ISSN: 2306-6091

International Journal of Pharmaceuticals and Health care Research (IJPHR)

IJPHR |Vol.15 | Issue 1 | Jan - Mar -2026

www.ijphr.com

DOI : https://doi.org/10.61096/ijphr.v15.iss1.2026.82-94

Review

# Herbal medicine as an emerging approach polycystic ovarian syndrome: A systematic review

**Rajendran S.S[1*], Neelaveni Thangavel[1], Devanarayanan[1], Nisha R[1], Sabeer Ahamed P[1], Seenivasan K[1], Angalaparameswari S[2], Nandhini S[1], Anuyashika T[1].**

*[1]Department of Pharmaceutical Chemistry, RVS College of Pharmaceutical Sciences, Sulur, Coimbatore 641 402, Tamilnadu, India. Affiliated to The Tamil Nadu Dr MGR Medical University, Guindy, Chennai – 600032, Tamil Nadu, India.*

*[2]Department of Pharmaceutical Analysis, RVS College of Pharmaceutical Sciences, Sulur, Coimbatore 641 402, Tamilnadu, India, Affiliated to The Tamil Nadu Dr MGR Medical University, Guindy, Chennai – 600032, Tamil Nadu, India*

Corresponding author: Rajendran S.S
Email: rajendran@rvsgroup.com

Published on: 06.03.2026

Published by: Futuristic Publications



## Abstract

**Background:** Polycystic ovarian syndrome (PCOS) is a a complex neuroendocrine and metabolic disorder condition that is frequently linked to irregular menstrual cycles. Although synthetic pharmacological agents are widely used and show clinical efficacy in managing PCOS, many patients increasingly prefer natural therapies because of their favorable therapeutic outcomes and the adverse effects or limitations linked to conventional allopathic treatments. Considering the rising interest in herbal medicine, this review highlights the potential role of various medicinal plants for the management of (PCOS). **Methods:** An extensive literature review was conducted, and relevant data were extracted from databases including Scopus, PubMed, Crossref, Google Scholar and Hinari to assess the efficacy of herbal interventions in the management of PCOS. **Result:** This review outlines the therapeutic significance of selected herbal medicines in PCOS, with emphasis on their phytochemical composition, mechanisms of action, and pharmacological effects. **Conclusion:** The findings presented in this review provide valuable insights and serve as a useful reference for researchers investigating the therapeutic potential of herbal interventions and approaches in PCOS.

**Keywords:** Herbal medicine, Polycystic Ovary Syndrome, Phytochemicals, Insulin resistance, Neuroendocrine dysfunction

## 1. INTRODUCTION

PCOS is a multifaceted hormonal disorder characterized by elevated androgen levels, menstrual disturbances, and ovarian cyst formation in one or both ovaries. Historically, it was known as Stein–Leventhal syndrome. It is a disorder that primarily impacts women and is marked by enlarged ovaries containing numerous small cyst-like structures, which represent immature follicles.[1] According to the World Health Organization (WHO), more than 116 million women globally were affected by PCOS in 2012, and the condition is estimated to affect approximately one in five women in India[2]. World wide, approximately 1.55 million new cases of PCOS were reported among women of reproductive age between 2007 and 2017, reflecting an overall increase of 4.47% (2.86–6.37%) during this period. In India, a nationwide survey conducted in 2020 revealed that nearly 16% of women aged 20–29 years were affected by PCOS, highlighting its substantial prevalence among females aged 15–49 years[3]. A nationwide survey carried out in India in 2020 reported that approximately 16% of women aged 20–29 years were affected by PCOS.The medicinal benefits and clinical applications of herbal therapies have been extensively documented [5]. Increasing concerns about the adverse effects and complications associated with synthetic medicines have encouraged a renewed interest in therapies derived from natural and plant sources. Evidence from scientific studies supports the safety and therapeutic efficacy of several complementary treatment approaches, including herbal remedies, in the management of certain diseases [6]. This review highlights the role of herbal approaches and therapies in the management of PCOS, focusing on the phytochemicals, therapeutic potential and mechanisms of action of selected medicinal plants

## 2. MATERIALS AND METHODS

Recognizing the importance of herbal interventions in PCOS management, this review evaluates selected medicinal plants with respect to their phytochemical profiles, mechanisms of action, and therapeutic applications, based on literature obtained from major scientific databases. The following section comprehensively reviews herbal medicines that demonstrate anti-PCOS activity through several mechanisms.

## 3. RESULTS

### 3.1. Herbs – Enhance the Ovulatory cycles

Alterations in prolactin concentrations and overall hormonal dysregulation can markedly disrupt ovulatory function. Conversely, lowering prolactin levels or restoring hormonal equilibrium can enhance ovulatory cycles and contribute positively to the management of PCOS. These actions may help limit cyst 7 development, promote cyst resolution, and enhance ovulatory function. Herbal medicines such as Vitex and turmeric have shown beneficial effects in PCOS by promoting and regulating ovulation cycles.

