

Understanding PCOD and PCOS: A Comparative Review of Causes, Differences, and Treatment Modalities

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ABSTRACT

Polycystic Ovarian Disease (PCOD) and Polycystic Ovarian Syndrome (PCOS) are two commonly prevalent endocrine problems in women of reproductive age. Although these are implicated interchangeably, the pathophysiology, diagnosis, and treatment approaches are very different between PCOD and PCOS. This review is primarily aimed at finding out the differences between these two clinical entities in terms of their causes of manifestation and treatment strategies. PCOD is characterized, in general, by the presence of multiple immature ovarian follicles, and often associated with lifestyle factors such as diet or physical activity; whereas, PCOS is a more complex syndrome comprised in it by various abnormalities such as hormonal imbalance, insulin resistance, chronic anovulation, etc. PCOS is frequently associated with metabolic consequences such as obesity, type 2 diabetes, and risks for cardiovascular disease, while those of PCOD are generally not so serious as regards systemic implications. Such conditions require a lifestyle intervention for treatment; however, in PCOS, pharmacological therapy is generally needed besides lifestyle changes, like insulin sensitizers and hormonal therapy, for such treatment. Complementary approaches such as herbal medicine, acupuncture, and mind-body therapies are also considered to show promise in symptom control. This review also comprises portions with the comparative efficacy of herbal and allopathic medicines in the restoration of hormonal imbalance and improvement in fertility. In doing this, this review aims to provide a thorough comparison of PCOD and PCOS to facilitate understanding among medical personnel and researchers in order to obtain improved individualized treatment for women suffering from these conditions

Keywords: *Polycystic Ovary Disease, Polycystic Ovary Syndrome, hormonal imbalance, insulin resistance, lifestyle modifications, herbal treatment, allopathy, infertility.*

1. INTRODUCTION

The menstrual cycle involves an intricate mechanism through the hypothalamus, pituitary gland and ovaries, creating readiness for possible pregnancy. This complex mechanism, divided into three phases, is as follows: during the follicular phase, the pituitary releases follicle-stimulating hormone (FSH) to stimulate the ovaries into developing follicles, including dominant follicle undergoing maturation and increasing estrogen levels that would thicken the endometrial lining of the uterus. The second phase occurs at mid-cycle when ovulation occurs, triggered by a peak of luteinizing hormone (LH) leading to the release of a mature egg from a dominant follicle into the fallopian tube. The next phase, luteal, is characterized by formation of corpus luteum from the ruptured follicle, which secretes progesterone to maintain the endometrial lining. If this does not occur, hormone levels drop and menstruation and the start of a new cycle begin.

Normal menstrual cycles get affected by hormonal imbalance in women affected by PCOD, which leads to irregular ovulation, and multiple immature follicles or cysts are observed in the ovaries. PCOD is perceived as a scalar condition compared to PCOS, and herein, cyclical disturbances occur without the metabolic complications inherited in PCOS (1).

PCO disease in women is quite broad: it is PCOD + metabolic disease. But the nomenclature applies to a myriad of cases or conditions where these women exhibit not only ovarian cysts but also higher than normal levels of androgens and insulin

resistance. Most women tend to have chronic anovulation, which means that they experience irregularities in menstruation where they cannot have periods for other acute intervals like once a year and in some cases, no periods at all (2). Metabolism, however, comes to involve heavy risks to megametabolic morbidity within the lines of development of obesity, type 2 diabetes, and cardiovascular disease in the long term (3, 4).

Knowing about the PCOD and PCOS is important, because of the fact that while these conditions have different causes and symptoms, they also carry quite different health risks in the long run. On the one hand, PCOD is a condition in which the ovaries produce immature eggs leading to multi-cyst formation, but otherwise, the reproductive system is relatively well functioning (1). On the other hand, PCOS is a little more complex wherein it actually takes the form of a more endocrine disorder that affects the metabolic processes in the body (2). For that reason, women have been reported to have very high levels of androgen and insulin resistance along with showing chronic anovulation symptoms which lead to more severe menstrual irregularities and reproductive challenges overall (5). PCOD has some milder symptoms such as irregular periods; however, PCOS patients experience much more severe health consequences that can include obesity, type 2 diabetes, and even cardiovascular disease (4). Also, the treatment regimen is quite different. Patients with PCOD mostly use lifestyle changes and mild hormone therapy for management, while patients with PCOS usually require a full-blown treatment for reproduction and metabolism (6). Fertility outcomes differ between these two conditions, with PCOD leading to more regular ovulation and easier conception compared with conception via PCOS that often leads toward infertility due to chronic anovulation (6). All these differences would be critical in paving the way for diagnosis and managing through personalized treatment or in preventing long-term complications in the women suffering from either condition (5).

