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Evaluation of Antidiabetic and Antioxidant Activity of Moringa Oleifera in Experimental Diabetes

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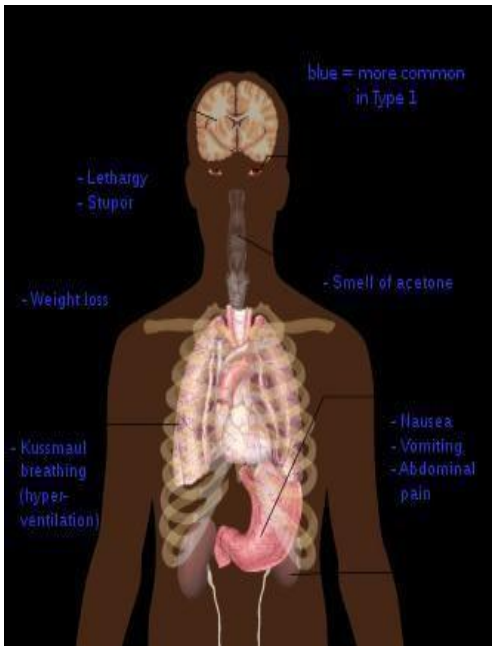
Abstract: *It's interesting to note the potential health benefits of Moringa oleifera in addressing issues like diabetes, obesity, and malnutrition. The diverse pharmacological properties of Moringa, including its anti-cancer, anti-diabetic, anti-inflammatory, and antioxidant effects, make it a valuable plant with various potential applications in traditional medicine. Its nutritional richness adds to its appeal in addressing health concerns, particularly in regions like India where diabetes mellitus and obesity are significant challenges. The study Investigated the antidiabetic and antioxidant effects of methanol extracts from M. oleifera pods in STZ-induced diabetic rats. Additionally, it aimed to determine the antihyperglycemic effect of dried M. oleifera leaves powder or its ethanolic extract in both diabetic and normal rats. The findings suggest potential benefits in reducing oxidative damage and hypoglycemic activity, particularly in diabetic rats, while highlighting the need for further research on the hypoglycemic properties in normal rats.*

Keywords: Moringa oleifera

I. INTRODUCTION

The study addresses the increasing incidence of diabetes, emphasizing the complexity of the disorder. Moringa oleifera, a plant native to the Indian subcontinent, is explored for its potential in treating diabetes due to its traditional use in Ayurvedic medicine. The research focuses on screening methanolic extracts from M. oleifera leaves, seeds, and a combined leaf/seed extract for both antidiabetic and antioxidant activities in mice, administered at a dose of 500 mg/kg of body weight per day.



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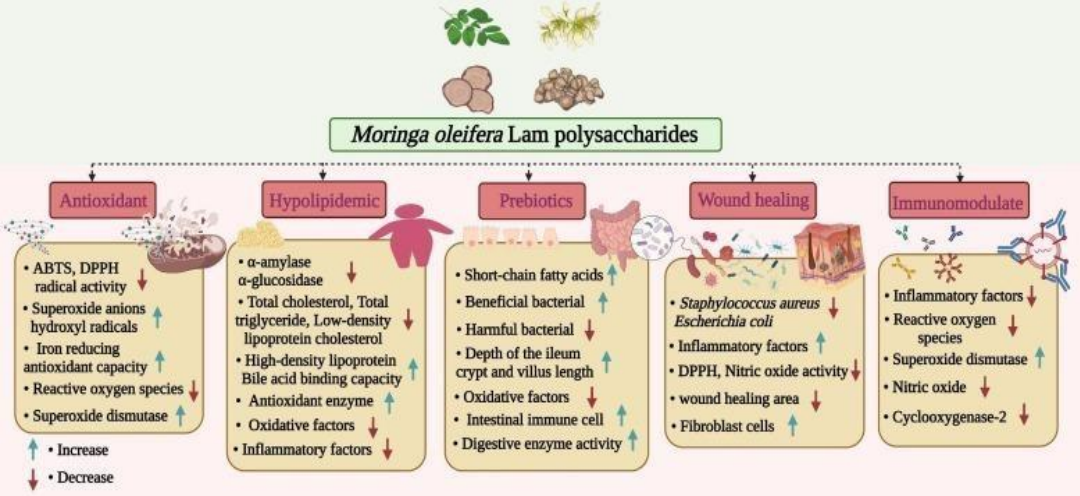
The presence of antidiabetic activities in over 400 herbal plants highlights their potential in treating and managing diabetes. Various secondary metabolites in these plants, such as alkaloids, polyphenols, flavonoids, saponins, tannins, and terpenoids, have been identified as responsible for the observed antihyperglycemic effects.

