

MEDICINAL PLANTS USED IN THE MANAGEMENT OF POLYCYSTIC OVARY SYNDROME (PCOD)

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Abstract

PCOS or polycystic Ovary Syndrome is also known as polycystic ovarian disease (PCOD) and is a common endocrine disease that afflicts women of the child-bearing age. Diagnosis of the disorder involves the imbalance of hormones, abnormal ovulation, hyperandrogenism and the presence of numerous cysts in the ovaries. Common symptoms of PCOS include irregular menstrual cycles, infertility, obesity, acne, and excessive hair growth (hirsutism). Besides the reproductive issues, PCOS is typically linked with a metabolic disorder comprising insulin resistance, dyslipidemia and increased probability to develop type-2 diabetes and heart diseases. The existing modalities of managing PCOS are largely based on the management of the symptoms with the help of hormonal therapy, insulin-sensitizing drugs as well as lifestyle modification. However, the drugs may be counter-productive in the long-term and may fail to cure the underlying metabolic abnormalities completely. This has also raised more interests in the use of the medicinal plants as alternative/supplementary therapy in the treatment of the PCOS. Medicinal plants have penetrated into the systems in traditional medicine because of their diversity in terms of their pharmacological effects. Endocrine functions, insulin sensitivity, reduction of oxidative stress and normalization of ovarian activity can be controlled by the use of such plants. It is reported that some of the herbs like *Withania somnifera*, *Trigonella foenum-graecum*, *Mentha spicata*, *Glycyrrhiza glabra*, *Linum usitatissimum*, *Nigella sativa* and *Gymnema sylvestre* and *Ocimum sativum* have been found to have a positive effect on the treatment of PCOS. The current review shows the potential pharmacological utility of therapeutic un-modified medicinal plants of interest that can be applied in the treatment of women with PCOS to enhance their reproductive and metabolic health.

Introduction

Polycystic Ovary Syndrome (PCOS), also known as Polycystic Ovarian Disease (PCOD), is a common endocrine disorder affecting women of reproductive age. It is characterized by hormonal imbalance, irregular menstrual cycles, hyperandrogenism, insulin resistance, and multiple ovarian cysts. Infertility, obesity, acne, excessive

body hair (hirsutism) and metabolic problems (type-2 diabetes and cardiovascular diseases) can manifest the condition of PCOS in women. PCOS affects approximately 5–10% of women of reproductive age worldwide, and hence a significant public health problem [1]. Although the exact pathophysiology of PCOS remains unclear, it

is believed to involve a combination of genetic, hormonal, metabolic, and environmental factors. but it is assumed that a combination of genetic predisposition, insulin resistance, hormonal imbalance, lifestyle changes, stress and obesity may be factors that lead to development of PCOS. The conventional treatments to PCOS involve hormonal treatment, insulin-sensitizing treatment, and ovulation-stimulating treatment. These medications can put under control the symptoms, however, they have a great number of negative consequences when used in the long-run. Consequently, many women seek complementary and alternative therapies, particularly herbal medicines, for the long-term management of PCOS. [2]. Medicinal plants have been used in the traditional medicine system such as Ayurveda, Unani or Traditional Chinese Medicine since ancient times in the treatment of female reproductive disorders. Medicinal plants contain numerous bioactive compounds with antioxidant, anti-inflammatory, antidiabetic, and hormone-regulating properties. Herbal medicines may help regulate menstrual cycles, improve ovarian function, reduce insulin resistance, and restore hormonal balance, enhancing ovarian activity, decreasing insulin resistance and the hormonal

balance, and without any serious side effects [3]. A number of medicinals were reported to help in the management of PCOS. These include *Withania somnifera*, *Trigonella foenum-graecum*, *Mentha spicata*, *Glycyrrhiza glabra*, *Linum usitatissimum*, *Nigella sativa*, *Gymnema sylvestre* and *Ocimum sanctum*. The herbs have been referred to improve metabolism, functioning of the endocrine system as well as reproductive health in the women with PCOS patients [4]. Scientific research has paid more emphasis on assessing the pharmacological characteristics of medicinal plants with PCOS treatment in the past few years. A number of experimental and clinical researches have shown that the herbal preparations can be very efficient in lowering the level of androgens, enhancing the insulin sensitivity, as well as stimulating ovulation. Medicinal plants are also promising alternative or complementary therapeutic options or drugs in the treatment of PCOS due to its multidrug effect and comparative low toxicity [5]. Thus, the current review underlines the importance of the chosen medicinal plants in the treatment and management of PCOS, their possible mechanism of action, and the advantages of medicinal plants in the improvement of the reproductive health of females.

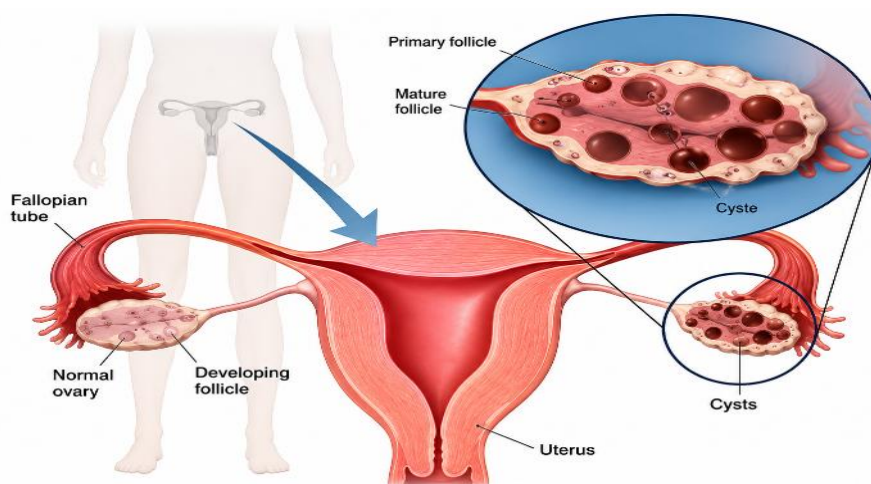


Figure 1. Internal morphology of polycystic ovaries

Etiology

Polycystic Ovary Syndrome (PCOS), also polycystic ovarian disease (PCOD) is a complicated endocrine disease affecting reproductively active women. It is coupled with hormonal disturbance, abnormal ovulation, hyperandrogenism and the occurrence of multiple cysts in the ovaries. Although the exact etiology of PCOS remains unclear, genetic, metabolic, hormonal, and environmental factors are believed to contribute to its development. Insulin resistance is considered one of the major contributors to PCOS, wherein body tissues exhibit a reduced response to insulin. As a compensatory mechanism, the pancreas secretes higher amounts of insulin to maintain normal blood glucose levels. Elevated insulin levels stimulate ovarian theca cells to produce excessive androgens, contributing to hyperandrogenism (male hormones) that distort the usual growth and ovulation of follicles [6]. The genetic predisposition is another factor that is of importance in development of PCOS. The Women with a family history of PCOS, type 2 diabetes mellitus, or metabolic disorders have a higher risk of developing the syndrome. Some genetic variations with references to insulin metabolism and regulation of hormones are considered as contributing to the pathogenesis of PCOS. Hormonal dysregulation also plays a crucial role in the pathogenesis of PCOS. An increased LH-to-FSH ratio disrupts normal follicular development and ovulation. The hormonal imbalance leads to anovulation and formation of many incomplete follicles in the ovaries. In addition to these, Lifestyle factors such as obesity, unhealthy dietary habits, physical inactivity, and chronic stress may aggravate insulin resistance and hormonal imbalance, thereby increasing the risk of PCOS.[7].