One of the trends recently observed in the medical industry has been the research into both herbal and allopathic treatments in the management of Polycystic Ovary Disease (PCOD) and Polycystic Ovary Syndrome (PCOS). By and large, the treatment in allopathic speculations covers hormonal contraceptives, metformin, and anti-androgen drugs. This treatment is what constitutes the core of approaches to regulate menstrual cycles in PCOS, reduces androgen levels and addresses insulin resistance in PCOS. Hormonal therapy has been successful in managing symptoms as well as fertility outcomes, but comes with side effects and requires long term use (7). This has led many women to seek herbal medicine as a complementary treatment or alternative. Some of these herbs that have received increasing attention regarding their capabilities of modulating steroids, inducing ovulation and combating insulin resistance naturally include Vitex agnus-castus (chasteberry), Cinnamomum cassia (cinnamon), and Withania somnifera (ashwagandha) (8). Berberine too has an action profile similar to what metformin does-to improve insulin sensitivity (9)-thus, these are increasingly considered as alternatives to allopathy in PCOS treatment. The research trend in the direction of synergizes herbal therapies with classical allopathic medicines thus representing a new trend to further mature while managing PCOD and PCOS cases holistically and personalized (10). In searching forward, there will be research advancement that is likely to improve treatment outcomes and overall health in women with these conditions through the mixed use of herbal and allopathic methods

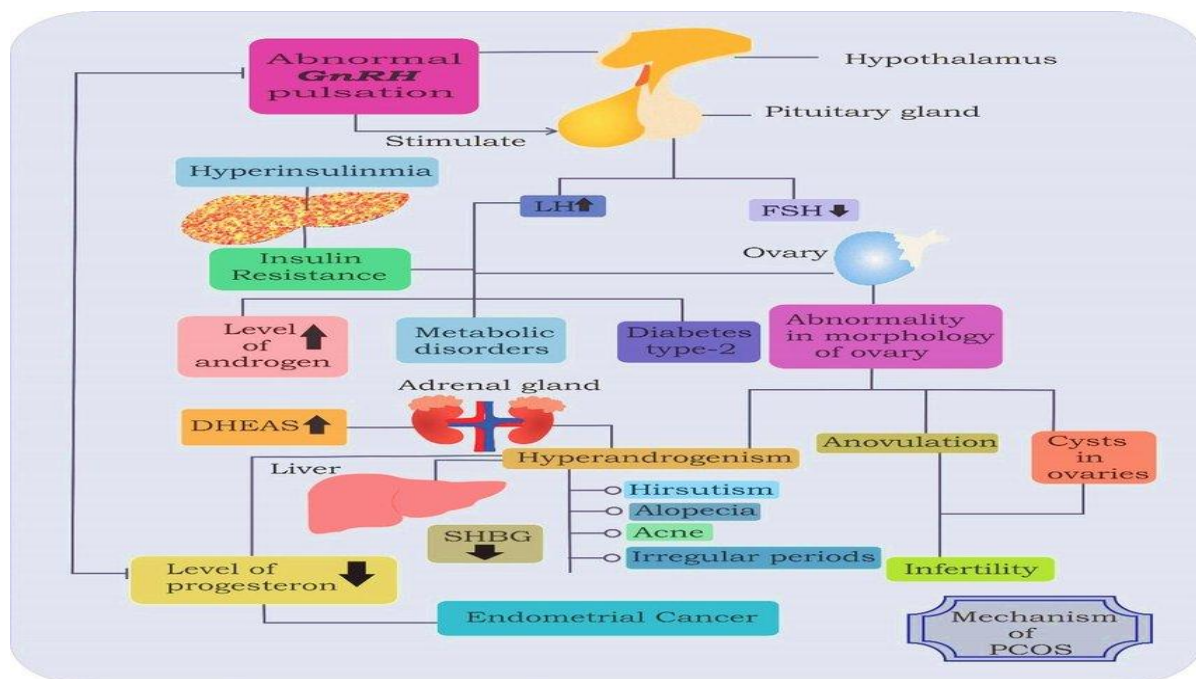


Figure-1 Mechanism of Polycystic Ovary Syndrome PCOS

Epidemiology

Polycystic Ovarian Disease is said to represent about 5-10% of those in the reproductive age of females, being quite a familiar disease. However, it is rarely diagnosed as compared to PCOS; this is primarily due to lesser symptom manifestation in the patient. Some of the women with PCOD include those who experience incomplete anovulation, because their cycle is marked with multiple ovarian cysts, and they may also have missed cycles. Symptoms generally start at adolescent age but continue to remain till the period between 20 and 30 years. Hence many women at this stage present to the clinics for menstrual cycle abnormalities. This disease is also linked to lifestyles such as poor diet, high stress, and zero mobility, which are high in cities. Some of the other women with PCOD are also at a very high risk of becoming obese, but they tend to have fewer metabolic problems in the long run as compared to the women suffering from PCOS. Commonly underdiagnosed is in regions where medical care is scarce or less aware of the condition (11,12).

Polycystic Ovary Syndrome (PCOS) is much more common and has been much more researched than Polycystic Ovary Diseases, with a worldwide incidence estimated between 6 % and 20 % of women for countries considering different diagnostic criteria and populations from which data is derived. PCOS, like most other endocrine disorders that afflict women under reproductive age, has no less severe forms, such as chronic anovulation, hyperandrogenism, and metabolic aberrations that include insulin resistance and obesity. Early symptoms of PCOS are usually manifestations that appear in adolescence when a girl starts menstruating, such as irregular periods, acne, or hirsutism, and it could end up having effects on fertility and other health issues later on in life. A significant genetic factor has been associated with this condition, and certain ethnicities, especially South Asians, have been found to report higher rates of PCOS, besides worse metabolic outcomes leading to a higher risk of developing type 2 diabetes mellitus. Lifestyle factors such as poor diet and inactivity play an even greater hegemonic role in worsening this condition, especially in industrialized countries. Because of the effect it has on reproductive, metabolic, and heart health, it has already been classified as a more serious and clinically important disease as compared to PCOD (13,14).

