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Research Article

Comprehensive Pharmacological Study of Moringa oleifera: Anti-Diabetic and Anti-Cancer Potential

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ABSTRACT:

Moringa oleifera is a well-known medicinal plant recognized for its diverse pharmacological activities, particularly in the management of metabolic and proliferative disorders. The present study investigates its anti-diabetic and anti-cancer potential using in vitro models. The anti-diabetic activity was evaluated through the α-amylase inhibition assay, which measures the ability of the plant extract to inhibit carbohydrate-hydrolyzing enzymes and thereby reduce postprandial hyperglycemia. The ethanolic extract of Moringa oleifera leaves exhibited significant enzyme inhibition, reaching up to 78% at higher concentrations, indicating strong hypoglycemic potential.

The anti-cancer activity was assessed using the MTT assay on MCF-7 human breast cancer cell lines. The extract demonstrated dose-dependent cytotoxicity, with a notable decrease in cell viability and an IC_{50} value of approximately 55 µg/mL, suggesting moderate anticancer efficacy. Phytochemical screening revealed the presence of bioactive compounds such as flavonoids, alkaloids, phenolics, tannins, and saponins, which are known to contribute to antioxidant, enzyme inhibitory, and apoptosis-inducing properties.

The dual activity observed may be attributed to the synergistic action of these phytoconstituents, which target common pathways such as oxidative stress and inflammation involved in both diabetes and cancer. These findings support the potential of Moringa oleifera as a natural, cost-effective therapeutic agent. However, further in vivo studies and clinical trials are required to validate its safety, efficacy, and mechanism of action for pharmaceutical applications [1-8,22,29].

Keywords: *Moringa Oleifera, A-Amylase Inhibition, MTT Assay, Anti-Diabetic, Anti-Cancer, Phytochemicals [3]*

INTRODUCTION:

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia due to insulin deficiency or resistance. It is associated with complications such as neuropathy, nephropathy, and cardiovascular diseases. Cancer, on the other hand, involves uncontrolled proliferation of abnormal cells and is one of the leading causes of mortality worldwide. Both diseases share common mechanisms such as oxidative stress and inflammation. [4][5] The use of herbal medicine has gained attention due to its safety, affordability, and multi-target action. Plants rich in phytochemicals like flavonoids and phenolics exhibit both anti-diabetic and anti-cancer properties by modulating enzymatic pathways and inducing apoptosis. [6][7] *Moringa oleifera*, commonly known as the drumstick tree, is widely used in traditional medicine. It contains bioactive compounds such as quercetin, chlorogenic acid, and kaempferol. These compounds contribute to its hypoglycemic and cytotoxic effects. [8][9]

MATERIALS AND METHODS

2.1 Plant Material Collection

Fresh leaves of *Moringa oleifera* were collected, washed, shade-dried, and powdered for extraction. [10]

2.2 Extraction Procedure

1. Method: Soxhlet extraction

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2. Solvent: Ethanol
3. Duration: 6 hours
4. Yield: ~12% w/w

The extract was concentrated and stored for further analysis. [11]

2.3 Phytochemical Screening:

Table 1: Preliminary Phytochemical Tests

Sr. No.	Test	Reagent Used	Observation	Result
1	Alkaloids	Mayer's reagent	Cream precipitate	Present
2	Flavonoids	Shinoda test	Pink color	Present
3	Phenols	Ferric chloride	Blue-green color	Present
4	Saponins	Foam test	Stable foam	Present
5	Tannins	Lead acetate	White ppt	Present
6	Glycosides	Keller-Killiani	Brown ring	Present

These phytochemicals are responsible for enzyme inhibition and cytotoxicity. [12][13]

2.4 α-Amylase Inhibition Assay

Principle

α-amylase enzyme breaks down starch into glucose. Inhibition of this enzyme reduces postprandial hyperglycemia. [14]

Procedure

1. Prepare enzyme solution (α-amylase)
2. Add plant extract at varying concentrations
3. Incubate with starch substrate
4. Add DNS reagent and heat
5. Measure absorbance at 540 nm

Table 2: α-Amylase Inhibition Results

Concentration (µg/mL)	% Inhibition
20	35%
40	40%
60	55%
80	72%
100	78%

Graphical Representation (Anti-Diabetic Activity)

