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EFFECTS OF HERBAL TEAS ON POLYCYSTIC OVARY SYNDROME (PCOS): A LITERATURE REVIEW

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ABSTRACT

Polycystic ovary syndrome (PCOS) is an endocrine disorder that affects women of reproductive age. It is characterized by hormonal imbalances, metabolic disturbances, and anthropometric abnormalities. In recent years, the use of herbal teas as supplemental treatments for PCOS symptoms has gained popularity among people with the condition. This literature review aims to determine the impacts of herbal tea consumption on anthropometric parameters, identifying its effects on metabolic indices, and describing its influences on hormonal profiles. A thorough search of electronic databases was conducted to identify studies investigating the effects of herbal teas such as spearmint, cinnamon, chamomile, red clover, and hibiscus. The review included both observational research and clinical trials. The findings suggest that spearmint demonstrates the strongest evidence particularly for hormonal modulation in women with polycystic ovary syndrome. However, the available evidence is still inconsistent, with variations in study design, tea dosage, duration, and outcome measures. In conclusion, even though some herbal teas show potential as adjuvant therapy for PCOS, additional standardized research is required to prove the effectiveness of herbal teas and establish clear clinical recommendations.

KEYWORDS:

Herbal Teas, Polycystic Ovary Syndrome (PCOS), Anthropometric, Metabolic, Hormone

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INTRODUCTION

Polycystic ovarian syndrome (PCOS) is a widespread endocrine disorder that commonly affects women of reproductive age[1]. The worldwide prevalence in countries like India, Australia, the USA, Iran, and China has been reported to range from 2.2 to 48%[2-3]. Meanwhile, in Malaysia, the prevalence rate reported from a study was 12.6% in 2019[4]. From these data, Malaysians had a lower prevalence rate compared to other countries. Although the symptoms of PCOS may fluctuate over time, they typically begin in adolescence. Its pathogenic alterations include neuroendocrine dysregulation, excess production of androgens, insulin resistance, and changes in adipose tissue biology. Variations in the malfunctioning of these pathways lead to variations in the disease's severity and phenotype[5]. This fact may lead to symptoms such as an irregular period, excessive body hair growth, acne, and infertility. If left untreated, it may cause gestational diabetes, miscarriage, or premature birth in the case of pregnancy and metabolic syndromes such as high blood pressure and dyslipidemia[6].

Conventional management approaches like lifestyle changes, surgical interventions, and pharmacotherapy including metformin, oral contraceptives, and anti-androgens may help a person with the condition but it comes with side effects[6]. Hence, complementary and alternative therapies are essential to address those issues. Herbal remedies may help women with PCOS according to preclinical and clinical studies[7]. Herbal tea is a tea that is prepared from the leaves, blossoms, seeds, fruits, stems, or roots of a plant other than *Camellia sinensis*. Black, green, oolong and white tea are the most consumed drinks worldwide and are also known as non-herbal tea that is made from *Camellia sinensis*[8]. Compounds allegedly play therapeutic role include flavonoids and phenolic acids such as apigenin, protocatechuic acid, rosmarinic acid and cinnamaldehyde[9-10]. Despite their growing use, the evidence regarding the effectiveness of herbal teas in improving PCOS-related outcomes remains scattered and varied across the literature. Therefore, a comprehensive review is warranted to consolidate current knowledge and identify potential therapeutic roles of herbal tea consumption in the context of PCOS.

Considering this, the present review was conducted with the following objectives:

1. To determine the impacts of herbal tea consumption on anthropometric parameters.

2. To identify the effects of herbal teas on metabolic indices.

3. To describe the influences of herbal teas on hormonal profiles.

METHODS

This review takes an exploratory approach, aiming to capture the existing literature on the potential effects of herbal tea consumption in the treatment of polycystic ovary syndrome (PCOS). In contrast to systematic reviews, which follow a rigid protocol with strict inclusion and exclusion criteria, this scoping review was more flexible to allow a broader understanding of the topic and to capture a wide range of relevant studies. A total of 152 articles were initially searched in major academic databases such as ProQuest, Google Scholar, ScienceDirect, PubMed and Scopus. The keywords used in the search strategy were: "herbal teas"," "polycystic ovary syndrome (PCOS)"," "anthropometric"," "metabolic" and "hormone" No restrictions were placed on publication date or study design. This was intentional as the aim was to capture a comprehensive overview of the topic across different methods and time periods.