Pathophysiology

The pathophysiology of PCOS involves complex interactions among the hypothalamus, pituitary gland, ovaries, pancreas, and adrenal glands, affecting both reproductive and metabolic functions. Under normal physiological conditions, gonadotropin-releasing hormone (GnRH) secreted by the hypothalamus stimulates the anterior pituitary gland to release follicle-stimulating hormone (FSH) and luteinizing hormone (LH). These hormones control the development and ovulation of the ovaries. Normal secretion of GnRH is disturbed in women with PCOS. In women with PCOS, altered GnRH pulsatility results in increased LH secretion and relatively decreased FSH secretion. Elevated LH levels stimulate ovarian theca cells to produce excessive amounts of androgens, particularly testosterone. Excess androgen production impairs follicular maturation and inhibits normal ovulation [8]. The resistance to insulin is also added to the pathophysiology of PCOS. Hyperinsulinemia enhances ovarian androgen synthesis and suppresses hepatic production of sex hormone-binding globulin (SHBG), thereby increasing circulating free androgen levels. This causes the amount of the free circulating androgens in the blood to increase. Impaired follicular development results in the accumulation of multiple immature follicles within the ovaries, producing the characteristic polycystic ovarian morphology. These follicles manifest themselves in the form of a number of cysts that are evenly distributed along the ovarian surface that is one of the characteristic peculiarities of PCOS [6]. Chronic low-grade inflammation and oxidative stress are increasingly recognized as important contributors to the pathogenesis of PCOS. These aspects can also increase the problem of metabolic

imbalances and reproductive failure in the affected people [9].

Symptoms

- PCOS has diverse clinical manifestations in women. Some of them can be experiencing mild symptoms, whereas others might develop serious reproductive and metabolic problems.
- Irregular menstrual cycles fall under the category of one of the most prevalent PCOS symptoms. Oligomenorrhea (infrequent menstruation) or amenorrhea (lack of menstruation) can be observed in women with PCOS because of irregular ovulation [6].
- The other symptom is hyperandrogenism, which is caused by a high level of male hormones. This disorder can lead to too much hair on the face, chest, or abdomen (hirsutism), acne, and loss of scalp hair [7].
- Many women with PCOS are also infertile since they find it hard to conceive due to irregular ovulation. The fact that there are several cysts on the ovary also disrupts normal ovary functioning [8].
- PCOS is often connected with weight gain and obesity especially in abdomen. Obesity increases the level of insulin resistance and hormonal imbalance which could further complicate the symptoms of the disorder. Other symptoms can be pelvic pains, fatigue, mood-alterations, depression, anxiety, and sleeping problems.
- PCS women are also more prone to developing metabolic disorders which include diabetes type 2, hypertension and heart diseases [10].

Mechanism of medicinal plants in the management of PCOD

Polycystic Ovary Syndrome (PCOS) is characterized by several metabolic and hormonal abnormalities, including insulin resistance, hyperandrogenism, chronic inflammation, and oxidative stress. Medicinal plants exert therapeutic effects through multiple mechanisms that regulate endocrine and metabolic functions associated with PCOS. Improvement of insulin sensitivity is one of the primary mechanisms through which medicinal plants help manage PCOS. The role of insulin resistance in PCOS pathogenesis is important since the high level of insulin induces ovarian androgen synthesis and interrupts the normal ovulation. Many medicinal plants improve glucose metabolism and enhance insulin sensitivity, thereby reducing hyperinsulinemia. The other mechanism is the mechanism of hormonal balance regulation. Several medicinal plants help regulate the hypothalamic–pituitary–ovarian (HPO) axis, thereby maintaining hormonal balance. such as follicle-stimulating hormone (FSH), luteinizing hormone (LH) and estrogen and progesterone. These plants help normal growth of the follicles and ovulation by restoring the hormonal balance and hence regulate ovulation and menstrual cycle in PCOS women thus improving fertility [11]. The antiandrogenic activity is also antiandrogenic in nature and it is exhibited by medicinal plants which are used in the suppression of high levels of androgens. Hyperandrogenism is a major characteristic of PCOS, and it leads to the symptoms of hirsutism, acne, and irregular menstruation. Some herbs can suppress androgen synthesis or prevent androgen receptors which suppress the impact of too much male hormone and enhances the sex life. Another mechanism of importance is their antioxidant property. Women

with PCOS can easily develop augmented oxidative strain due to metabolic disturbances. Antioxidant compounds are also found in the medicinal plants and are used to counter the effect of free radicals, to maintain the ovarian tissues and to maintain the overall functioning of the cell. Majority of the medicinal plants are also anti-inflammatory in addition to being an antioxidant. Low grade chronic inflammation was also found to be significant contributor of the development and progression of PCOS. Herbal medicine helps in reducing inflammatory mediators thus improving metabolic health, and normal ovary functioning [12]. Medicinal plants are also available that help in

controlling the lipid metabolism and body weight that is significant in managing PCOS. PCOS is typically associated with obesity and can lead to a higher level of insulin resistance and hormonal imbalance. The symptoms of weight and PCOS can be managed using herbal remedies which increase metabolism and reduce lipid accumulation [13]. Altogether, medicinal plants perform various pharmacological activities like enhancing insulin sensitivity, hormonal, antiandrogenic, antioxidant and anti-inflammatory actions. The effects of these combined to restore endocrine balance, ovulate and enhance reproductive and metabolite health in women with PCOS.

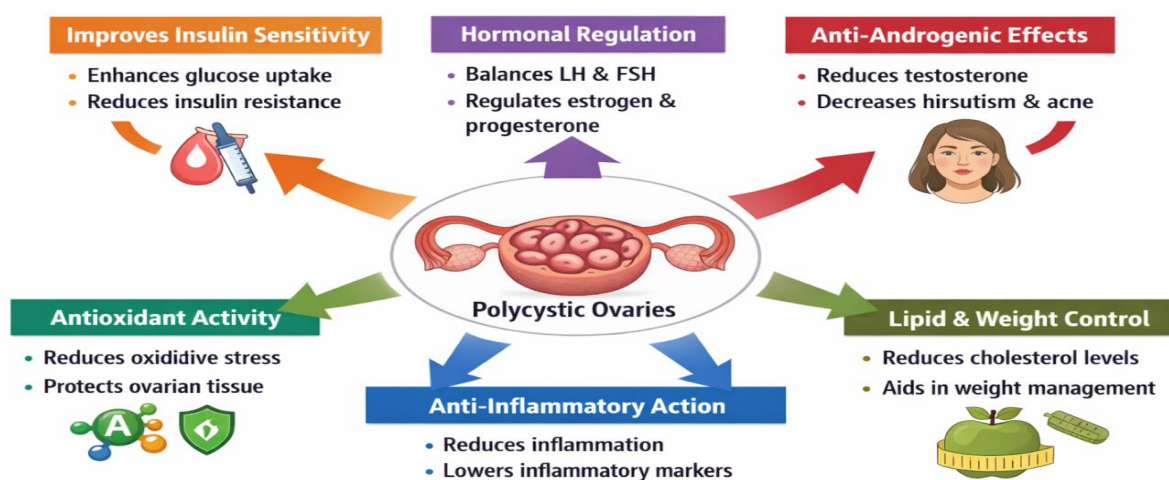


Figure 2. Mechanism of medicinal plant in the management of PCOS

Ayurvedic herbal remedies for PCOS

The Ayurvedic medicine works on the multifaceted approach to Correct the hormonal balance, Treat obesity and prevent a high cholesterol level, Treat insulin resistance. To allow the menstrual cycle to occur in a more normal manner, the objective of herbal treatment is to allow the body to readjust the excess hormone ratio to more normal levels [14]. These are alkaloids, cardiac glycosides,

anthraquinones, flavonoids, mucilage, and enzymes which are all present in herbs and possess diverse pharmacological initiatives. These herbs may be used as an individual treatment or a combination in the treatment of PCOS. A few of the botanicals and commercial preparations are mentioned in this article [14].

