Evaluation Of Antioxidant Activity of *Moringa Oleifera* Leaves by DPPH Method

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***Abstract*—Moringa oleifera is widely recognized for its rich nutritional composition and medicinal properties, particularly its antioxidant potential. The present study aimed to evaluate the antioxidant activity of Moringa oleifera leaf extract using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay. Fresh leaves were collected, shade-dried, powdered, and extracted using a suitable solvent. Different concentrations of the extract were prepared and tested against DPPH solution.**

The decrease in absorbance was measured spectrophotometrically, and the percentage inhibition of DPPH radicals was calculated. The results demonstrated a concentration-dependent increase in radical scavenging activity, indicating strong antioxidant potential. The presence of bioactive phytochemicals such as flavonoids, phenolic compounds, tannins, and vitamins is believed to contribute to the observed antioxidant effect.

The extract exhibited significant free radical scavenging activity when compared with the standard antioxidant, ascorbic acid. These findings suggest that Moringa oleifera leaves are a valuable natural source of antioxidants and may be useful in preventing oxidative stress-related disorders. The study supports the traditional use of Moringa oleifera as a functional food and highlights its potential application in pharmaceutical and nutraceutical formulations.

***Index Terms*—Moringa oleifera, Antioxidant activity, DPPH assay, Free radical scavenging, Phenolic compounds, Flavonoids.**

I. INTRODUCTION

Oxidative stress arises from an imbalance between the production of reactive oxygen species (ROS) and the body's capacity to neutralize them [1]. ROS are inevitable by products of aerobic metabolism, generated continuously during cellular respiration and other metabolic processes; at low, physiological concentrations they serve essential signalling roles in immune defence, cellular communication, and tissue homeostasis, but excessive or deregulated production disrupts redox balance [1]. Key ROS/RNS species include superoxide radicals, hydroxyl radicals, hydrogen peroxide, and proximities [2]. When oxidant generation exceeds antioxidant defence capacity, extensive damage occurs through lipid peroxidation, protein oxidation, and DNA damage, contributing to diabetes, cancer, neurodegenerative disorders, cardiovascular disease, and inflammatory conditions [1,3].

Cellular antioxidant defence comprises enzymatic antioxidants (superoxide dismutase, catalase, glutathione peroxidase) and non-enzymatic antioxidants (vitamins C and E, glutathione, flavonoids) [3]. The concept was formally defined by Helmut Sies in 1985 as an imbalance between prooxidants and antioxidants favouring the former, and it is now recognized as a central mediator of cell signalling, damage, and disease pathogenesis [1,2].

Treatment of Oxidants Oxidative stress is implicated in a wide range of conditions. In chronic airway diseases (Asthma, COPD, bronchiectasis) it drives inflammation and impairs mucociliary clearance [4]; it contributes to endothelial dysfunction and atherosclerosis in cardiovascular disease [6]; and it plays a dual role in cancer, promoting tumorigenesis or triggering apoptosis depending on ROS concentration [5]. It also mediates ocular, cutaneous, renal, and reproductive dysfunction [7, 8]. Notably, moderate exercise-induced ROS can drive beneficial adaptive responses, whereas excessive levels impair recovery and immunity a "redox window" that argues against blanket antioxidant elimination in favour of precision-based approaches [9, 4].

Therapeutic strategies include enzymatic and non-enzymatic antioxidants, Nrf2 pathway activators, and mitochondria-targeted antioxidants, with effective treatment increasingly requiring attention to disease-specific redox endotypes, dosing, and individual antioxidant capacity, alongside exercise, polyphenol-rich diets, and targeted supplementation [4, 9].

Oxidants and Body Systems:

ROS and RNS arise from endogenous sources (mitochondrial respiration, NADPH oxidases) and exogenous sources (radiation, drugs, smoking, pollution); oxidative stress is defined by the mismatch between their production and the body's detoxification capacity [10, 11, 12]. Free radicals damage carbohydrates, lipids, proteins, and nucleic acids, contributing to diabetes, cancer, and cardiovascular disease [13, 14]. Vulnerable organs include the kidneys (glomerular and tubular injury), the heart (cardiomyopathy and heart failure), and the liver, brain, and lungs, with ROS-driven neuroinflammation implicated in Parkinson's and Alzheimer's disease [13, 15, 16]. Enzymatic (SOD, catalase, GPx) and nonenzymatic (vitamins C/E, flavonoids, carotenoids) defences counteract this damage; their depletion leads to progressive organ dysfunction [11].