Etiology

The etiology of PCOD is very complex; genetic, hormonal, and environmental factors have a role to play. The major hormonal imbalance in PCOD is elevation in the levels of luteinizing hormone (LH), which results in excessive production of androgen hormones like testosterone in the ovaries. This leads to an inhibition of normal follicular development and ovulation, with the consequent production of multiple immature ovarian follicles or cysts. Another hallmark feature seen in PCOD women is that of insulin resistance. On exposure to elevated levels of insulin, the ovaries release more androgens, negatively affecting their activity and adding to the symptoms of acne, hirsutism, or baldness. Insulin resistance produces metabolic-related problems in most cases like obesity but with reduced severity as compared to PCOS. Environmental factors such as lifestyle diet stress and physical inactivity aggravate the condition. Moreover, family history plays a genetic role in the inheritance of this disorder, as it is more prevalent among women who have family history on the disease. In recent studies, it has been found that a polymorphism in the insulin receptor gene is also involved in the mechanism of development of insulin resistance in PCOD patients (15,16).

PCOS has a much more complicated etiology than that, which includes genetic, hormonal, metabolic, and environmental components. An elevated luteinizing hormone (LH) level, often in combination with a decreased follicle-stimulating hormone (FSH), is one of the central distortions of PCOS. This state induces hyperandrogenism (like testosterone) caused by the excess production of such androgens in the ovaries and results in signs like hirsutism, acne, and thinning of scalp hair. Besides, insulin resistance is one of the most critical factors in the development and continuation of PCOS. It is estimated that about 70% of women with PCOS are somewhat insulin resistant. This causes an increase in the supply of insulin in the bloodstream, which leads to increased production of the androgenic hormones and worsens the hormonal imbalance that is already ongoing, thus resulting in the dysfunction of the ovaries. Insulin resistance in PCOS is additionally an increased risk factor for developing metabolic disorders such as type 2 diabetes, obesity, and cardiovascular diseases (17,18).

PCOS also tends to have a genetic predisposition; it tends to run in families. Studies indicate that women with a first-degree relative who is affected by PCOS are more prone to developing the syndrome. Several genes involved in insulin signaling, production of androgens, and ovarian follicular development have been implicated with the condition, including some polymorphisms in the FTO gene (fat mass- and obesity-associated gene) and the INSR gene (insulin receptor gene) (19,20).

Obesity, high-fat diets, and lack of physical activity are environmental factors that seem to incite and worsen insulin resistance in PCOS, along with aggravating its general symptoms. Other studies show that low-grade inflammation among women with this condition might worsen the condition by increasing insulin resistance and inducing ovarian dysfunction. Inflammatory conditions have been related to the alteration in immune response and insulin resistance, which leads to various metabolic and reproductive problems in patients with PCOS (21-23).

Pathophysiology

Despite some variation in outcomes, the underlying causative mechanisms such as hormonal deregulations of ovarian

functions when compared are similar in PCOD and PCOS. Hormonal dysregulation with increased LH levels and excess androgen leads to the classical pathophysiology with multiple immature follicles in developing into small cysts filled with fluids in ovaries. However, most of these women are still classified under the PCOD umbrella: these women could actually ovulate intermittently and hence retain their such women with PCOD are also likely to have some degree of insulin resistance, although not to the same extent as someone with PCOS. These two will lead to androgen excess, the possible phenotypic manifestations of which are mild hirsutism, acne, and irregular menstrual cycles. Ovulation is an issue for these women, but it does not mean they cannot achieve spontaneous conception since it is not a very severe degree of endocrinal dysfunction due to PCOD.

Greater levels of LH are linked to endometriosis, whereas hormonal disorders and the exhibition of insulin resistance in a girl lead to multiple anovulatory conditions in the case of PCOS. An increased amount of LH promotes overproduction of androgens by the ovary and the particulate body does not yield follicular growth, whereas a clear absence of FSH has to cause cyst formation which is continuous and periodically shuts down the menstrual period or even none at all. Consequently, there is a high risk of infertility. In the case of a patient with PCOS, there is no insulin sensitivity; insulin rises in such cases and, in turn, stimulates the androgen more, giving rise to even more severe clinical presentations such as severe hirsutism, acne, obesity, and several metabolic aberrations. The corporeal health risks that come about as a result of PCOS compared to PCOD include type 2 diabetes, cardiovascular diseases, and endometrial cancers that are attributed to hormonal and metabolic dysregulation (26,27).

The most severe hormonal imbalance statement concerning the reproductive process has a lot more to do with PCOD than with this other condition PCOS. For one, women affected by PCOD are generally more likely to manifest the regulatory disorders of hormones and can possibly ovulate at irregular intervals; those with PCOS experience total disruption of hormones and do not ovulate at all within a cycle. Since both conditions exhibit insulin resistance, the abdominal fat storage characteristic of PCOS makes the metabolic and cardiovascular risk more prevalent (24).

