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RESEARCH ARTICLE
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SYNERGISTIC EFFECTS OF *MORINGA OLEIFERA* AND *CARICA PAPAYA* ON BLOOD GLUCOSE AND CHOLESTEROL LEVELS IN DIABETIC AND HYPERLIPIDEMIC RATS

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ABSTRACT
The therapeutic benefits of papaya leaf and Moringa oleifera on fasting blood sugar (FBS) and cholesterol levels in diabetic and hyperlipidemic mice were assessed in this study. The control group, Moringa oleifera-treated group, and Moringa oleifera + Papaya Leave-treated group comprised thirty adult male rats. Using conventional biochemical assays, FBS and cholesterol levels were assessed following a four-week course of therapy. Comparing the Moringa oleifera group ($p=0.004$) and the combination treatment group ($p=0.001$) to controls, the results showed a substantial decrease in FBS levels. Significant drops in cholesterol were also observed in both therapy groups ($p=0.002$ and $p=0.001$, respectively). Significant differences between the groups were confirmed by ANOVA. According to these results, papaya leaves and Moringa oleifera may be used in conjunction as complimentary treatments to treat hyperglycemia and hyperlipidemia. To confirm these results, more studies with bigger sample numbers and clinical trials are advised.

Keywords: Herbal therapy, antioxidants, fasting blood sugar, hyperlipidemia, Moringa oleifera, Carica papaya, and diabetes

INTRODUCTION
Metabolic disorders interfere with the body's normal physiological processes, often leading to conditions like diabetes and hyperlipidemia. Diabetes mellitus is characterized by persistent high blood sugar levels due to impaired insulin function, which can result in serious complications such as cardiovascular diseases, kidney damage (nephropathy), nerve damage (neuropathy), and vision impairment (retinopathy) (1). Hyperlipidemia, defined by increased cholesterol and triglyceride

levels, further amplifies the risk of cardiovascular diseases and contributes to conditions like atherosclerosis and fatty liver disease (2).

While conventional treatments such as insulin therapy, statins, and fibrates are commonly used to manage diabetes and hyperlipidemia, they often come with undesirable side effects and potential long-term health concerns (3). As a result, there has been growing interest in plant-based compounds as natural alternatives or complementary treatments. Medicinal plants contain various bioactive compounds, including flavonoids, polyphenols, and alkaloids, which are known for their antioxidant, anti-inflammatory, and blood sugar-lowering properties (4).

Moringa oleifera, commonly known as the "drumstick tree," has gained attention in scientific research due to its remarkable medicinal benefits. Packed with essential vitamins, minerals, and bioactive compounds, it has shown promising effects in lowering blood sugar and cholesterol levels in both preclinical and clinical studies (5). The plant's leaves, seeds, and pods possess strong antioxidant properties, which help reduce oxidative stress and enhance insulin sensitivity (6).

Similarly, Carica papaya, or papaya, has been traditionally used for its wide range of health benefits. Its bioactive components, such as papain, flavonoids, and phenolic compounds, have demonstrated anti-inflammatory and cholesterol-lowering effects (7). Research indicates that papaya leaf extract may play a role in regulating glucose metabolism and lipid balance, contributing to better blood sugar control (8).

With the rising prevalence of metabolic disorders, investigating the therapeutic potential of Moringa oleifera and Carica papaya could offer new insights into managing hyperglycemia and hyperlipidemia. This study seeks to assess the combined effects of these plant-based treatments by analyzing their impact on fasting blood glucose and cholesterol levels in a controlled experimental model.

Material and Method

This study was designed to explore how Moringa oleifera and papaya leaves influence fasting blood sugar (FBS) and cholesterol levels. A total of 30 adult male rats were randomly assigned to one of three groups: a control group, a group treated with Moringa oleifera, and a third group that received a combination of Moringa oleifera and papaya leaves.

Before starting the experiment, the rats were given a week to adapt to their environment. Throughout the four-week study period, the control group was maintained on a regular diet and had access to water, while the treatment groups received oral extracts of Moringa oleifera and/or papaya leaves. Blood samples were collected from all rats at the beginning and end of the study to measure FBS and cholesterol levels using standard biochemical testing methods.

To evaluate the results, paired t-tests and one-way ANOVA were applied to compare the pre- and post-treatment values. Statistical significance was determined at a confidence level of $p < 0.05$, ensuring the validity of the observed effects.

RESULTS

In **Table I**, the control group showed a slight increase in FBS levels from 210 mg/dl to 224 mg/dl, with a statistically significant **p-value of 0.049**. Conversely, the groups treated with **Moringa oleifera** and **Moringa oleifera + Papaya Leave** demonstrated significant reductions in FBS levels (**p = 0.004** and **p = 0.001**, respectively). A similar trend was observed for cholesterol levels, where the control group exhibited a non-significant change (**p = 0.579**). In contrast, both treatment groups showed significant reductions in cholesterol levels, with **Moringa oleifera** (**p = 0.002**) and **Moringa oleifera + Papaya Leave** (**p = 0.001**).

In **Table II**, the ANOVA results confirmed the significant differences between groups. For FBS, the mean difference between the control and **Moringa oleifera** was **117 mg/dl** (**p < 0.001**) and between the control and **Moringa oleifera + Papaya Leave** was **126 mg/dl** (**p < 0.001**). Similarly, for cholesterol levels, the control group showed a significant mean difference of **20 mg/dl** with **Moringa oleifera** (**p < 0.001**) and **35 mg/dl** with **Moringa oleifera + Papaya Leave** (**p < 0.001**). The 95%

confidence intervals for these differences also indicated reliable and consistent results, as depicted in **Figure 1**.

