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Effect of *Moringa oleifera* Leaf Powder Biscuits on Blood Cholesterol Levels in Patients with Hypercholesterolemia at the Kutablang Community Health Center, Bireuen Regency

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Abstract

Hypercholesterolemia is a major risk factor for cardiovascular disease and is characterized by elevated blood cholesterol levels. *Moringa oleifera* leaves are rich in dietary fiber, polyphenols, flavonoids, and phytosterols that have been reported to improve lipid metabolism and may contribute to cholesterol reduction. This study aimed to evaluate the association between the consumption of *Moringa oleifera* leaf powder biscuits and total blood cholesterol levels among patients with hypercholesterolemia. A quasi-experimental study using a one-group pretest–posttest design was conducted from July 1 to July 7, 2025, at the Kuta Blang Community Health Center, Bireuen Regency, Indonesia. Sixteen patients with hypercholesterolemia who met the inclusion criteria were recruited using purposive sampling. Participants consumed three *Moringa oleifera* leaf powder biscuits daily for seven consecutive days. Total blood cholesterol levels were measured before and after the intervention. Data were analyzed using the paired-samples *t*-test with a significance level of $p < 0.05$. The mean total cholesterol level decreased significantly from **272.75 ± 45.24 mg/dL** before the intervention to **241.38 ± 45.99 mg/dL** after the intervention, representing a mean reduction of **31.37 mg/dL** ($t = 7.057$, $p < 0.001$). Consumption of *Moringa oleifera* leaf powder biscuits for seven days was associated with a significant reduction in total blood cholesterol levels among patients with hypercholesterolemia. These findings suggest that *Moringa oleifera* leaf powder biscuits may have potential as a functional food to support dietary management of hypercholesterolemia. Further randomized controlled studies with larger sample sizes and longer intervention periods are recommended to confirm these findings.

Keywords: *Moringa oleifera,* hypercholesterolemia, cholesterol, functional food, biscuits

Introduction

Hypercholesterolemia is a metabolic disorder characterized by elevated blood cholesterol concentrations and is one of the major modifiable risk factors for cardiovascular disease (CVD). Persistent elevation of total and low-density lipoprotein (LDL) cholesterol promotes the formation of atherosclerotic plaques, leading to narrowing of the arteries and increasing the risk of coronary heart disease, stroke, and premature mortality. Cardiovascular diseases remain the leading cause of death worldwide, accounting for approximately 20.5 million deaths in 2021,

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with dyslipidemia recognized as one of the principal contributing risk factors (World Heart Federation, 2024).

The prevalence of hypercholesterolemia continues to increase, particularly in low- and middle-income countries undergoing rapid nutritional and lifestyle transitions. In Indonesia, the growing consumption of foods high in saturated fat, inadequate dietary fiber intake, physical inactivity, obesity, and smoking contribute substantially to dyslipidemia. The Indonesian Health Survey (SKI) 2023 also indicates that non-communicable diseases related to metabolic disorders remain an important public health challenge, highlighting the need for effective nutritional interventions (Ministry of Health of Indonesia, 2023).

Management of hypercholesterolemia generally combines pharmacological therapy with lifestyle modification. Lipid-lowering medications, particularly statins, effectively reduce cardiovascular risk; however, long-term therapy may be associated with adverse effects and poor treatment adherence in some patients. Therefore, dietary interventions using functional foods have attracted considerable attention as complementary approaches for improving lipid profiles (Mach et al., 2020).

Moringa oleifera is a tropical plant widely cultivated in Asia and Africa and is recognized as one of the most nutrient-dense edible plants. Moringa leaves are rich in dietary fiber, polyphenols, flavonoids, quercetin, chlorogenic acid, carotenoids, vitamins, minerals, and phytosterols. These bioactive compounds exhibit antioxidant, anti-inflammatory, and hypolipidemic activities. Experimental evidence suggests that *Moringa oleifera* may reduce blood cholesterol through several mechanisms, including inhibition of intestinal cholesterol absorption, increased bile acid excretion, suppression of hepatic cholesterol synthesis, reduction of oxidative stress, and improvement of lipid metabolism (Alia et al., 2022).

Among various food products, biscuits represent an attractive vehicle for delivering functional ingredients because they are inexpensive, widely consumed, have a long shelf life, and are highly acceptable to consumers. Incorporating *Moringa oleifera* leaf powder into biscuits may therefore provide a practical strategy for increasing the intake of bioactive compounds without substantially changing eating habits. Nevertheless, although numerous studies have investigated the nutritional composition of Moringa-enriched foods, evidence regarding the effectiveness of Moringa leaf powder biscuits in reducing blood cholesterol among patients with hypercholesterolemia remains limited, particularly in Indonesian primary healthcare settings. This represents an important research gap.

