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THE EFFECT OF CAMELLIA SINENSIS EXTRACT ON HORMONES AND BODY WEIGHT IN ANIMAL MODELS WITH POLYCYSTIC OVARY SYNDROME (PCOS): A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstrak

Sindrom Ovarium Polikistik (PCOS) merupakan gangguan endokrin poligenik yang paling sering terjadi pada perempuan usia reproduktif. PCOS ditandai oleh hiperandrogenisme, gangguan ovulasi, serta obesitas. Kandungan polifenol dalam ekstrak Camellia sinensis dilaporkan memiliki manfaat dalam menurunkan kadar testosteron dan menstabilkan produksi hormon luteinizing (LH), sehingga berpotensi memperbaiki proses ovulasi pada pasien PCOS. Mengidentifikasi studi uji klinis serta penelitian eksperimental yang mengevaluasi efektivitas ekstrak Camellia sinensis pada model hewan PCOS. Penelusuran literatur secara komprehensif dilakukan pada lima basis data, yaitu SCOPUS, ScienceDirect, PubMed, ProQuest, dan EBSCO, sesuai dengan kriteria inklusi yang ditetapkan. Risiko bias dinilai menggunakan instrumen SYRCLE. Analisis data dilakukan dengan perangkat lunak RevMan versi 5.4. Tiga studi yang melibatkan 74 tikus betina dimasukkan dalam meta-analisis. Dibandingkan dengan kelompok tikus PCOS tanpa perlakuan, pemberian polifenol Camellia sinensis menunjukkan penurunan signifikan kadar testosteron (MD = -7,17; 95% CI: -9,96 hingga -4,39; $p < 0,00001$; $I^2 = 59\%$), kadar LH (MD = -4,57; 95% CI: -4,67 hingga -4,46; $p < 0,00001$; $I^2 = 15\%$), serta berat badan (MD = -40,31; 95% CI: -50,62 hingga -30,00; $p < 0,00001$; $I^2 = 0\%$), yang mengindikasikan konsistensi efek intervensi pada seluruh studi yang dianalisis. Polifenol Camellia sinensis secara signifikan menurunkan kadar testosteron, LH, dan berat badan pada model hewan PCOS, sehingga berpotensi menjadi terapi alternatif yang efektif dalam penatalaksanaan sindrom ovarium polikistik.
Kata kunci: Camellia sinensis, polifenol, PCOS, testosteron, LH, berat badan..

Abstract

Polycystic Ovary Syndrome (PCOS) is the most common polygenic endocrine disorder in women of reproductive age. PCOS is characterized by symptoms of excess androgen hormones, ovulation disorders, and obesity. The polyphenol content in Camellia sinensis extract has been reported to be beneficial in lowering testosterone levels and stabilizing luteinizing hormone production, thereby improving the ovulation process in PCOS patients. Identify studies that use clinical trials and studies that evaluate Camellia sinensis extract in animal models of PCOS. A comprehensive search was conducted on five databases, including SCOPUS, Science Direct, PubMed, ProQuest, and EBSCO met inclusion criteria. Risk of bias was assessed using SYRCLE's. Data were analyzed using RevMan 5.4 software. Three studies were included in the meta-analysis, which involved 74 female rats. Compared to the untreated PCOS rat group, managing of Camellia sinensis polyphenols to PCOS rats had a significant effect in reducing testosterone levels (MD = -7.17, 95% CI: -9.96 to -4.39, $P < 0.00001$, $I^2 = 59\%$), luteinizing hormone (LH) levels (MD = -4.57, 95% CI: -4.67 to -4.46, $P < 0.00001$, $I^2 = 15\%$), and body weight (MD = -40.31, 95% CI: -50.62 to -30.00, $P < 0.00001$, $I^2 = 0\%$) indicating high consistency of treatment effects across all included studies. Camellia sinensis polyphenols significantly reduced testosterone, LH, and body weight levels in PCOS mouse models, demonstrating their potential as an effective alternative therapy for polycystic ovary syndrome management.

Keywords: *Camellia sinensis, Polyphenol, PCOS, Testosteron, LH, Body Wight.*

BACKGROUND

Polycystic ovary syndrome (PCOS) is the most common reproductive hormonal disorder and metabolic disorderin women. Globally, the prevalence of PCOS is 10-13% among women of reproductive age, with an estimated 69 million cases in 2021, and this number continues to rise (Chai *et al.*, 2025).PCOS caused by hormonal imbalance, excess androgen hormones, persistent anovulation, cyclic menstruation, insulin resistance, obesity, and infertility (Attia *et al.*, 2023). The pathophysiology of PCOS is related to the hypothalamic-pituitary-ovarian axis. Hypothalamic gonadotropin releasing hormone (GnRH) is activated and releases luteinizing hormone (LH), which increases relative to follicle-stimulating hormone (FSH), resulting in theca cells producing excessive androgens (testosterone, androstenedione). Hyperandrogenism affects follicular development through mechanisms such as insulin resistance and dyslipidemia (Zhang *et al.*, 2022)