Key Differences between PCOD and PCOS

Clinical Differences in Symptoms:

PCOD (Polycystic ovarian disease) and PCOS (Polycystic ovarian syndrome) differ mainly in the extent of clinical symptoms in terms of an irregular menstrual cycle and infertility. In PCOD, the cycles are irregular as there is an incomplete development of follicles after which, it is also leading to haphazard shedding irregular and thus resulting in periodic ovulation that is less disturbed with fertility. Moderate hirsutism, acne, and weight gain are symptoms which are less in severity compared to those in PCOS (28, 29).

In contrast, the menstrual cycle disorders arising from PCOS are quite extensive, including severe anovulatory oligomenorrhea or oligo-amenorrhea due to chronic anovulation. Infertility due to either irregular or absent ovulation is a common complaint of women suffering from PCOS. Furthermore, they appear to experience more severe and widespread symptoms such as hirsutism, severe acne, obesity, and insulin resistance when compared to individuals who do not suffer from this condition (30, 31).

The criteria for diagnosis between PCOD and PCOS have several things in common, with the major difference residing in the hormonal level and metabolic abnormalities. Generally, in PCOD, diagnosis is made on the basis of ultrasonological findings showing more than ten immature follicular structures in an ovary. Blood tests can reveal slight elevation of androgen levels, which are neither as prominent as those in case of PCOS. Ovulation does not completely absent; it is irregular in PCOD.

Diagnosis of PCOS is based on the Rotterdam Criteria; at least two of the following three manifestations should be present: polycystic ovaries by ultrasound, hyperandrogenism (clinical signs like hirsutism or acne), and anovulation or irregular menses; Biochemical hallmarks of PCOS include high LH, high androgen levels, and, in some cases, manifestations of insulin resistance such as increased fasting insulin levels or glucose intolerance (30, 31).

However, the health risks caused by PCOD and PCOS have important differences in them. When it comes to complications, PCOD is not nearly as serious as its counterparts-women may continue to ovulate sporadically in the future and experience even less severe metabolic disturbances. But untreated PCOD could also result in mild insulin resistance, develop to type 2 diabetes and obesity, though it would not be as commonly associated with such conditions as PCOS.

While PCOS affects people's lives strongly, it has overreaching associations with long-term risks related to from hormonal and metabolic disturbances. Most women with interesting conditions associated with PCOS present themselves with a metabolic syndrome which includes, but is not limited to, type 2 diabetes, insulin resistance, dyslipidemia, and hypertension. PCOS exposes yet another space of increased risk of acquiring cardiovascular disease and endometrial cancer owing to anovulation in the long term with unopposed estrogen resulting in hyperplastic growth of the endometrium. Higher levels of obesity are also observed with people having PCOS in order to add them to the high risk of suffering from complications

related to diabetes and heart-related issues (29-33).

Table 1: Key difference between PCOD and PCOS

Mechanism Component	PCOD (Polycystic Ovary Disease)	PCOS (Polycystic Ovary Syndrome)
Prevalence	Affects about 5-10% of women of reproductive age	Affects 6-20% of women worldwide
Hormonal Imbalance	Milder hormonal imbalance compared to PCOS. - LH and FSH imbalance leads to immature follicle development, but not as severe as in PCOS.	Milder hormonal imbalance compared to PCOS. - LH and FSH imbalance leads to immature follicle development, but not as severe as in PCOS.
Ovarian Function	Ovaries produce immature eggs , which can result in multiple small cysts, but the ovaries still retain some functionality. - Ovulation occurs intermittently.	- Chronic anovulation (lack of ovulation) due to improper follicle development. - Ovaries produce excess androgens , leading to polycystic ovaries.
Cyst Formation	- Multiple small cysts form due to the accumulation of immature follicles, but the condition is typically less severe.	- Ovaries develop numerous cysts from underdeveloped follicles that fail to mature and release an egg
Androgen Levels	Androgen levels may be slightly elevated, but not to the extent seen in PCOS.	- Elevated androgen levels (e.g., testosterone), leading to symptoms like hirsutism (excessive hair growth), acne, and scalp hair thinning.
Insulin Resistance	- Insulin resistance is less common or less severe compared to PCOS.	- Insulin resistance is a common feature, contributing to hyperinsulinemia , which increases androgen production.
Menstrual Irregularities	- Irregular menstrual cycles due to anovulation or infrequent ovulation. - Periods may be delayed but still occur.	- Severe menstrual irregularities such as oligomenorrhea (infrequent periods) or amenorrhea (absence of periods).
Ovulation	- Ovulation occurs intermittently, and fertility is usually less impacted compared to PCOS.	- Chronic anovulation is more common, leading to significant fertility issues and difficulty conceiving.
Estrogen Levels	Estrogen levels may fluctuate but typically remain within normal ranges.	- Elevated estrogen levels due to continuous follicular development without ovulation, leading to endometrial hyperplasia (thickening of the uterine lining).
Symptoms	- Milder symptoms such as irregular periods, mild acne, and weight gain. - Less pronounced metabolic symptoms.	More severe symptoms including weight gain, hirsutism , acne, and metabolic disturbances (e.g., type 2 diabetes).