Natural Antioxidants:

Natural antioxidants abundant in plant-based foods, neutralize ROS generated by metabolism and environmental exposure [17, 18]. Plant-derived antioxidants offer anti-inflammatory, anti-aging, anti-atherosclerotic, and anticancer properties, and are generally preferred over synthetic antioxidants for their bioavailability and lower toxicity [17, 19]. Fruits, vegetables, berries, herbs, mushrooms, nuts, and whole grains supply polyphenols, carotenoids, flavonoids, vitamins, and trace minerals such as selenium and zinc, with composition varying by species and environment [17, 20, 21]. Antioxidant-rich diets are associated with reduced risk of cardiovascular disease, type 2 diabetes, cancer, and neurodegenerative conditions, and may support immune function, healthy aging, cognition, and gut microbiome balance [22, 23, 18].

Current Drug Therapy for Oxidative Stress:

Oxidative stress underlies cardiovascular disease, neurodegeneration, cancer, diabetes, inflammatory, and metabolic disorders, with excessive ROS overwhelming antioxidant defences to damage DNA, lipids, and proteins while activating pathological signalling [24, 25, 26, 27]. Traditional therapy relies on direct antioxidant supplementation or enhancement of endogenous defences — vitamins C and E, glutathione, N-acetylcysteine, and lipoic acid — while newer nanoparticle-based and redox-responsive delivery systems aim to overcome bioavailability limits [28, 29]. Despite preclinical promise, large clinical trials of antioxidant therapy have yielded inconsistent results, underscoring gaps in translating oxidative stress biology into effective treatment [25, 26].

Clinically used antioxidant drugs include N-acetylcysteine (a glutathione precursor used for acetaminophen poisoning and as a mucolytic), edaravone (a free-radical scavenger for acute ischemic stroke and ALS), Coenzyme Q10 (a mitochondrial, lipid-soluble antioxidant used in heart disease), melatonin (a scavenger used for neuroprotection), and alpha-lipoic acid (a water- and lipid-soluble "universal" antioxidant) [30].

Certain drugs prescribed for other indications also show secondary antioxidant activity, including statins, ACE inhibitors such as captopril, the antidepressant fluoxetine, and bromocriptine [30, 31]. Natural compounds used pharmaceutically include vitamin E and vitamin C, alongside the polyphenol’s resveratrol and curcumin, particularly in cancer therapy research [30– 33]. Broader clinical use of these agents remains limited by poor bioavailability and rapid metabolism, motivating research into nanotechnology-based delivery.

Herbal Drug Therapy for Oxidative Stress:

Oxidative stress — the imbalance between ROS production and antioxidant defence — underlies diabetes, cardiovascular disease, neurodegenerative disorders, cancer, and inflammatory conditions [32, 33]. Conventional synthetic antidiabetic and antioxidant drugs, though effective, are often limited by poor long-term efficacy, side effects, and cost, and single-target strategies frequently fail in complex, redox-heterogeneous disease [32, 33]. Herbal medicines, rich in flavonoids, polyphenols, alkaloids, terpenoids, and saponins, offer a multi-component, systems-level alternative capable of modulating several interconnected pathways at once [32, 33].

Evidence indicates herbal extracts and phytochemicals can scavenge ROS and restore redox balance [34]; enhance endogenous antioxidant enzymes such as SOD, catalase, and glutathione peroxidase [35]; modulate inflammatory pathways by suppressing proinflammatory cytokines [36]; protect mitochondria from oxidative damage [37]; and regulate gene expression and epigenetic mechanisms linked to redox homeostasis [38].

II. REVIEW OF LITERATURE

1. Barkha Sharma et al., (2020) Performed “Moringa oleifera: The Miracle Tree on the Earth”.

Moringa oleifera really recognized to be a "Miracle tree", because it has multipurpose use for humankind and thus named as a nature gift at very low price. In order to discover and utilize full uses of this miracle tree, market development strategies, Strong policies, and research were required. Due to its multipurpose unlimited benefits for humanity, supports the fact that it is often referred to as both “miracle tree” and “gift of nature”. India could easily fight against the problems of malnutrition and diseases through plantation in unutilized areas to build up socioeconomic importance [39].