Medical treatments for PCOS, such as letrozole, metformin, oral contraceptives, antiandrogens, and clomiphene, are still suboptimal due to their long-term side effects, such as ovarian hyperstimulation syndrome, clinical resistance, and nausea. Therefore, invasive treatments focused on prevention are needed (Zhang *et al.*, 2022). Currently, research focuses on restoring normal serum hormone levels and menstrual cycles using herbal remedies, one of which is Camellia Sinensis (Techniques, 2025). Camellia sinensis has strong antioxidant content, namely polyphenols, especially catechins, including epigallocatechin-3-gallate (EGCG), epigallocatechin (EGC), epicatechin-3-gallate (ECG), and epicatechin (EC), which have an effect of reducing insulin resistance, suppressing the activation of the CYP17A1 enzyme that triggers excessive androgen production, lower HOMA-IR, suppress inflammatory pathways, reduce ROS, and enhance metabolism (Siddiqui *et al.*, 2025).

Several studies have used Camellia sinensis extract in animal models of PCOS, yielding favorable results, such as improvement in LH/FSH hormones, reduction in testosterone hormones, reduction in insulin resistance, and significant weight loss. However, these studies show considerable variation due to differences in study design, dosage, duration of intervention, and animal models used. This systematic review and meta-analysis aims to determine the effects of Camellia sinensis extract administration, the optimal dosage that can be given, identify knowledge gaps, and determine the direction of future research related to PCOS.

METHODS

Search Strategy

A systematic search of electronic databases (SCOPUS, Science Direct, PubMed, ProQuest and EBSCO) was conducted to identify eligible the effect of camellia sinensis extract on hormones and body weight in animal models with polycystic ovary syndrome (PCOS)

Scopus

TITLE-ABS-KEY ("polycystic ovary syndrome" OR "PCOS" OR "polycystic ovary" OR "letrozole-induced" OR "DHEA-induced" OR "hyperandrogenism") AND ("green tea" OR "Camellia sinensis" OR "EGCG" OR "epigallocatechin gallate" OR "catechin" OR "tea extract" OR "tea polyphenol") AND ("rat" OR "mice" OR "animal model"

OR "in vivo") AND ("molecular" OR "biochemical" OR "oxidative stress" OR "hormonal" OR "gene expression" OR "protein expression")

Science Direct

("polycystic ovary syndrome" OR PCOS) AND ("green tea" OR EGCG) AND (rat OR mice)

PubMed

(("Polycystic Ovary Syndrome"[Mesh] OR "polycystic ovary syndrome" OR PCOS OR "letrozole-induced" OR "DHEA-induced" OR hyperandrogenism) AND ("Camellia sinensis"[Mesh] OR "green tea" OR EGCG OR "epigallocatechin gallate" OR catechin OR "tea extract") AND ("Animals"[Mesh] OR rat OR rats OR mice OR "animal model" OR "in vivo") AND ("oxidative stress" OR hormonal OR molecular OR biochemical OR "gene expression" OR "protein expression"))

ProQuest

("polycystic ovary syndrome" OR PCOS) AND ("animal model*" OR "animal experiment*" OR "preclinical study" OR "in vivo") AND ("green tea extract" OR "Camellia sinensis")
AND ("testosterone" OR "LH" OR "FSH" OR "estradiol" OR "insulin" OR "HOMA-IR" OR "oxidative stress" OR "CYP17" OR "AMPK") NOT ("human study" OR "clinical trial")

EBSCO

(TX ("green tea extract" OR EGCG OR "epigallocatechin gallate" OR catechin* OR "green tea polyphenol*")) AND (TX ("polycystic ovary syndrome" OR PCOS OR "letrozole-induced" OR "DHEA-induced" OR "estradiol valerate-induced" OR "experimental PCOS" OR "PCOS model")) AND (TX (rat OR rats OR mice OR mouse OR "experimental animal*" OR "animal model*")) AND (TX ("oxidative stress" OR "antioxidant enzyme*" OR "MDA" OR "SOD" OR "CAT" OR "GPx" OR "hormonal change*" OR "gene expression" OR "protein expression")) NOT (TX (human OR clinical OR "cell line" OR "in vitro"))

The search for studies on the effect of camellia sinensis extract on hormones and body weight in animal models with polycystic ovary syndrome (PCOS) yielded 13 articles from Scopus, 71 from Science Direct, 11 from PubMed, 95 from ProQuest and 450 from EBSCO. To ensure comprehensive coverage, the reference lists of included studies were manually screened to identify additional eligible articles. The overall search process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Study Incusion Criteria