### 3.1.1. Vitex agnus castus

Vitex agnus-castus, commonly known as chaste tree, belongs to the Verbenaceae family and has been utilized in traditional herbal medicine for more than 2,000 years. This large shrub is indigenous to Europe and is also found abundantly in the southern U.S. Disruptions to estrogen levels are linked to menstruation problems such as pre-menstrual symptoms and irregular menstruation (due to corpus luteum deficiency, cyclical breast pain, or hot flashes after menopause7. Figure 1). The fruits of Vitex agnus-castus are rich in bioactive compounds, predominantly monoterpenes such as borneyl acetate, limonene, 1,8-cineole, α-pinene, and β-pinene, along with labdane-type diterpenes including viteagnusins, vitexilactone, rotundifuran, and vitexlactam A. They also contain moderate amounts of flavonoids, such as luteolin, apigenin, 3-methylkaempferol, casticin, and chrysoplenetin, as well as iridoid constituents like cynaroside.

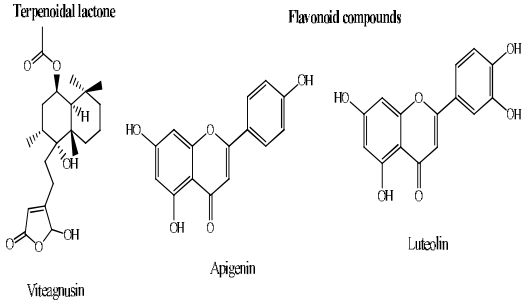


Figure 1. Terpenoidal lactones and flavonoid compounds in Vitex agnus-castus contribute to the improvement of ovulatory function.

### 3.1.2. Curcuma longa

Curcuma longa, a member of the Zingiberaceae family, is a rhizomatous plant whose rhizome is widely utilized as a culinary spice across Asia. It is recognized by various names, such as Curcuma domestica Valeton, Curcuma domestica Loir, curcuma, Amomum curcuma Jacq, yellow ginger, yellow root and Indian saffron. Prior research has offered an in-depth analysis of turmeric's chemical structure. Turmeric exhibits considerable chemical diversity, comprising over 250 identified primary and secondary metabolites. The main components consist of terpenes (1.5–5%), carbohydrates (60–70%), resins and proteins (5–10%) with the resinous part—commonly referred to as curcuminoids—gaining notable interest. (Figure 2). Turmeric resins, often referred to as 2.5–8% of curcuminoids, are the primary secondary metabolites and are responsible for the many biological effects and color. The three principal curcuminoids identified are curcumin (diferuloylmethane), which constitutes the major fraction (71.5–94%), followed by desmethoxycurcumin (6–19.4%) and bisdemethoxycurcumin (0.3–9.1%). Turmeric is rich in phenolic constituents, including curcumins and related curcuminoids, as well as ferulic, vanillic, caffeic, syringic, protocatechuic, and p-coumaric acids, eugenol, and ascorbic acid. It also contains important terpenoids such as turmerone, α-turmerone, camphene, β-sesquiphellandrene, γ-terpinene, and carotene. In the context of Polycystic Ovary Syndrome (PCOS), curcuminoids have demonstrated therapeutic promise by reducing cystic follicular changes, promoting corpus luteum formation, and supporting ovulatory function, thereby improving ovarian histoarchitecture. They are also reported to modulate hormonal balance by lowering serum progesterone and increasing estradiol levels. Furthermore, their estrogenic, antihyperlipidemic, antioxidant, and hypoglycemic activities contribute to ovarian protection, improved ovulation, and enhanced fertility outcomes in women with PCOS.8

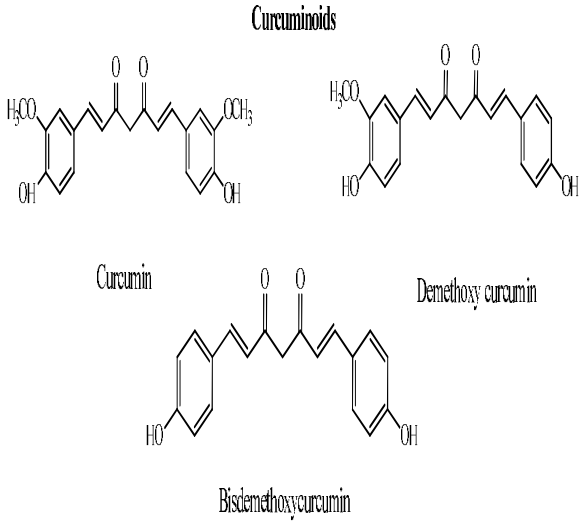


Figure 2. The curcuminoids present in Curcuma longa play a key role in mproving PCOS conditions.

### 3.2. Herbs – anti-androgenic activity

Elevated androgen levels play a central role in the pathogenesis of PCOS; consequently, agents with anti-androgenic activity are commonly used in its management. Several medicinal plants, including *Glycyrrhiza glabra (*Family: *Fabaceae), Linum usitatissimum (*Family: *Linaceae), Mentha spicata (*Family: *Labiatae), Cocos nucifera (*Family: *Arecaceae),* and *Punica granatum (*Family: *Grenade)*, have demonstrated potential in reducing androgen activity and may therefore be beneficial in the treatment of PCOSwith anti-androgen effects.