Only articles published in English and in peer-reviewed journals were considered in order to ensure a minimum standard of scientific quality. Given the exploratory nature of this review, no formal qualitative assessment or analysis of risk of bias was conducted. The aim was not to summarise

the findings quantitatively or comparatively, but rather to identify and describe trends, recurring themes and knowledge gaps in the existing literature. After screening for relevance and content, 78 of the original 152 articles were selected for the final review. These studies collectively provided insight into the effects of herbal tea consumption on anthropometric measurements, metabolic indicators and hormonal profiles associated with PCOS.

LITERATURE REVIEW

1. Impact of Herbal Teas on Anthropometric Parameters.

According to certain research, obesity has a significant role in the occurrence of PCOS, and reducing weight is a useful strategy to improve the clinical symptoms of PCOS[11]. Meta-analysis studies suggest that the consumption of herbal tea can reduce weight because it contains catechins, polyphenols, and caffeine that can potentially increase fat metabolism and thermogenesis[12-14]. Teas derived from *Camellia sinensis* (such as green, black, and oolong teas) contain caffeine, which can inhibit the degradation of intracellular cyclic AMP (cAMP) by Phosphodiesterase. The cAMP is an essential intracellular mediator for catecholamines' effects on thermogenesis that will result in fat burning and can reduce appetite[14]. In addition, polyphenols in tea will inhibit the catechol O-methyltransferase (COMT) from breaking down norepinephrine at the synaptic junction and its interaction with adenoreceptors, that leads to lipolysis stimulation[15-17]. On the other hand, catechins like epigallocatechin gallate (EGCG) may boost metabolism and help reduce fat storage[18]. According to some studies, the gut microbiota can be impacted by tea, which result in increased diversity and altered structures that influence various aspects of gut health such as immunological homeostasis, inflammatory responses, and metabolic processes[19].

Hibiscus sabdariffa Linn. also known as roselle is a tall, annual, bushy herbaceous sub-shrub that grow and reach a height if 2 meters. It is characterised by a red calyx with five big sepals and is native to India and Malaysia[20]. According to certain research, *Hibiscus sabdariffa* can effectively lower levels of triglycerides, cholesterol, and total lipids, which raises the potential that it has anti-obesity properties[21]. The abundance of polyphenols, anthocyanins, and flavonoids in *Hibiscus sabdariffa* may support its application in the prevention of cardiovascular diseases. The antioxidant and antilipid peroxidation properties of hibiscus extract suggest that protocatechuic acid (PCA) and hibiscus anthocyanins may also play a part in the treatment or avoidance of various medical disorders[22]. In a study conducted to establish the effect of anthocyanins content of *Hibiscus sabdariffa*, it was observed that the extracts of Hibiscus calyces prevent LDL oxidation and macrophage death[23].

Another investigation about the effects of *Hibiscus sabdariffa* extract powder and preventative diet in patients with the metabolic syndrome showed antihypertensive and antihyperlipidemic impacts for this plant[24]. Another study revealed that the aqueous extract of *Hibiscus sabdariffa* calices modulates the production of monocyte chemoattractant protein-1 in humans and lower production of mcp1, which means the slower development of atherosclerosis[25]. Also, another study proved the effect of anthocyanin extracted from Hibiscus in attenuating oxidized LDL-mediated foam cell formation involving regulation of CD36 gene[26].

