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Review article

Effects of fenugreek supplementation on polycystic ovary syndrome: a systematic review of human and animal model studies

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Abstract

Objective: Polycystic ovary syndrome (PCOS) is a common endocrine disorder. Fenugreek (*Trigonella foenum-graecum*) is an herbal supplement investigated for managing PCOS symptoms, but its efficacy remains unclear. This systematic review assessed the impact of fenugreek supplementation on PCOS outcomes in human and animal studies.

Materials and Methods: A search was conducted in PubMed, Scopus, and Web of Science up to December 2024. Eligible studies included clinical trials involving women with PCOS and animal models utilizing rodent PCOS models that assessed fenugreek supplementation (any form or dose) against a control group. Outcomes of interest included insulin resistance, hormonal parameters, and ovarian morphology.

Results: Thirteen studies (8 human and 5 animal) were included. In human studies, fenugreek supplementation (doses ranging from 333 mg/day to 2000 mg/day) significantly improved ovarian morphology and lipid profiles in a majority of studies investigating these outcomes. Effects on insulin resistance (HOMA-IR), fasting blood glucose, and testosterone levels were significant in some, but not all, clinical trials. Menstrual regularity improved in half of the relevant studies. In animal studies, fenugreek (0.5 to 100 mg/kg) consistently reduced ovarian cyst formation and improved estrous cyclicity. No significant adverse effects were reported.

Conclusion: Fenugreek supplementation demonstrates promise in improving ovarian morphology and lipid metabolism in PCOS. Its effects on hormonal and glycemic outcomes are inconsistent. The evidence suggests benefits may be dependent on the specific extract and patient population. Further high-quality, standardized trials are required to confirm these findings and establish optimal clinical protocols.

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Introduction

Polycystic ovary syndrome (PCOS), also referred to as hyperandrogenic anovulation or Stein–Leventhal syndrome, is a polygenic and multifactorial endocrine disorder that affects women of reproductive age worldwide (Deans 2019). Ovarian dysfunction, high levels of androgens, and insulin resistance are associated with this condition. It increases the likelihood of developing cardiovascular disease, type 2 diabetes mellitus (T2DM), metabolic syndrome (MetS), anxiety, depression, and other mental health issues (Damone et al. 2019; Witchel et al. 2019). Evidence suggests that PCOS affects approximately 5% to 20% of women of reproductive age worldwide (Joshi A 2024). Contemporary research has disproved the long-held belief that PCOS is exclusively a disorder of adult women and has demonstrated that its clinical manifestations frequently emerge during adolescence. Using the Rotterdam diagnostic criteria, the reported prevalence of PCOS among adolescents varies considerably, ranging from approximately 3% to 26%, depending on the population studied and the diagnostic criteria applied (Tay CT 2020; Kiconco S 2023); however, the prevalence of the disease in children is not yet known (Kamangar et al. 2015). Even though PCOS is characterized by an imbalance in luteinizing hormone (LH), it is also associated with issues with follicle-stimulating hormone (FSH) and gonadotropin-releasing hormone (GnRH) (Bednarska and Siejka 2017). The exact causes and mechanisms of PCOS are still a mystery (Bednarska and Siejka 2017). According to research, there are numerous factors that contribute to the development of this condition, including insulin resistance (IR), hyperandrogenism (HA), and environmental, genetic, and epigenetic variables. Moreover, low-grade chronic inflammation appears to cause and accompany the syndrome (Zhai and Pang 2022).

The management of PCOS typically involves lifestyle modifications and pharmacological agents such as metformin and oral contraceptives (Ee and Tay 2024; Ghafari et al. 2025). However, these treatments can have side effects and may not be suitable for all patients, leading to a growing interest in complementary and alternative medicine (Mohamed et al. 2025). Herbal medicines and natural compounds are increasingly sought after by patients due to their perceived safety and historical use in traditional healing systems for various chronic conditions, including endocrine and metabolic disorders (Jandari et al. 2020). Several herbal supplements have been investigated for their potential role in managing PCOS symptoms, with varying degrees of success (Singh et al. 2023). Among these, fenugreek (*Trigonella foenum-graecum* L.) has emerged as a promising candidate.

Fenugreek, scientifically known as *Trigonella foenum-graecum* L., is a Leguminosae plant that is widely grown in Asia, the Mediterranean, and North Africa. Traditional medicine has long used the herb topically to treat a variety of conditions, including DM, fever, abdominal colic, boils, carbuncles, and abscesses (Gong et al. 2016; Ranade and Mudgalkar 2017). Fenugreek is rich in beneficial secondary metabolites including alkaloids, phenolics, volatile oils, saponins, vitamins, and carbohydrates (Chehregosha et al. 2025; Husseini and Zainulabdeen 2023). Nevertheless, the exact biochemical and cellular mechanisms by which it exerts its hypoglycemic and antihyperglycemic effects remain largely unknown. Studies have shown that the plant, particularly the seed powder, positively influences enzymes involved in glucose homeostasis, gluconeogenesis, and lipogenesis, thereby alleviating alloxan-induced diabetes in rats (Raju et al. 2001). Clinical and experimental studies in humans and animals have demonstrated hypocholesterolemic and anti-diabetic effects of fenugreek seed as a pharmaceutical agent (Nagulapalli Venkata et al. 2017; Vijayakumar et al. 2005).

Additionally, the seeds can help those living with diabetes by lowering their blood glucose levels, as they are a rich source of fiber (Kumar et al. 2014). Saponins constitute the highest chemical content in fenugreek seed extract, which contains various types of saponins and flavonoids that help improve insulin sensitivity and reduce blood lipid levels. By improving insulin sensitivity, these compounds facilitate greater insulin-stimulated glucose uptake into cells, and by lowering insulin resistance, PCOS can be more effectively managed (Kannappan and Anuradha 2009). Fenugreek is generally well tolerated in clinical studies, with most reported adverse effects being mild gastrointestinal symptoms such as diarrhea, flatulence, and abdominal discomfort (Ouzir et al. 2016). Rats with PCOS had lower androgen levels after supplementing with fenugreek due to its anti-androgenic properties (Husseini and Zainulabdeen 2023). A recent study demonstrated that fenugreek seed extract can help treat PCOS by reducing the size and number of cysts in the ovaries (Jaipuriar et al. 2018). Accordingly, this helps maintain regular menstrual cycles. Further benefits included more regular menstrual cycles, properly matured eggs, reduced ovarian volume, and no infertility after three months of fenugreek seed consumption (Jaipuriar et al. 2018). As an alternative to metformin, 60 days of fenugreek supplementation do not alleviate hyperglycemia caused by PCOS (Mirgaloybayat et al. 2024).