Long-term Health Risks	Generally, lower risk of developing metabolic disorders. - Fertility is less affected, and lifestyle changes can restore normal ovulation.	- Higher risk of long-term health issues like type 2 diabetes, obesity, cardiovascular disease, and endometrial cancer.
Treatment Focus	- Primarily focuses on regulating periods and improving ovulation with lifestyle changes or mild hormone therapy.	- Requires comprehensive treatment addressing both reproductive and metabolic issues , often including insulin-sensitizing agents, hormonal therapy , and lifestyle management.

Allopathic Drugs for the Treatment of PCOS and PCOD

Metformin

Metformin oral medication, known indeed as Glucophage, is a very insulin-specific medicine procured for optimum management in patients resistant to insulin; thus, making it one of the most commonly prescribed medicines for the management of women with polycystic ovary syndrome (PCOS) and polycystic ovarian disease. The conditions are largely pathophysiologically insulated and create a framework for metformin use in relieving hepatic production of glucose, improving peripheral utilization of glucose, reduction in blood glucose, and helping restore normal insulin sensitivity. It also has other advantages in regulating menstrual cycles, decreasing androgen levels, and ovulation stimulation among them. Thus, it takes care of menstrual irregularity, hyperandrogenism, and anovulation. Loss of weight also proves efficacy in this treatment practice. It is very good at improving fertility with respect to insulin resistance in women with PCOS or PCOD (34, 35).

Clomiphene Citrate (Clomid)

Clomiphene citrate, more popularly known as Clomid, is an ovulation-inducing drug for women suffering from PCOS and PCOD. It is an antagonist for estrogen receptors in the hypothalamus. This action leads to gradually rising levels of gonadotropin-releasing hormone, which in turn stimulates follicle-stimulating hormone (FSH) and luteinizing hormone (LH) release. These actions induce follicle development and ovulation in healthy women. Ovulation Clomiphene stimulation helps induce normal estrus cyclicity in women with either abnormal menstruation or absence of menstrual cycles. It is first line treatment given to women with infertility due to PCOS.

Spirolactone (Aldactone)

Spirolactone anti-androgen drug offers treatment for women with PCOS with their high androgen levels as one of the major features of such condition. Because excess androgen produces symptoms such as hirsutism and acne, androgen blockade is done through the inhibition of androgen receptor and suppression of 17α -hydroxylase enzyme in testosterone biosynthesis, thereby reducing androgens and their signs. Since the drug is taken along with other medications for hyperandrogenism symptom management, it will not be recommended for women who desire to conceive (38, 39).

Oral Contraceptives (OCPs)

Birth control pills, typically referred to as oral contraceptives, are the means by which menstrual cycle dysregulation is treated and androgen levels reduced in women suffering from polycystic ovaries and polycystic ovarian disease. These contraceptive pills, which contain estrogen and progestin combinations, negatively regulate the secretion of LH from the pituitary gland, which in turn reduces ovarian androgen production. This helps alleviate problems such as acne, hirsutism, and irregularity in the menstrual flow. OCP also causes endometrium not to be hyperplastic, which happens during estrous cycles in case of repeated ovulations. They maintain hormonal equilibrium and standardize cycles as well (40, 41).

Gonadotropins (FSH, LH)

Evolved recombinant or non-recombinant gonadotrophins, namely FSH and LH, partake in the reproductive treatments of patients with PCOS or PCOD. In cases where ovulation is not observed, gonadotropins are administered along with clomiphene, for treatment. Gonadotropins stimulate the ovaries directly for egg production, and these are usually administered during monitoring and will restore ovulatory cycles, thus increasing the efficacy in women who are anovulatory (42).

Table 2: Allopathic Drugs for the Treatment of PCOS and PCOD

Drug	Mechanism of Action	Effect on Symptoms	Reference
Metformin	Improves insulin sensitivity and decreases glucose production	Reduces insulin resistance, regulates menstrual cycles, improves ovulation	34,35
Clomiphene Citrate	Increases GnRH and gonadotropin secretion, stimulating ovulation	Restores ovulatory cycles, improves fertility, regulates estrus cyclicity	36,37
Spironolactone	Anti-androgen effects, inhibits androgen production	Reduces elevated androgen levels, alleviates symptoms like hirsutism and acne	38,39
Oral Contraceptives (OCPs)	Suppresses LH secretion, decreases ovarian androgen production	Regulates menstrual cycles, reduces hirsutism, prevents endometrial hyperplasia	40,41
Gonadotropins (FSH, LH)	Stimulates ovary function directly by mimicking natural gonadotropins	Induces ovulation, improves fertility in women with anovulation	42

Herbal drugs used for treating PCOS and PCOD

Herbal drugs to increase ovulation cycle

Vitex agnus castus (chaste berry)

Vitex agnus castus is undoubtedly one of the most ancient remedies for disorders related to menstruation and some specific hormonal abnormalities. Historically, the fruit is now available widely in the southern United States and Europe and is found to be rich in aquamethanol such as bornyl acetate, limonene, and α -pinene; labdone-type diterpenoids like viteagnusin and rotundifuran; flavonoids like luteolin, apigenin, and casticin; and iridoids like cynaroside. Among these, viteagnusin and casticin have functions to reduce prolactin levels via inhibiting activity on dopamine-2 (D-2) receptors with subsequent beneficial influences on the ovulatory cycles. Besides, the ingredient apigenin overwrote selective ER β action in ovulating effects, which denies the use of this herb only in sealing off the ovarian cysts in treating PCOS (43-45).