The preliminary phytochemical analysis of M. oleifera extracts revealed the presence of various compounds, including simple sugars (rhamnose, isothiocyanates, and glucosinolates), niazimicin, salicylic acid, ferulic acid, vitamins (e.g., ascorbic acid), provitamins (such as tocopherols and carotenoids), minerals (such as potassium and calcium), and secondary metabolites like phenols, flavonoids, tannins, and alkaloids. Additionally, the leaves are traditionally used for treating wounds, fever, sores, bronchitis, as well as eye and ear infections.



The study aimed to explore the antidiabetic effect of methanolic extracts from M. oleifera leaf, seed, and their combination, administered at a dose of 500 mg/kg of body weight per day. Insulin secretion from the pancreatic beta-cells plays a crucial role, and diabetes, a significant risk factor for cardiovascular disease, impacts the heart muscle, leading to both systolic and diastolic heart failure. Diabetes is also associated with symptoms like polyuria, polyphagia, polydipsia, and ketosis. The global prevalence of diabetes has more than doubled over the last three decades, surpassing modeled projections, even with improved surveillance.

Moringa oleifera, the most widely cultivated species in the monogeneric family Moringaceae, has been extensively studied for its diverse properties. Scientific literature cites Moringa preparations for nutritional, antimicrobial, hypotensive, antispasmodic, antiulcer, anti-inflammatory, hypocholesterolemic, and hypoglycemic activities. Additionally, it demonstrates efficacy in water purification through flocculation, sedimentation, antibiosis, and reduction of Schistosome cercariae titer. The plant's hypoglycemic efficacy is noted, and it holds therapeutic potential for hepatic disorders. Diabetes, a metabolic disorder characterized by elevated fasting and postprandial blood glucose concentrations, is among the conditions addressed by Moringa oleifera.

Maintaining blood glucose within recommended ranges is crucial for preventing and controlling diabetes complications. The oral administration of Moringa leaf extract resulted in a notable reduction, with a maximum of 26.7% in fasting blood glucose level (FBG) and a substantial maximum reduction of 30% in glucose tolerance observed after 3 hours of glucose consumption.

The aqueous extract of Moringa leaves demonstrated potential hypoglycemic effects in alloxan-induced diabetic rats, attributed to the reduction of gluconeogenesis and regeneration of damaged hepatocytes and pancreatic β-cells. Additionally, Moringa leaf extract exhibited hypoglycemic effects in STZ-induced diabetic rats, with the presence of cryptochlorogenic acid, quercetin 3-β-Dglucoside, and kaempferol 3-O-glucoside suggested as contributing factors. Furthermore, methanol extracts from Moringa pods showed a decrease in blood glucose concentration and an increase in insulin levels in STZ-induced diabetic rats after 21 days of treatment compared to untreated diabetic rats.

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Histological Examination.

The study suggests that Moringa oleifera leaf extract, particularly at higher doses (400 and 800 mg/kg), demonstrated gastroprotective effects against aspirin-induced ulcers in rats. The observed protection included maintaining surface epithelium and enhancing mucus production, indicating potential as a treatment for ulcers. Further research may explore the active agents responsible for these effects and consider the extract's potential as a safe and effective antiulcer agent.