Given the conflicting evidence from multiple studies and the lack of a comprehensive systematic review simultaneously synthesizing data from both human clinical trials and animal models, the objective of this study was to quantitatively summarize the available evidence and evaluate the impact of fenugreek supplementation on metabolic and hormonal functions in PCOS.

Materials and Methods

Study design

This systematic review was conducted to evaluate the effects of fenugreek supplementation on PCOS in both human and animal model studies. The review was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al. 2021).

Eligibility criteria

Studies were included if they met the following criteria:

Population: Human studies that involved women diagnosed with PCOS, and animal model studies that utilized rodent models (rats or mice) of PCOS.

Intervention: Studies that administered fenugreek supplementation (any dose, form, or duration) to the treatment group.

Comparison: Control groups that received either a placebo, standard treatment, or no intervention.

Outcome Measures: Studies that reported at least one of the following outcomes: insulin resistance (e.g. fasting blood glucose (FBG), HOMA-IR), hormonal parameters (e.g. LH, FSH, LH/FSH ratio, testosterone, Dehydroepiandrosterone sulfate (DHEAs), estrogen and progesterone), menstrual irregularities (e.g. frequency of menstruation, and ovulation), ovarian appearance (number and size of cysts) ovarian morphology (in animal studies), and adverse effects.

Study Type: clinical trials and animal model studies.

Exclusion Criteria: Studies that were not published in English (due to resource constraints for translation), studies involving non-PCOS populations, reviews, conference abstracts, or studies with insufficient data on outcomes of interest.

Search strategy

We systematically searched the following electronic databases for relevant studies published up to December 2024: PubMed, Scopus, and Web of Science.

Additionally, we manually searched the reference lists of relevant studies and reviews to identify any additional articles. No language restrictions were applied to the search. The search strategy was designed to capture studies that assessed the effects of fenugreek supplementation on PCOS and included the terms: "fenugreek", "trigonella", "foenumgraecum", "fenugreek seed", "polycystic ovary syndrome", "stein leventhal syndrome", "Sclerocystic Ovarian Degeneration", and "Sclerocystic Ovary Syndrome". The complete search strategy is available in the supplementary materials.

Study selection

Two independent reviewers (A.C. and S.S.) screened all retrieved studies in two stages: 1) Title and Abstract Screening: Studies were first screened based on their titles and abstracts. 2) Full-Text Screening: The full-text articles of potentially eligible studies were assessed for inclusion based on the eligibility criteria outlined above. Non-English articles identified in the search were excluded at the full-text stage due to a lack of translation resources. Any disagreements during the study selection process were resolved through discussion or by consulting a third reviewer (H.B.).

Data extraction

Data were independently extracted by two reviewers (A.C. and S.S.) using a standardized data extraction form. The following data were extracted from each study:

Study characteristics: First author, year of publication, study design, sample size, duration of supplementation, fenugreek dose, and form (e.g. capsule or powder).

Population characteristics: Age, body mass index (BMI), and inclusion/exclusion criteria.

Outcomes:

Human studies: Changes in insulin resistance (e.g., FBG and HOMA-IR), hormonal parameters (e.g. testosterone, and LH/FSH ratio), menstrual regularity (e.g. ovulation), body weight, BMI, and adverse effects.

Animal studies: Ovarian morphology (e.g. cyst formation, and follicular development), insulin sensitivity (e.g. glucose tolerance test), and hormonal levels (e.g. testosterone, LH, and FSH).

Discrepancies in data extraction were resolved through consensus between reviewers.

A meta-analysis was not performed due to significant heterogeneity in study designs, interventions, and reported outcomes among the included studies. Therefore, a narrative synthesis was conducted to summarize the findings from human and animal studies (Campbell et al. 2020). The results are presented descriptively, with data tabulated to illustrate study characteristics and key outcomes.

Quality assessment

The quality of the included studies was assessed using appropriate tools:

For Human Studies: The Cochrane Risk of Bias tool was used to assess the methodological quality of randomized controlled trials (RCTs) (Higgins 2008).

For Animal Studies: The Systematic Review Centre for Laboratory Animal Experimentation (SYRCLE) risk of bias tool was used to assess the risk of bias in animal studies (Hooijmans et al. 2014).

Results

Study selection

The study selection process is detailed in the PRISMA flow diagram (Figure 1). A systematic database search identified 51 records. After the removal of 13 duplicates, 38 unique records were screened based on their titles and abstracts. This led to the exclusion of 18 articles that were irrelevant or were review papers. The remaining 20 full-text articles were assessed for eligibility, resulting in the inclusion of 13 studies. The final analysis comprised 8 clinical trials with a total of 861 female

participants diagnosed with PCOS (Abbasi and Abbasi 2019; Hassanzadeh et al. 2013; Jaipuriar et al. 2018; Mirgaloybayat et al. 2024; Sankhwar et al. 2023; Shukla et al. 2024; Singh et al. 2023; Swaroop et al. 2015), and 5 randomized animal studies (Alansari et al. 2018; Alkalby and Hamzah 2017; Husseini and Zainulabdeen 2023; Lodhi and Firdous ; Osman et al. 2019). The included human trials were heterogeneous, featuring five RCTs (Abbasi and Abbasi 2019; Hassanzadeh et al. 2013; Mirgaloybayat et al. 2024; Shukla et al. 2024; Singh et al. 2023), and three open-label single-arm studies (Jaipuriar et al. 2018; Sankhwar et al. 2023; Swaroop et al. 2015), with fenugreek dosages ranging from 333 to 2000 mg/day over 8 weeks to 6 months. The animal studies utilized rodent models of PCOS (mice and rats) and doses from 50 to 200 mg/kg (Tables 1 and 2).