Cimicifuga racemosa (Black Cohosh)

The Black Cohosh of the family Ranunculaceae had been used by women in regularising their menstrual cycles for many months, focusing on particular hormonal imbalance conditions like PCOS. It is acting as a selective estrogen receptor modulator (SERM) and particularly working on estrogen receptor- α , which helps the regulation of the menstrual cycle and improves ovulation. It also helps to control symptoms of hormonal imbalance like hot flashes in postmenopausal women. The compounds that seem to account for efficacy in black cohosh, included actein, 27-deoxyactein, and cimigoside that might be involved in estrogen pathways and follicular development. Phytoestrogens and their kory effects might help greatly women with PCOS since they can reset the balance of the hormones affecting ovulation(46-48).

Tribulus terrestris

It has been conventionally employed for its stimulatory effect on fertility enhancement, a case of organs. *Tribulus* raises secretion of follicle-stimulating hormone (FSH) and luteinizing hormone (LH), which generally improve the ovarian function and control menstrual cycles. It was found to be particularly beneficial for women suffering from polycystic ovaries (PCOS) and polycystic ovaries disease (PCOD), where hormonal imbalances restrict regular ovulation. Citration of active ingredients such as protodioscin, tribulosin, and other flavonoids like kaempferol and quercetin balance androgen levels, reducing the risk of cyst formation and at the same time aids follicular development. The *Tribulus* has been proved to have effectiveness in the stimulation of ovulation and hence will be of benefit to women who have anovulatory cycles (49-51).

Cinnamomum cassia

Cinnamomum cassia or cinnamon is a spice that is generally used for increasing insulin sensitivity specifically in women

with hyperandrogenism or any form of variation of irregular ovulation in relation to PCOS and/or PCOD. Cinnamon is said to lower insulin levels and improve insulin sensitivity, which reduces hyperandrogenism and related symptoms of irregular ovulation. Cinnamaldehyde, and eugenol, and flavonoids, such as quercetin and catechin, are said to improve the cycle and stimulate ovulation in the insulin-resistant female. In addition, it has been reported that cinnamon lowers elevated testosterone levels, allowing maintaining normal ovulatory cycles (52–54).

***Withania somnifera* (Ashwagandha)**

Adaptation by the family Solanaceae is probably the prominent herb in one of the application-based stress suppressants, which are significant for improvement in fertility and regulation of menstrual cycles. Ashwagandha normalizes hormonal secretion by stimulating the hypothalamic-pituitary-ovarian axis and promotes ovulation in women with PCOS. Compounds of Ashwagandha, such as withanolides (withaferin A and withanolide D), alkaloids, and saponins not only bring correction to cortisol levels but also restore ovarian functioning. The effects of these compounds enable normal cycle restoration and enhancement of ovulatory cycles in women suffering from PCOD and PCOS (55-57).

***Foeniculum vulgare* (Fennel)**

Fennel plant's, which is classified under Apiaceae family, function as a biologically active estrogen and is often prescribed to induce regular menstruation. Owing to its estrogenic property, it makes ovulation and the follicular phase of the cycle more viable in women suffering from PCOS and PCOD, where anovulatory cycles often lead to increased suffering. The implemented active phytochemicals-in particular-anethole, fenchone, estragole, and flavonoids-that is, quercetin and rutin work on the estrogen receptors, regulate hormone release, and compel ovulation. In addition, they have antioxidant effect that would help protect the ovarian health and inhibit cyst formation, making fennel a worthy treatment option for women with PCOS and PCOD (58-60).

Table 3: Herbal drugs to increase ovulation cycle

Plant	Scientific Name	Family	Effective Compound(s)	Impact on PCOS/PCOD	References
Chasteberry	<i>Vitex agnus-castus</i>	Verbenaceae	Viteagnusin, casticin, apigenin	Reduces prolactin levels, suppresses ovarian cysts, enhances ovulatory cycles	(43–45)
Tribulus	<i>Tribulus terrestris</i>	Zygophyllaceae	Protodioscin, quercetin	Stimulates FSH and LH, promotes follicular development, improves ovulation	(46–48)
Black Cohosh	<i>Cimicifuga racemosa</i>	Ranunculaceae	Actein, ferulic acid	Mimics estrogen, regulates hormonal balance, reduces oxidative stress	(49–51)
Cinnamon	<i>Cinnamomum cassia</i>	Lauraceae	Cinnamaldehyde, catechin	Improves insulin sensitivity, reduces androgens, enhances ovulation	(52–54)
Ashwagandha	<i>Withania somnifera</i>	Solanaceae	Withaferin A, withanolide D	Lowers cortisol levels, restores HPO axis function,	(55–57)

				improves ovulatory cycles	
Fennel	<i>Foeniculum vulgare</i>	Apiaceae	Anethole, chlorogenic acid	Promotes estrogenic activity, reduces oxidative stress, enhances follicular growth	(58–60)

Herbal drugs to maintain androgen level:

***Glycyrrhiza glabra* (Licorice)**

While glucophage and other sulfonylureas had in the past tantalized their users with hopes of management for PCOS and PCOD, licorice has, for centuries, found gratification in soothing and expectant hands. Such anti-androgenic potencies of the herb glycyrrhizin, flavonoids and saponins, are thought to be responsible. Glycyrrhizin is a competitive inhibitor of the enzyme 17-hydroxysteroid dehydrogenase, which catalyzes the conversion of testosterone into the more potent DHT. *Glycyrrhiza glabra* may also help suppress hyperandrogenism by reducing the elevated levels of DHT, which is a significant cause of PCOS and PCOD symptoms like hirsutism and acne. In addition, the herb has adaptogenic and anti-inflammatory properties that can support overall hormonal balance, making it a tailored remedy to manage the symptoms of the condition.