1. Spearmint

- **Synonyms:** Garden mint, Common mint, Lamb mint, Pudina (Hindi)

- **Biological source:** Spearmint consists of the fresh or dried leaves of *Mentha spicata*.
- **Family:** Lamiaceae.



Figure 3. Spearmint (*Mentha spicata*)

Description and Role in PCOD:

Mentha spicata (Spearmint) is a medicinal herb with a wide range of therapeutic applications due to the presence of numerous bioactive compounds such as flavonoids, rosmarinic acid, carvone and essential oils. Due to their potent antioxidant, anti-inflammatory and anti-androgenic activity, it is a promising plant used as a complementary therapy for the management of Polycystic Ovary Syndrome (PCOS) [15]. One of the key clinical symptoms of PCOS is hyperandrogenism, which means elevated androgen levels, most specifically elevated testosterone levels, resulting in symptoms of hyperandrogenism (hirsutism, acne, and menstrual irregularities). Experimental and clinical studies have shown that the extract of *Mentha spicata* has anti-androgenic activity that can lower serum free testosterone levels and thus promote hormonal balance in women suffering from PCOS. Furthermore, it has antioxidant effects that can help to lower oxidative stress, and its anti-inflammatory properties can help to reduce chronic low-grade inflammation that is often seen in PCOS. Moreover, *Mentha spicata* has been shown to

enhance insulin sensitivity and glucose metabolism, which may help to maintain metabolic homeostasis in women with PCOS. According to a clinical study by Akdoğan et al., women with PCOS who consumed spearmint tea twice a day had a significant decrease in free testosterone concentration, which led to improvements in the levels of luteinizing hormone (LH) and follicle-stimulating hormone (FSH). Based on these findings, spearmint supplementation could be beneficial for women suffering from PCOS, as it could balance hormones and alleviate hyperandrogenic symptoms [16]. From the above, it is evident that *Mentha spicata* is a potential complementary therapeutic agent that can be used for the management of PCOS due to their anti-androgenic, antioxidant, anti-inflammatory, metabolic regulatory properties. Overall, *Mentha spicata* appears particularly effective in reducing hyperandrogenism and improving hormonal balance, making it one of the most promising complementary herbal therapies for PCOS.

2. Black cumin

- **Synonyms:** Black seed, Kalonji (Hindi), Habbatul Barakah, Black caraway
- **Biological Source:** Dried ripe seeds of *Nigella sativa* L.

- **Family:** Ranunculaceae



Figure 4. Black cumin (*Nigella sativa*)

Description and Role in PCOD:

Nigella sativa (Black cumin) is a medicinal plant of great value that has been used traditionally in the treatment of many metabolic, endocrine and reproductive disorders. The chemical composition of the seeds is complex, with various bioactive compounds present, such as thymoquinone, thymohydroquinone, nigellidine, nigellicine, alkaloids, saponins, and fixed oils containing linoleic and oleic acids, which are responsible for the wound healing effect of the seeds [17]. Polycystic Ovary Syndrome (PCOS) is a complex syndrome of insulin resistance, hyperandrogenism, chronic low-grade inflammation and oxidative stress. Due to its pharmacological activities against multiple targets, *Nigella sativa* is receiving great interest as a complementary therapeutic agent for PCOS treatment. Thymoquinone, the main bioactive compound in *Nigella sativa*, has potent anti-inflammatory properties, which inhibit the production of pro-inflammatory cytokines such as tumor necrosis factor alpha (TNF- α) and interleukin-6 (IL-6) and thus alleviate the chronic inflammatory condition characteristic of PCOS [18]. In women with PCOS, oxidative stress is an

important factor that contributes to ovarian dysfunction and follicular arrest. *N. sativa* has strong antioxidant properties that activate the endogenous antioxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx). Such antioxidant properties can help to prevent oxidative damage to ovarian tissue, facilitate follicular development and enhance ovarian function [19]. Insulin resistance is a key hallmark of PCOS that plays a role in hyperandrogenism and metabolic dysfunction. Experimental and clinical studies have shown that *Nigella sativa* enhances insulin sensitivity, lowers the blood sugar and levels of glycosylated hemoglobin (HbA1c), and has beneficial effects on lipids, including a reduction in total cholesterol, triglycerides, and low-density lipoprotein (LDL) cholesterol, with an increase in high-density lipoprotein (HDL) cholesterol. Such metabolic changes can decrease the chances of developing type 2 diabetes mellitus and cardiovascular problems often seen in PCOS. Further experimental studies using Letrozole induced PCOS model in female Wistar rats have also shown that *Nigella sativa* extract has the ability to decrease the circulating level of testosterone, restore the balance

of Luteinizing hormone (LH) and Follicle-stimulating hormone (FSH), normalize estrous cycle and normalize the ovarian histopathology. Other studies have also shown similar therapeutic effects to that of traditional therapies including clomiphene citrate, but more evidence is needed to confirm this [20]. In conclusion, *Nigella sativa* is a potential complementary therapeutic agent for the

treatment of PCOS, given its anti-inflammatory, antioxidant, antihyperglycemic, antihyperlipidemic and hormone-regulating properties. The broad antioxidant, anti-inflammatory, and insulin-sensitizing actions of *Nigella sativa* make it a valuable herbal candidate for improving both metabolic and reproductive abnormalities associated with PCOS.

3. Aloe

- **Synonym(s):** *Aloe barbadensis* Mill, *Aloe indica* Royle
- **Biological Source:** The biological source is the dried juice from the leaves of various Aloe species.
- **Family:** Asphodelaceae (formerly Liliaceae).



Figure 5. Aloe

Description and Role in PCOD:

Aloe vera (*Aloe barbadensis*) Miller is a perennial medicinal plant with antioxidant, anti-inflammatory, antidiabetic and wound healing properties, which is used in traditional and complementary medicine around the world. The leaves are filled with a clear gel with bioactive contents, such as polysaccharides (acemannan, glucomannan and mannose derivatives), amino acids, minerals, enzymes, sterols, phenolic compounds, tannins and salicylic acid which account for its multiple pharmacologic effects [21]. Recent research has shown that Aloe vera could be beneficial in the management of Polycystic Ovary Syndrome (PCOS). Experimental studies have

shown that A. vera gel is beneficial in improving ovarian steroidogenesis, restoring ovarian hormonal balance, improving ovarian folliculogenesis, and improving ovarian morphology in letrozole induced PCOS rat model. These positive effects are mainly due to its phytosterols, polyphenols and antioxidant properties, which help to mitigate oxidative stress and to enhance ovarian function. Furthermore, it is reported that Aloe vera has positive effects on glucose metabolism and insulin sensitivity (which causes a decrease in hyperinsulinemia) one of the major pathological characteristics of PCOS [21]. The effects of the hydroalcoholic extract of Aloe vera on PCOS rats induced by estradiol valerate were also investigated. The serum estrogen level

was significantly decreased, serum progesterone was increased, the ovarian biochemical activity was improved, and the histological structure of the ovary was improved than the PCOS animals when treated with Aloe vera extract. The results indicate that the use of Aloe vera can be beneficial for regulating steroid hormone biosynthesis and ovarian physiology, thus affecting endocrine function and reproductive health [22]. In

conclusion, Aloe vera is a promising complementary therapeutic agent for the management of PCOS due to its antioxidant, anti-inflammatory, antidiabetic, and hormone-regulating effects. Presently, however, the evidence is mostly experimental animal studies. Current evidence suggests that *Aloe vera* may improve ovarian function and insulin sensitivity, supporting its potential role as an adjunctive therapy for PCOS