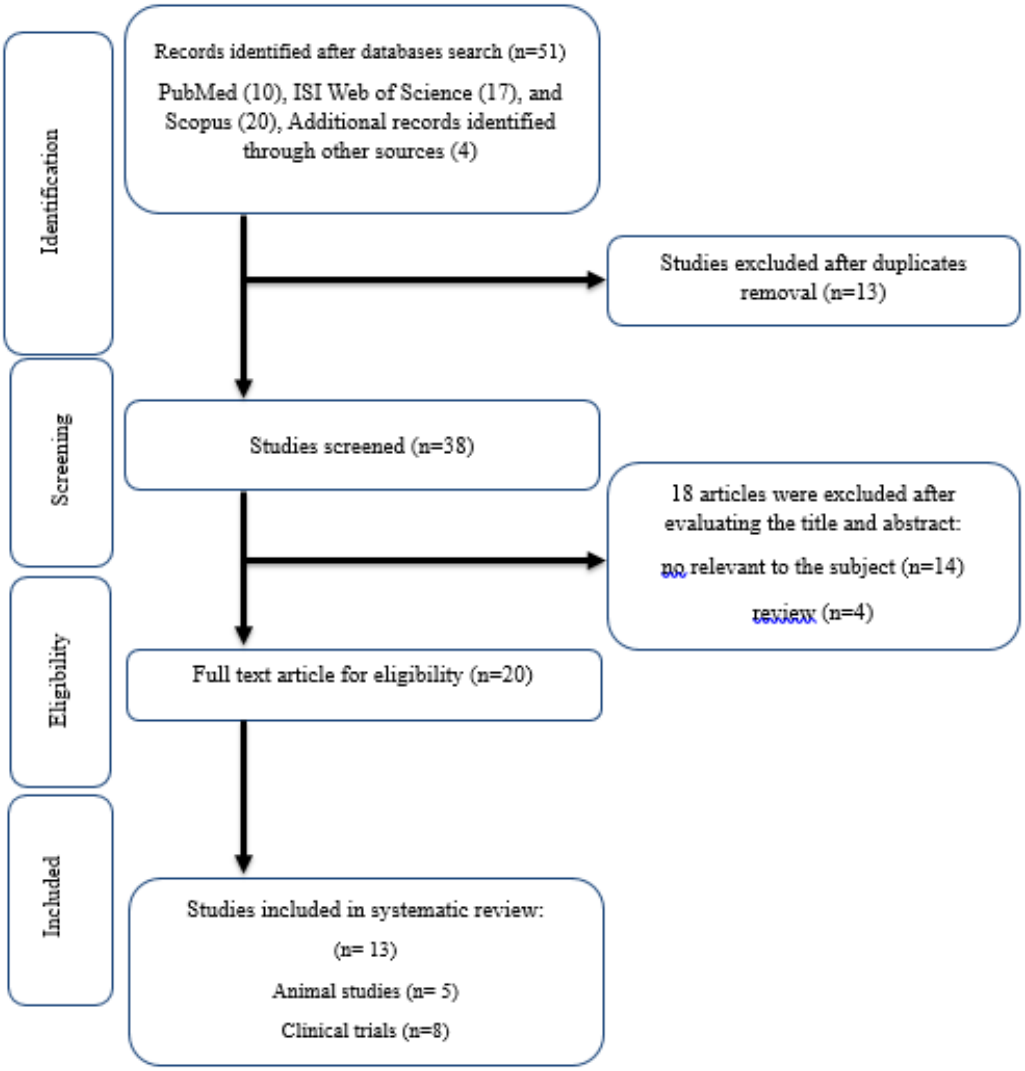

Figure 1. Flow chart of study selection for inclusion trials in the systematic review

Human studies

Effects on insulin resistance and glucose metabolism

All eight human studies assessed the impact of fenugreek supplementation on insulin resistance (Abbasi and Abbasi 2019; Hassanzadeh et al. 2013; Jaipuriar et al. 2018; Mirgaloybayat et al. 2024; Sankhwar et al. 2023; Shukla et al. 2024; Singh et al. 2023; Swaroop et al. 2015). Three studies reported significant improvements in insulin sensitivity, with reductions in FBG levels (mean reduction of 10-15%, $p<0.05$) and Homeostasis Model Assessment for

Insulin Resistance (HOMA-IR) scores (mean reduction of 20-25%, $p<0.01$) (Mirgaloybayat et al. 2024; Shukla et al. 2024; Singh et al. 2023) (Figure 2). A 20-25% reduction in HOMA-IR represents a substantial improvement in insulin sensitivity, which is likely to be clinically meaningful for metabolic health in PCOS. Other studies, however, reported no significant change in insulin resistance, possibly due to differences in supplementation duration or the relatively low doses used (500 mg/day)(Abbasi and Abbasi 2019; Hassanzadeh et al. 2013; Jaipuriar et al. 2018; Swaroop et al. 2015).

Impact on menstrual irregularities and ovulatory function

Four studies assessed the effect of fenugreek on menstrual cycle regularity and ovulation, reported significant improvements, with 50-70% of participants experiencing more frequent cycles and resumption of ovulation (Abbasi and Abbasi 2019; Jaipuriar et al. 2018; Sankhwar et al. 2023; Swaroop et al. 2015). However, studies that used a lower dose (333-500 mg/day) did not show any improvement in menstrual regularity (HASSANZADEH et al. 2013; Mirgaloybayat et al. 2024).

Effects on hormonal parameters

Three studies reported significant decreases in serum testosterone levels following fenugreek supplementation (Mirgaloybayat et al. 2024; Sankhwar et al. 2023; Singh et al. 2023). The effects on gonadotropins were variable; one study reported a significant decrease in the LH/FSH ratio (Sankhwar et al. 2023), while others reported non-significant decreases (Jaipuriar et al. 2018; Swaroop et al. 2015) or no significant changes in LH and FSH levels (Abbasi and Abbasi 2019; Hassanzadeh et al. 2013).