***Linum usitatissimum* (Flaxseed)**

Another herb having advocate scope is *Linum usitatissimum* (flaxseed). Some of the major agents in flaxseed comprise lignans (for example, secoisolariciresinol diglucoside), omega-3 fatty acids (especially, alpha-linolenic acid), and fiber. The lignans can have weakly estrogenic effects and provide another means by which a type of imbalance that may characterize PCOS might be modulated. These, along with the omega-three fatty acids with anti-inflammatory features, that is alpha-linolenic acid at this time: that way, it can meddle with the inflammation and insulin resistance which women with PCOS tend to exhibit. This will hence open flaxseed avenues toward ameliorating any symptom that could characterize their aspect, for instance, irregular menstrual cycles or ovulatory dysfunction, because of enhancement in the sensitivity to insulin.

Mentha spicata

Mentha spicata, more familiarly known as spearmint, has been studied for antiandrogenic effects and has therefore become useful in the management of PCOS and PCOD. The main active ingredients of spearmint are menthol, flavonoids, and phenolic acids. In women with PCOS, spearmint reduces testosterone and, hence, hirsutism. Indian spearmint also throws in antioxidant and anti-inflammatory effects to tone down ovarian inflammation, which eventually leads to hormonal balance in the body. It's a natural means of restoring a more normal hormone profile in women affected with PCOS and PCOD.

***Cocos nucifera* (Coconut)**

Coconut oil contributes to the hormonal balance of women suffering from PCOS and PCOD. It is made primarily up of medium-chain fatty acids like lauric acid and contains these fatty acids as well as an antioxidant. Lauric acid has anti-inflammatory and antimicrobial property compounds. MCFAs would have a beneficial effect on enhancing insulin sensitivity. Coconut oil is said to be beneficial in relation to one of its very important contributory factors, PCOS, based on increased metabolism of insulin. The possible includes potential management with PCOS as well as PCOD on the basis of its novel combined action against hormones and inflammation-reducing property.

Punica granatum

Punica granatum, also known as pomegranate, has greatly assisted in the treatment of PCOS and PCOD since it possesses antioxidant properties. Punicalagins, ellagic acid, and flavonoids are the most essential bioactive constituents of *Punica granatum*. These compounds have been shown to reduce high oxidative stress among women with PCOS. It is anti-inflammatory, among other things, and may help restore some hormonal balance by reducing excess testosterone. It is also effective in treating insulin resistance that is usually associated with PCOS and PCOD in women. Therefore, it is excellent in overall well-being and relieving symptoms of PCOS and PCOD.

Table 4: Herbal drugs to maintain androgen level

Plant	Scientific Name	Family	Effective Compound(s)	Impact on PCOS and PCOD	Reference
Glycyrrhiza glabra	<i>Glycyrrhiza glabra</i>	Fabaceae	Glycyrrhizin, Flavonoids, Saponins	Reduces hyperandrogenism, helps alleviate symptoms like acne and hirsutism	[61, 62]
Linum usitatissimum	<i>Linum usitatissimum</i>	Linaceae	Lignans (Secoisolariciresinol diglucoside), Omega-3 Fatty Acids	Reduces inflammation, improves insulin sensitivity, supports hormonal balance	[63, 64]
Mentha spicata	<i>Mentha spicata</i>	Lamiaceae	Menthol, Flavonoids, Phenolic acids	Reduces elevated testosterone, alleviates hirsutism, supports hormonal balance	[65, 66]
Cocos nucifera	<i>Cocos nucifera</i>	Arecaceae	Medium-Chain Fatty Acids (Lauric acid), Antioxidants	Improves insulin sensitivity, reduces inflammation, helps with hormonal balance	[67, 68]
Punica granatum	<i>Punica granatum</i>	Lythraceae	Punicalagins, Ellagic acid, Flavonoids	Reduces oxidative stress, balances testosterone levels, improves insulin resistance	[69, 70]

There are several other recent treatment modalities besides the allopathy and herbal treatment for the management of PCOS and PCOD, all of which are commonly referred to as lifestyle changes, alternative or complementary therapies or joint therapies that enhance the overall effectiveness towards hormonal balance, improving insulin sensitivity, and reproductive wellness. Here are some approaches other than allopathy:

Lifestyle Modifications

Lifestyle modifications, especially changes in both diet and physical activities, are quite contributory in treating PCOS and PCOD symptoms. Consumption of low glycemic food in a healthy diet can help improve insulin sensitivity, which is vital for managing symptoms of PCOS and PCOD. A diet rich in whole grains, lean proteins, healthy fats, and vegetables also serves to promote normalization of blood sugar levels [71]. In fact, very beneficial regular aerobic exercise such as walking, cycling, and swimming has been shown to improve insulin sensitivity, manage weight, and enhance fertility [72]. This type of exercise has the positive effects of adding muscle and increasing metabolism. A woman with PCOS would only require a 5-10% weight loss of total body weight to restore ovulatory cycles and improve menstrual regularity [73]. In addition, activities such as yoga that are focused on mindfulness have been proven effective in regulating menstrual cycles and reducing stress and the emotional consequences of PCOS [74].