4. Saw palmetto

- **Synonyms:** Shrub palmetto, Juzhong, and palmier
- **Biological source:** Saw palmetto is a botanical extract that comes from the fruit of the *Serenoa repens* palm tree, which is native to the southeastern United States
- **Family:** Palm family (Arecaceae)



Figure 6. Saw palmetto

Description and Role in PCOD:

Saw Palmetto (*Serenoa repens*) has gained significant popularity as a herbal medicine with anti-androgenic, anti-inflammatory and antioxidant properties. Due to its hormone-modulating effects, it has been widely researched for the management of androgen-related disorders and is currently being investigated as a complementary therapeutic agent for Polycystic Ovary Syndrome (PCOS) management [23]. One of the most important clinical manifestations of PCOS is hyperandrogenism, which can manifest itself in the form of hirsutism, acne, irregular menses, and anovulation, among other ailments. Experimental research indicates that 5 α -reductase activity is

suppressed in the presence of *Serenoa repens*, which could minimize the conversion of testosterone to dihydrotestosterone (DHT) and hence affect androgen activity. This mechanism can contribute to normalize hormonal levels, enhance the functionality of the ovulation and reduce the symptoms of hyperandrogenism in women with PCOS [24]. *Serenoa repens* is also anti-androgenic and has strong antioxidant, anti-inflammatory effects, which could help, to some extent, to decrease oxidative stress and chronic inflammation, both of which have been implicated in the pathogenesis of PCOS. Saw palmetto has also been shown to have a beneficial effect on the

morphology of the ovary through a reduction of follicular cyst formation and supporting normal follicular development in animal studies. Additionally, it has been suggested that modulation of prolactin receptor signaling and intracellular pathways is involved in the protective actions of prolactin on ovarian function [25]. In summary, the

beneficial anti-androgenic, antioxidant, and anti-inflammatory effects of *S. repens* make it a promising complementary treatment for PCOS. The anti-androgenic activity of *Serenoa repens* may provide particular benefits for women with hyperandrogenic symptoms of PCOS, although current evidence remains limited.

5. Berberine

- **Synonyms:** Berberina, Umbellatine.
- **Biological source:** Berberine (BBR) is a phytochemical alkaloid that can be isolated from many vegetable species including barberry (*Berberis*), meadow rue (*Thalictrum*), celandine (*Chelidonium*), goldenseal (*Hydrastis canadensis* L.), and *Phellodendron amurense*.
- **Family:** Berberidaceae



Figure 7. Berberine plant parts

Description and Role in PCOD:

Berberine is an isoquinoline alkaloid that is naturally occurring and found in a variety of medicinal plants, such as *Berberis vulgaris*, *Coptis chinensis*, and *Berberis aristata*. The antidiabetic, anti-inflammatory, antioxidant, hypolipidemic and hormone regulating properties have garnered it a lot of interest as a possible complementary therapeutic intervention for the treatment of Polycystic Ovary Syndrome (PCOS) [26]. Insulin sensitivity, glucose metabolism and insulin resistance are all impaired in PCOS; experimental and clinical studies have shown the beneficial effect of berberine on all three of these. Furthermore, berberine is reported to have beneficial effects on lipid metabolism, oxidative

stress, and chronic inflammation, which helps to maintain metabolic homeostasis in women with PCOS. In addition, there is clinical evidence that berberine can lower the serum level of free testosterone and free androgen index while simultaneously raising the level of sex hormone-binding globulin (SHBG) which can help improve hyperandrogenic symptoms like acne and hirsutism. Rondanelli's clinical study demonstrated that berberine was effective in improving the hormonal profile and decreasing the severity of acne in women with PCOS, which suggests that berberine can be used to treat hyperandrogenism [27]. High blood levels of the hormones testosterone, androstenedione, and dehydroepiandrosterone sulfate (DHEAS) are

characteristic of PCOS. Ovarian dysfunction and follicular arrest is caused by increased androgen production along with insulin resistance and hyperinsulinemia. Experimental research has indicated that berberine might inhibit the production of androgens by regulating ovarian steroidogenesis and insulin sensitivity, as well as by regulating androgen receptor-mediated signaling pathways. Such pharmacologic effects might help with better ovarian function, restoration of

ovulation and normal menstrual cycles in women with PCOS [28]. In conclusion, Berberine is a potent complementary drug for the management of PCOS due to its insulin-sensitizing, anti-inflammatory, antioxidant, hypolipidemic and anti-androgenic effects. Among the medicinal agents reviewed, berberine demonstrates some of the strongest evidence for improving insulin resistance, lipid metabolism, and endocrine function in women with PCOS.

6. Ginger

- **Synonyms:** Rhizoma zingiberis, *Zingiber officinale*, Ginger
- **Biological source:** The ginger is the rhizomes of *Zingiber officinale*, Roscose are dried in the sun.
- **Family:** Zingiberaceae



Figure 8. Ginger

Description and Role in PCOD:

Zingiber officinalis which is also known as ginger. Ginger contains more than 60 bioactive compounds, including gingerol, shogaol, and zingerone, which contribute to its pharmacological activities. The most active are zingiberone, shogaol and caffeic acid- phytochemicals. Ginger also contains phenolics. flavonoids found to be helpful in the PCOS. Gingerol, shogaol, zingerone and a small portion resin of oily kind. ginger also has antioxidants of high strength. an anti-prostaglandin effect by inhibiting the production of prostaglandins and suppressing the production of

arachidonic acid. The weight of the testes, the number of testes and seminal vesicles, the motility of male sperm in serum, the fertility index and the ginger will raise the amount of testosterone in the serum. Their own are the ginger flavonoid and phenolic constituents. are drug and physiological and perhaps. observes blood sex hormones and helps in the progesterone-estrogen homeostasis. Phytoestrogen of ginger can cure PCOS and create a pro-esterone ratio of progesterone to estrogen [29].

7.TURMERIC

- **Synonyms:** *Curcuma domestica*, Saffron Indian, and Haldi (Hindi).

- **Biological source:** Turmeric comes from the dried rhizome of the *Curcuma longa* plant.
- **Family:** Zingiberaceae



Figure 9. Turmeric (*Curcuma longa*)

Description and Role in PCOD:

The *Curcuma longa* L., commonly known as Turmeric, is a medicinal plant with antioxidant, anti-inflammatory, antidiabetic, hypoglycaemic and hypolipidemic activity, and is widely used in traditional medicine. The main bioactive compound of *C. longa*, curcumin, has been a subject of intensive research for its therapeutic benefits in the treatment of a variety of metabolic and inflammatory diseases, including Polycystic Ovary Syndrome (PCOS) [30]. While curcumin is not a cure for PCOS, there is emerging evidence that it may alleviate some metabolic and reproductive abnormalities associated with PCOS. Curcumin has strong anti-inflammatory and antioxidant properties, which can help decrease oxidative stress and chronic inflammation, which are major factors in the development of PCOS. Curcumin further has been documented to enhance insulin sensitivity, control glucose metabolism and decrease the levels of fasting blood glucose, which helps lower the risk of insulin resistance and type 2 diabetes mellitus in women with PCOS [31]. Experimental, further

studies have also shown the therapeutic potential of curcumin for PCOS. The effects of the use of curcumin were compared with clomiphene citrate in a study by Reddy et al. (2016) in which female Wistar rats were made with PCOS by using letrozole. Fasting blood glucose, glycated hemoglobin (HbA1c), lipid profile and antioxidant enzyme activities (superoxide dismutase and catalase) were measured biochemically. Administration of curcumin significantly lowered the levels of fasting blood glucose, HbA1c, restored lipid homeostasis, enhanced antioxidant profile and normalized serum sex hormones levels, thus favoring the metabolic and reproductive effects in PCOS-induced rats [32]. The overall picture of *Curcuma longa* is that it is a promising complementary therapeutic agent for PCOS due to its antioxidant, anti-inflammatory, hypoglycemic, and insulin-sensitizing properties. Curcumin may offer significant protection against oxidative stress and chronic inflammation, two major contributors to the pathophysiology of PCOS.