### 3.2.1. Glycyrrhiza glabra

*Glycyrrhiza glabra*, belonging to the Fabaceae family, contains approximately 2–9% of glycyrrhizin, along with glycyrrhetic acid, triterpenoid saponins, flavonoids, isoflavonoids, amino acids and carbohydrates. The major phytoestrogenic compounds identified in licorice include liquiritigenin, isoliquiritigenin, liquiritin, isoliquiritin, glabridin, and glabrenes.[9] *Glycyrrhiza* demonstrates significant anti-androgenic effects and helps regulate estrogen synthesis and release in the body. Its flavonoid compounds (Figure 3) exhibit estrogenic activity by interacting with estrogen receptors, thereby contributing to anti-androgenic effects. In addition, these flavonoids can stimulate

insulin secretion, lowering blood glucose levels, which is advantageous in managing polycystic ovary syndrome (PCOS).[10] In addition to its effects on PCOS, licorice exhibits a range of therapeutic benefits, including antitussive, antibacterial, and antiviral properties, as well as effectiveness in managing digestive disorders, hepatitis, and oral ulcers.[11]

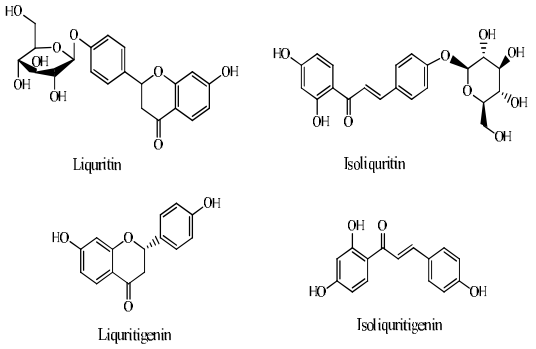


Figure 3. **The flavonoid constituents of licorice contribute to the management of PCOS through their anti-androgenic properties.**

### 3.2.2. Linum usitatissimum

*Linum usitatissimum, or linseed, is a member of the Linaceae family and serves as an abundant source of biologically active constituents*. Linseed seeds contain 30–40% fixed oil (in addition to 25% protein, 6–10% mucilage) and fatty acids (both saturated and unsaturated) and lignans (figure 4). The major lignans found in flaxseed are secoisolariciresinol and secoisolariciresinol diglucoside (SDG). L-galactose, D-galacturonic acid, D-xylose and L-rhamnose are the major components of the mucilaginous fiber of linseed. Both lignans and mucilage contribute to their potential to influence estrogen levels and may provide benefits to fertility and regular menstrual cycles. In addition to this, flaxseed has been utilized to lower levels of circulating androgens (i.e., testosterone) and may provide benefits in treating PCOS[13]. Flaxseed-containing foods have been shown to alleviate hirsutism and hyperandrogensim, which are symptoms associated with PCOS. In preclinical studies, supplementation of flaxseed (in female rats) decreased androgen levels, increased the formation of corpus luteum and decreased the number of cystic ovarian follicles.

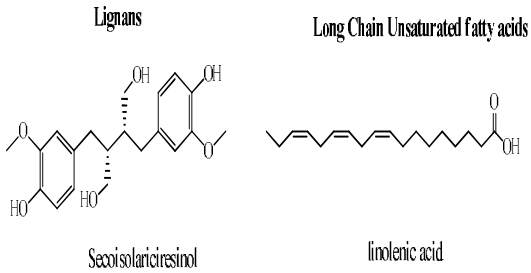


Figure 4. ***Lignans and polyunsaturated fatty acids in* Linum usitatissimum *contribute to its anti-androgenic properties***

### 3.2.3. Mentha spicata

Mentha spicata, part of the Labiatae family, has been used historically as a culinary herb andis a plentiful supply of bioactive compounds. It includes carotenoids like lutein, alongside various flavonoids and their derivatives, such as xanthomicrol, quercetin-4-glucoside, catechin, rutin, sorbifolin, hesperidin, thymonin, ladanein, gallocatechin gallate,, luteolin-7-O-rutinoside, isorhoifolin, 5-O-demethylnobiletin and eriodictyol-7-O-glucoside,. Moreover, M. spicata contains a high concentration of phenolic acids, including rosmarinic acid, caffeic acid, salvianolic acids, dehydrosalvianolic acids, and derivatives of cinnamic acid. Main compounds that enhance its potent antioxidant effects are lutein, rutin, rosmarinic acid, and caffeic acid (Figure 5)[14].

In in-vivo study with experimental animals, these bioactive compounds demonstrated a significant reduction in free and total testosterone levels and helped decrease hirsutism. Supplementing with spearmint also positively affected ovarian cystic structure in PCOS by reducing the count of atretic follicles and promoting the maturation of Graafian follicles. Additionally, Mentha spicata shows significant anti-inflammatory, antidiabetic, and anticancer effects[15]. Research indicates that Mentha species may influence the circulating ratio of luteinizing hormone (LH) to follicle-stimulating hormone (FSH) and via this hormonal regulation spearmint could offer therapeutic advantags in managing PCOS. Numerous preclinical studies also reinforce

itsantiandrogenic capabilities[16].