2. Thirumal Sivakumar (2024) Performed “A Review of Moringa oleifera (Miracle tree) and its Potential Phytochemistry, Traditional, Health Benefits, Pharmacological Applications”.

Moringa oleifera is a prominent source of nutrients and antioxidants. Still, there is a knowledge gap regarding the potential uses of Moringa as a food supplement and fortification. Moringa has enormous potential uses but is much less explored. It can be utilized to make foods that could be a step towards curbing malnutrition. The published literature gives the total scenario of the chemical constituents, nutritional content, potential uses and pharmacological activities of the plant. The identification, isolation, and standardization of plant extracts may be considered for detailed studies, which can be useful for further developing promising food products with health benefits and nutrients to cure different lifestyle-related diseases as well as malnutrition [40].

Nouran M. Fahmy and Shaimaa Fayez et al. (2024) Performed “Moringa oleifera flowers: insights into their aroma chemistry, anti-inflammatory, antioxidant, and enzyme inhibitory properties”. The aroma of fresh Moringa oleifera flowers is mainly attributed to its content of E-2hexenal which constitute more than 50% of its total GC- MS chromatogram. The extract displayed moderate antioxidant activity yet good enzymatic inhibition especially to acetylcholinesterase, tyrosinase, and α-glucosidase. The good anti-inflammatory and enzyme inhibitory properties of the hexane extract of M. oleifera flowers beside its non-cytotoxic nature to cells warrant further investigations to explore the extract’s mechanisms of action and potential therapeutic applications [54].

3. Don-lawson Chioma et al., (2019) Performed “Analysis of Moringa oleifera (leaves and flowers) to determine some phytochemicals and functional groups”.

Phytochemical analysis of moringa oleifera leaves and flowers reveal the presence of saponins, alkaloid, cyanogenic glycoside and flavonoid which have so much health benefits especially for treatment of some ailments.

Industrially, the phytochemicals are also very useful in making food, beverages, drinks, shampoos and some facial cleansers. The IR bands also indicated the presence of some functional groups like O-H, carboxylic, fatty acid and O-H fatty alcohol, while the absorption band of C-N and N-H shows the presence of some protein and cyanide materials [58]

III. MATERIALS AND METHODS

Moringa oleifera — consolidated review table

Nomenclature	**Scientific name**	Moringa oleifera Lam.
	Family	Moringaceae
	Synonym	Moringa pterygosperma Gaertn.
	Common English names	Drumstick tree, horseradish tree, ben oil tree, miracle tree
Vernacular names	**Hindi**	Sahjan, Munaga
	Sanskrit	Shobhanjana
	Tamil	Murungai
	Telugu	Munaga
	Malayalam	Muringa
	Bengali	Sajina
	Marathi	Shevga
	Gujarati	Saragavo
	Arabic	Rawaq, Shajara al-rauwaq
	Spanish	Moringa, Árbol del ben
	French	Moringa, Arbre à raifort
	Swahili	Mzunze, Mrongo
	Tagalog	Malunggay
	Malay / Indonesian	Kelor
Botanical description	**Habit**	Small to medium, fast-growing, deciduous tree, 5–12 m tall
	Bark	Corky, whitish-grey; softwood, brittle branches
	Leaves	Tripinnately compound, feathery, 30–60 cm long; small elliptic leaflets
	Flowers	Bisexual, fragrant, creamy-white to yellow, in axillary panicles
	Fruit	Three-angled pendulous pod ("drumstick"), 20–45 cm long
	Seeds	Round, winged (trialate), blackish-brown, oil-rich
	Roots	Tuberous when young; pungent, horseradish-like taste
	Native range	Sub-Himalayan India, Pakistan, Bangladesh, Afghanistan; now pantropical
Medicinal uses	**Leaves**	Antidiabetic, antioxidant, anti-inflammatory, galactagogue, anti-anemic
	Seeds	Water purification, antihypertensive, antimicrobial, anti-ulcer
	Pods	Digestive aid, antidiarrheal, hypocholesterolemic
	Roots	Rubefacient, antirheumatic, vermifuge, treats kidney stones
	Flowers	Aphrodisiac, diuretic, cold / cough remedy
	Bark	Digestive stimulant, treats skin diseases
	Oil	Emollient, wound healing, cosmetic use
	General	Hepatoprotective, anticancer, antimicrobial, anti-hyperlipidemic