8. Pomegranate (*Punica granatum*)

- **Synonym(s):** *Punica granatum* L
- **Biological source:** The pomegranate (*Punica granatum*) is a deciduous shrub or small tree.
- **Family:** Punicaceae



Figure 10. Pomegranate (*Punica granatum*)

Description and Role in PCOD:

Punica granatum L. (Pomegranate) is a medicinal plant that is well known as a nutritive and therapeutic plant. It is packed with antioxidants, anti-inflammatory, hypoglycemic and cardioprotective properties due to its rich content of polyphenols, flavonoids, tannins, anthocyanins, punicalagins, ellagic acid, vitamins (B1, B2, C, folic acid), organic acids and essential fatty acids. This pharmacological property has gained significant attention about the possible usage of it in the treatment of Polycystic Ovary Syndrome (PCOS) [33]. Experimental investigations with PCOS induced animal models have shown that the *Punica granatum* extract can normalize the hormonal imbalance by decreasing the level of free testosterone, androgen and androstenedione in the bloodstream and increasing the level of estrogen to normal concentrations. Phytosterols and polyphenolic compounds might play a role in regulation of endocrine function and enhancing ovarian physiology, which could reduce

reproductive abnormalities that are linked to PCOS [34]. Additionally, the antioxidant and anti-inflammatory activity of *Punica granatum* decreases the oxidative stress and chronic inflammation, which play a role in the pathogenesis of PCOS. Moreover, pomegranate has been reported to positively affect on the regulation of lipid metabolism, glycemic control, and cardiovascular health, thereby decreasing the risk of metabolic complications of PCOS such as insulin resistance, dyslipidaemia, hypertension, and type 2 diabetes mellitus [35]. In general, *Punica granatum* is a superior complementary therapeutic agent for PCOS due to its antioxidant, anti-inflammatory, hypoglycaemic, cardioprotective and hormonal regulating properties. Obviously, more well-designed, large, controlled clinical trials are needed to confirm its safety, efficacy, long-term duration of action and mechanism of action in routine clinical use in women with PCOS.

9. Maca (*Lepidium meyenii*)

- **Synonyms:** *Lepidium peruvianum*, Ayak Chichira, Maka
- **Biological source:** Maca is a herbaceous biennial plant that grows at elevations of 13,000–14,800 feet. Maca's fleshy hypocotyl is fused with a taproot, and it's typically dried and used as a powder or flour.
- **Family:** Brassicaceae

**Figure 11. Maca (*Lepidium meyenii*)****Description and Role in PCOD:**

The medicinal plant *Lepidium meyenii* (Maca), a member of the family Brassicaceae, has been traditionally used to boost reproductive health, energy and overall wellbeing. The roots of *L. meyenii* have several bioactive constituents such as macamides, macaenes, glucosinolates, flavonoids, sterols and polyphenols, responsible for its various pharmacological properties. Maca has been recognized for its adaptogenic and endocrine regulating properties and as a possible complementary therapeutic material for the treatment of Polycystic Ovary Syndrome (PCOS) [36]. Based on experimental research, *Lepidium meyenii* can be suggested as a modulator of the hormone activities and a support for reproductive function, which is a part of endocrine homeostasis maintenance. The mechanism by which Maca

works has not been completely understood, but it is known that it affects the hypothalamic–pituitary–gonadal (HPG) axis which is of great importance in the regulation of reproductive hormones. These effects can lead to better ovarian function, regular periods and fertility in women suffering from PCOS. Furthermore, its antioxidant and adaptogenic effects can also contribute to the body's ability to manage its response to physiological stressors, and potentially support women with PCOS symptoms indirectly. In conclusion, *Lepidium meyenii* shows potential as a complementary therapeutic agent for managing PCOS, thanks to its endocrine-modulating, antioxidant, and adaptogenic effects. Although clinical evidence is still limited, *Lepidium meyenii* shows promise in supporting endocrine homeostasis and female reproductive health.

10. Flax seed

- **Synonym:** Linseed or oilseed flax.
- **Biological source:** Linseed is dried, ripe seed of *Linum usitatissimum* Linn. Linseed oil is obtained by expression of linseeds.
- **Family:** Linaceae



Figure 12. Flax seed**Description and Role in PCOD:**

Linum usitatissimum L. (Flaxseed) is a medicinal plant well known due to its nutritional and therapeutic value, and it has been widely used in traditional and modern medicine. Flaxseed is rich in antioxidants, anti-inflammatory, hypolipidemic, and hormone modulating properties due to its content of lignans, α -linolenic acid (ALA), dietary fibre and polyunsaturated fatty acids. Because of these pharmacological effects, *L. usitatissimum* is currently gaining increased interest as a therapeutic complementary alternative for treating Polycystic Ovary Syndrome (PCOS) [38]. Studies have indicated that flaxseed may help alleviate several reproductive and metabolic abnormalities that are found with PCOS. Fatima et al. conducted an interventional study in an open label design, in which female PCOS patients were supplemented with flaxseed for 3 months, which resulted in a decrease in the volume of the ovary and the number of follicles, suggesting a positive effect on the morphology of the ovary [38]. Furthermore, a study with a 41-year-old woman with PCOS found that taking 40 g of flaxseed daily for 4 months led to

substantial decrease in free and total serum testosterone levels, fasting insulin levels and body mass index (BMI). The participant also had significant reduction in hirsutism, which indicated improvements in hyperandrogenism and metabolic health [39]. The positive effects of the use of **Linum usitatissimum** are mainly due to its phytoestrogenic, antioxidant, and anti-inflammatory effects, which can positively affect insulin sensitivity, lipid metabolism, reducing oxidative stress, and normalize hormonal balance. Pharmacological effects could help enhance ovarian function, regularity of the menstrual cycle and general reproductive health in women suffering from PCOS. In general, *Linum usitatissimum* is considered as a promising complementary treatment for PCOS due to its antioxidant, anti-inflammatory, hypolipidemic and hormone balancing effects. Flaxseed supplementation may serve as a beneficial nutritional strategy for improving hormonal balance and metabolic health in women with PCOS.