We included all studies that met the following requirements (1) Population: Female experimental animals (rats or mice) induced with PCOS by letrozole, estradiol valerate, dehydroepiandrosterone (DHEA), or other validated methods; (2) intervention: Administration of green tea extract, EGCG, catechin, or green tea polyphenols alone or in combination with other natural compounds at any dose or duration; (3) Comparation: PCOS-induced control group without green tea treatment (vehicle or placebo group); (4) Outcome: Quantitative data on at least one of the following: Biochemical outcomes**:** oxidative stress markers (MDA, SOD, CAT, GPx), lipid/glucose profile, hormonal levels (LH, FSH, testosterone, insulin, estradiol). Molecular outcomes**:** expression of genes/proteins involved in oxidative stress, inflammation, or metabolic

pathways (e.g., NF-κB, PI3K/Akt, AMPK, CYP17A1, CYP19A1); (5) Study Type: In vivo experimental studies (laboratory animal studies) that investigate the effects of green tea extract (*Camellia sinensis*) or its bioactive compounds (e.g., EGCG, catechins) on PCOS (6) Publication Type: Peer-reviewed original research articles (excluding conference abstracts, reviews, or theses).

Study Exclusion Criteria

The exclusion criteria were as follows (1) Types of Studies: In vitro studies, clinical trials, observational studies in humans, review articles, case reports.; (2) Animal Models: Non-mammalian species (e.g., fish or chickens), or models that are not PCOS. (3) Intervention: use of a mixture of plant materials without separation of the specific effects of Camellia sinensis; (4) Data No reporting of numerical data (mean ± SD) for relevant outcomes or no provision of PCOS controls.

Data Extraction

The titles and abstracts were evaluated by two reviewers based on inclusion and exclusion criteria, and the full text was read in detail to make a final decision on eligibility. The following important details are summarized as the basic characteristics of the study. The following details were summarized as baseline characteristic of the studies (1) Publication details (author, year, and country); (2) Animal characteristic (species, strain, age, body weight, PCOS induction method, and induction duration); (3) Intervention performed (Type of Camellia sinensis extract, dose, route of intervention, treatment duration); (4) Biochemical outcomes (mean ± SD values for SOD, CAT, GPx, MDA, glucose, insulin, LH, FSH, testosterone, and estradiol) (6) Statistical analysis (effect size measures such as mean difference and standardized mean difference, and significance tests used); Any disagreement between the reviewers during the processing of papers was resolved by discussion among all the reviewers

Study Quality Assessment

The SYRCLE risk of bias tool for animal experiments was used by two researchers to make low-risk, high-risk and unclear judgments for each entery according to appropite criteria. This six-part checklist of evaluation included: (1) Selection bias (sequence generation, baseline characteristics, and allocation concealment); (2) performance bias (random housing and blinding of trial caregivers); (3) detection bias (random outcome assessment and blinding of outcome assessors); (4) attrition bias (incomplete outcome data); (5) reporting bias (selective outcome reporting); and (6) other bias (assessment of PCOS model, temperature control, drug production institutions, conflict of interest). Any disagreements were resolved by discussion with another researcher

Statistical Analysis

Meta-analyses were performed using Review Manager (RevMan) version 5.4 to analyze the collected data. Standardized mean differences (SMDs) were used for continuous variables to calculate 95% confidence intervals (CIs). If the heterogeneity test showed $p > 0.05$ and $I2 < 50\%$, when the heterogeneity test was high in the literature, a subgroup analysis was performed to determine the source of heterogeneity.

Result

Study Selection

This study was conducted in strict accordance with the guidelines of the

System Evaluation and Meta-Analysis (PRISMA). We identified a total of 640 studies. Six hundred and sixty studies remained after excluding replication literature, and 16 studies remained after excluding reviews, clinical and in vitro research, nonpolycystic ovarian syndrome animal models, and drug combinations. Eventually, 3 studies were included in the final meta-analysis (Fig.2). The basic characteristics of the included studies are shown in Tabels 1 and 2.