Therefore, this study aimed to evaluate the effect of *Moringa oleifera* leaf powder biscuits on blood cholesterol levels among patients with hypercholesterolemia attending the Kutablang Community Health Center, Bireuen Regency. The findings are expected to provide scientific evidence supporting the utilization of locally available functional foods as complementary nutritional interventions for the management of hypercholesterolemia.

Methods

This study employed a quasi-experimental one-group pre-test–post-test design to evaluate the effect of *Moringa oleifera* leaf powder biscuits on blood cholesterol levels among patients with hypercholesterolemia at the Kuta Blang Community Health Center, Bireuen Regency,

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Aceh, Indonesia. Total blood cholesterol levels were measured before (pre-test) and after (post-test) the intervention.

The study was conducted from July 1 to July 7, 2025. The study population consisted of 46 patients aged 21–60 years who had been diagnosed with hypercholesterolemia and were registered at the Kuta Blang Community Health Center between January and October 2024. A total population sampling approach was initially applied; however, only **16 participants** who met the inclusion criteria and agreed to participate were enrolled in the study.

Participants consumed three biscuits containing *Moringa oleifera* leaf powder once daily for seven consecutive days. The preparation of *Moringa oleifera* leaf powder involved separating the leaves from the stems, washing them under running water, draining excess water, sun-drying the leaves until completely dry, grinding them into powder using a milling machine, and sieving the powder through an 80-mesh sieve to obtain a uniform particle size, following the method described by Kurniawati and Fitriyya (2018).

Data processing included editing, coding, scoring, data entry, and tabulation. Statistical analyses were performed using IBM SPSS Statistics version 22. Data normality was assessed using the Shapiro–Wilk test, with a p-value > 0.05 indicating that the data were normally distributed. The differences in total blood cholesterol levels before and after the intervention were analyzed using a paired-samples t-test. A p-value < 0.05 was considered statistically significant. The study findings are presented in both tabular and narrative forms.

Results

Changes in Blood Cholesterol Levels Following Consumption of *Moringa oleifera* Leaf Powder Biscuits

Table 1. Total blood cholesterol levels before and after the intervention

Time of measurement	Mean (mg/dL)	Min	Max	SD
Before intervention	272.75	200	373	45.24
After intervention	241.38	175	350	45.99

As shown in Table 1, the mean total blood cholesterol level decreased from 272.75 ± 45.24 mg/dL before the intervention to 241.38 ± 45.99 mg/dL after seven days of consuming *Moringa oleifera* leaf powder biscuits. This represents a mean reduction of 31.37 mg/dL.

Effect of *Moringa oleifera* Leaf Powder Biscuits on Blood Cholesterol Levels

Table 2. Paired-samples t-test comparing blood cholesterol levels before and after the intervention

Variable	n	Mean (mg/dL)	Mean Difference (mg/dL)	t-value	p-value
Before intervention	16	272.75	31.38	7.057	<0.001
After intervention	16	241.38			

The paired-samples *t*-test demonstrated a statistically significant reduction in total blood cholesterol levels following the seven-day intervention with *Moringa oleifera* leaf powder biscuits (t = 7.057, p < 0.001). The mean reduction in cholesterol concentration was 31.38

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mg/dL, indicating that consumption of the biscuits was associated with a significant decrease in blood cholesterol levels among patients with hypercholesterolemia.

Discussion

Effect of *Moringa oleifera* Leaf Powder Biscuits on Blood Cholesterol Levels

The present study demonstrated that the consumption of *Moringa oleifera* leaf powder biscuits for seven consecutive days was associated with a significant reduction in total blood cholesterol levels among patients with hypercholesterolemia. The mean total cholesterol concentration decreased from **272.75 mg/dL** before the intervention to **241.38 mg/dL** after the intervention, representing an average reduction of **31.37 mg/dL** ($p < 0.001$). These findings indicate that incorporating *Moringa oleifera* leaf powder into biscuits may provide a beneficial dietary approach for improving lipid profiles in individuals with hypercholesterolemia. However, because this study employed a one-group pretest–posttest design without a control group, the observed reduction should be interpreted as an association with the intervention rather than definitive evidence of causality.

The reduction in cholesterol levels observed in the present study is biologically plausible because *Moringa oleifera* leaves are rich in bioactive compounds, including flavonoids, phenolic acids, chlorogenic acid, quercetin, kaempferol, phytosterols, saponins, vitamins, minerals, and dietary fiber. These phytochemicals have been reported to exert hypolipidemic, antioxidant, and anti-inflammatory activities that contribute to improved lipid metabolism and cardiovascular health and reduce oxidative stress (Louisa et al., 2022; Pareek et al., 2023; Su et al., 2023).

