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Fenugreek extract as a natural therapy for dyslipidaemia: an *in vivo* study on rats

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ABSTRACT

Dyslipidaemia is a major risk factor for cardiovascular disease, necessitating effective lipid-lowering interventions. This study investigates the lipid-modulating effects of fenugreek (*Trigonella foenum-graecum*) extract in comparison to atorvastatin, on rats, with a focus on dose-dependent responses. Male rats (n=150) were randomly assigned to five groups (n=30 per group): negative control (NC), positive control treated with atorvastatin (5–20 mg/kg), and three experimental groups receiving low (100 mg/kg), medium (250 mg/kg), or high (500 mg/kg) doses of fenugreek extract. Lipid profiles – including total cholesterol (TC), low-density lipoprotein (LDL)-cholesterol, high-density lipoprotein (HDL)-cholesterol, and triglycerides (TG) – were assessed post-treatment using standard biochemical assays. Atorvastatin significantly reduced TC (75.33 ± 19.49 mg/dL, $p<0.05$) and LDL-cholesterol (26.93 ± 10.36 mg/dL, $p<0.0001$), while elevating HDL-cholesterol (55.20 ± 13.19 mg/dL, $p<0.0001$). Similarly, high-dose fenugreek extract significantly lowered TC (75.97 ± 32.58 mg/dL, $p<0.05$) and LDL-cholesterol (22.17 ± 10.11 mg/dL, $p<0.0001$), with a concomitant increase in HDL-cholesterol (57.90 ± 20.45 mg/dL, $p<0.0001$). No significant changes in TG levels were observed across the assessed groups. These findings suggest that the fenugreek extract, particularly at higher doses, exerts lipid-lowering effects comparable to atorvastatin, supporting its potential as a natural alternative or adjunctive therapy in the management of dyslipidaemia.

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1. Introduction

Fenugreek (*Trigonella foenum-graecum*), a plant native to the Mediterranean, South Asia, and North Africa, is renowned for its diverse health-promoting properties, attributed to its exceptional nutritional and bioactive composition. The seeds and leaves of fenugreek have long been utilized in both traditional medicine and modern therapeutic applications. Rich in proteins, dietary fibre, vitamins (notably B_6 and C), and phytochemicals such as saponins, alkaloids, and flavonoids, fenugreek contributes significantly to overall health maintenance[1].

This study aimed at evaluating the effects of fenugreek extract on the lipid profiles of rats and to compare its dose-dependent lipid-modulating effects with those of atorvastatin (a widely used lipid-lowering agent), in order to assess its potential as a natural alternative for improving lipid metabolism.

2. Methodology

Fresh fenugreek was procured from a local market. Extraction was performed on 100 g of finely crushed seed powder using a Soxhlet apparatus at 70°C for 4 h, in order to isolate bioactive constituents.

A total of 150 healthy male Wistar rats (weight range: 350–500 g) were housed in ventilated cages under controlled environmental conditions: 12-h light/dark cycle, temperature of 22°C ± 2°C, and relative humidity of 50%–60%. All experimental procedures adhered to ethical standards for animal research and were approved by the Ethical Research Committee of the College of Dentistry of Al-Iraqia University (ESA & HER 09-12-08-2024). The rats were randomly assigned to five groups (n=30 per group): (i) healthy control (HC) group (no treatment administered), (ii) positive control (PC) group (treated with atorvastatin at 10 mg/kg body weight), (iii) low-dose fenugreek (LD-F) group (treated with fenugreek extract at 100 mg/kg body weight), (iv) medium-dose fenugreek (MD-F) group (treated with fenugreek extract at 250 mg/kg body weight), and (v) high-dose fenugreek (HD-F) group (treated with fenugreek extract at 500 mg/kg body weight). Treatments were administered orally once daily for one month. Rats were monitored for adverse effects and treatment responses. Blood samples (~3 mL) were collected *via* cardiac puncture under anaesthesia and centrifuged at 1,600 rpm for 20 min so as to obtain serum.

Serum lipid levels – including those of total cholesterol (TC), low-density lipoprotein (LDL)-cholesterol (LDL-cholesterol), high-density lipoprotein (HDL) cholesterol (HDL-cholesterol), and triglycerides (TG) – were analysed using the Biolyzer 300 (Analyticon Biotechnologies AG, Germany), employing automated enzymatic and colorimetric techniques. Statistical comparisons were performed using one-way analysis of variance (ANOVA), followed by *t*-tests in order to identify significant differences among groups. A *p*-value below 0.05 was considered as statistically significant.

3. Results and Discussion

The lipid-modulating effects of atorvastatin and of the fenugreek extract were evaluated across all experimental groups (Table 1). ANOVA revealed no statistically significant differences in TG levels (p=0.1491), but significant differences were observed for TC (p=0.0072), LDL-cholesterol (p<0.0001), and HDL-cholesterol (p<0.0001).

As shown in Table 1, the fenugreek extract exhibited dose-dependent effects on TC. The LD-F and MD-F rat groups did not show significant reductions compared to the HC group, suggesting that these doses may be insufficient to elicit a substantial hypocholesterolaemic effect. These findings are consistent with those of previous studies indicating that bioactive compounds in fenugreek, such as saponins and galactomannan, require adequate concentrations to meaningfully influence lipid metabolism. In contrast, the HD-F group demonstrated a significant reduction in TC, achieving mean values comparable to those observed in the atorvastatin-treated group. This suggests that high-dose fenugreek extract may confer therapeutic benefits similar to conventional lipid-lowering agents. The hypocholesterolaemic effect of fenugreek is likely mediated through multiple

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Table 1. Lipid profile parameters (mg/dL) across the herein assessed experimental groups. Abbreviations used: CI, confidence interval; HD-F, high-dose fenugreek group (500 mg/kg); HDL, high-density lipoprotein; LD-F, low-dose fenugreek group (100 mg/kg); LDL, low-density lipoprotein; MD-F, medium-dose fenugreek group (250 mg/kg); NC, negative control group (untreated); PC, positive control group (treated with atorvastatin); SD, standard deviation.