Proximate composition (per 100 g dried leaf powder)	**Moisture**	5–8 g
	Protein	25–30 g
	Fat	5–7 g
	Carbohydrates	38–45 g
	Crude fiber	8–12 g
	Total ash	8–10 g
	Energy	~205 kcal
Vitamins (per 100 g)	**Vitamin A (β-carotene)**	16,000–18,000 IU
	Vitamin C	15–20 mg
	Vitamin E	100–113 mg
	Vitamin B1 (thiamine)	2.0–2.6 mg
	Vitamin B2 (riboflavin)	20–21 mg
	Vitamin B3 (niacin)	8 mg
	Folic acid (B9)	~40 µg
Minerals (per 100 g)	**Calcium**	2,000–2,185 mg
	Potassium	1,300–1,500 mg
	Iron	25–28 mg
	Magnesium	350–380 mg
	Phosphorus	200–204 mg
	Zinc	3–3.3 mg
	Copper	0.5–0.6 mg
Amino acids	**Essential**	Leucine, lysine, methionine, valine, isoleucine, threonine, phenylalanine, tryptophan, histidine
	Non-essential (notable)	Arginine, glutamic acid, aspartic acid
	Note	Contains all essential amino acids — relatively complete plant protein
Phytochemicals / bioactive compounds	**Flavonoids**	Quercetin, kaempferol, rutin — antioxidant, anti-inflammatory
	Phenolic acids	Chlorogenic, gallic, caffeic, ferulic acid — antioxidant, antimicrobial
	Glucosinolates	Glucomoringin — anticancer precursor
	Isothiocyanates	Moringin — antimicrobial, anti-inflammatory
	Alkaloids	Moringine, moringinine — cardiotonic, hypotensive
	Saponins	Antimicrobial, hypocholesterolemic
	Tannins	Astringent, antimicrobial
	Sterols	β-sitosterol — anti-inflammatory, cholesterol-lowering
	Carotenoids	β-carotene, lutein, zeaxanthin — antioxidant, vision support
	Terpenoids	Anti-inflammatory, antimicrobial

Values represent commonly cited ranges from published literature; figures vary with plant part, origin, season, and analytical method. Cite primary/original sources when using in a formal review paper.

1)Phytochemical Extraction of Moringa Oleifera by Maceration method:

Preliminary Qualitative Phytochemical Screening Tests

Phytoconstituent	Test Name	Procedure Summary	Positive Result
Carbohydrates	Molisch's Test	Molisch's reagent + conc. H_2SO_4 added along tube sides	Violet ring at junction
Reducing Sugars	Fehling's Test	Fehling's A & B boiled, test solution added, heated	Yellow, then brick red precipitate
	Benedict's Test	Benedict's reagent + test solution, heated	Green/yellow/red colour
Monosaccharides	Barfoed's Test	Barfoed's reagent + test solution, heated	Red precipitate
Hexose Sugars	Cobalt Chloride Test	Test solution + $CoCl_2$, boiled, cooled, + NaOH	Greenish blue (glucose) / purplish (fructose)
Non-Reducing Sugars	Fehling's/Benedict's (pre & post hydrolysis)	Negative before hydrolysis, positive after	Colour change after hydrolysis
Starch	Iodine Test	Test solution + dilute iodine	Blue colour (reversible with heat)
	Tannic Acid Test	With 20% tannic acid	Precipitate
Gum	Hydrolysis + Fehling's/Benedict's	HCl hydrolysis, then sugar tests	Red colour
Proteins	Biuret Test	NaOH + $CuSO_4$	Violet / pink colour
	Millon's Test	Millon's reagent, warmed	Brick red / red colour
	Xanthoprotein Test	Conc. H_2SO_4	White precipitate
	Sulphur Test	NaOH + lead acetate, boiled	Black / brownish (PbS)
Steroids	Salkowski Reaction	Chloroform + conc. H_2SO_4	Red chloroform layer, greenish-yellow fluorescence
	Liebermann-Burchard Reaction	Chloroform + acetic anhydride + H_2SO_4	Red, then blue, then green
	Liebermann's Reaction	Acetic anhydride, heated, + H_2SO_4	Blue colour
Amino Acids	Ninhydrin Test	5% Ninhydrin, boiled	Purple / bluish colour
	Tyrosine Test	Million's reagent, heated	Dark red colour
	Tryptophan Test	Glyoxalic acid + conc. H_2SO_4	Reddish violet ring
Flavonoids	Shinoda Test	Ethanol + HCl + magnesium	Pink colour
	Lead Acetate Test	Lead acetate solution	Yellow precipitate
	NaOH Test	Increasing NaOH, then acid	Yellow, decolorized by acid
	Ferric Chloride Test	$FeCl_3$ solution	Intense green colour
Alkaloids	Dragendorff's Test	Dragendorff's reagent	Orange-brown precipitate
	Mayer's Test	Mayer's reagent	Precipitate
	Hager's Test	Hager's reagent	Yellow precipitate
	Wagner's Test	Wagner's reagent	Reddish-brown precipitate
Tannins & Phenolics	Ferric Chloride Test	5% $FeCl_3$	Deep blue-black colour
	Lead Acetate Test	Lead acetate	White precipitate
	Gelatin Test	Gelatin solution	Decolouration of bromine water
	Acetic Acid Test	Acetic acid	Red colour
	Potassium Dichromate Test	$K_2Cr_2O_7$	Red precipitate
	Iodine Test	Dilute iodine	Transient red colour
Glycosides (General)	Part A vs Part B comparison	H_2SO_4 hydrolysis + Fehling's A&B (A) vs. plain + Fehling's A&B (B)	Increased red ppt in A vs B
Cardiac Glycosides	Baljet's Test	Sodium picrate	Yellow to orange colour
	Legal's Test	Pyridine + sodium nitroprusside	Pink to red colour
	Kellar-Kellani Test	Glacial acetic acid + $FeCl_3$ + H_2SO_4	Reddish brown; bluish-green upper layer
	Libermann's Test	Acetic anhydride + H_2SO_4	Blue colour
Saponin Glycosides	Foam Test	Vigorous shaking with water	Persistent foam
	Haemolytic Test	Test solution + blood on slide	Haemolytic zone
Coumarin Glycosides	Odour Test	Sensory	Aromatic odour
	Alkaline Fluorescence Test	Alkalinized test solution	Blue/green fluorescence

2)Pharmacological In-Vitro Method: Antioxidant Activity of Moringa Oleifera by DPPH Free Radical Scavenging Assay

Principle

The DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay is a simple, rapid, and widely used invitro method for evaluating the antioxidant potential of plant extracts. DPPH is a stable free radical with a deep violet color that exhibits a strong absorbance at 517 nm. Antioxidant compounds present in Moringa oleifera donate hydrogen atoms or electrons to DPPH, reducing it to the yellow-colored

2,2-diphenyl-1-picrylhydrazine. The decrease in absorbance is proportional to the free radical scavenging activity of the extract.

Materials Required

Dried Moringa oleifera leaf extract• DPPH (2,2-diphenyl-1-picrylhydrazyl)

- Methanol (analytical grade)
- Standard antioxidant (Ascorbic acid or Trolox)
- UV-Visible Spectrophotometer
- Micropipettes
- Test tubes
- Volumetric flasks

Preparation of Reagents

1. DPPH Solution

Prepare 0.1 mM DPPH solution by dissolving 3.94 mg DPPH in 100 mL methanol.

Store the solution in a dark bottle and protect it from light.

2. Standard Solution

Prepare ascorbic acid stock solution (1 mg/mL)

Dilute to obtain concentrations of 20, 40, 60, 80, 100, and 120 µg/mL.

3. Sample Solution

Prepare Moringa oleifera Leaf extract (MOLE) in ethanol: 10mg of Moringa oleifera taken in 10ml conical flask and dissolved it with ethanol and make up to the volume with ethanol. This is the stock solution having the concentration of 1mg/ml (1000µg/ml).

Then from this stock solution (MOLE) different concentrations of sample are formed. 20 µg/mL - 0.2ml of MOLE is taken in 10 ml conical flask and made up to volume with ethanol.

- 40 µg/mL - 0.4ml of MOLE is taken in 10 ml conical flask and made up to volume with ethanol.
- 60 µg/mL - 0.6ml of MOLE is taken in 10 ml conical flask and made up to volume with ethanol.
- 80 µg/mL - 0.8ml of MOLE is taken in 10 ml conical flask and made up to volume with ethanol.
- 100 µg/mL - 1ml of MOLE is taken in 10 ml conical flask and made up to volume with ethanol.
- 120 µg/mL - 1.2ml of MOLE is taken in 10 ml conical flask and made up to volume with ethanol.