11. Shatavari (*Asparagus racemosus*)

- **Synonym(s):** Asparagu, Satmuli, Sukshma Patra, Pivari, Indivari, Abhiru, Bahumula, and Jatamula.
- **Biological source:** *Asparagus racemosus* commonly known as Shatavari or Kurilo is a spinous shrub with tuberous roots found commonly in the tropical and subtropical regions
- **Family:** Liliaceae



Figure 13. Shatavari (*Asparagus racemosus*)**Description and Role in PCOD:**

Asparagus racemosus L. commonly known as Shatavari is a well recognised medicinal plant and has been used extensively in the Ayurvedic system of medicine for the treatment of female reproductive, hormonal and endocrine disorders. The dried roots of *Asparagus racemosus* possess multiple active compounds such as steroidal saponins (shatavarins), flavonoids, alkaloids and phytoestrogens, responsible for its wide range of pharmacological effects. Due to its phytoestrogenic, anti-inflammatory, antioxidant, and adaptogenic properties, *Asparagus racemosus* has been the subject of interest as a complementary therapeutic agent for the management of Polycystic Ovary Syndrome (PCOS) [40]. Research and medical experiences indicate that the consumption of *Asparagus racemosus* can help manage hormonal levels, enhance ovarian function, stimulate follicular development, and encourage menstrual regularity in women suffering from PCOS. Furthermore, it is suggested that its phytoestrogenic activity can play a role in maintaining the balance of the endocrine system and the insulin-modulating activity could positively impact insulin sensitivity

and hyperinsulinemia, which are pathological processes that are significant in the development of PCOS. The plant's antioxidant and anti-inflammatory properties could also help to alleviate oxidative stress and chronic inflammation linked to the condition. Moreover, *Asparagus racemosus* has been used in the past to supplement female reproductive health and help regulation of uterus, reproductive health and menstruation ailments. The adaptogenic function can also alleviate stress, a factor that can worsen hormonal imbalance in women with PCOS. The synergistic pharmacological activities indicate that *Asparagus racemosus* could be beneficial for reproductive and metabolic well-being. In conclusion, due to its phytoestrogenic, antioxidant, anti-inflammatory, adaptogenic, and hormone-regulating properties, *asparagus racemosus* emerges as a promising complementary therapeutic agent for treating PCOS. Additional well-designed, large, randomized controlled clinical trials are needed, however, to define its long-term safety, efficacy, optimal dosage, and mechanisms of action, before its use in women with PCOS can be recommended [41].

12. Gymnema (*Gymnema sylvestre*)

- **Synonym(s):** Gurmar, Madhunashini, Meshashringi
- **Biological Source:** It consists of the dried leaves of *Gymnema sylvestre* (Retz.) R.Br. ex Sm., a perennial woody climber widely distributed in the tropical forests of India, Africa, and Australia.
- **Family:** Apocynaceae (formerly Asclepiadaceae)

**Figure 14. Gymnema (*Gymnema sylvestre*)****Description and Role in PCOD:**

PCOS is a condition that affects the hormones in the body. PCOS is a hormonal disorder. *Gymnema sylvestre* (Retz.) R.Br. ex Sm. is an important medicinal plant with extensive application in Ayurvedic system of medicine for treating various metabolic and endocrine disease. The leaves of *Gymnema sylvestre* contain several bioactive components that account for its various pharmacological activities, such as the gymnemic acids, saponins, flavonoids, and alkaloids. *Gymnema sylvestre*, commonly referred to as "Gurmar" or the "sugar destroyer," is known for its potential to enhance glucose metabolism and manage blood glucose levels. Due to its antidiabetic activity, the plant has been very interesting for use as a complementary medicine in the treatment of Polycystic Ovary Syndrome (PCOS) which is one of the important pathological conditions of the disease [42]. Experimental and clinical evidences prove that *Gymnema sylvestre* stimulates insulin release, boosts insulin uptake in peripheral tissues and lowers hyperglycaemia,

which helps to increase insulin sensitivity and metabolic balance. The plant has also been reported to have a positive effect on regulating lipid metabolism and body weight management, which can help to prevent abnormal lipid metabolism typically seen in PCOS. Moreover, *Gymnema sylvestre* has strong antioxidant and anti-inflammatory activities, which help combat oxidative stress and chronic inflammation, which are crucial factors in the development of PCOS. The plant has also been reported to have the ability to improve pancreatic β -cell function and increase insulin sensitivity, which helps in maintaining the homeostasis of the endocrine system. These pharmacological actions could help in enhancing the function of the ovary, the ovarian hormonal balance and the reproductive health of PCOS women. While encouraging results have been reported in experimental studies, more rigorously designed and larger-scale randomized controlled clinical trials are needed to prove the long-term safety, effectiveness, optimum dosage and mechanism of action of *Gymnema sylvestre* in PCOS management [43].

13. Liquorice (*Glycyrrhiza glabra*)

- **Synonym(s):** Yashtimadhu, Mulethi, Sweet wood
- **Biological Source:** It consists of the dried roots and stolons of *Glycyrrhiza glabra*.
- **Family:** Fabaceae



Figure 15. Licorice (*Glycyrrhiza glabra*)

Description and Role in PCOD:

Glycyrrhiza glabra (Licorice) is a commonly used medicinal plant in traditional medicine, which is used in the treatment of a variety of hormonal, inflammatory and endocrine disorders. The plant also possesses several bioactive compounds, such as glycyrrhizin, liquiritigenin, glabridin and flavonoids, which are responsible for its various pharmacological effects. In recent years, the therapeutic potential of *Glycyrrhiza glabra* has been shown to keep a healthy endocrine balance and to support reproductive health [44]. One of the primary clinical symptoms of Polycystic Ovary Syndrome (PCOS) is hyperandrogenism, or high levels of the male hormones. High levels of androgens cause acne, hirsutism, irregular periods, anovulation and infertility. Multiple studies have documented the ability of this plant to inhibit steroid hormone metabolism, which in turn helps to restore hormonal balance for women with PCOS

through a decrease in serum testosterone. Moreover, **Glycyrrhiza glabra** has strong antioxidant and anti-inflammatory effects which help to alleviate oxidative stress and chronic inflammation, both of which are crucial to the development of PCOS. The plant also has an effect on the function of the adrenal gland, which can have a regulatory effect on androgen production and endocrine homeostasis. The pharmacological effects could help to maintain normal ovarian function and improve reproductive health in women with PCOS [45]. In conclusion, *G. glabra* is a potential complementary therapeutic herb for PCOS management due to its anti-androgenic, antioxidant, anti-inflammatory, and hormonal regulation effects. On the other hand, more well-designed, large-scale RCTs are needed to prove its long-term safety, efficacy, optimum dosing, and mechanism of action to widely use in women with PCOS.

14. Holy basil (*Ocimum sanctum* / *Ocimum tenuiflorum*)

- **Synonym(s):** Tulsi, Sacred basil, Vishnupriya, Surasa
- **Biological Source:** It consists of the fresh or dried leaves and aerial parts of *Ocimum sanctum* Linn., a medicinal plant widely cultivated in India and other tropical regions.
- **Family:** Lamiaceae



Figure 16. Holy basil (*Ocimum sanctum* / *Ocimum tenuiflorum*)

Description and Role in PCOD:

Ocimum sanctum L., known as holy basil or Tulsi, is a popular medicinal plant, with a diverse range of medicinal properties and therapeutic applications, especially in Ayurvedic medicine for metabolic, endocrine and inflammatory disorders. It has strong antioxidant, anti-inflammatory, antidiabetic, and adaptogenic effects, among others, that give it its multiple pharmacological properties. In recent times, research has indicated that *Ocimum sanctum* could be beneficial for the management of Polycystic Ovary Syndrome (PCOS), with its effectiveness being seen in enhancing insulin sensitivity and managing glucose levels. Because insulin resistance is one of the pathological characteristics of PCOS, improving insulin sensitivity can be helpful in decreasing hyperinsulinemia, correcting hormonal levels and metabolic issues. Moreover, **Ocimum sanctum** has been reported to act as an endocrine supporting

agent to keep the hormones within normal limits and to maintain normal ovarian function. It can also lower androgen levels, which can help to relieve the clinical symptoms of hyperandrogenism such as acne, hirsutism and irregular periods. Moreover, Tulsi possesses adaptogenic properties and has the ability to lower stress levels and regulate the hypothalamic–pituitary–ovarian (HPO) axis, which could be beneficial for women suffering from PCOS [46,47]. In summary, the beneficial effects of *Ocimum sanctum* on insulin and glucose metabolism, along with its antioxidant, anti-inflammatory, adaptogenic, and hormone balancing properties indicate that it may prove to be a valuable complementary therapeutic agent for PCOS treatment. Whilst its long-term safety, efficacy, optimum dosing and mechanisms of action need to be confirmed by additional well-designed, large-scale randomized controlled clinical trials before it is recommended for routine clinical use in women with PCOS.