Group	N	Mean ± SD	Range	Significant difference	95% CI of difference
Total cholesterol					
NC	30	101.4 ± 38.19	52–187	-	-
PC	30	75.33 ± 19.49	36–110	yes	1.616 to 50.52
LD- F	30	97.40 ± 41.11	40–193	no	-20.45 to 28.45
MD-F	30	86.83 ± 35.86	39–210	no	-9.884 to 39.02
HD-F	30	75.97 ± 32.58	42–185	yes	0.9824 to 49.88
Triglycerides					
NC	30	71.70 ± 24.43	38–105	-	-
PC	30	59.47 ± 20.04	24–102	no	-4.440 to 28.91
LD- F	30	68.03 ± 29.12	33–121	no	-13.34 to 20.01
MD-F	30	67.67 ± 20.39	44–108	no	-12.64 to 20.71
HD-F	30	57.33 ± 21.33	32–102	no	-2.307 to 31.04
LDL-cholesterol					
NC	30	39.17± 11.88	14–62	-	-
PC	30	26.93 ± 10.36	10–48	yes	4.027 to 20.44
LD- F	30	34.43 ± 13.43	12–58	no	-3.473 to 12.94
MD-F	30	32.60 ± 11.45	11–59	no	-1.640 to 14.77
HD-F	30	22.17 ± 10.11	10–51	yes	8.793 to 25.21
HDL-cholesterol					
NC	30	35.47 ± 13.60	19–78	-	-
PC	30	55.20 ± 13.19	31–88	yes	-31.50 to -7.963
LD- F	30	44.80 ± 16.35	22–84	no	-21.10 to 2.437
MD-F	30	47.03 ± 17.71	23–91	no	-23.34 to 0.2041
HD-F	30	57.90 ± 20.45	25–89	yes	-34.20 to -10.66

mechanisms, including the inhibition of intestinal cholesterol absorption, an enhanced faecal excretion of bile acids, and the modulation of hepatic lipid metabolism by bioactive phytochemicals[2].

Table 1 also summarizes TG values across groups. Although atorvastatin is known to moderately reduce TG by inhibiting hepatic production of very-low-density lipoprotein, the observed reductions were not statistically significant. This may be attributable to the NC group's normal baseline TG levels, the atorvastatin dosage, or sample size limitations. Fenugreek has demonstrated a potential to lower TG levels, particularly at higher concentrations. Bioactive constituents such as dietary fibre and saponins may contribute to this effect. However, the absence of statistically significant TG reductions in the fenugreek-treated groups suggests that its TG-lowering capacity may be modest, requiring higher doses or extended treatment duration in order to achieve clinically meaningful outcomes[3].

Table 1 presents the recorded LDL-cholesterol levels across groups. The lack of significant reductions in the LD-F and MD-F groups may reflect insufficient concentrations of active compounds such as sapon-

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ins, flavonoids, and alkaloids. Additionally, inter-individual variability in absorption and metabolism may influence treatment efficacy[4]. A larger sample size or longer treatment duration may be necessary to detect subtle changes at lower doses. Notably, the HD-F group exhibited LDL-cholesterol reductions comparable to those achieved with atorvastatin. This effect may result from synergistic actions of fenugreek's bioactive constituents. Saponins inhibit intestinal cholesterol absorption, flavonoids modulate hepatic lipid metabolism, and enhanced bile acid excretion promotes conversion of cholesterol into bile salts, collectively reducing circulating LDL-cholesterol levels. These findings support the potential of high-dose fenugreek extract as an alternative or adjunctive strategy for managing hyperlipidaemia. While statins such as atorvastatin remain the cornerstone of dyslipidaemia management, they are associated with adverse effects including myopathy, hepatotoxicity, and increased diabetes risk in some patients[5]. The fenugreek extract may offer a safer, plant-based alternative with comparable efficacy at appropriate doses.

Finally, the recorded HDL-cholesterol levels for all rat groups are summarized in Table 1. The dose-dependent increase in HDL-cholesterol observed in fenugreek-treated groups is likely attributable to its complex phytochemical profile, including alkaloids, flavonoids, and saponins. These compounds possess lipid-lowering, anti-inflammatory, and antioxidant properties. Fenugreek may enhance HDL-cholesterol through multiple mechanisms, including an up-regulation of HDL-associated proteins and enzymes involved in cholesterol efflux. It may also stimulate apolipoprotein A-I synthesis, thereby promoting HDL particle formation and improving reverse cholesterol transport[6].

4. Conclusion

Both atorvastatin and the fenugreek extract significantly modulated lipid parameters in rats, with the exception of TG levels, where effects were not statistically significant. Atorvastatin effectively increased HDL-cholesterol and reduced TC and LDL-cholesterol levels. The fenugreek extract demonstrated a dose-dependent efficacy, with the HD-F group achieving lipid profile improvements comparable to those of the atorvastatin-treated group.

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Conflicts of interest

None exist.

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