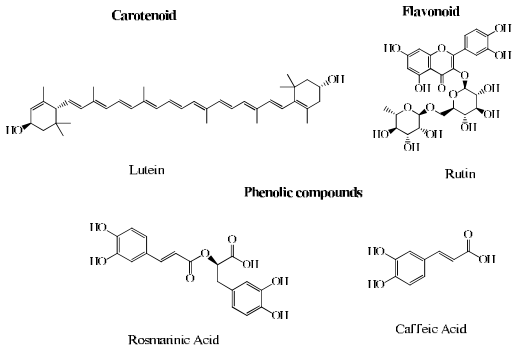


Figure 5. *A wide range of secondary metabolites in* Mentha spicata *exhibit anti-androgenic activity.*

### 3.2.4. Cocos nucifera

Coconut oil from the coconut palm is a product of the family Arecaceae and has both α-tocopherol (vitamin E) and lauric acid as oil's main two nutrients. The root of the plant also contains several types of phenolic compounds, including many flavonoids and saponins[17]. In addition, this plant contains bioactive constituents - including lupeol methyl ether, skimmiwallin, and isoskimmiwallin (Figure 6) - as well as approximately twenty-five other volatile and semi-volatile phytochemicals.

Flavonoids found in coconuts have been shown to inhibit the release of insulin while lowering blood glucose levels. Also, lipid methyl (9Z,12Z)-9,12-octadecadienoate included in C. nucifera has anti-androgenic activity. Furthermore, coconuts may affect the circulation of endogenous sex hormones (i.e., follicle-stimulating hormone (FSH) and luteinizing hormone (LH))[18].

Preclinical research continues to evaluate the benefit of C. nucifera on the histology of ovaries in women with PCOS. Studies suggest that C. nucifera reduces the number and size of ovarian cysts, as well as decreasing ovarian weight while increasing uterine weight. By perhaps influencing the hormonal balance inherent to hormone-producing tissues, coconuts may also be helpful in preventing the development of ovarian cysts[19].

In Ayurvedic medicine, coconut flowers are prepared in oral infusions and traditionally used for menstrual disorders. Furthermore, drinking coconut milk may also have some degree of contraceptive efficacy.

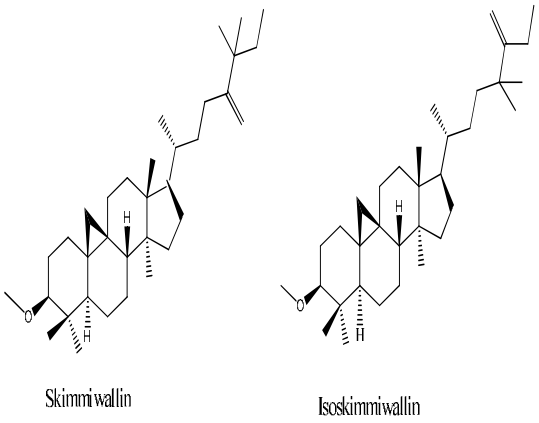


Figure 6. *Triterpenoid compounds present in* Cocos nucifera *exhibit anti-androgenic activity.*

### 3.2.5. Punicagranatum

The Punicaceae family includes Punica granatum (grenade), a member of that family is an abundant source of pantothenic acid, sugars, organic acids, folic acid and vitamins B1, B2 and C. The seeds of P. granatum contain both saturated and unsaturated fatty acids, while the extract from the seed of P. granatum is rich in phenolic compounds (Δs), such as flavonoids and catechins (figure 7), as well as phytosterols. These compounds are important in helping to alleviate problems related to PCOS. There is a correlation between the consumption of P. granatum and the restoration to normal levels of the serum hormones, estrogen, androstenedione, and circulating free testosterone in females[20]. Additionally, several studies support that supplementation with P. granatum can help to reduce the severity of PCOS problems.

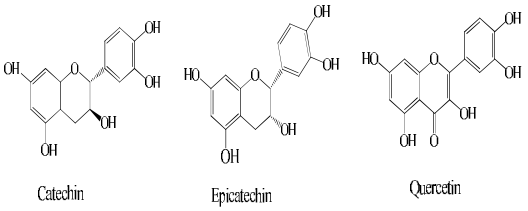


Figure 7. *Phenolics identified in* Punica granatum *possess androgen-suppressing activity*

## 4. Herbs - Enhance Enzymatic Activity, Estrous Cyclicity, and Glucose Sensitivity:

Some herbs also enhance the activity of enzymes, regulate the menstrual cycle (estrous

cycle), and improve glucose (sugar) sensitivity in women who have polycystic ovarian syndrome (PCOS). In general, women with PCOS have problems with their insulin (insulin resistance) or they have high blood sugar levels, therefore common treatment options include methods to increase how well the body uses insulin. Additionally, some of these herbs have similar ways to act on the body as insulin in regulating blood sugar levels, and these herbs include Aloe Vera and Cinnamomum cassia. Both aloe vera and Cinnamomum cassia have been indicated to help women manage PCOS by decreasing their blood sugar levels and regulating their menstrual cycles.