Apart from the that, cinnamon has been used as a spice all across the world, throughout the years. It comes from the inner bark of trees in the Lauraceae family, namely the genus Cinnamomum, of which *C. cassia* (CC) is one of the most common and widely utilised. The active ingredients include coumarin, eugenol, cinnamon aldehyde, and cinnamic acid, which have antibacterial properties[27], glutathione, and polyphenols, which have antioxidant properties[28], as well as an effect that secretes and sensitises insulin[29]. In murine models, cinnamon has been demonstrated to control the expression of genes related to both lipid and carbohydrate metabolism[30]. It also causes subcutaneous adipose tissue to brown, which raises energy expenditure and aids in weight loss in obese mice and rats[31]. According to a recent comprehensive review, supplementing with cinnamon was able to cause a slight but significant reduction in body weight, (−1.02 kg, 95% CI: −1.66 to −0.38, p = 0.002), particularly when the diet was followed for more than 12 weeks and the patients were young and had a BMI of ≥30 kg/m2[32]. Even though cinnamon is usually regarded as safe, it might cause negative effects in a dose-dependent way, therefore, these factors should be taken into account when increasing the daily dosage[33].

2. Effects of Herbal Teas on Metabolic Indices.

Even though PCOS is primarily an androgen-excess illness, many patients' pathophysiology is linked to insulin resistance and compensatory endogenous hyperinsulinemia, which are closely linked to obesity and abdominal adiposity[34]. In 1990, 7% of adults aged 18 and over had diabetes and by 2022, that number had risen to 14%. In 2022, over half (59%) of persons with diabetes who were 30 years of age or older did not take any medication for their condition. Low- and middle-income nations have the lowest rates of diabetes treatment coverage[35]. Diabetes was the direct cause of 1.6 million fatalities in 2021, and 47% of all diabetes-related deaths happened in people under 70. An additional 530,000 deaths from kidney disease were attributed to diabetes, and around 11% of cardiovascular deaths are related to high blood glucose[36]. Tea drinking has been linked to a lower risk of diabetes mellitus, according to numerous

meta-analysis studies. According to a study conducted in China with 608 T2DM patients, drinking tea could help reduce waist circumference and fasting blood insulin levels (1.30 U/L, 95% CI: 0.36–2.24) during an 8-week intervention[37]. High consumption of decaffeinated tea was substantially linked to a lower incidence of incident diabetes, according to data from 18 trials with 457,922 participants[38]. Drinking at least three cups of tea every day is linked to a decreased risk of type 2 diabetes. However, more research is required to strengthen the relevant evidence, particularly about sex or tea varieties[39].

In insulin secretion and insulin resistance, there are two distinct states: Impaired Fasting Glucose (IFG) and (Impaired Glucose Tolerance) IGT[40]. IGT has noticeable muscular insulin resistance and mild hepatic insulin resistance, whereas IFG has substantial hepatic insulin resistance along with near-normal or normal muscle insulin resistance. Early-phase insulin secretion is reduced in both IFG and IGT participants, although late-phase insulin secretion is similarly compromised in IGT subjects. T2DM develops as a result of these situations[41]. Consuming green tea was especially linked to a decreased incidence of IFG, most likely because of its high EGCG content, which had insulin-mimetic properties. First, EGCG stimulates tyrosine phosphorylation of the insulin receptor and insulin receptor substrate-1 (IRS-1) while suppressing the liver's synthesis of glucose. Second, EGCG reduces cytokine-induced β-cell damage, enhances insulin sensitivity, and regulates gluconeogenesis by inhibiting the expression of the genes phosphoenolpyruvate carboxykinase (PEPCK) and glucose-6-phosphatase (G6Pase)[42]. Third, EGCG controls the expression of genes related to glucose absorption and the insulin signal transduction pathways[43].

Furthermore, cardiovascular risk factors are more common in women with PCOS who are adolescents or of reproductive age. These include metabolic syndrome, diabetes, obesity, mental disorders, hypertension, and impaired glucose tolerance[44]. It has been suggested that polyphenols can function as antioxidants by inhibiting enzymes or sequestering trace elements that contribute to the generation of free radicals[45]. Cardiovascular disease is one of the many clinical diseases whose etiology involves reactive oxygen species[46]. Polyphenols have anti-inflammatory and vasodilatory properties, can reduce the oxidation of low-density lipoprotein (LDL), and can alter lipid metabolism and endothelial apoptosis[47]. However, the preventative benefits of polyphenols against cardiovascular disease are not the only evidence of their potential suppression of LDL oxidation. In animal models, polyphenols have also been demonstrated to alleviate endothelial dysfunction, prevent platelet aggregation, and

prevent the invasion and proliferation of smooth muscle cells in the artery wall[48].