The liver, kidney, and pancreas were swiftly removed, rinsed with cold saline, dried, and promptly weighed. After preservation, the tissues underwent dehydration, clearing, and embedding in paraffin wax. Sections of 7 µm thickness were obtained from the tissue blocks and stained with hematoxylin and eosin. Histopathological examination was conducted by observing the slides under a light microscope at 400x magnification, and photographs were taken for further analysis.

PLANT PROFILE

Scientific classification
Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Violas
Family: Moringaceae
Genus: Moringa
Species: Pterygosperm**a**

LOCAL NAMES

Amharic (shiferaw); Arabic (rawag); Bengali (sujina,sohjna,sajina); Burmese (dan-da-lun,dandalonbin); Cantonese (nugge); Creole Patois (benzolive tree); English (moringa tree,ben-oil tree,cabbage tree,clarifier Tree,horseradish tree,drumstick tree, West Indian ben); Filipino (malunggay); French (acacia blanc,Neverdie,moringa ailé,Ben ailé,Pois Quenique); German (Pferderettichßaum, Meerrettichßaum); Gujarati (midho-saragavo); Hausa (zogallagandi); Hindi

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BOTANIC DESCRIPTION

Moringa oleifera's distinctive characteristics, such as the crooked bole, smooth dark grey bark, and umbrella-shaped crown, contribute to its unique identity.

The alternating leaves of Moringa oleifera, with their large size and distinctive structure, contribute to the tree's overall appearance. The presence of opposite pinnae and leaflets, with a second set often bearing slightly larger terminal leaflets, adds to the variability in size and shape. It's interesting to note the characteristics of the dark green upper surface and pale under surface of the leaflets

The continuous production of flowers throughout the year In loose axillary panicles, along with the slender flower stalks and distinct features like pale green sepals and unequal white petals, adds to the botanical charm of Moringa oleifera. The sweet fragrance of the flowers, coupled with the slender style and stamens, further enhances its appeal..

The large and distinctive fruit of Moringa oleifera, reaching up to 90 cm in length and 12 mm in breadth, is a notable feature. Characterized by a slightly constricted structure, gradual tapering to a point, and being 3- (or occasionally 4-) angled, the light brown fruit bears two grooves on each face. Upon splitting along each angle, it reveals rows of rounded blackish oily seeds, each adorned with three papery wings. It's interesting to note that the generic name "Moringa" originates from the Sinhalese name 'morunga'.

BIOLOGY

The bisexual, oblique, stalked, axillary, and heteromorphic flowers of Moringa oleifera exhibit characteristics that promote highly cross-pollinated reproduction, thanks to heteromorphism. Carpenter bees, particularly Xylocopa latipes and X. pubescens, have been identified as reliable and suitable pollinators. Additionally, sunbirds like Nectaria zeylanica and N. asiatica have been observed playing an active role in pollination. This intricate interplay between the tree and its pollinators contributes to the reproductive success of Moringa oleifera.

Studies of Moringa in relation to human health

While numerous studies have highlighted various pharmacological properties of Moringa, utilizing its leaves, seeds, and pods, many of these investigations fall short in establishing conclusive data regarding the direct relationship between Moringa and its health benefits. This challenge in drawing firm conclusions mirrors a common issue observed in research on various plants, where diverse factors may influence the outcomes, making it complex to establish a clear link between the plant and its health effects.