"Decreased insulin sensitivity and hyperglycemia are characteristic features of PCOS, leading to the use of therapies that enhance insulin action. Herbs including Cinnamomum cassia and Aloe vera have shown efficacy in lowering blood glucose levels and normalizing the estrous cycle, highlighting their potential therapeutic value in PCOS.

## 4.1. Cinnamomum cassia

The Lauraceae Cornus Swine's Cinnamomum cassia genus contains numerous polyphenol-providing phytochemicals. They include several cinnamyl alcohols, linalool, eugenol, methyl eugenol, eugenol acetate, procyanidins and benzaldehydes among many other bioactive species such as cinnamaldehydes and cinnamylic acids, *carophyllene, monoterpenes, pinene, hydrocarbons, benzyl benzoate, phellandrene, safrole, puhenyl vertical hydrocarbyls and cineols, etc. (Figure 8)21. The average composition of Cinnamomum cassia includes a considerable amount of(CHO) of approximately 80.59%; about 53.1–59.55% in dietary fibre;70 to 90% in moisture; Protein from approximately 3.89% to 4.65%; Ash roughly equaling approximately 3.55% from Vitamins(a score of all); and the general 5,6,7,8 etc.19 of components or sub-parts22. The energy (calorie content) components may be very important as well. Phenolic substances from Cinnamomum cassia have been shown to improve how you use glucose, and therefore also aid in halting high-levels of glucose in conjunction with or without insulin regulation23. Research has provided evidence that cinnamon extract may increase the sensitivity of people with polycystic ovaries (PCOS) to insulin and/or that the presence of procyanidins along with more phenolic components increase insulin levels through stimulation along pathways for glucose;– adequate amounts of glucose when compared to how far out they are from their general homeostasis.* Taking cinnamon orally in the luteal phase has been noted to help maintain progesterone levels, while regular daily intake could aid in normalizing menstrual cycles and alleviating symptoms linked to PCOS. Additionally, Cinnamon demonstrates notable antioxidant and anti-inflammatory properties by enhancing the function of crucial antioxidant enzymes—superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase (CAT)—while also lowering malondialdehyde (MDA) levels. In various clinical trials with a total of 183 participants, cinnamon was evaluated either by itself or alongside other herbal remedies and compared to placebo or control treatments. Due to the minimal heterogeneity across studies ($p = 0.30$, $I^2 = 17\%$), a fixed effects method was utilized. The combined findings showed decrease in LDL levels among women with PCOS undergoing cinnamon-based treatments, emphasizing its potential advantage in enhancing lipid profiles in the management of PCOS

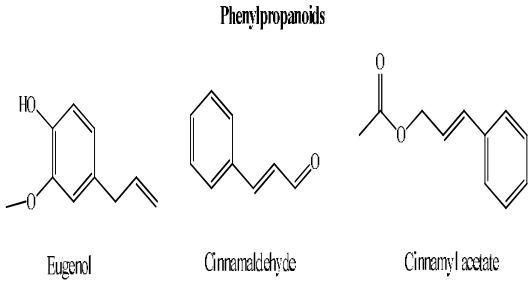


Figure 8. ***Phenylpropanoid compounds in* Cinnamomum cassia *that demonstrate enzymatic activity.***

## 4.2. Aloe vera

The genus of the plant Aloe, family Liliaceae, contains a multitude of secondary metabolite compounds such as anthraquinone derivatives, flavonols and flavonoids, sterols, phenolic compounds and other essential nutrients; barbaloin and aloe emodin are the primary active ingredients in Aloe (Figure 9)[24]. Clinical studies have indicated that the application of Aloe gel may restore some/regulate the production of estrogens in women with disrupted ovarian function. Based on previous

research conducted with rats, it was shown that Aloe suppresses both 17β-hydroxysteroid dehydrogenases (17β-HSD) and 3β-hydroxysteroid dehydrogenases (3β-HSD) leading to reduced ovarian weights and lower levels of androgen secretions from ovaries. In contrast, Aloe's activity promotes increased estrogen secretion via the increased throughput of the steroidogenic pathway. Additionally, Aloe has also been shown to improve glucose accountability, re-establish regularity in the estrous cycle and modulate plasma lipoproteins while simultaneously suppressing the liver's production of cholesterol. Overall, Aloe's regulatory activities in blood sugar levels and fat metabolism show great potential for the treatment or management of PCOS as it relates to metabolic dysfunction.