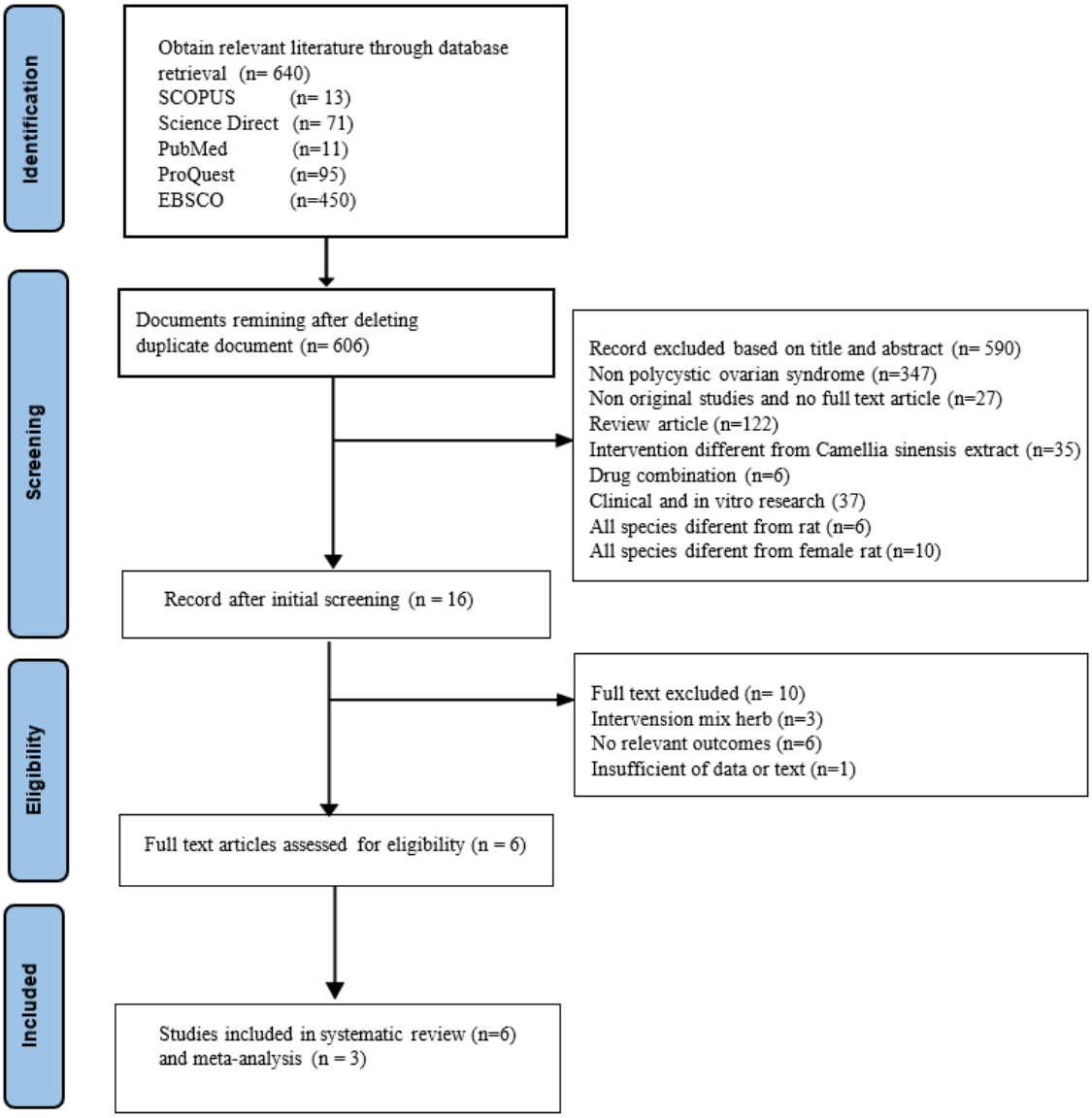

Fig. 1 Literature search flow chart

Study Characteristic

Tabel 1. Basic characteristic of the included studies

No	Author, year	Country	Animal Characteristic	Model	Modeling material	Method of administration	Dose	Time	Intervention	Control	Outcome
1	Ghafurniyan et al. (2014)	Iran	Female Wistar rats (7-8 weeks old) (200 ± 20 g)	PCOS	Estradiol valerat	Be injected with 2 mg Estradiol valerat subcutaneously for 60 days to inducted PCOS	- 50 mg/kg - 100 mg/kg - 200 mg/kg	10 days	Green tea extract	Be given saline orally	(1), (2), (3)
2	Siddiqui et al. (2025)	India	Female Wistar albino rats (6 weeks old) (170 ± 200 g)	PCOS	Letrozole	Be given 1 mg/kg Letrozole 21 days through oral	- 100 mg/kg	15 days	- EGCG - CGA	0.5% carboxymethyl cellulose (CMC)	(2), (3)
3	Khudhair et al. (2025)	Iraq	Female Wistar rats (185 ± 195 g)	PCOS	Letrozole	Be given 1 mg/kg Letrozole 28 days through oral	- 250 mg/kg	28 days	Green tea extract	Be given distilled water	(1), (3)
4	Rashed et al. (2025)	Iraq	Female Wistar rats (8-10 weeks old)	PCOS	testosterone enanthate	Be injected with 1 mg testosterone enanthate subcutaneously for 5 weeks to inducted PCOS	-250 mg/kg	28 days	Green tea extract	Didn't receive any treatment	(2), (3)
5	Zhou et al. (2021)	China	female Sprague-Dawley (SD) rats (6 weeks	PCOS	Letrozole	Be given 1 mg/kg Letrozole 21 days through oral	- 50 mg/kg - 150 mg/kg	21 days	Proanthocyanidins (PCs)	Be given saline orally	(1), (2), (3)