These findings suggest that **Moringa oleifera** and its combination with **Papaya Leave** significantly reduce FBS and cholesterol levels compared to the control group, supporting their potential therapeutic effects in managing hyperglycemia and hypercholesterolemia

Table I compression of pre and post treatment for FBS and Total Cholesterol

	Control			**Moringa oleifera**			**Moringa oleifera +Papaya Leave**		
	Pre	Post	P-Value	Pre	Post	P-Value	Pre	Post	P-Value
FBS mg/dl	210	224	0.049	203	107	0.004	198	98	0.001
Cholesterol mg/dl	72	69	0.579	64	49	0.002	79	34	0.001

Paired test was applied, level of significance <0.05

Table II Variance analysis among groups

Dependent Variable			**Mean Difference (I-J)**	**Std. Error**	**P value**	**95% Confidence Interval**	
						Lower Bound	**Upper Bound**
FBS mg/dl	Control	Moringa oleifera	117*	6.32	.000	0.02	43.25
		Moringa oleifera + Papaya	126*	9.35	.000	26.37	50.25
Cholesterol mg/dl	Control	Moringa oleifera	20*	12.93	.000	98.04	11.25
		Moringa oleifera + Papaya	35*	17.14	.000	13.15	37.39

ANOVA test was applied, level of significance <0.05

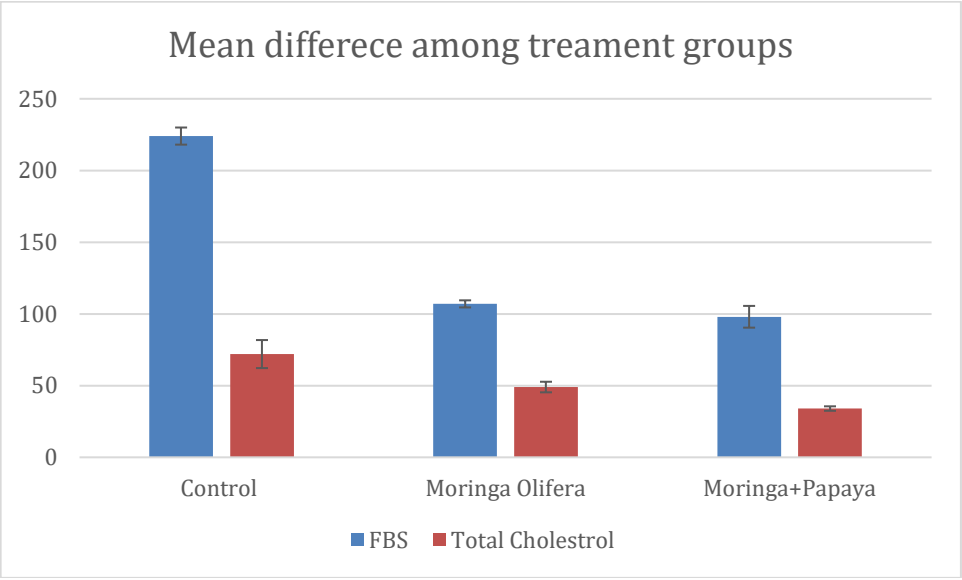

Figure 1 mean difference among treated groups

DISCUSSION

This study found that treatment with *Moringa oleifera* and its combination with papaya leaves significantly reduced fasting blood sugar (FBS) and cholesterol levels compared to the control group. These results provide strong evidence for the potential of these plant-based therapies in managing hyperglycemia and hyperlipidemia.

The reduction in FBS levels in the treatment groups is consistent with previous studies highlighting the antidiabetic effects of *Moringa oleifera*. The plant's bioactive compounds, including flavonoids, phenolic acids, and isothiocyanates, are known to enhance insulin secretion, improve glucose uptake,

and lower insulin resistance (9, 10). Additionally, its antioxidant properties play a key role in reducing oxidative stress, which is often linked to insulin resistance and the deterioration of pancreatic beta cells (11).

Similarly, the hypoglycemic effect of papaya leaves was evident in this study. Research indicates that *Carica papaya* contains beneficial alkaloids and flavonoids that help regulate blood sugar levels by stimulating insulin secretion and inhibiting enzymes like alpha-glucosidase, which break down carbohydrates (12, 13). The more pronounced reduction in FBS levels observed in the combined treatment group suggests a potential synergistic effect, enhancing glucose metabolism.

The lipid-lowering effects observed in the treatment groups also align with existing evidence supporting the cardiovascular benefits of these medicinal plants. *Moringa oleifera* has been found to lower cholesterol by influencing hepatic enzyme activity and promoting the excretion of cholesterol through feces (14, 15). Likewise, the antioxidant properties of papaya leaves reduce lipid peroxidation, which further supports healthier cholesterol levels by enhancing lipid metabolism (16). On the other hand, the lack of significant changes in cholesterol levels within the control group highlights the limitations of conventional management without additional interventions. The significant differences in cholesterol and glucose levels between the control and treated groups, as indicated by the p-values and confidence intervals, reinforce the efficacy of *Moringa oleifera* and papaya leaves as promising therapeutic options.

Despite these promising results, further large-scale studies are necessary to confirm these findings and explore the underlying mechanisms of action. Long-term research will also provide valuable insights into the safety and sustained efficacy of these therapies for chronic metabolic disorders. Additionally, future investigations could explore the effects of varying dosages and the potential benefits of other plant combinations to optimize treatment outcomes.

In summary, this study supports the potential use of *Moringa oleifera* and papaya leaves as complementary treatments for managing diabetes and hyperlipidemia. Their antioxidant, anti-inflammatory, and insulin-sensitizing properties offer a natural and effective alternative for individuals with metabolic disorders.

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Conflict of Interest: The authors declare no conflicts of interest.

Ethical Approval: Ethical approval for this study was obtained from the Institutional Review Board (IRB).

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