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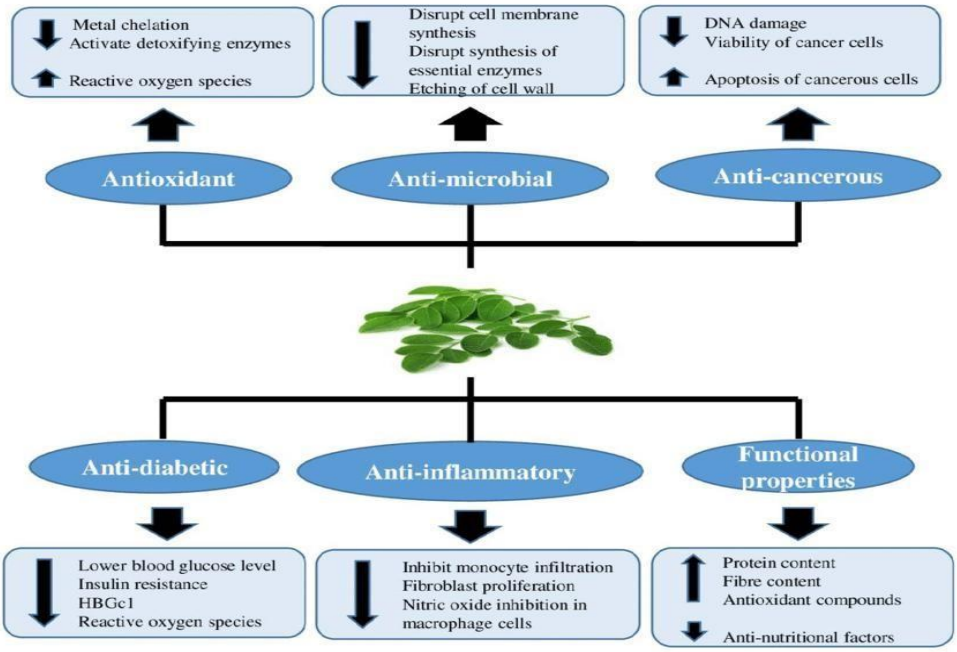
Effects on biomarkers of oxidative stress

- Anti-cancer effect
- Effects on biomarkers of inflammatio
- Hepatoprotective effect
- Effects on biomarkers of diabetes

Numerous studies have indeed explored the antioxidant potential of various extracts derived from Moringa leaves, seeds, and pods. In a recent in vitro study, the focus was specifically on investigating the antioxidant activity of a hydroethanolic extract obtained from Moringa leaves. This type of research aims to understand the extent to which Moringa exhibits antioxidant properties, which could have implications for its potential health benefits.



II. MATERIAL AND METHODS

Chemicals Used

Alloxan monohydrateo5,5′-Dithiobis (2-nitrobenzoic acid)

MethanoloEthanol, ochloroform,o guanidine hydrochloride, o2,4dinitrophenylhydrazine (DNPH), trichloroacetic acid (TCA),o thiobarbituric acid(TBA), o hydrochloric acidoPhosphate buffered salineoHydrogen peroxideo1,1,3,3-tetramethoxypropaneoBiochemical analysis of liveroEnzymes (aspartate aminotransferase (AST), oalanine aminotransferase (ALT), o alkaline phosphate (ALP)), total protein, ocreatinine

Plant material

Fresh Moringa Oleifera leaves and seeds were collected from Mohamed Alkamoushi garden in Tajoura, Tripoli, Libya (Figure 1). The plant's identity was verified by Dr. M. Abohadra, a plant taxonomist at the Botany Department, Faculty of Science, University of Tripoli. A voucher specimen of M. oleifera (FHI-110287) was deposited in the herbarium at the Faculty of Science, University of Tripoli, confirming the authenticity of the plant material.