		old) (207.5 ± 17.35 g)							
6	Sadoughi & Rahbarian (2017)	Iran	Female Wistar rats (aged 85-5 days) (190 ± 8 g)	PCOS	Estradiol valerat	Be injected with 4 mg Estradiol valerat intramuscularly for 24 days to inducted PCOS	- 50 mg/kg - 150 mg/kg	24 days	- Camellia sinensis aqueous extract - Catechin	Given 0,5 ml saline with an intaperitoneal injaction	(1), (2), (3)

Note: (1) LH, (2) Testosteron, and (3) Body Weight

Risk of bias assessment

We assessed the quality of the literature using SYRCLE's risk of bias tool, and the data were analyzed with RevMan 5.3 software (Fig. 2 and Fig. 3)

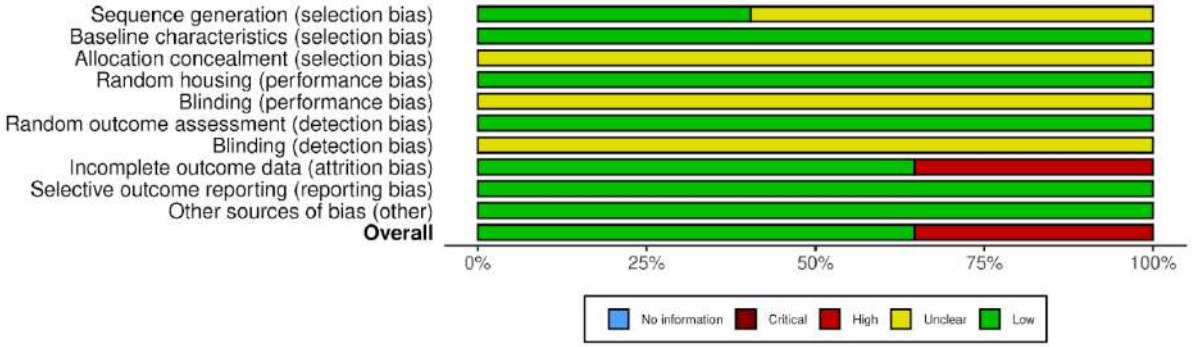

Fig. 2 Risk of bias summary. A summary table of review authors' judgments for each risk of bias item for each study

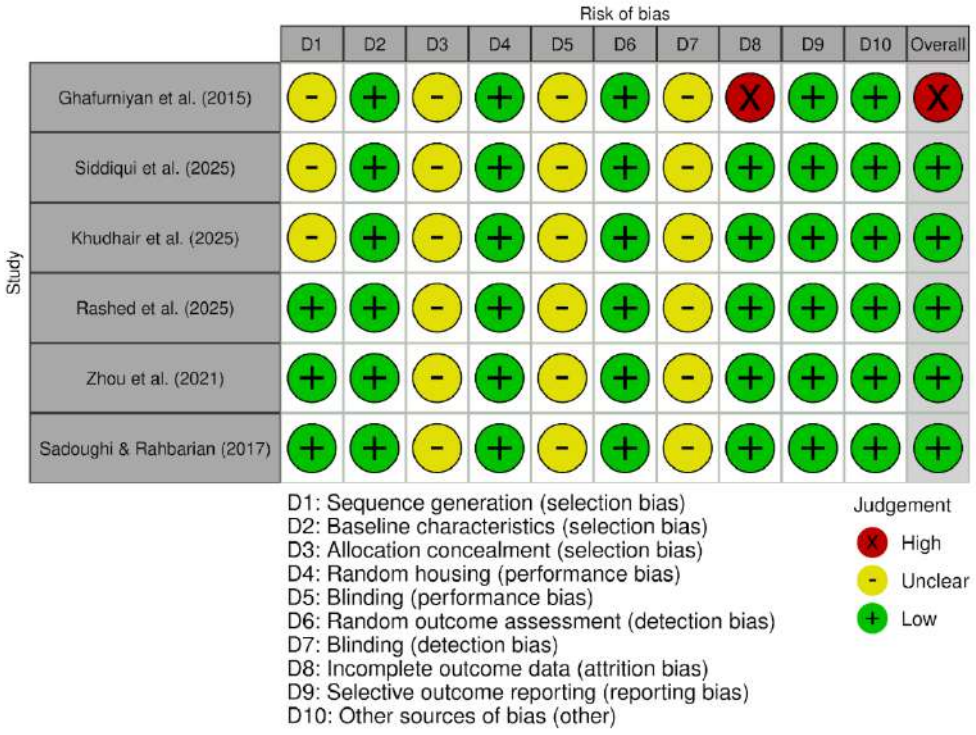

Fig. 3 Risk of bias graph. A plot of the distribution of review authors' judgments across studies for each risk of bias item.