Body mass index, weight reduction, and lipid profile

Two studies reported a significant reduction in BMI after fenugreek consumption (Mirgaloybayat et al. 2024; Shukla et al. 2024). The effects on lipid metabolism were particularly notable. Three RCTs demonstrated that fenugreek supplementation, particularly the Furocyst extract, led to significant reductions in total cholesterol, triglycerides, very low density lipoprotein (VLDL), and low-density lipoprotein (LDL), as well as improvements in atherogenic ratios (LDL-HDL, CH-HDL), with no significant effect on HDL levels (Sankhwar et al. 2023; Shukla et al. 2024; Singh et al. 2023).

Adverse effects

Fenugreek supplementation was well tolerated in all human studies, with mild gastrointestinal discomfort (e.g. bloating and nausea) occurring in 10% of participants (Mirgaloybayat et al. 2024). No serious adverse events were reported, and no participants discontinued due to side effects.

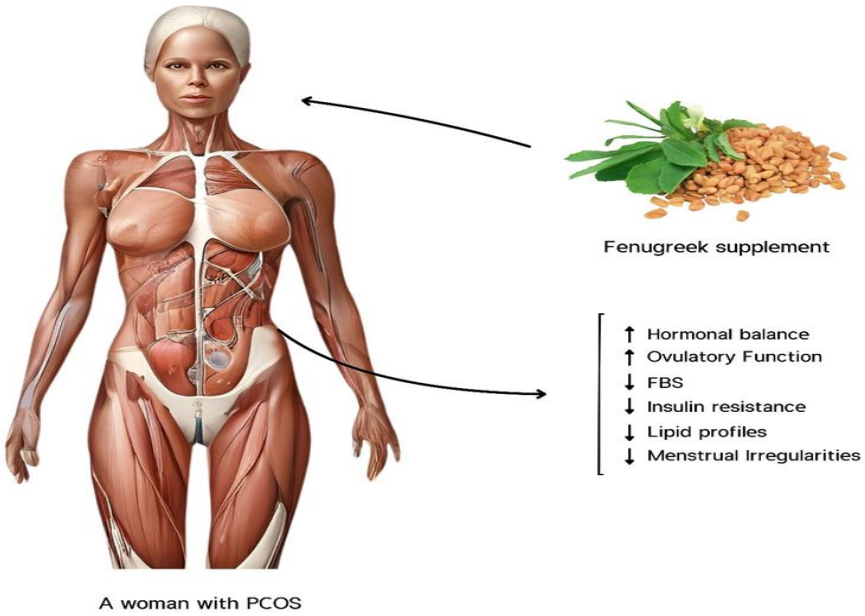

Figure 2. Fenugreek supplementation can improve hormonal balance, ovulatory function, fasting blood sugar (FBS), insulin resistance, lipid profile, and menstrual irregularities in women with Polycystic Ovary Syndrome (PCOS).

Animal studies

Study design and characteristics

The five animal model studies included in this review involved various rat and mouse models of PCOS. Fenugreek supplementation ranged from 0.5 mg/kg to 100 mg/kg body weight and was administered for durations ranging from 3 weeks to 8 weeks. The studies were primarily focused on evaluating the effects of fenugreek on ovarian morphology, hormonal regulation, and metabolic parameters (Alansari et al. 2018; Alkalby and Hamzah 2017; Husseini and Zainulabdeen 2023; Lodhi and Firdous 2021; Osman et al. 2019).

Effects on ovarian morphology and hormonal regulation

Four of the five animal studies reported a significant reduction in ovarian cyst formation following fenugreek supplementation (Alansari et al. 2018; Alkalby and Hamzah 2017; Husseini and Zainulabdeen 2023; Lodhi and Firdous). In these studies, fenugreek significantly reduced the size and number of ovarian cysts compared to the PCOS control group. Additionally, fenugreek extract for 21 days significantly increased serum concentrations of LH and testosterone and significantly decreased levels of estrogen and progesterone compared to the control group (Alkalby and Hamzah 2017). Also, fenugreek supplementation improved hormonal balance by significantly returning LH, FSH, testosterone, and progesterone to normal level (Osman et al. 2019). The beneficial effects on ovarian morphology and hormonal parameters were observed in animals supplemented with doses of 0.5 mg/kg to 100 mg/kg body weight (Alansari et al. 2018; Alkalby and Hamzah 2017; Husseini and Zainulabdeen 2023; Lodhi and Firdous 2021; Osman et al. 2019).

Impact on insulin sensitivity and glucose metabolism

Two animal studies assessed the effect of fenugreek on insulin sensitivity. Fenugreek supplementation (1mg/kg to 100 mg/kg) significantly improved glucose tolerance and insulin sensitivity by reducing FBG levels and insulin resistance (IR) (Lodhi and Firdous 2021; Osman et al. 2019).

Body weight and lipid profile

The weight of the animal models decreased significantly after treatment with

fenugreek extract (100 mg/kg) ($p<0.05$). In terms of lipid metabolism, fenugreek supplementation led to a significant increase in HDL ($p<0.001$) and a significant decrease in total cholesterol (TC) and triglyceride (TG) ($p<0.001$). There was no significant change in LDL (Lodhi and Firdous 2021).

Adverse effects

In animal studies, fenugreek was well-tolerated with no severe adverse effects reported. No significant toxicity or organ damage was noted upon histopathological examination (Alansari et al. 2018; Alkalby and Hamzah 2017; Husseini and Zainulabdeen 2023; Lodhi and Firdous 2021; Osman et al. 2019).

Quality assessment

Among the eight included human studies, four were identified as having a high overall risk of bias, primarily due to issues with allocation concealment, blinding of participants and personnel, and blinding of outcome assessment (Hassanzadeh et al. 2013; Jaipuriar et al. 2018; Sankhwar et al. 2023; Swaroop et al. 2015), while the remaining studies demonstrated a low overall risk of bias. The specific details of the risk of bias evaluation for each category are presented in Supplementary Table 1.