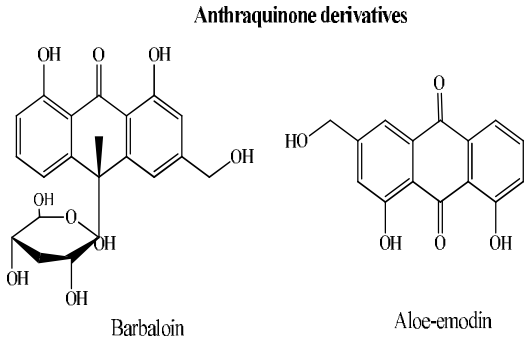


Figure 9. *Secondary metabolites of* Aloe vera *that modulate enzymatic activity and may be beneficial in the management of PCOS.*

### 4.3. Herbs - Enhance FSH and Reduce LH Secretions

Polycystic Ovarian Syndrome (PCOS) usually has both high Lutonizing Hormone (LH) and low Follicle-Stimulating Hormone (FSH) levels, which makes it a case of hormone imbalance. Many treatment options for PCOS are believed to work by increasing FSH production while decreasing LH levels. Some herbal options that could potentially modulate hormones include Panax Ginseng, Cimifugua Racemosa and Foeniculum Vulgare among others, but these may also help in the treatment of PCOS.

#### 4.3.1. Foeniculum vulgar

Fennel, or Foeniculum vulgare, is a member of the Apiaceae family and 4%-5% of it contains volatile oil. Fennel also has many bioactive compounds related to many health benefits. The phytochemicals in fennel include β-pinene, trans-anethole, estragole, fenchone, β-carotene, 1,8-cineole, myristicin, β-sitosterol limonene, and a number of phenolic acids (cinnamic, caffeic, ferulic, fumaric, benzoic, p-coumaric and vanillic acid). Additionally, flavonoids such as quercetin, rutin, kaempferol, and vanillin also exist in fennel. Fennel has considerable levels of anethole (50%-60%) along with phenolic esters, fenchone (18%-22%), fixed oils, proteins and vitamin A, B, C and E (α, β, γ and δ tocopherols) which includes ascorbic acid (see Figure 10)[25]. The vitamins in fennel have strong antioxidant properties, thus protecting the cells from oxidative damage. Anethole has also been found to stimulate menstruation and childbirth as well as have estrogenic effects on ovarian follicles. These factors combined may explain the therapeutic effects of fennel in the treatment of PCOS.

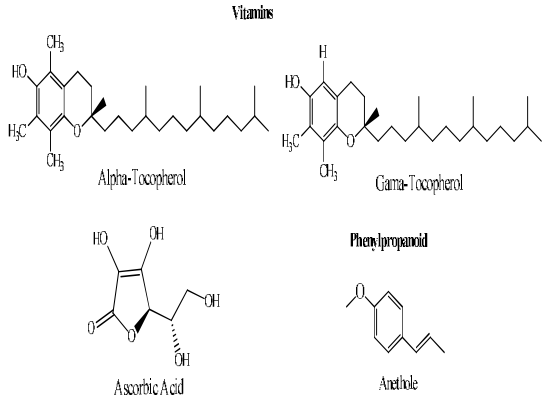


Figure 10. *Vitamins and phenylpropanoid compounds of* Foeniculum vulgare *that are beneficial in the management of PCOS.*

#### 4.3.2. Panax ginseng

The therapeutic properties of Panax ginseng are mainly due to its saponin levels, which make up its primary category of bioactive substances. Commonly referred to as the “king of herbs,” Panax ginseng has been employed in traditional medicine for over 2,000 years. Its saponin component mainly includes ginsenosides like Rb1, Rb2, Rc, Rd, Re, Ro, and Ra, as well as a few lesser ginsenosides. Experimental research has shown that Panax ginseng promotes the growth of estrogen receptor–positive ($ER^+$) cells in vitro. Specific ginsenosides, such as Rb1 and Rg1, can stimulate estrogen receptors and produce estrogenic effects, resulting in elevated serum estradiol levels and

simultaneous decreases in follicle-stimulating hormone (FSH) and luteinizing hormone (LH) levels[26]. Lowering circulating LH levels may be especially advantageous for enhancing fertility results in women experiencing anovulation related to PCOS. Moreover, ginseng has been noted to alleviate postmenopausal issues like insomnia, anxiety, and depression. Due to its ability to control the estrous cycle and demonstrate notable estrogenic effects—shown by the reversal of uterine and vaginal atrophy and the increased expression of ERα and ERβ in reproductive tissues—ginseng is frequently utilized as a natural estrogen substitute. In summary, these characteristics emphasize the promise of Panax ginseng as a beneficial therapeutic option in treating PCOS

### 4.3.3. Cimicifuga racemose

Cimicifuga racemosa, commonly called black cohosh, is a member of the Ranunculaceae family of plants. Research on Cimicifuga racemosa over the past few decades has focused on two groups of the bioactive compounds that are found in black cohosh: triterpene glycosides and phenolic acids. The major component of the phenolic acids of black cohosh include hydroxycinnamic along with their condensed derivative phenolic acids (i.e., ferulic acid, isoferulic acid, caffeic acid) which are referred to as cimicifugic acids (see Figure 11). These compounds are thought to be significant contributors to the prevention of ovarian cysts by acting upon the estrogen receptor α (ERα) in the hypothalamus and pituitary glands. Specifically, in the pituitary gland, the binding of cimicifugic acid to the ERα decreases the secretion of luteinizing hormone (LH). Studies have also shown that flavonoid compounds in CIMICAFUGA have also resulted in decreased LH levels in circulation and improved pregnancy outcomes for women who were treated with clomiphene. For example, 14 of 21 women who received clomiphene treatment have become pregnant within their first menstrual cycle following the use of black cohosh as part of their fertility treatment[27].