Meta-analysis Results

Table 2 Meta-analysis results for each outcome indicator

Outcome indicator	Heterogeneity test results		Effect models	Meta-analysis results		
	I^2 (%)	*P*		Effect sizes	95%CI	*P*
Luteinizing Hormone Levels	15	0.32	Random effect	-4.81	[-5.50-4.11]	<0.00001
Testosterone Levels	59	0.02	Random effect	-7.17	[-9.96-4.39]	<0.00001
Body Weight	0	0.45	Random effect	-40.31	[-50.62-30.00	<0.00001

Luteinizing hormones

Seven treatment arms from three studies (Ghafurniyan *et al.*, 2015; Sadoughi and Rahbarian, 2017; Zhou *et al.*, 2021) reported LH levels. There was heterogeneity ($p<0.0001$, I^2 =15%), and the random effect model was adopted. The pooled meta-analysis revealed that green tea extract and its derivatives significantly reduced LH level compared to control groups (MD = -4.81; 95% CI:-5.50 to -4.11; P < 0.00001 (Fig. 3). The effect sizes across individual studies ranged from -2.99 to -7.52 mIU/mL, with six out of seven treatment arms showing statistically significant reductions in LH levels (Table 2).

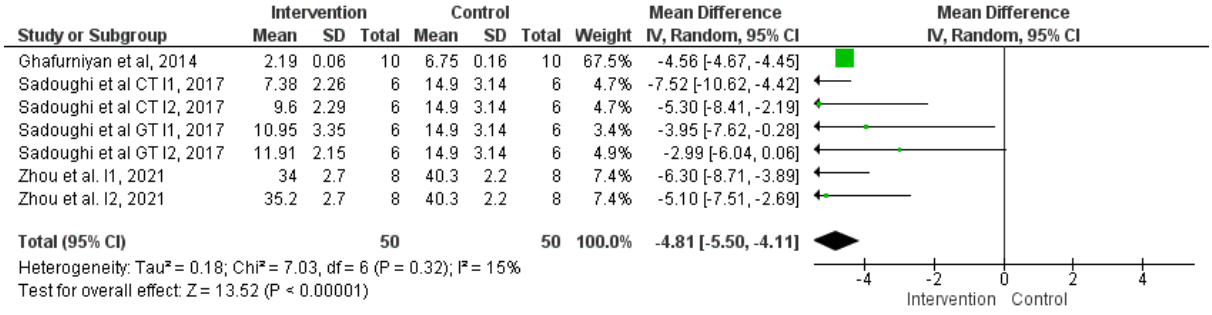

Fig. 4 Forest plot green tea extract and its derivatives for LH

Testosterone

Seven treatment arms from three studies (Ghafurniyan *et al.*, 2015; Sadoughi and Rahbarian, 2017; Zhou *et al.*, 2021) reported T levels. There was heterogeneity ($p<0.0001$, I^2 =59%), and the random effect

model was adopted. The pooled meta-analysis revealed that green tea extract and its derivatives significantly reduced T level compared to control groups (MD = -7.17; 95% CI:-9.96 to -4.39; P < 0.00001 (Fig. 4). The effect sizes across individual studies ranged from -1.80 to -17.50 mIU/mL, with four out of seven treatment arms showing statistically significant reductions in T levels (Table 2).

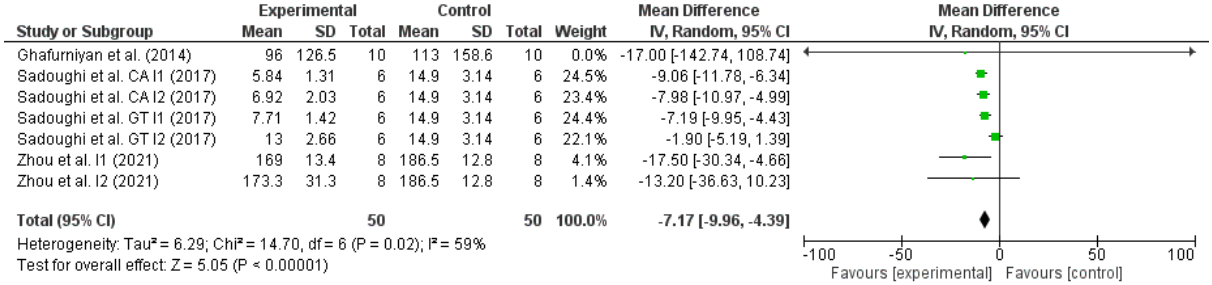

Fig. 5 Forest plot green tea extract and its derivatives for testosterone

Body weight

Three treatment arms from two studies (Ghafurniyan *et al.*, 2015; Sadoughi and Rahbarian, 2017; Zhou *et al.*, 2021) reported body weight outcomes. There was no heterogeneity ($p = 0.45$, $I^2 = 0\%$), and the random effect model was adopted. The pooled meta-analysis revealed that green tea extract and its derivatives significantly reduced body weight compared to control groups (MD = -40.31 g; 95% CI: -50.62 to -30.00; P < 0.00001) (Fig. 5). The effect sizes across individual studies ranged from -26.80 to -46.97 g, with all three treatment arms showing statistically significant reductions in body weight (Table 2).