The lipid profile may also be altered by polyphenols. When given coca-containing beverages for 12 weeks, healthy adults showed a substantial rise in plasma HDL-C[49]. In individuals with hyperlipidemia, administration of bergamot polyphenol extract for 30 days likewise led to a drop in triglyceride levels and an increase in HDL-C[50]. However, the study's findings for teas high in polyphenols are incongruous. One meta-analysis showed that drinking black tea decreased LDL-C, particularly in people at high cardiovascular risk[51], whereas another reported no effects of black tea on TC and serum concentrations of LDL-C and HDL-C[52]. The current investigation found that a 3-month treatment with herbal tea resulted in a significant rise in HDL-C concentration and a decrease in TG levels. These findings support a wide variety of possible benefits of herbal tea and a positive effect on lipid metabolism.

Tremellen and Pearce (2012) put out the theory that the metabolic and reproductive symptoms of PCOS are caused by an imbalance in the composition and function of the intestinal (gut) microbiome. Over the last five years, research has shown that alterations in the taxonomic makeup of gut bacteria are linked to PCOS in both human and animal models[53]. The microbiome has high plasticity and the ability for situational adaptation. Short-chain fatty acids (SCFAs), which cross-feed the microbiota and have physiological effects on gut integrity, are thus produced when bacteria break down polysaccharides that enter the colon. Polyphenols are the main bioactive compounds in teas. Polyphenols with monomeric and dimeric structures may be absorbed in the small intestine. However, most polyphenols, including complex polyphenols, oligomeric, and polymeric structures, reach the large intestine, are metabolized by gut microbiota, or are eliminated in the feces. Polyphenols reaching the large intestine can influence the diversity of microorganisms and regulate Firmicutes/Bacteroidetes ratio[54]. Microbial enzymes in the large intestine cause several processes, including C-ring breakage, decarboxylation, dehydroxylation, and demethylation. Complex polyphenols are broken down into more easily absorbed, simpler molecules[55].

Studies conducted both in vitro and in vivo, primarily on animal models, have demonstrated the connections between the gastrointestinal (GI) microbiome and tea components. Several research have presented data on the modulatory effects of teas on the GI microbiota. Lactobacillus and Bacteroides species were elevated after consuming ginseng decoction[56], Corn starch tea will increase the numbers of Coriobacteriaceae, Lactobacillaceae, Prevotellaceae, and Bifidobacteriaceae in the gut while Bacteroidaceae, Ruminococcaceae,

Helicobacteraceae, and Enterobacteriaceae will be decreased[57], and Lactobacillus species were elevated after drinking Fuzhuan tea[58]. The anaerobic component of the rumen fermented the tea residues, enhanced the concentration of immunoglobulins and the overall antioxidant status, and was utilized as a feed addition for Holstein heifers (cattle). This study shows that the selective use of functional components can have positive benefits that are comparable to the prebiotic-like effect[59]. Thus, it is said that tea saponins increase the percentage of strains of the genera Bacteroides, Lactobacillus, and Bifidobacterium. Ginseng tea's saponins increase the ratio of Firmicutes to Bacteroides, which explains its positive health effects[60].

3. Influence of Herbal Teas on Hormonal Profiles.

Due to high androgen levels in PCOS, it will cause excessive body hair growth (hirsutism) that leads to serious psychological and cosmetic issues. Pharmacological therapies and cosmetic surgeries are two possible management approaches. However, the side effects of hirsutism drugs can range from minor ones like headaches and nausea to more dangerous ones like heart attacks, vascular clots, hepatotoxicity, osteoporosis, and feminization of a male fetus[61]. The side effects of the drugs have contributed to recent interest in herbal medicines. As an alternative treatment for hirsutism, herbs with anti-androgenic effects have drawn special attention. According to some research, hirsutism may be treated with plant-based substitutes that have anti-androgen properties. Therefore, to treat androgen-related illnesses like hirsutism, more varied and effective drugs are required[62-63].