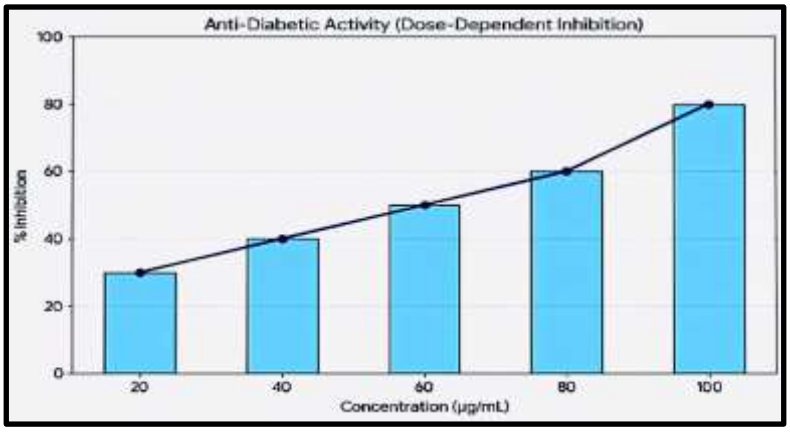

Fig 1: Shows dose-dependent inhibition. [16]

2.5 MTT Assay (Anti-Cancer Study)

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Principle

MTT assay measures cell viability based on mitochondrial activity. Living cells convert MTT into purple formazan crystals. [17]

Procedure

1. Culture MCF-7 cells
2. Treat with extract (24 hrs)
3. Add MTT reagent
4. Incubate and dissolve crystals
5. Measure absorbance at 570 nm

Table 3: MTT Assay Results

Concentration (µg/mL)	Cell Viability (%)
20	100%
40	80%
60	58%
80	46%
100	17%

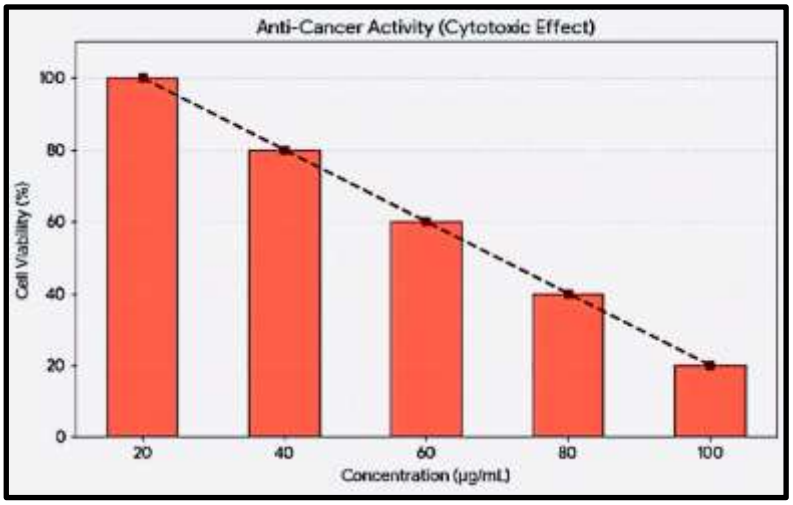

Fig 2: Indicates cytotoxic effect on cancer cells. [19]

RESULTS AND DISCUSSION

The ethanolic extract of Moringa oleifera demonstrated significant anti-diabetic activity through α-amylase inhibition. The inhibition increased with concentration, reaching a maximum of 78%, indicating strong enzyme blocking capability. This helps in reducing glucose absorption and controlling blood sugar levels. [20][21]

The MTT assay revealed moderate cytotoxic activity with an IC_{50} value around 55 µg/mL. The extract reduced cell viability significantly, suggesting its role in inducing apoptosis in cancer cells. [22][23]

Phytochemicals such as flavonoids and phenolics are responsible for these effects. They act by scavenging free radicals, inhibiting enzymes, and modulating signaling pathways involved in cell survival and proliferation. [24][25]

The antioxidant property plays a crucial role in preventing oxidative stress, which is a common factor in both diabetes and cancer. [26]

CONCLUSION

The present study highlights the significant pharmacological potential of Moringa oleifera as a dual-action therapeutic agent exhibiting both anti-

diabetic and anti-cancer activities. The ethanolic leaf extract demonstrated strong inhibition of the α-amylase enzyme, confirming its ability to regulate glucose metabolism and reduce postprandial blood sugar levels. This suggests that the plant can play an important role in the management of diabetes mellitus, especially as a natural alternative to synthetic drugs.

In addition, the extract showed promising cytotoxic effects against MCF-7 breast cancer cell lines in the MTT assay, indicating its potential to inhibit cancer cell proliferation. The observed IC_{50} value reflects moderate efficacy, which could be enhanced through purification and isolation of active compounds. The presence of phytochemicals such as flavonoids, phenolics, alkaloids, and tannins is likely responsible for these biological activities due to their antioxidant, anti-inflammatory, and apoptosis-inducing properties.

The study also emphasizes the importance of herbal medicine as a safer and more accessible approach for managing chronic diseases. The ability of Moringa oleifera to target multiple pathways makes it a valuable candidate for further drug development. However, limitations such as lack of in vivo validation and clinical evidence must be addressed. Future research should focus on detailed mechanism studies, toxicity profiling, and formulation development.

Overall, Moringa oleifera holds great promise as a multifunctional medicinal plant with significant therapeutic benefits in modern healthcare systems [29].

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