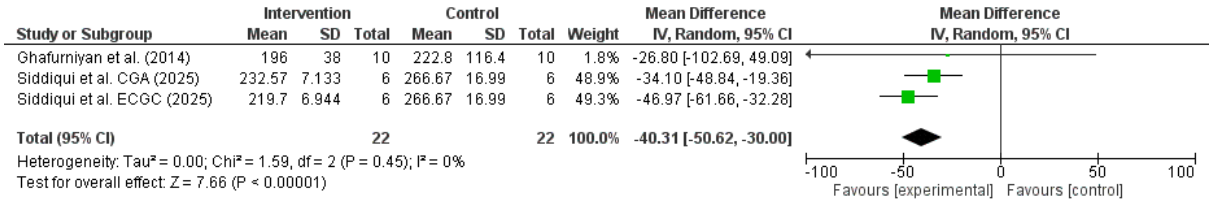

Fig. 6 Forest plot green tea extract and its derivatives for body weight

DISCUSSION

PCOS is a complex endocrine and metabolic disorder that severely affects a woman's reproductive health and quality of life. Endocrine disorders in PCOS are mainly characterized by increased levels of androgens and LH secretion (Rashed et al., 2024). A significant increase in serum T levels is a consistent finding in both letrozole and valerate estradiol-induced PCOS models. In addition, metabolic disorders, one of which is lipid metabolism dysregulation, are a major factor in the clinical presentation of this disorder (Sadoughi and Rahbarian, 2017; Zhou *et al.*, 2021)

This meta-analysis presents strong evidence supporting the therapeutic potential of green tea extract and its derivatives in the treatment of PCOS. Significantly, green tea extract and its derivatives reduced body weight in mouse models of PCOS. In addition, GE and its derivatives lower serum testosteron and LH levels, suggesting estrogenic effects that may contribute to the restoration of ovarian function through modulation of sex hormone levels. Green tea extract's role in improving metabolic and hormonal profiles in PCOS models highlights its potential as a therapeutic agent for managing this complex disorder. These findings suggest that green tea extract may provide a multifaceted approach to treating PCOS by addressing both metabolic and hormonal imbalances, ultimately enhancing reproductive health (Maleki *et al.*, 2021)

GE administration in a study conducted by Colonetti et al., 2022 of 4 RCTs with 169 women had an average weight loss of 2.80 kg and another study conducted by Wenjuan Shen et al., 2021 confirmed a weight loss of 2.71 kg. In a study conducted by Ghafurniyan *et al.*, 2015 GE administration consistently showed a significant weight loss effect in animal models with PCOS. The increase in body weight observed in PCOS is likely related to excessive accumulation of adipose tissue. Treatment with GE has been shown to reduce body weight in mouse models of PCOS. This effect can be attributed to the antioxidant properties of GE by increasing the activity of antioxidant enzymes (superoxide dismutase, catalase, glutathione peroxidase) that help reduce oxidative stress by effectively neutralizing reactive oxygen species (ROS) and significantly decreasing lipid peroxidation, thereby reducing cell damage. By lowering the level of oxidative stress, GE can inhibit the proliferation and differentiation of adipocytes, which contributes to a decrease in the accumulation of adipose tissue. In addition, the reduction of oxidative stress can increase insulin sensitivity, which further favors weight management (Sina Khodarahmi at al., 2021).

In addition, most of the included studies show the role of GE and its derivatives in modulating hormonal status. Elevated levels of LH and testosterone are due to disruption of the hypothalamic-pituitary axis. LH is a major actor in the regulation of theca cells, which follows ovarian hyperandrogenism (Rashed et al., 2024). Previous studies have shown that estrogens stimulated by LH are beneficial for maturation of the cytoplasm and oocyte membrane, revealing the importance of LH. In addition, in the middle and late stages of follicular development, granulosa cells begin to express luteinizing hormone receptors (LHCGR), and LH peaks. Meanwhile, LH and FSH work together to stimulate ovulation and promote

luteinization of granulosa cells. Meanwhile, in PCOS patients, LHCGR expression is premature in granulosa cells. Elevated levels of LH in ovarian follicles may contribute to ovulatory dysfunction often seen in women with PCOS, indicating challenges in effective hormonal regulation (Maleki *et al.*, 2021).