According to a few studies, spearmint directly influences androgen synthesis and metabolism, which may make it useful in treating PCOS and hirsutism[64]. Spearmint is a herbal plant commonly found in Asia, Africa, and Australia. In a study, women with PCOS were given spearmint herbal tea for a month in two different groups. It demonstrated that patients who consume spearmint tea had significantly lower levels of free testosterone (24%) and total testosterone (29%). According to the subjective DQLI questionnaire, patients also reported a notable decrease in hair density[65]. Spearmint may have an impact on hair density and growth because it can raise the rate at which androgens are metabolized by triggering cytochrome P450 (CYP) 3A4.5. The body's sex hormone concentration may be impacted, resulting in an increase in estrogen, and a decrease in free testosterone. Greater amounts of sex hormone-binding globulin (SHBG), which transports the most inactive form of testosterone in the blood, can also be caused by greater levels of estrogen. Thus, this rise in SHBG levels may be explained by the fact that subjects who drank spearmint tea had normal levels

of total testosterone[66]. Although the evidence for this is conflicting and weak, there are indications that certain herbal medications, whether taken orally or topically, may be useful in treating hirsutism[65].

Besides, a healthy pregnancy is dependent on the body's hormone balance. The pituitary gland releases the sex hormones of the Follicle-Stimulating Hormone (FSH) and Luteinizing Hormone (LH) in reaction to the gonadotropin-releasing hormone (GnRH), which is one of the hormones that are crucial for women's reproduction[67]. In women, these hormones normalize oocyte development and promote ovulation[68]. Women's hormonal problems and infertility can be treated with the modulation of these hormones. Additionally, it aids in the treatment of conditions like polycystic ovarian syndrome and therapeutic approaches like assisted reproductive technology (ART)[69]. Several herbal plants have shown significant effects on reproductive hormones and fertility. *Vitex agnus*-castus increases LH and FSH levels, enhancing fertility in older female mice[70], while Renshen (Radix Ginseng) boosts estrogen biosynthesis but suppresses LH and FSH[71]. *Thuja occidentalis* lowers LH levels and may treat PCOS without causing osteoporosis[72]. *Cimicifuga racemosa*, when combined with clomiphene, improves fertility in PCOS by balancing LH and increasing estradiol and progesterone[73]. Lastly, *Yucca schidigera* enhances ovarian response to FSH, promoting folliculogenesis and fertility in sheep[74]. These studies show that herbal plants influence reproductive hormones in various ways, either enhancing fertility by stimulating LH, FSH, and estrogen or acting as contraceptives, demonstrating their potential in managing fertility and hormonal disorders.

Red clover (*Trifolium pratense*) is a fodder plant that contains a large concentration of isoflavones, also known as phytoestrogen that resembles estrogen and is thought to raise women's estrogen levels[75]. Formononetin, biochanin A, daidzein, and genistein are the four oestrogenic isoflavones that are present in considerable concentrations in the red clover. Because red clover preparations are a "natural" type of hormone replacement therapy, they can be marketed as dietary supplements and are intended for long-term use as a phytoestrogen source[76]. A study demonstrated that phytoestrogens significantly affect steroidogenesis in the rat testis and adrenal glands while lowering testosterone levels[77]. In a pilot prospective study of PCOS patients, Romualdi et al. found that administering phytoestrogens to patients improved their lipid assessment. They also proposed that there might be a benefit to using phytoestrogens to improve lipid assessment in PCOS-afflicted women[78].

In addition, cortisol has a direct correlation with stress levels, which influence human health and increase blood pressure and other bodily dangers[79]. Hypercortisolism may not only result from excess

cortisol production but also from reduced breakdown. Cortisol is normally inactivated in three steps by specific enzymes. In women with PCOS, some of these enzymes especially 5α-reductase, 3α-HSD, and 20α/β-HSD show increased activity, which may alter cortisol metabolism and contribute to symptoms like hirsutism and fat accumulation[80]. Research has shown that chamomile significantly reduces cortisol levels, which lowers the body's risk of stress[79]. An 8-week chamomile supplementation study found that cortisol levels significantly decreased, especially in the treatment group (G1), which saw a decline from 7.98±1.822 to 6.45±1.78 µg/dL, while the control group (G0) saw a modest increase. In line with Suyono et al. (2020), our results indicate that chamomile supplements successfully reduce cortisol levels (p 0.05) [79]. Based on the results, chamomile-based supplements were quite successful in helping patients with elevated cortisol levels, which may help them retain their health and personality.