For the animal studies, the quality assessment scores, outlined in Supplementary Table 2, revealed that most studies achieved a score of 5 out of 10 (Alansari et al. 2018; Husseini and Zainulabdeen 2023; Lodhi and Firdous 2021; Osman et al. 2019), indicating a moderate risk of bias, with only one study scoring slightly higher at 6 (Alkalby and Hamzah 2017). Common limitations in animal studies included a lack of information on random housing and blinding of caregivers and investigators.

Key summary points:

In human studies

Fenugreek supplementation demonstrated promising but inconsistent benefits. The most consistent findings were a significant improvement in ovarian morphology (6/8 studies) and a favorable impact on the lipid profile with specific extracts (3/8 studies). Positive effects on menstrual regularity (4/8 studies), insulin sensitivity (3/8 studies), and testosterone levels (3/8 studies) were observed in a subset of trials, suggesting that factors like dosage, extract type, and patient population are critical. Effects on body weight were largely inconclusive, with only 2 of 8 studies reporting a significant reduction (Table 3).

In animal studies

Fenugreek supplementation showed significant improvements in ovarian morphology, insulin sensitivity, and glucose metabolism, with moderate effects on body weight and lipid profile. The most pronounced effects were seen in studies using doses between 100 mg/kg and 150 mg/kg.

Table 1. Characteristics of the included human studies.

Studies	Country	Study design	Sample size and sex	Sample size		Trial Duration (Days)	Means age (years)		Means BMI (kg/m²)		Intervention	Control group	Findings
				IG	CG		IG	CG	IG	CG			
Mirgaloybayat et al. 2024	Iran	Parallel, R, PC, TB	F:110	55	55	60	27.7± 7.1	25.5± 6.4	27.9± 3.3	27.6± 3.5	Dry Fenugreek seed extract (3 capsules/day) 333 mg	Metforminn 500 mg	Significant reduction in weight, BMI, WHR, cholesterol, LDL, TG, free testosterone, DHEAS, hydroxyprogesterone, prolactin, LH, fasting blood sugar, insulin resistance, and hair loss.
Jaipuriar et al. 2018	India	single-arm, open	F:50	50	-	84	24.06 ± 5.35	-	23.88 ± 4.72	-	water-ethanol extracted fenugreek seed extract (1 Furocyst capsules/day) 500 mg	-	Significant reduction in ovary volume and cyst size. Normalization of LH:FSH ratio.
Swaroop et al. 2015	India	single-arm, open	F:50	50	-	90	24.06 ± 5.35	-	23.88 ± 4.72	-	water-ethanol extracted fenugreek seed extract (2 Furocyst capsules/day) 1000mg	-	Significant reduction in ovarian volume and number of ovarian cysts. Resumption of regular menstrual cycle. Significant increase in LH and FSH.
Hassanzadeh et al. 2013	Iran	Parallel, R, PC, DB	F:58	30	28	56	23-31	23.75-26.25	27-31.23	28.37-35.34	Ethanol extracted fenugreek seed extract (2 capsules/day) 1000 mg+ 1500 metformin	Placebo+1500metformin	Significant reduction in polycystic-appearing ovaries.
Abbasi et al. 2019	Pakistan	Parallel, R, PC, SB	F:90	60	30	90	18-45	18-45	NR	NR	fenugreek seed powder (5gr and10gr/day) 500 mg and 1000 mg	diane-35/primolet-N, metformin/Glucophage	Significant reduction in ovarian volume and cysts. No significant difference in FSH.
Sankhwar et al. 2023	India	single-arm, R	F:107	107	-	84	25.94 ± 5.78	-	24.58 + 5.35	-	water-ethanol extracted fenugreek seed extract (2 Furocyst capsules/day) 1000 mg	-	>40% reduction in mean cyst size and ovarian volume. Normalization of LH:FSH ratio. Reduction in total testosterone and prolactin. Improvement in menstrual cycle regularity, insulin resistance, and dyslipidemia.
Singh et al. 2023	India	two-arm, R, PC, DB	F:208	95	113	84	18-45	18-45	25.72 +4.94	25.72 +4.94	water-ethanol extracted fenugreek seed extract (2 Furocyst capsules/day) 1000 mg	Placebo	Significant reduction in number of cysts, ovarian volume, and hirsutism. Normalization of menstrual cycle. Reduction in LH, FSH, TSH, prolactin, and testosterone. Reduction in fasting blood glucose, HOMA Index, cholesterol, LDL, and triglyceride.
Shukla et al. 2024	India	Parallel, R, PC, SB	F:188	104	84	84	18-45	18-45	~24.7	~24.4	water-ethanol extracted fenugreek seed extract (2 Furocyst capsules/day) 1000 mg	Placebo	Significant reduction in BMI (especially in obese patients), HOMA-IR, fasting blood sugar, total cholesterol, triglycerides, VLDL, and LDL. Significant improvement in LDL-HDL and CH-HDL ratios. No significant effect on HDL.

Abbreviations: SB, single-blind; DB, double-blind; TB, triple-blind; PC, placebo-controlled; R, randomized; F, female; BMI, body mass index; IG, intervention group; CG, control group; NR, not reported; LH, Luteinizing hormone; FSH, follicle stimulating hormone; TG, triglycerides; LDL, Low-density lipoprotein; HDL, High-density lipoprotein; BMI, Body mass index; WHR, Waist–hip ratio; DHEAS, Dehydroepiandrosterone

Table 2. Characteristics of the included animal studies.