Several biological mechanisms have been proposed to explain the cholesterol-lowering effects of *Moringa oleifera*. Experimental evidence suggests that *Moringa* suppresses hepatic cholesterol synthesis through modulation of lipid-metabolism pathways, including inhibition of **3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase**, the rate-limiting enzyme in endogenous cholesterol biosynthesis. In addition, its antioxidant and anti-inflammatory properties reduce oxidative stress and improve lipid homeostasis, while dietary fiber and phytosterols may decrease intestinal cholesterol absorption and promote bile acid excretion, thereby contributing to lower circulating cholesterol concentrations (Louisa et al., 2022; Pareek et al., 2023).

These findings are consistent with recent reviews indicating that *Moringa oleifera* supplementation improves lipid profiles, particularly total cholesterol, LDL cholesterol, and triglycerides, owing to its high content of polyphenols and flavonoids (Jikah & Edo, 2023). A recent systematic review by Louisa et al. (2022), which summarized 108 experimental and clinical studies, concluded that *Moringa oleifera* consistently improves lipid metabolism through antioxidant, anti-inflammatory, and metabolic regulatory mechanisms. The review also reported reductions in total cholesterol, low-density lipoprotein cholesterol (LDL-C), and triglycerides in both animal models and human studies, suggesting that *Moringa* has considerable potential as a complementary dietary intervention for cardiometabolic disorders.

Similarly, Pareek et al. (2023) reported that *Moringa oleifera* contains a wide range of pharmacologically active phytochemicals with demonstrated antihyperlipidemic properties. Their comprehensive review highlighted that flavonoids and polyphenolic compounds in *Moringa* improve lipid metabolism by reducing oxidative damage, regulating hepatic lipid synthesis, and

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enhancing antioxidant defense systems. These mechanisms support the cholesterol-lowering effect observed in the present study following short-term biscuit supplementation.

A comprehensive meta-analysis by Ali Redha et al. (2025) covering 108 studies on Moringa oleifera showed that Moringa supplementation is effective in lowering total cholesterol, LDL-C, and triglyceride levels in individuals with dyslipidemia. The analysis also revealed that moderate doses (<10 g/day) consumed for a minimum of 12 weeks yielded the most optimal effects. Research by Afiaenyi et al. (2023) on patients with type 2 diabetes mellitus demonstrated that the administration of steamed Moringa leaves at doses of 20, 40, and 60 grams for 14 days reduced total cholesterol and LDL-C levels in a dose-dependent manner while increasing HDL-C levels. Meanwhile, a recent study by Dahili et al. (2025) using a metabolomics approach revealed that the lipid-lowering effect of Moringa leaves occurs through the modulation of various metabolic pathways, including the inhibition of endogenous lipid synthesis via the downregulation of SREBP-1c and FAS, as well as increased bile acid excretion.

Pharmacological studies indicate that extracts from various plants, such as Moringa oleifera, possess hepatoprotective, cardioprotective, and anti-inflammatory potential. These cardioprotective effects stem not only from the plant's ability to lower cholesterol levels but also from the antioxidant and anti-inflammatory activities present in Moringa leaves. Quercetin and other flavonoids found in Moringa leaves are known to exert pleiotropic effects that protect blood vessels from damage caused by oxidative stress and inflammation—key factors in the pathogenesis of atherosclerosis (Mbikay, 2012). However, several recent clinical studies have shown more varied results. Munir et al. (2025) reported that, although a significant reduction occurred in the group consuming Moringa, the difference between the treatment and control groups did not always reach statistical significance across all lipid parameters

Although a statistically significant reduction in cholesterol levels was observed after only seven days of intervention, several limitations should be considered. The relatively short intervention period, small sample size, and absence of a control group limit the generalizability of the findings. Furthermore, dietary intake, physical activity, body weight, and medication adherence were not controlled during the intervention and may have influenced the observed changes in cholesterol levels. Therefore, larger randomized controlled trials with longer intervention periods are required to confirm the long-term effectiveness of *Moringa oleifera* biscuits and to evaluate their effects on comprehensive lipid parameters, including LDL-C, HDL-C, triglycerides, inflammatory biomarkers, and oxidative stress indicators (Louisa et al., 2022; Pareek et al., 2023).

Conclusion

The present study demonstrated that the consumption of *Moringa oleifera* leaf powder biscuits for seven consecutive days was associated with a significant reduction in total blood cholesterol levels among patients with hypercholesterolemia at the Kuta Blang Community Health Center, Bireuen Regency ($p < 0.001$). These findings suggest that *Moringa oleifera* leaf powder biscuits may serve as a promising functional food to support the dietary management of hypercholesterolemia. However, given the one-group pretest–posttest design and the relatively short intervention period, further randomized controlled studies with larger sample sizes and longer intervention durations are recommended to confirm their long-term effectiveness.

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