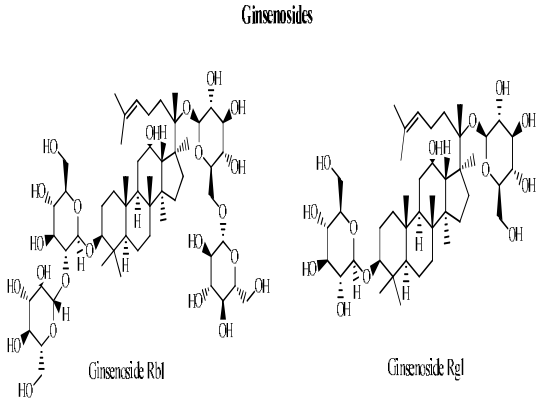


Figure 11. *Phenylpropanoids present in Cimicifuga racemosa.*

### 4.3.4. Pimpinella anisum L

Anise is a member of the family Apiaceae and is known by its scientific name, Pimpinella anisum. The nutritional values of anise are approximately 9% moisture, 35% sugars, 18% protein, 16% lipids, 7% ash, 5% starch, 12% - 25% crude fiber and 2% - 7% essential oil[28]. In addition to oils, anise also contains oleoresin (a yellow-green to orange-brown) and other substances (derived from the source of its essential oils) that belong to this family. These include trans-anethole (approx 90%), anisketone, anisaldehyde and methyl chavicol; other minor compounds can be categorized as γ-himachalene (2-4%), trans-pseudo-isoeugenol 2-methylbutyrate (1.3%), p-anisaldehyde (1%) and methyl chavicol (from 0.9-1.5%). (Figure 12)[29].

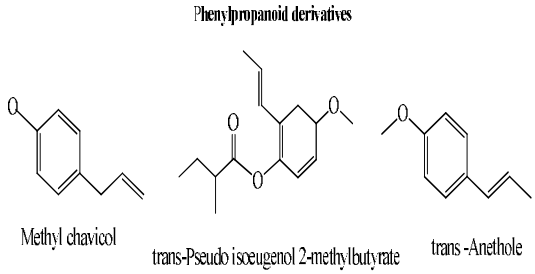


Figure 12. ***Phenylpropanoid compounds found in* Pimpinella anisum *L. that exhibit anti-PCOS activity.***

### 3.4.5. Trigonella-foenum-graecum

Trigonella foenum-graecum has several common names, including fenugreek, and is in the family of plants known as Fabaceae. The seeds of fenugreek contain roughly 8% to 10% moisture, 45% in carbohydrates, 15% to 28% in

proteins, 6% to 12% in lipids, 4%-8% in ash, and 8%-16% from dietary fibre, with 0.2 - 0.3% classified as essential oils[30]. The seed oil contains many bioactive constituents that have been shown to inhibit ovarian cyst formation, including β-pinene, caryophyllene, camphor and neryl acetate (Figure 13). The volatile oils also exhibit high concentrations of sesquiterpenes, n-alkanes, and a wide variety of oxygenated compounds[31].

Fenugreek seeds are an excellent source of numerous bioactive phytochemicals, including phytosterols, terpenoids and several flavonoids such as naringenin, saponaretin, lyin, kaempferol, isovitexin, orientin, vitexin, isoorientin, luteolin and quercetin, as well as alkaloids such as choline, trigonelline and carpaine. Moreover, fenugreek seeds contain significant amounts of a saponin, including fenugrin, foenugracin, trigonoesides, glycosides, yamogenin, smilagenin, yuccagenin, sarsasapogenin, hederagin, tigonenin and diosgenin[32].

Clinical studies have demonstrated that daily consumption of two fenugreek capsules can effectively reduce PCOS-related symptoms in women[33]. Supplementation over a 90-day period has been shown to decrease ovarian cyst size and overall ovarian volume, lower the LH/FSH ratio, and promote stabilization of the menstrual cycle[34]. Collectively, these findings suggest that fenugreek may play a beneficial role in the management of PCOS[35].

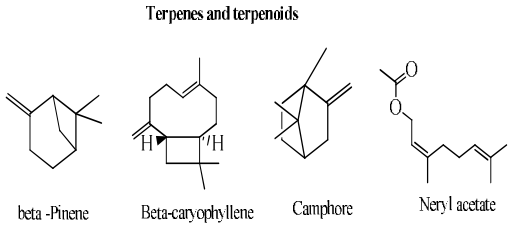


Figure 13. *Terenes and terpenoids compounds found in Trigonella foenum-graecum. that suppress the formation of cyst.*

## 4.5. Effective agents for inducing ovulation.

Infertility or recurrent miscarriages due to poor gestational ability can occur frequently with polycystic ovarian syndrome(PCOS). Consequently, ovulation induction will often be part of the treatment plan for PCOS. Medications such as Tribulus terrestris and Zingiber officinale, two plants that promote ovulation through stimulation, may have a synergistic effect on PCOS.

