 2019). Blood sugar testing provides useful information for diabetes management. It can help to monitor the effect of medications on blood sugar levels as well as identify blood sugar levels that are high or low. In this present study, ethanolic root extracts of *Moringa oleifera* was administered to albino Wistar rats. The treatment did not alter the blood sugar level significantly ($p > 0.05$) on day 1, day 7, day 14, as well as day 21 compared with the control group. From the study, the results suggested that the extract has no significant effect ($p > 0.05$) on the blood sugar level of the normal (non-diabetic) Wistar rats. In line with the current investigation on the root of aqueous extract of *M. oleifera*, determining its antidiabetic effect (Al-Awwadi *et al.*, 2004), in their research indicated that leaf aqueous extract of the plant significantly decreased blood glucose concentration in Wistar rats and Goto-Kakizaki rats. The therapeutic use of the leaves have been evaluated in diabetes because of their possible capacity to decrease blood sugar concentrations after ingestion because they contain polyphenols such as quercetin-3-glycoside, rutin, kaempferol and glycosides (Arora *et al.*, 2013; Al-Malki and El Rabey, 2015). The results in this present study tend to suggest that the extract may be safe for a diabetic and this is because they tend to seek food that would not increase their sugar level or when they are taking medications, they do not want their sugar level to be altered. Therefore, the

extract may not pose any threat to a diabetic patient. Another study conducted by (Ghasi *et al.*, 2000) indicated that the extract from the leaf of the plant was effective in lowering blood sugar level within 3 hours after ingestion. Similarly, (Lenzen, 2008; Rohila and Ali, 2012) indicated that dark chocolate polyphenols are responsible for hypoglycemic activity of the leaf extract of the plant. This present study also suggests, that hypoglycemics may not benefit from the use this extract because they tend to seek food that would increase their sugar level but it is safe for their consumption because it does not alter their sugar level. Increased blood sugar level could cause very serious health problems if it's not treated or carefully monitored. It can damage the vessels that supply blood to vital organs, which can increase the risk of heart disease, stroke, kidney disease, vision problems and nerve problems. Therefore, the potential antidiabetic activity of *Moringa oleifera* can be commercialized pharmaceutically through the development of suitable technology that will match the internationally standard recognized antidiabetic drugs.

CONCLUSION

In conclusion, the study has shown that *M. oleifera* does not have any significant ($p > 0.05$) effect on the blood sugar level of the non-diabetic Wistar rats. Therefore, the extract can be recommended as safe for a diabetic because it is not likely to raise their sugar level.

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