Procedure:

Pipette 1 mL of each concentration of the plant extract into separate test tubes.

1. Add 1 mL of freshly prepared 0.1 mM DPPH solution.
2. Mix thoroughly by vortexing.
3. Incubate the reaction mixture in the dark at room temperature for 30 minutes.
4. Prepare a control containing 1 mL methanol + 1 mL DPPH solution.
5. Measure the absorbance at 517 nm using a UV-Visible spectrophotometer.
6. Perform all experiments in triplicate and express the results as Mean ± SD.

Calculation

The percentage inhibition of DPPH radicals is calculated using the following equation DPPH radicals scavenging activity = A0 − A1 / A0 × 100 IC50 Value The antioxidant potential of the studied extracts was evaluated by determining their IC50 values, which represent the concentration required to reduce DPPH radical levels by 50%. A lower IC50 value signifies greater radical scavenging ability, indicating stronger antioxidant potential of the sample. To determine the IC50, a graph was plotted with radical scavenging activity (%) on the Y-axis and extract concentration (mg/mL) on the X-axis. The regression equation obtained from the graph was used to identify the values of each parameter and calculate theIC50 value, indicating the concentration required to inhibit 50% of DPPH radicals. The graph followed the linear equation $y = mx + c$, based on which the values of each parameter were identified. The slope (m) and intercept (c) were determined from the graph. Using these values, the IC50 was then calculated using the standard formula provided below: $y = mx + c$ IC50 = $(y - c) / m = (50 - c) / m$. This method provides a quantitative assessment of antioxidant efficiency. A lower IC50 value thus signifies a greater antioxidant potential, demonstrating the extract's enhanced ability to scavenge free radicals effectively

IV. RESULTS AND DISCUSSION

4.1 PHYTOCHEMICAL STUDIES

Preliminary phytochemical analysis revealed the presence of carbohydrates, flavonoids, alkaloids, amino acids, glycosides.

Preliminary phytochemical analysis of Moringa oleifera.

Phytochemical tests	Results
Test for Carbohydrates	+ve
Test for Reducing sugars	+ve
Test for Monosaccharide's	+ve
Test for Hexose sugars	+ve
Test for Starch	+ve
Test for Gums	-ve
Test for proteins	+ve
Test for steroids	+ve
Test for Amino acids	+ve
Test for flavonoids	+ve
Test for Alkaloids	+ve
Test for Tannins and Phenolic compounds	+ve
Test for Glycosides	+ve
Test for Saponin Glycosides	+ve
Test for Coumarin Glycosides	+ve

+ve: indicates the presence of compounds and –ve: indicates the absence of compounds.

4.2 IN-VITRO STUDIES

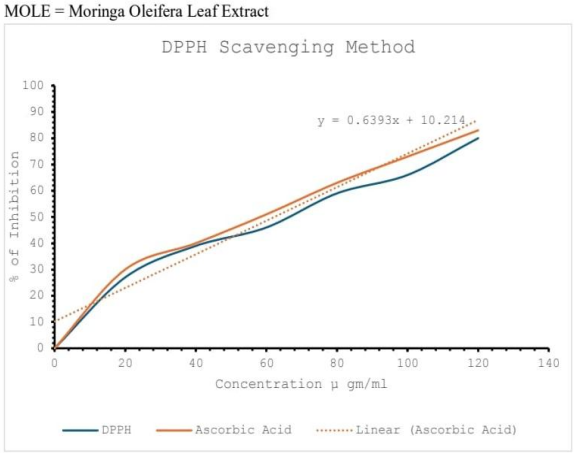
Table: 1 Effect of Moringa Oleifera on Antioxidant Activity by using DPPH Method

S. no	Concentration (µ gm/ml)	Absorbance of MOLE (A)	(%) Inhibition of (MOLE)	Absorbance of Ascorbic Acid (A)	(%) Inhibition of Ascorbic Acid
1	20	0.647	27	0.621	30
2	40	0.539	39	0.532	40
3	60	0.476	46*	0.437	51
4	80	0.362	59**	0.325	63
5	100	0.298	66***	0.236	73
6	120	0.178	80****	0.152	83

IC 50 = 67.8 IC 50 = 62.23

The results indicate that both Moringa oleifera leaf extract and ascorbic acid exhibited a concentration-dependent increase in DPPH radical scavenging activity. At lower concentrations (10–40 µg/mL), the extract showed moderate antioxidant activity, while a substantial increase in inhibition was observed at higher concentrations. The percentage inhibition increased from nearly 0% at 0 µg/mL to approximately 80% at 120 µg/mL for the Moringa oleifera extract.