### 4.5.1. Zingiber officinalis

The plant Zingiber officinale, better known as Ginger, is part of the Zingiberaceae family and its essential oil is made up of approximately 60-65 different biological compounds. The main bioactive chemical compounds found in the oil include geraniol, gingerol, curcumin, α-curcumene, geranial, neral borneol, linalool, sesquiphellandrene, α-farnesene, sabinene, camphene, γ-terpinene and terpinen-4-ol. The resin portion of ginger, the part of the plant that produces the most medicinal effects, contains paradol, zingerol, zingiberene, zingiberone, shogaol, ascorbic acid, β-carotene, p-coumaric acid, and caffeic; and is considered to contain various therapeutic properties useful for the treatment of PCOS primarily through its action on various phenolic and flavonoid compounds36.

The two strongest anti-inflammatory active compounds in ginger, gingerol and shogaol, as well as zingerone, produce anti-prostaglandin effects by inhibiting the production of arachidonic acid (Figure 14)37. Ginger's reputation for improving male reproductive indicators (e.g., increasing serum testosterone levels, increasing testicular and seminal vesicle weights, and improving sperm motility) has been supported by its unique pharmacological profile, which may allow it to regulate the balance of sex hormones by modulating circulating levels of sex hormones, thus ensuring the proper amounts of progesterone and estrogen remain in balance38. Ginger's phytoestrogen compounds support the balance between estrogen and progesterone, indicating their potential value in treating women with polycystic ovarian syndrome39.

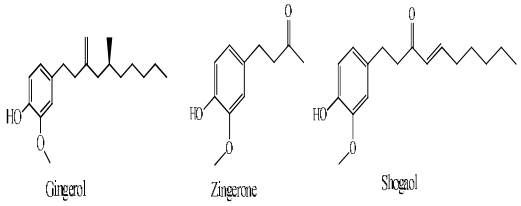


Figure 14. *Resinous constituents of* Zingiber officinalis**.**

### 4.5.2. Tribulus terrestris

Gokharu, or puncture vine, belongs to the Zygophyllaceae family, specifically the genus Tribulus (i.e., Tribulus terrestris). The main groups of compounds found abundantly in Tribulus are flavonoids, such as kaempferol and its derivatives furostanol, saponins; examples of these compounds are tigogenin, diosgenin, gitogenin, hecogenin, neogitogenin, neohecogenin, chlorogenin, ruscogenin, protodioscin, and protogracillin (Figure.15). Saponins isolation from Tribulus have shown to produce hypoglycemic effects[40]. Trials on Tribulus have shown that consuming Tribulus lowers blood cholesterol, triglycerides, and glucose significantly. In addition to supporting ovarian follicle growth and normalizing steroid hormones, Tribulus has been shown to promote normal estrous cycles in females. Due to multiple bioactive components acting as ovarian stimulants and fertility promoting agents, Tribulus is appropriate alternative medicine for women with polycystic ovaries[41].

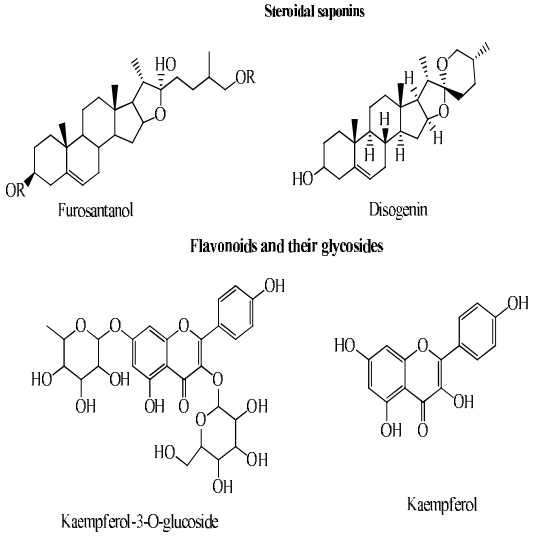


**Figure 15.** ***The saponins and flavonoids found in*** **Tribulus terrestris** ***exert beneficial effects in PCOS by promoting ovulation.***

## 5. CONCLUSION

Women of all ages, from puberty through post-menopause, suffer from Polycystic Ovarian Syndrome (PCOS), which is an endocrine disorder that causes problems with health, metabolism, heart function, and infertility for many years. A large number of women are already using herbal medicine as a natural alternative to pharmaceutical drugs that help manage their symptoms because these medications can be difficult or unwanted to use for long periods of time due to their side effects. This paper provides a review of the major plant constituents found in many different edible plants that may offer relief for women with PCOS and also examines how these plant substances will work to improve hormonal and over-all reproductive health through the use in complementary or alternative healthcare approaches. By exploring these and other natural treatments, we hope to provide some useful knowledge about natural modalities for researchers and healthcare providers to use in the treatment of PCOS.

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