15. Cinammon

- **Synonym(s):** Kalmi-Dalchini, Ceylon cinnamon
- **Biological Source:** Cinammon consists of dried inner bark of shoots of coppiced trees of *Cinnamomum zeylanicum* Nees
- **Family:** Lauraceae

**Figure 17. Cinammon****Description and Role in PCOD:**

Cinnamon or *Cinnamomum verum* (*Cinnamomum zeylanicum*) is a medicinal plant with antioxidant, anti-inflammatory, antidiabetic and hypolipidemic properties, which is widely used in traditional and modern medicine. Several bioactive compounds such as cinnamaldehyde, eugenol, cinnamic acid, procyanidins and polyphenolic compounds are found in the bark of the cinnamon tree and are responsible for its various pharmacological properties [48]. Recent research has shown that cinnamon can be a potential complementary therapeutic agent for the management of Polycystic Ovary Syndrome (PCOS) in part due to its insulin sensitizing properties. As insulin resistance is one of the key pathological characteristics of PCOS, the improvement of insulin sensitivity helps to restore the hormonal balance, normalize glucose metabolism, regulate menstrual cycles and minimize metabolic abnormalities. Moreover, low blood glucose, lipid profile and body weight management in women with PCOS have been reported to be improved by cinnamon [49]. Cinnamon extract is found to improve insulin sensitivity and decrease insulin resistance when it

activates the phosphatidylinositol 3-kinase (PI3K) pathway, influencing insulin signaling, as revealed by experimental and clinical studies. A randomized controlled clinical study was conducted on women with PCOS, where they were given 333 mg of cinnamon extract thrice daily for eight weeks, and the insulin resistance was seen to be reduced significantly compared to the placebo group [50]. In addition, there are reports that cinnamon supplementation can improve menstrual regularity, ovulatory function, antioxidant status, and lipid metabolism. The favorable outcome could also alleviate metabolic and reproductive problems of PCOS and enhance reproductive health in general [51]. In conclusion, *Cinnamomum verum* has shown promise as a complementary therapeutic agent for managing PCOS, given its insulin-sensitizing, antioxidant, anti-inflammatory and metabolic regulatory properties. Nevertheless, more well-designed and large-scale randomized controlled clinical trials are needed to provide information about duration of safety, effectiveness, optimum dosage and mechanisms of action before its routine use in women with PCOS can be recommended.

16. *Tribulus terrestris* Linn (Thorny vine)

- **Synonyms:** Goat's head, b ullhead, bindii, burra gokharu, bhakhdi, caltrop, puncture vine, tackweed, and devil's eyelashes.
- **Biological source:** *Tribulus terrestris* is an annual plant that is native to warm temperate and tropical regions in southern Eurasia and Africa.
- **Family:** Zygophyllaceae



Figure 18. *Tribulus terrestris* (Thorny vine)

Description and Role in PCOD:

Tribulus terrestris is a plant known for its medicinal properties and is commonly used in traditional Ayurvedic and traditional medicine to treat reproductive and hormonal issues. Several bioactive constituents such as steroidal saponins, flavonoids, alkaloids and glycosides are found in the fruits and aerial parts of the plant, and are responsible for the wide range of pharmacological activities. Recent studies have indicated that the use of *Tribulus terrestris* may have therapeutic potential in the management of Polycystic Ovary Syndrome (PCOS) due to its hormone-balancing, ovarian stimulating, and fertility enhancing properties. Experimental studies with PCOS rat model induced with estradiol valerate have shown that hydroalcoholic extracts of *T. terrestris* decrease ovarian cyst formation, restore ovarian normal morphology, enhance follicular development, normalize the reproductive hormone parameters, and enhance ovulatory function. Based on these results, it's likely that *Tribulus terrestris* could help

with hormonal irregularities, restore regular menstrual periods, and enhance ovarian function in cases of PCOS [52]. The pharmacological activities of *Tribulus terrestris* mainly have been attributed to steroidal saponins, especially protodioscin; flavonoids and alkaloids. These bio-active properties include gonadotropin-like properties, anti-oxidant and anti-inflammatory effects that can have beneficial effects on folliculogenesis, restoration of endocrine balance, reduction of oxidative stress and improvement of reproductive function. In addition, its phytohormonal properties could help enhance fertility and ovarian health for women suffering with PCOS. In summary, *Tribulus terrestris* is a promising complementary therapeutic agent for PCOS due to its hormone-regulating, antioxidant, anti-inflammatory, ovarian-stimulating and fertility-enhancing effects. Before it can be recommended for routine clinical use in women with PCOS, further well designed, large scale randomized controlled trials are needed to determine long-term safety, efficacy, dosage and mechanisms of action [53].

17. Fennel

- **Synonyms:** Feukel, Fructus Foeniculum.
- **Biological source:** It consists of dried ripe fruit of plant of *Foeniculum vulgare* Mill.
- **Family:** Umbellifera

**Figure 19. Fennels****Description and Role in PCOD:**

Foeniculum vulgare (Fennel) is a medicinal plant, popular in traditional medicine, due to its antioxidant, anti-inflammatory, analgesic, diuretic and phytoestrogenic properties. The compounds of seeds of *Foeniculum vulgare* include trans-anethole, estragole, fenchone, dianethole and anisaldehyde that have various pharmacological effects. In these compounds trans-anethole is identified as the main phytoestrogen and is believed to be the main contributor to the estrogenic effects of fennel [54]. Recent research indicates that the use of *F. vulgare* could be beneficial in the treatment of Polycystic Ovary Syndrome (PCOS) for its hormone-regulatory, antioxidant and anti-inflammatory properties. The presence of phytoestrogens in fennel could be useful to restore hormonal balance, normalize insulin sensitivity, lower oxidative stress and maintain normal reproductive function in women with PCOS. These pharmacological actions might play a role in the improvement of metabolic and endocrine abnormalities that can be related to the disorder. Experimental research of PCOS-induced rat model has shown that *Foeniculum vulgare* extract has a protective effect on reproductive and metabolic functions. Fennel extract significantly decreased the serum urea levels, ameliorated the renal histopathological changes and showed Reno

protective activity when induced PCOS rats. In addition, fennel treatment resulted in a better ovarian and uterine histopathology with increased thickness of the endometrium, decreased thickness of uterine epithelium, an increase in serum progesterone concentration, and a decrease in serum estrogen concentration in PCOS rats when compared to untreated rats [54]. In another experimental study, the therapeutic effect of fennel extract was compared with that of metformin, in the PCOS model developed by estradiol valerate in rats. The results showed the protective effect of fennel on the female reproductive system by improving the morphology of the uterus, hormonal balance, and development of the uterus's endometrium. Based on these observations, *F. vulgare* can be considered a promising complementary therapeutic agent for the treatment of reproductive disorders in women suffering from PCOS [55]. In conclusion, the pharmacological effect of *Foeniculum vulgare* is an attractive phytotherapeutic option to be used in the management of PCOS due to its phytoestrogenic, antioxidant, anti-inflammatory and hormone regulating properties. But more carefully-designed, larger-scale, randomized controlled trials are needed to confirm its long-term safety, effectiveness, dosing, and how it works in women who have PCOS.