Our meta-analysis revealed decreased regulation of LH and testosterone levels with the administration of GE and its derivatives. Dosage, duration of administration, and PCOS induced drugs are major sources of heterogeneity in LH decline. As we expected, with higher doses of GE, there are lower levels of LH. By considering each study separately, we found studies using moderate doses showed better reductions in terms of LH/FSH than studies using low doses (Ghafurniyan *et al.*, 2015; Sadoughi and Rahbarian, 2017; Zhou *et al.*, 2021). These results underscore the potential of green tea extract as a beneficial intervention for managing hormonal imbalances in PCOS, particularly through its effects on LH and testosterone levels.

Polycystic Ovary Syndrome (PCOS) is a multifaceted endocrine and metabolic disorder that significantly impacts women's reproductive health and overall quality of life. Characterized by an imbalance in hormone levels, particularly elevated androgens and LH, PCOS presents a range of clinical manifestations, including reproductive dysfunction and metabolic disturbances. Research has consistently demonstrated that increased serum testosterone levels are prevalent in both letrozole and valerate estradiol-induced models of PCOS, further complicating the disorder's management (Zhou et al., 2021; Sadoughi & Rahbarian, 2017). Notably, dysregulation of lipid metabolism is a critical factor contributing to the clinical presentation of PCOS, underscoring the need for effective therapeutic interventions. This meta-analysis aims to evaluate the therapeutic potential of green tea extract (GE) and its derivatives in the management of PCOS.

Recent studies indicate that GE administration not only facilitates weight loss in PCOS models but also positively influences serum testosterone and LH levels. The estrogenic effects of GE may play a pivotal role in restoring ovarian function by modulating sex hormone levels, thereby presenting a promising multifaceted approach to address both metabolic and hormonal imbalances in PCOS (Almozie'l et al., 2024). Furthermore, GE's antioxidant properties are believed to enhance insulin sensitivity and reduce oxidative stress, which are crucial for managing weight gain associated with the disorder (Rashed et al., 2024). The interplay between insulin resistance, hyperinsulinemia, and hormonal dysregulation is a hallmark of PCOS, where elevated insulin levels exacerbate androgen production and disrupt normal follicular development. By targeting these underlying mechanisms, GE and its derivatives may offer a viable strategy for restoring endocrine balance and improving reproductive health in women with PCOS. This analysis will further explore the evidence supporting the efficacy of GE in modulating hormonal levels, particularly LH and testosterone, and its implications for clinical practice in managing this complex syndrome (Maleki *et al.*, 2021).

Insulin resistance and subsequent hyperinsulinemia are hallmarks of PCOS. Insulin resistance is characterized by reduced sensitivity of peripheral tissues to

insulin, resulting in impaired absorption and metabolism of glucose. To compensate, pancreatic β cells secrete excess insulin, which leads to hyperinsulinemia (Almozie'l et al., 2024). This cascade not only increases the risk of fasting glucose disorders but also makes individuals vulnerable to impaired glucose metabolism, such as type 2 diabetes. Hyperinsulinemia directly stimulates androgen production by theca cells and amplifies the effect of LH on ovarian androgen biosynthesis. Specifically, insulin increases the number of LH binding sites in theca cells, thereby enhancing the LH-mediated androgen synthesis response (Maleki *et al.*, 2021). The increased androgenic environment in ovarian follicles severely impairs granulosa cell (GC) function by downregulating aromatase expression, which consequently reduces the efficiency of androgen conversion to estrogen, thereby further exacerbating androgen levels (Balieiro et al., 2023).

In PCOS, increased LH levels further stimulate the proliferation of theca cells, which contributes to increased androgen production (Shen et al., 2021). This excessive production of androgens creates a pathological microenvironment inside the follicle, inhibits normal follicle maturation and interferes with the development of the dominant follicle. Recent studies have shown that GE and its derivatives can alleviate insulin resistance by lowering fasting blood sugar and insulin levels, while also reducing LH and testosterone levels, thereby restoring endocrine balance (Rashed et al., 2024).

CONCLUSIONS

This meta-analysis highlights the significant therapeutic potential of green tea extract (GE) and its derivatives in managing Polycystic Ovary Syndrome (PCOS), a multifaceted endocrine and metabolic disorder. The findings indicate that GE administration not only facilitates weight loss but also effectively modulates hormonal levels, particularly reducing elevated serum testosterone and luteinizing hormone (LH) levels, which are critical in the pathophysiology of PCOS. Moreover, the antioxidant properties of GE contribute to the reduction of oxidative stress and improvement of insulin sensitivity, thus addressing the metabolic disturbances commonly associated with disorder.

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