Studies	Country	Animal model	Sample size		Trial Duration (Days)	Intervention	Control group	Results
			IG	CG				
Lodhi et al. 2021	Pakistan	female Wistar rats	9	6	21	1mg/kg/day Fenugreek seed aqueous extract	saline (0.9%NaCl)	Restoration of normal ovarian stroma and estrous cycle. Significant reduction in testosterone, insulin, glucose, and cholesterol levels.
Alkalby et al. 2017	Iraq	adult female rats	8	8	21	15 ml/kg/day ethanol extracted fenugreek seed extract	carboxy Methyl Cellulose	Significant increase in LH and testosterone. Significant decrease in estrogen and progesterone. Significant improvement in polycystic-appearing ovaries and cycle disorders.
Husseini et al. 2023	Iraq	female rats	5	5	30	2 ml/kg/day Fenugreek leaves extract	distilled water	Significant decrease in amylase and malondialdehyde. Significant increase in superoxide dismutase. Significant reduction in the number and size of follicular cysts.
Osman et al. 2019	Saudi Arabia	adult female Wistar rats	8	8	60	100 mg/kg/day Fenugreek aqueous extract	distilled water	Significant reduction in ovarian volume, glucose, insulin, insulin resistance, cholesterol, TG, LDL, ALT, AST, GGT, LPO, and NO. Significant increase in HDL and antioxidants. Significant restoration of FSH, LH, testosterone, and progesterone to normal levels.
Alansari et al. 2018	Saudi Arabia	female Wistar rats	5	5	35	0.5 ml/kg/day Fenugreek seed extract	None	Significant reduction in PCOS symptoms in ovarian tissues. Resumption of ovarian follicle development. Significant decrease in the number of ovarian cysts.

Abbreviations: IG, intervention group; CG, control group; LH, Luteinizing hormone; FSH, follicle stimulating hormone; TG, triglycerides; LDL, Low-density lipoprotein; HDL, High-density lipoprotein; IR, Insulin resistance; ALT, Alanine transaminase; AST, Aspartate transaminase; GGT, Gamma-glutamyl transferase; LPO, Lipid peroxidation; NO, nitric oxide; PCOS, Polycystic ovary syndrome

Table 3. Summary of key findings from human studies.

Outcome Measure	Summary of findings from human studies	Consistency and notes
Insulin Resistance and Glucose	3/8 studies reported significant improvements in HOMA-IR and FBG. Others found no significant change.	Inconsistent; positive effects are more reliably observed with standardized extracts (e.g., Furocyst) and potentially higher doses.
Menstrual Regularity	4/8 studies reported significant improvement in cycle frequency and resumption of ovulation (up to 70% of participants).	A positive, dose-dependent effect is suggested; lower doses (≤500 mg/day) showed less benefit.
Testosterone	3/8 studies reported significant reductions in serum testosterone levels.	Promising, but not consistently observed across all trials.
LH/FSH Ratio	3/8 studies reported a significant decrease in the LH/FSH ratio. One study reported a non-significant decrease.	A trend towards improvement is evident, particularly with specific fenugreek seed extracts.
Body Weight / BMI	2/8 studies reported a significant reduction in BMI. The other six found no significant change.	Effects may be more pronounced in obese subgroups; not a consistent effect across the general PCOS population.
Lipid profile	3/8 studies reported significant improvements, including reductions in total cholesterol, TG, VLDL, and LDL, as well as improved atherogenic ratios (LDL-HDL, CH-HDL).	The most consistent metabolic benefits are seen with standardized extracts (Furocyst) on specific lipid parameters and cardiovascular risk indices.
Ovarian Morphology	6/8 studies reported a significant reduction in ovarian volume and/or cyst size/number.	A consistently positive finding across multiple studies.
Adverse Effects	Mild and transient GI discomfort (e.g., bloating) was reported in a minority of participants (≈10%). No serious adverse events.	Fenugreek is well-tolerated at the studied doses.

Discussion

This systematic review evaluated the effects of fenugreek supplementation on PCOS by examining both human clinical trials and animal model studies. The findings from the included studies suggest that fenugreek supplementation may offer benefits for women with PCOS, particularly in improving ovarian morphology, lipid profiles, and menstrual irregularities. However, the extent and consistency of these benefits vary across studies, warranting further investigation to establish standardized dosing and duration for optimal therapeutic outcomes.

Glucose metabolism and insulin sensitivity

The effect of fenugreek on glycemic control in women with PCOS shows a trend toward improvement, though inconsistencies remain. While animal studies consistently show promising anti-diabetic benefits, human trials yield mixed results. Three of the eight human studies reported significant improvements in FBG and insulin resistance (HOMA-IR) (Mirgaloybayat et al. 2024; Shukla et al. 2024; Singh et al. 2023), which is supported by fenugreek known high fiber and bioactive compound content (Kannappan and Anuradha 2009). However, other clinical trials found no significant effect, likely due to variations in dosage, treatment duration, or participant profiles (Abbasi and Abbasi 2019; Hassanzadeh et al. 2013; Jaipuriar et al. 2018; Swaroop et al. 2015). The most consistent benefits in human trials are observed with standardized extracts like Furocyst, where significant reductions in HOMA-IR and FBG have been reported (Shukla et al. 2024; Singh et al. 2023). This suggests that the specific formulation and potentially higher doses may be crucial for eliciting reliable hypoglycemic effects.

The molecular mechanisms through which fenugreek supplementation benefits PCOS are multifaceted, targeting key metabolic and hormonal pathways. Fenugreek's bioactive compounds, including saponins, flavonoids, and alkaloids, interact with multiple molecular targets to improve insulin sensitivity and reduce hyperandrogenism. A primary mode of action involves the high fiber content, which delays gastric emptying and carbohydrate absorption, leading to a blunted postprandial glucose response. This reduction in blood sugar spikes alleviates demand on pancreatic beta-cells and mitigates postprandial hyperinsulinemia, a key driver of ovarian androgen production (Cortez-Navarrete et al. 2023; Mathern et al. 2009; Srichamroen et al. 2009).