18. *Withania somnifera* (Ashwagandha)

- **Synonym(s):** Ashwagandha, Indian ginseng, Winter cherry
- **Biological Source:** Ashwagandha consists of the dried roots and sometimes leaves of *Withania somnifera* (L.) Dunal.
- **Family:** Solanaceae.



Figure 20. *Withania somnifera* (Ashwagandha)

Description and Role in PCOS

Ashwagandha (*Withania somnifera*), a popular medicinal herb, has been widely popular in traditional Ayurvedic medicine for treating a range of hormonal, metabolic and reproductive conditions such as Polycystic Ovary Syndrome (PCOS). It comprises a number of constituents with bioactive properties, notably withanolides, steroidal lactones that account for its pharmacologic activity. The adaptogenic, antioxidant, anti-inflammatory, and insulin-sensitizing properties of ashwagandha have garnered attention in the management of PCOS as a promising complementary therapy. Chronic stress and increased cortisol are known to play a role in hormonal imbalance, insulin resistance and ovulatory dysfunction in women with PCOS. *Withania somnifera* is an adaptogenic herb that is known to modulate the hypothalamic–pituitary–adrenal (HPA) axis, which in turn leads to a decrease in cortisol levels and a hormonal balance [58]. Multiple studies have shown that extract of *W. somnifera* can help to improve insulin sensitivity, boost glucose metabolism and promote metabolic

health. Women with PCOS may experience improved glycemic control, body weight control, restoration of ovarian function, normalisation of the menstrual cycle and enhanced ovulatory function with improved insulin sensitivity [59]. Furthermore, Ashwagandha has strong antioxidant and anti-inflammatory properties, which can help lower oxidative stress and chronic inflammation, which are linked to the development of PCOS. In addition, clinical research indicates that Ashwagandha supplementation can help lower stress, anxiety, and cortisol levels, and aid in balancing hormones, supporting thyroid function, and managing lipid levels. These have been beneficial and can enhance reproductive health, menstrual regularity, and ovulatory function. In conclusion, *Withania somnifera* holds promise as a complementary therapeutic agent for the management of PCOS owing to its adaptogenic, insulin sensitizing, antioxidant, anti-inflammatory and hormonal balancing effects. Additional well-designed, large-scale RCTs should determine its efficacy, safety, optimal dose, and mechanism of action in the women with PCOS [60].

19. *Trigonella foenum-graecum* L

- **Synonym(s):** Fenugreek, Methi, Greek hay
- **Biological Source:** Fenugreek consists of the dried ripe seeds of *Trigonella foenum-graecum* L
- **Family:** Fabaceae (Leguminosae).

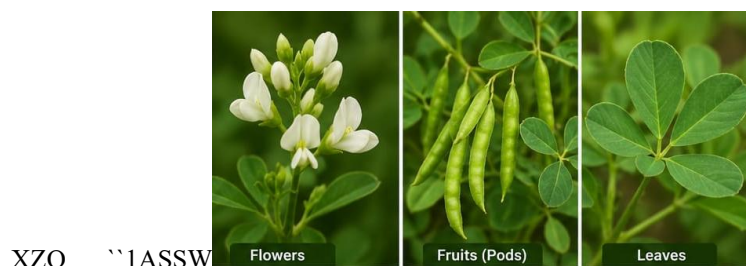


Figure21. *Trigonella foenum-graecum* L

Description and Role in PCOD:

Trigonella foenum-graecum (Fenugreek) is a medicinal plant that has been widely used in traditional systems of medicine for the management of various metabolic and hormonal disorders. Several bioactive compounds, including trigonelline, steroidal saponins, and dietary fibers, have been reported in fenugreek seeds, and are believed to be the cause of the pharmacological activities of fenugreek seeds. It is reported that the seed extract of fenugreek has a positive influence in the treatment of polycystic ovary syndrome, and that the seed extracts of fenugreek contain insulin-sensitizing and carbohydrate metabolism-regulating properties. Insulin resistance has been reported to be one of the major factors in the pathogenesis of PCOS, and fenugreek seed extracts have been reported to have the potential to reduce high levels of glucose in the blood. Studies have indicated that the use of fenugreek supplementation is able to effectively regulate the menstrual cycles and also improve the ovarian functions of women with PCOS. The presence of steroidal saponins such as diosgenin has been found to affect hormonal balance, thus enabling the normal physiological functions of the reproductive system in the female body [61]. Studies have also found that insulin resistance, body weight and

triglyceride levels of PCOS patients can be reduced using fenugreek seed extract. Moreover, it has been found to enhance the morphology of the ovaries as well as menstrual cycles in women suffering from PCOS after the supplementation of fenugreek in the female body [62]. Fenugreek has been found to possess antioxidant, anti-inflammatory, as well as hypolipidemic properties, thus enabling the reduction of oxidative stress as well as the metabolic problems that affect the female body in PCOS. The pharmacological effect of fenugreek has been discovered to render it a natural therapeutic agent that can effectively manage the symptoms of PCOS in the female body such as irregular menstruation, insulin resistance, and as well as metabolic imbalance in the female body [63].

CONCLUSION

Polycystic Ovary Syndrome (PCOS) is a multifactorial endocrine and metabolic disorder that adversely affects the reproductive, metabolic, and psychological health of women of reproductive age. Despite the availability of conventional therapeutic approaches, their long-term use is often associated with adverse effects, limited efficacy, and inadequate management of the underlying pathophysiological mechanisms. Therefore, the

development of safer and more effective complementary therapeutic strategies remains an important area of research.

Medicinal plants have gained considerable attention as potential complementary therapies for the management of PCOS because of their diverse pharmacological properties, including insulin-sensitizing, antioxidant, anti-inflammatory, anti-androgenic, and hormone-regulating activities. Herbal medicines such as *Withania somnifera*, *Trigonella foenum-graecum*, *Mentha spicata*, *Nigella sativa*, *Glycyrrhiza glabra*, *Aloe vera*, *Curcuma longa*, *Linum usitatissimum*, *Gymnema sylvestre*, and *Ocimum sanctum* have demonstrated promising therapeutic potential in improving insulin resistance, hormonal imbalance, ovarian dysfunction, oxidative stress, inflammation, and other metabolic abnormalities associated with PCOS.

Although numerous experimental and clinical studies have reported encouraging outcomes, the current evidence remains limited by small sample sizes, variations in herbal formulations, inconsistent treatment protocols, and insufficient long-term clinical data. Therefore, well-designed randomized controlled trials, standardized herbal formulations, and comprehensive mechanistic studies are essential to establish the long-term safety, efficacy, optimal dosage, and mechanisms of action of these medicinal plants.

In conclusion, medicinal plants represent promising complementary therapeutic agents for the management of PCOS and may serve as valuable adjuncts to conventional treatment. Their multi-target pharmacological actions provide a holistic approach to improving reproductive, metabolic, and endocrine health. Future research should focus on the integration of evidence-based herbal

therapies into clinical practice to optimize the long-term management of women with PCOS.

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