MOLE = Moringa Oleifera Leaf Extract



The standard ascorbic acid demonstrated slightly higher scavenging activity than the extract throughout the concentration range, reaching approximately 83% inhibition at 120 µg/mL. However, the antioxidant activity of the Moringa oleifera extract closely paralleled that of ascorbic acid, indicating a strong free radical scavenging potential. The linear regression equation obtained for ascorbic acid (y = 0.6393x + 10.214) indicates a positive correlation between concentration and percentage inhibition. The gradual increase in scavenging activity with increasing concentration suggests that the bioactive compounds present in Moringa oleifera leaves effectively donate hydrogen atoms or electrons to neutralize DPPH free radicals.

DISCUSSION

The present study evaluated the antioxidant potential of Moringa oleifera leaf extract using the DPPH radical scavenging assay, a widely accepted method for assessing the free radical scavenging ability of natural products. The results demonstrated that the leaf extract exhibited significant DPPH radical scavenging activity in a concentration-dependent manner, indicating its strong antioxidant capacity. The antioxidant activity observed may be attributed to the presence of various phytoconstituents in Moringa oleifera leaves, including phenolic compounds, flavonoids, tannins, alkaloids, and vitamins such as vitamin C and vitamin E. These bioactive compounds are capable of donating hydrogen atoms or electrons to neutralize free radicals, thereby preventing oxidative damage to biological molecules. The increase in percentage inhibition with increasing extract concentration suggests that higher amounts of these antioxidant compounds enhance the radical

scavenging effect. The DPPH assay is based on the reduction of the purple-colored DPPH radical to a yellow colored non-radical form in the presence of antioxidant substances. The significant decrease in absorbance observed during the study confirms the ability of Moringa oleifera leaf extract to act as an effective hydrogen donor. Similar findings have been reported in previous studies, where Moringa oleifera leaf extracts showed remarkable antioxidant activity due to their high phenolic and flavonoid content. The antioxidant activity of Moringa oleifera is of considerable importance because oxidative stress plays a major role in the development of several chronic diseases, including diabetes mellitus, cardiovascular disorders, neurodegenerative diseases, cancer, and aging-related conditions. By scavenging free radicals, the leaf extract may help protect cells from oxidative damage and contribute to disease prevention and health

Overall, the findings of the present study confirm that Moringa oleifera leaves possess potent antioxidant properties and can serve as a natural source of antioxidants. Further studies involving isolation and characterization of specific antioxidant compounds, as well as in vivo investigations, are recommended to better understand their therapeutic potential and mechanisms of action.

V. CONCLUSION

The present study successfully demonstrated the antioxidant potential of Moringa oleifera leaf extract using the DPPH radical scavenging assay. The extract exhibited significant free radical scavenging activity in a concentration-dependent manner, with the percentage inhibition increasing progressively as the concentration increased. The antioxidant activity of the extract was found to be comparable to that of the standard antioxidant, ascorbic acid, indicating its strong ability to neutralize free radicals. The observed antioxidant effect can be attributed to the presence of bioactive phytoconstituents such as phenolic compounds, flavonoids, tannins, and vitamins, which are known for their free radical scavenging properties. These compounds play an important role in reducing oxidative stress and protecting biological systems from oxidative damage. The findings of this study support the traditional use of Moringa oleifera as a medicinal plant and highlight its potential as a natural source of antioxidants for pharmaceutical, nutraceutical, and functional food applications. Therefore, Moringa oleifera leaves may serve as an effective and economical alternative to synthetic antioxidants. Further studies involving the isolation of active compounds and in vivo evaluation are recommended to establish their therapeutic efficacy and safety. In conclusion, Moringa oleifera leaves possess potent antioxidant activity, as evidenced by their strong DPPH radical scavenging capacity, making them a promising natural antioxidant for the prevention and management of oxidative stress-related disorders.

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