Furthermore, fenugreek enhances insulin sensitivity by modulating insulin receptor activity (Gao et al. 2024), glucose transporter proteins like GLUT4 (Vijayakumar et al. 2005), and by activating AMP-activated protein kinase (AMPK) (Luan et al. 2018; Mohammad et al. 2006), a central regulator of cellular energy. AMPK activation promotes glucose uptake in peripheral tissues while inhibiting liver-based gluconeogenesis (Micic et al. 2023). Additionally, fenugreek bioactive components decrease the expression of negative regulators of insulin signaling, such as protein tyrosine phosphatase 1B (PTP1B), and may directly stimulate insulin secretion from pancreatic beta cells (Kannappan and Anuradha 2009). The inhibition of carbohydrate-digesting enzymes like alpha-amylase and sucrase in the gastrointestinal tract provides another pathway for its blood sugar-lowering effects (Basch et al. 2003; Puri et al. 2002). Despite the promising mechanistic evidence largely observed in animal models, further human RCTs are necessary to establish optimal dosing and confirm these pathways for achieving consistent clinical outcomes in PCOS.

Hormonal regulation and ovarian morphology

Fenugreek supplementation demonstrated notable effects on hormonal parameters in both human and animal studies. Fenugreek remains widely utilized

due to its well-documented benefits in alleviating various female reproductive disorders. It has been traditionally used as a remedy for menstrual cramps (dysmenorrhea) (Younesy et al. 2014) and has demonstrated potential in managing Ovarian Hyperstimulation Syndrome by lowering serum estradiol levels (Hameid et al. 2019). These findings suggest that Fenugreek could serve as a valuable adjunct therapy in assisted reproductive treatments.

The most consistent finding across human studies was the significant improvement in ovarian morphology. Six of the eight included trials reported a reduction in ovarian volume and/or cyst size and number (Abbasi and Abbasi 2019; Jaipuriar et al. 2018; Sankhwar et al. 2023; Shukla et al. 2024; Singh et al. 2023; Swaroop et al. 2015). For instance, one study showed that fenugreek seed extract effectively reduced the number of cysts in both ovaries of women with PCOS by over 35%, accompanied by a notable decrease in ovarian volume (Singh et al. 2023). The effects on reproductive hormones were more variable. Three studies reported significant reductions in serum testosterone (Mirgaloybayat et al. 2024; Sankhwar et al. 2023; Singh et al. 2023), and three reported improvements in the LH:FSH ratio, though this was not a universal finding (Sankhwar et al. 2023; Singh et al. 2023). The mechanism underlying these effects may partly be due to fenugreek phytoestrogenic properties and its ability to improve insulin sensitivity, which in turn, modulates endocrine function and improves ovarian folliculogenesis (Najafi et al. 2018). The inconsistencies in hormonal responses across human studies suggest that individual variations and differences in supplementation protocols significantly influence outcomes.

Menstrual cycle regularity and ovulatory function

Menstrual irregularities are a common manifestation of PCOS, and fenugreek supplementation appears to have a beneficial effect on menstrual cycle regulation (Younesy et al. 2014). Four of the eight human studies reported significant improvements in cycle frequency and ovulatory function following supplementation (Abbasi and Abbasi 2019; Jaipuriar et al. 2018; Sankhwar et al. 2023; Swaroop et al. 2015), while others failed to show such improvements. This is mainly in line with the observed improvements in ovarian morphology in animal models, where fenugreek supplementation consistently reduced the number and size of ovarian cysts (Alansari et al. 2018; Alkalby and Hamzah 2017; Husseini and Zainulabdeen 2023; Lodhi and Firdous). These findings suggest that fenugreek may enhance follicular maturation and ovulation, potentially through its role in modulating insulin resistance and androgen levels. While higher doses have been associated with significant improvements in menstrual regularity and ovarian function, studies using lower dosages failed to yield meaningful clinical benefits (Hassanzadeh et al. 2013; Mirgaloybayat et al. 2024). While the findings of this review suggest that fenugreek supplementation may help regulate the menstrual cycle and improve ovulatory function, future clinical trials with standardized dosing regimens are essential to establish the optimal therapeutic threshold for its efficacy in managing PCOS.

Body weight and lipid profile

The evidence regarding fenugreek effect on body weight in PCOS is strengthened but remains specific. Two of the eight RCTs report significant reductions in BMI, with one study noting that this effect was particularly pronounced in obese patients (Mirgaloybayat et al. 2024; Shukla et al. 2024). This indicates a potential subgroup that may benefit more from fenugreek supplementation for weight management. However, as six studies found no significant effect, it cannot be considered a primary intervention for

weight loss across the general PCOS population.

More compelling is the consistent evidence for its positive impact on dyslipidemia, a common and serious comorbidity in PCOS. Recent, high-quality RCTs provide robust evidence that fenugreek seed extract (Furocyst) significantly improves the lipid profile. Three independent studies demonstrated reductions in atherogenic lipids, including total cholesterol, triglycerides, VLDL, and LDL, as well as improvements in key cardiovascular risk indices like the LDL-HDL and CH-HDL ratios, with a neutral effect on HDL (Sankhwar et al. 2023; Shukla et al. 2024; Singh et al. 2023). The proposed mechanisms involve saponins inhibiting the activity of hepatic enzymes involved in cholesterol synthesis, such as HMG-CoA reductase, and ameliorating VLDL overproduction (Khound et al. 2018; Uemura et al. 2011). Furthermore, bioactive compounds like diosgenin have been shown to modulate liver X receptor (LXR) activity, which plays a role in hepatic lipogenesis and VLDL secretion. By inhibiting LXRα, fenugreek components can reduce plasma and hepatic triglycerides, contributing to the improved lipid profile observed in both animal and human studies (Fuller and Stephens 2015). These molecular actions suggest fenugreek may be a useful complementary therapy for addressing the dyslipidemia common in PCOS.