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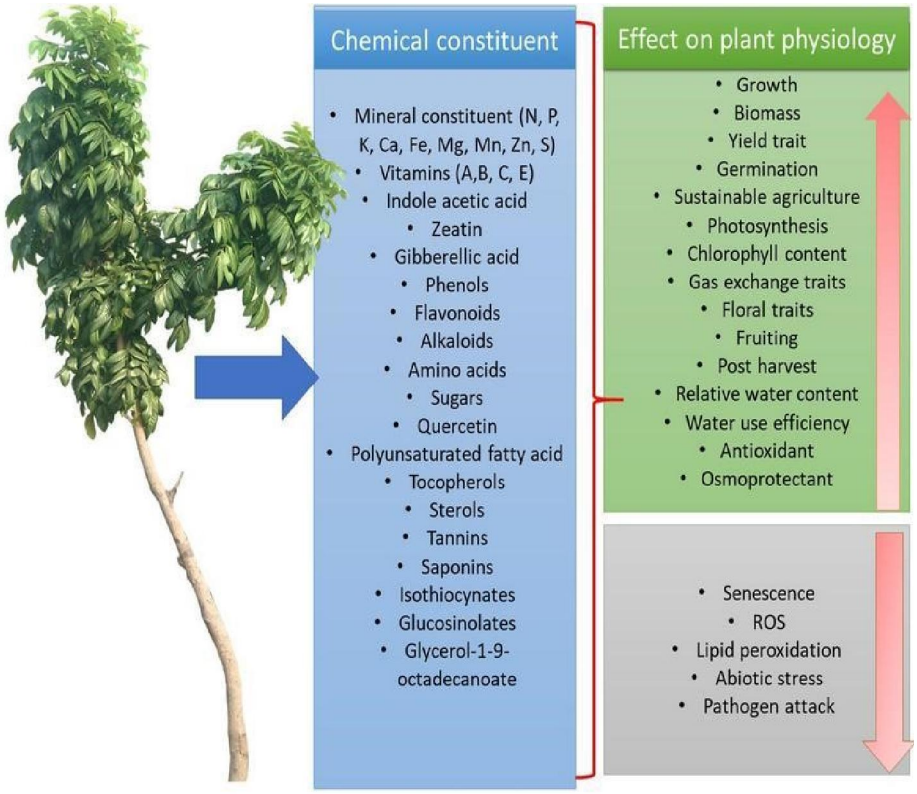

Preparation of Crude Leaf and Seed Extracts

The process of preparing crude extracts from Moringa oleifera leaves and seeds involved air-drying freshly collected samples, grinding them into powder, and storing the powder at 4°C. The extraction was carried out using methanol, and the resulting extracts were filtered and concentrated using a rotary evaporator to obtain pure crude stock extract.

The yield of methanol extracts was 3.8% for leaves and 2.8% for seeds. The extracts were stored at 4°C until use. In subsequent experiments, a dose of 500 mg/kg body weight/day of M. oleifera administered orally for 1 or 3 months was identified as the most suitable treatment.

Extraction of M. oleifera leaves

The preparation of the Moringa oleifera extract involved washing the leaves, air-drying them, and then crushing the dried leaves into powder using a commercial blender. The powdered material (1 kg) underwent extraction by percolation using ethanol (95%). The resulting filtrate was filtered and allowed to dry at room temperature for 7 days. Subsequently, the extract underwent freeze-drying to form a concentrate. The dried extract (concentrate) was stored in an airtight container at 4°C. Before administration, the extract was suspended in 1% CMC (Carboxymethyl cellulose) in distilled water.

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Methodology

The crossover study involved participants from Sugarfit's diabetes reversal and management program (SDRMP). This program focuses on an evidence-based, individualized approach for type 2 diabetes and prediabetes. Participants used a portable instrument (T) to monitor blood glucose levels through finger-pricking and collecting blood on a strip placed in the glucometer. During the six-day study period, participants underwent fasting SMBG tests, initially for three days without ingesting MOLP, followed by three days with ingesting 0.25g/kg body weight (approximately 15–25g) of MOLP.

Hba1c in %	7.24±1.3
Weight in kgs	74.72±13.4
BMI	26.4±4.1

Table 1: Baseline characteristics of study participants

The filtrates were concentrated In vacuo at low temperatures (3740ºC) to approximately one-tenth of the original volume using a rotary evaporator. Subsequently, the concentrates were left open in a water bath at 40ºC to ensure complete dryness, resulting in the production of 80 g (4.0%), 75.5 g (3.8%), and 75.5 g of a greenish-brown substance.

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