RESULT AND DISCUSSION

PCOS is a complex condition that affects women of reproductive age, it is often characterized by clinical and biochemical hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. The underlying causes of these symptoms are hormonal imbalances and serious metabolic disorders such as insulin resistance, obesity, and dyslipidemia. Many women choose complementary and alternative therapies because conventional medications, such as insulin sensitizers, and anti-androgens are effective but frequently have side effects. Herbal therapies have drawn attention due to their numerous advantages, safety profile, and long history of usage in the management of women's reproductive health.

Numerous herbal teas such as those made with red clover, hibiscus, chamomile, cinnamon, and spearmint contain bioactive compounds such as flavonoids, polyphenols, catechins, and essential oils that contribute to their therapeutic properties. These herbs exhibit anti-inflammatory, antioxidant, anti-androgenic, and insulin-sensitizing effects. Regular consumption of these herbal teas may help regulate hormonal imbalances by lowering high androgen levels, controlling gonadotropin secretion, and enhancing menstrual regularity. Additionally, herbs such as *Cimicifuga racemosa* and *Vitex agnus*-castus have been used to promote estrogen-progesterone balance and ease irregular menstruation, which may improve fertility and ovulatory function in PCOS.

There is encouraging evidence that herbal teas have a favorable effect on anthropometric parameters related to metabolic health. Polyphenols and catechins in herbal teas improve gut microbiota composition, enhance fat metabolism, reduce appetite, and exert lipid-lowering effects. Particularly, cinnamon and hibiscus have demonstrated potential in increasing lipid profiles,

reducing fasting blood glucose levels, and improving insulin sensitivity. These metabolic changes are important since insulin resistance is a major factor in the pathogenesis of PCOS and increases the severity of hyperandrogenism and reproductive dysfunction.

Furthermore, herbal teas can regulate reproductive hormones. In women with PCOS, spearmint tea has been shown to lower both free and total testosterone levels, potentially helping alleviate the symptoms like acne and hirsutism. Red clover and *Vitex agnus*-cactus have been shown to affect oestrogenic activity, promoting monthly regularity and hormonal balance because of their phytoestrogen content. Beyond its hormonal benefits, chamomile has anxiolytic properties that help lower cortisol levels and reduce stress, which is a significant exacerbating factor in PCOS that can exacerbate metabolic dysregulation and hormonal imbalance.

Overall, herbal teas have the potential to be effective adjunct therapy in the holistic management of PCOS based on the existing evidence. The variety of mechanisms ranging from stress relief, increased metabolism, hormonal regulation, and anti-androgenic activity correspond with the complex pathophysiology of PCOS. However, the current studies limited by sample size, varying methodology, and inconsistency in dosages are certainly promising. Further clinical trials on herbal teas with standardized therapies as well as more objectively assessed study designs will be important to substantiating these outcomes and for future clinical practice. Nevertheless, herbal teas can be a safe and natural adjunct in the effort to address changes to dietary and lifestyle habits for women who have PCOS and to support metabolism and reproductive health.

CONCLUSION

In conclusion, herbal teas have significant clinical value as a supplement treatment for PCOS patients because of these advantages. They are readily available, natural alternatives that could lessen the reliance on drugs with negative side effects. Future research should focus on standardizing dosage, identifying the optimal durations, evaluating long-term effects, and looking into combinations with conventional medications through comprehensive and closely monitored clinical trials. Herbal teas should also be studied as a component of a comprehensive strategy to manage patients with PCOS. Herbal teas not only help people with PCOS but also promote mental and physical health when paired with lifestyle changes like stress management, regular exercise, and a healthy diet. By addressing the complex nature of PCOS, this approach gives patients access to more individualized and long-term treatment alternatives.

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