Clinical relevance of findings

An important consideration is the clinical relevance of the statistically significant changes reported in the included studies. While formal Minimal Clinically Important Difference (MCID) values for many PCOS-specific parameters are not universally established, the magnitude of the observed improvements can be interpreted within known clinical benchmarks. For instance, reductions in HOMA-IR of 20-25%, as reported in several studies, translating to absolute decreases of approximately 1.0 to 1.5 points, are considered a meaningful improvement in insulin sensitivity, as a reduction of ≥1.0 in HOMA-IR has been associated with improved metabolic status (Kim et al. 2019). The reported declines in total cholesterol and LDL, often in the range of 15-30 mg/dL, align with targets for reducing cardiovascular risk, which is a critical concern in the long-term management of PCOS (Wild et al. 2010). The reductions in serum testosterone levels, around 15-20%, are of a scale that can contribute to the amelioration of clinical hyperandrogenism, as even modest reductions can lead to perceptible improvements in symptoms like hirsutism over time (Martin et al. 2018). Perhaps the most direct patient-centered benefits were observed in ovarian morphology, where reductions in cyst number and ovarian volume exceeded 35% in some studies, and in menstrual regularity, where 50-70% of participants in responsive trials experienced a resumption of ovulatory cycles, an outcome that is inherently significant to patients. These collective findings suggest that fenugreek supplementation, particularly with standardized extracts, can induce changes that are not only statistically significant but also likely to be of clinical importance, impacting key metabolic, endocrine, and reproductive facets of PCOS.

Strengths and limitations

This study provides a comprehensive evaluation of fenugreek supplementation for PCOS, integrating both human and animal studies to offer valuable insights. Key strengths include a rigorous quality assessment using standardized risk of bias tools, ensuring methodological reliability, and reducing the risk of errors. However, significant limitations must be acknowledged. The interpretation of our findings is constrained by a limited number of high-quality RCTs in humans, inconsistencies in reported outcomes, and generally short follow-up durations. A

major challenge is the considerable heterogeneity observed across the included studies, which can be attributed to several specific factors. First, the PCOS population itself is heterogeneous, encompassing various phenotypes (e.g., lean vs. obese, hyperandrogenic vs. normoandrogenic) that may respond differently to the intervention. Second, the formulation of fenugreek varied considerably, from crude seed powder to standardized extracts, which contain different concentrations of active constituents. Third, the dosage and duration of intervention differed widely, making it difficult to identify an optimal treatment protocol. These factors, combined with the generally small sample sizes and varying methodological quality of the primary studies, weaken the strength of clinical recommendations, limit the generalizability of the findings, and preclude definitive conclusions, ultimately highlighting the need for more standardized, high-quality research.

This systematic review provides evidence that fenugreek supplementation may offer selective benefits in managing specific features of PCOS. The most consistent findings from human clinical trials are a significant improvement in ovarian morphology and a favorable modification of the lipid profile, particularly with standardized extracts like Furocyst, which reduce atherogenic lipids and improve cardiovascular risk indices. Effects on menstrual regularity were positive in half of the studies, while improvements in insulin sensitivity and hyperandrogenism were observed in a subset of trials, indicating a less consistent response. The effect on body weight was largely inconclusive, with evidence of benefit potentially limited to specific patient subgroups, such as those with obesity.

The observed inconsistencies across studies underscore the impact of heterogeneity in fenugreek formulations, dosages, and PCOS phenotypes. Future research should prioritize large-scale, high-quality randomized controlled trials with longer follow-up periods. These studies must employ standardized extracts, define optimal dosing protocols, and stratify participants by PCOS phenotype to identify those most likely to benefit. Given its favorable safety profile, fenugreek represents a promising complementary and alternative medicine intervention. However, until more robust and targeted evidence is available, its use should be considered an adjunct to, rather than a replacement for, conventional PCOS management strategies.

Acknowledgment

Not applicable.

Conflicts of interest

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

H.B. and A.Ch. Conceived and designed the research. A.Ch. and H.A. performed screening and data extraction. M.R., S.S., and H.R. drafted the manuscript. H.R. and I.R. revised the manuscript. All authors have read and agreed to the published version of the manuscript.

Data Availability

All data generated or analyzed during this study are included in this published article.

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Supplementary

Supplementary Table 1. Risk of bias assessment for human studies.

Study	Random sequence generation	Allocation concealment	Selective reporting	Other sources of bias	Blinding (participants and personnel)	Blinding (outcome assessment)	Incomplete outcome data	General risk of bias
Mirgaloybay at et al. 2024	L	L	L	H	L	L	L	Low
Jaipuriar et al. 2018	H	H	L	H	H	H	L	High
Swaroop et al. 2015	H	H	L	H	H	H	L	High
Hassanzadeh et al. 2013	L	U	L	H	L	H	L	High
Abbasi et al. 2019	L	U	L	L	L	H	L	Low
Singh et al. 2023	L	L	L	L	L	L	L	Low
Sankhwar et al. 2023	L	H	L	L	H	H	L	High
Shukla et al. 2024	L	L	L	L	L	L	L	Low

L; low risk of bias; H, high risk of bias; U, unclear risk of bias. General risk of bias is considered as high if there were high risk of bias in ≥2 items or unclear risk of bias in ≥3 criteria.

Supplementary Table 2. Risk of bias assessment for animal studies.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Quality score
Lodhi et al. 2021	PN	PY	PN	PY	PN	PN	PN	Y	Y	Y	5
Alkalby et al. 2017	PN	PY	PN	Y	NI	Y	NI	Y	Y	Y	6
Husseini et al. 2023	PN	PY	PN	PY	NI	NI	NI	Y	Y	Y	5
Osman et al. 2019	PY	PY	PN	PN	NI	NI	NI	Y	Y	Y	5
Alansari et al. 2018	PY	PY	PN	PN	NI	PN	NI	Y	Y	Y	5

Abbreviations: Y, yes; PY, probably yes; N, no; PN, probably no; NI, no information; NA, not applicable. Quality of included animal studies was assessed using the SYstematic Review Centre for Laboratory animal Experimentation (SYRCLE) RoB tool for animal intervention studies. Q1. Was the allocation sequence adequately generated and applied? Q2. Were the groups similar at baseline or were they adjusted for confounders in the analysis? Q3. Was the allocation adequately concealed? Q4. Were the animals randomly housed during the experiment? Q5. Were the caregivers and/or investigators blinded from knowledge of which intervention each animal received during the experiment? Q6. Were animals selected at random for outcome assessment? Q7. Was the outcome assessor blinded? Q8. Were incomplete outcome data adequately addressed? Q9. Are reports of the study free of selective outcome reporting? Q10. Was the study apparently free of other problems that could result in high risk of bias?