Acupuncture

Acupuncture, a traditional health methodology of Chinese medicine, has been found effective in possible treatments of PCOS or PCOD due to its functional benefits in stimulating the ovaries, as well as balancing hormonal levels. It improves blood circulation to the ovaries and hence is believed to play a part in regulating the hypothalamic-pituitary-ova-axis, follicular development, and ovulation [75]. Acupuncture can also be useful in reducing stress, improving insulin resistance, and regulating the menstrual cycle [76]. Several studies further confirmed that acupuncture, when incorporated with other fertility treatments, improves the chances of conception in women diagnosed with PCOS [77]. Although result variability is possible, acupuncture provides one more alternative avenue for such women seeking alternative treatments for PCOS [78].

Homeopathy

Homeopathic treatment for PCOS and PCOD is usually symptom specific for each person. Homeopathic remedies like

Sepia, Pulsatilla, and Calcarea Carbonica are generally prescribed based on individual symptoms, both physical and emotional [79]. Sepia is recommended for irritability, fatigue, and disturbed menstrual cycles, while Pulsatilla is recommended for hormonal imbalances and emotional disturbances [80]. Calcarea Carbonica is usually given for those women with a lot of weight gain having a sluggish metabolic activity. According to some reports, there is no significant evidence regarding the effects of homeopathy in PCOS; however, several women report improvement in symptoms, hormones, and menstrual cycles [81].

Mind-Body Therapies

Some of mind-body therapies like Cognitive Behavior Therapy (CBT), meditation, and mindfulness-based approaches were proved effective in managing emotional stress and psychological symptoms in women suffering PCOS and PCOD [82]. CBT involves the identification and modification of negative thought patterns by the patients; in this way, it minimizes anxiety, depression, and stress [83]. Such psychological issues tend to agitate physical manifestations such as menstrual irregularity and weight gain. Additionally, the meditation and mindfulness practices are instrumental in lowering cortisol levels and enhancing overall emotional wellbeing. Mindfulness-based stress reduction (MBSR) appears to have had a great impact on the management of stress and quality of life of women suffering from PCOS [84].

Bariatric Surgery

Sometimes, bariatric surgery is an option for women suffering from severe obesity with polycystic ovarian syndrome (PCOS) when mere lifestyle modifications seem to fail. These surgical options such as gastric bypass or sleeve gastrectomy come with significant weight loss, which results in improved insulin sensitivity and the resumption of ovulatory cycles. Women who underwent surgery for weight loss usually experience improvement in hormonal balance, including reduced androgen levels, as well as improvement in regular menstrual cycles. However, bariatric surgery is only recommended for women with a BMI of 35 or over, who have failed all other weight management methods. Nonetheless, it's an effective treatment to help manage the symptoms of PCOS related to obesity; it will, however, require continuous observation and follow-up.

Vitamin and Mineral Supplements

Various vitamin and mineral supplements can be useful in treating the signs and symptoms presented by this illness PCOS and PCOD. Vitamin D deficiency should also be one of the deficiencies most women with PCOS have and discouraged supplementation if it has been shown to improve insulin sensitivity, testosterone levels, and the regularity of menstrual cycles [89]., Inositol, especially myo-inositol and D-chiro-inositol, is popularly used to improve insulin sensitivity, regulate menstrual cycles, and promote ovarian function [90]. Omega-3 fatty acids increase their presence in fish oils or flaxseed. Anti-inflammatory properties are known in many and are reported to be of help in reducing insulin resistance and the levels of androgen [91]. Magnesium supplementation, as shown in studies, could manage painful symptoms related to stress and sleep, which are major components in dealing with PCOS [92].

Herbal Supplements (Other than Traditional Herbal Remedies)

Berberine and N-Acetyl Cysteine (NAC) are among the most famous folk herbal supplements for managing PCOS and PCOD. The alkaloid berberine derived from several plant sources is also found to improve insulin sensitivity, decrease glucose levels, and promote weight loss in women with PCOS [93]. It has also improved ovulation and regulated ovarian function. N-Acetyl Cysteine (NAC) is an antioxidant which, aside from improving insulin resistance, also regulates menstrual cycles. NAC has been found, in research, to improve fertility in women with PCOS, particularly when used with other treatments [94].

Fertility Treatments (Non-medication-based)

These treatments do not involve medications and include such procedures as Intrauterine Insemination (IUI) and In Vitro Fertilization (IVF). The indications for these treatments include infertility due to PCOS in women and IUI is meant for a woman with PCOS who is not ovulating regularly. The sperm is introduced directly into the uterus during ovulation to increase the chances of fertilization [95]. For cases of severe infertility or when all previous treatments have failed, IVF is recommended. IVF is performed by removing eggs from ovaries, fertilizing them in vitro, and placing them into a woman's uterus [96]. Both treatments have been shown to improve the fertility of women with PCOS, although these procedures are generally considered only after failure of other more conservative methods [97]

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