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HERBAL CARE FOR WOMEN: A GUIDE TO PHYTOTHERAPEUTIC AGENTS IN GYNAECOLOGY AND REPRODUCTIVE HEALTH

CHAPTER 4: PHYTOTHERAPY IN PCOS AND HORMONAL IMBALANCE

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Abstract

Polycystic ovary syndrome (PCOS) is a multifactorial endocrine metabolic disorder characterized by hyperandrogenism, insulin resistance, menstrual irregularities, chronic inflammation, and ovarian dysfunction. Although conventional pharmacological interventions remain central to PCOS management, growing concerns regarding adverse effects, limited long term efficacy, and symptom-oriented treatment have increased interest in complementary phytotherapeutic approaches.

This chapter critically explores regimen oriented phytotherapy as an emerging strategy for the management of PCOS and hormonal imbalance. Unlike conventional herb centered reviews, the chapter focuses on integrated therapeutic approaches that target multiple pathological pathways simultaneously.





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Major phytotherapeutic regimens discussed include insulin sensitizing botanical therapy, adaptogenic herbal therapy, gut hormone axis phytotherapy, anti-androgenic herbal therapy, polyherbal formulations, seed cycling, and functional food and nutraceutical interventions.

The chapter examines the mechanistic basis of these therapies, including modulation of insulin signaling, regulation of steroidogenesis, reduction of oxidative stress and inflammatory cytokines, restoration of gut microbial balance, and normalization of hypothalamic–pituitary–ovarian axis function. Experimental and clinical evidence demonstrating improvements in menstrual cyclicity, ovulation, and metabolic profile, androgen excess and reproductive outcomes are also evaluated.

Moreover, the chapter addresses the healing capacity of phytochemicals, combination therapy of multiple herbs, and microbiome-focused nutrition approaches in integrative endocrinology. Although there is some encouraging evidence, there are still major issues that include lack of standardisation, inconsistency in clinical evidence, and limited safety studies.

Evidence-based validation, standardised formulations, and extensive clinical trials, therefore, become essential in determining the role of phytotherapeutic regimes in the management of PCOS today. In general, phytotherapy using regimens is an approach that can be used effectively to manage PCOS.

Key words: Polycystic ovary syndrome; Phytotherapy; Hyperandrogenism; Insulin resistance; Nutraceuticals; Herbal therapy

1. Introduction to PCOS and Hormonal Imbalance

Polycystic ovarian syndrome is among the most common endocrine diseases prevalent among reproductive-age females, with an estimated prevalence of 8-13% across the globe, but higher prevalences have also been noted based on the specific diagnostic criteria and





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community examined. Although hyperandrogenism, ovulatory disorders, and polycystic ovarian appearance characterize the syndrome clinically, the syndrome's impacts extend beyond reproductive health. Polycystic ovarian syndrome is now considered a multifactorial metabolic-endocrine disorder that is influenced by factors such as hormonal imbalance, insulin resistance, oxidative stress, dyslipidaemia, obesity, and low-grade chronic inflammation. In the affected individuals, infertility, type 2 diabetes mellitus, metabolic syndrome, cardiovascular disease, and endometrial abnormalities are also highly prevalent.

The main pathophysiology of PCOS involves hormonal imbalance, caused by intricate relations between metabolic, endocrine, genetic, and environmental factors. Hyperinsulinism serves as an adaptation mechanism, which increases the concentration of free androgens in the bloodstream due to increased androgen production in ovaries and reduced production of SHBG in the liver. Irregular menstrual cycles and reproductive system disorders develop as a consequence of disruption in hypothalamic-pituitary-ovarian axis signaling. It also interferes with proper development and maturation of the follicles and their subsequent release. The complex nature of PCOS is additionally confirmed by studies on oxidative stress, mitochondria dysfunctions, adipose tissue inflammation, and alterations in the gut microbiome.

Examples of pharmacological therapies include ovulation-inducing drugs, insulin sensitizing drugs, combined oral contraceptive pills, and anti-androgen treatment, among others, which are being used in combination with lifestyle modifications. Although these approaches may be successful in managing some of the clinical features, they are primarily symptom-driven and often restricted due to side effects, lack of efficacy, and inability to manage the inflammatory and metabolic aspects underlying the disease pathophysiology. For this reason, an increasing number of phytotherapeutic approaches based on bioactive phytochemicals are now being employed, which aim to modify multiple disease pathways





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at the same time. There are several botanicals and plant extracts which have been found to exhibit mechanistic and experimental as well as clinical support for their efficacy in improving insulin resistance, hormonal balance, oxidative stress, inflammation, and fertility, apart from being used in a supplementary manner. This chapter aims to critically review the major phytotherapeutic approaches employed for PCOS taking into consideration all these aspects.

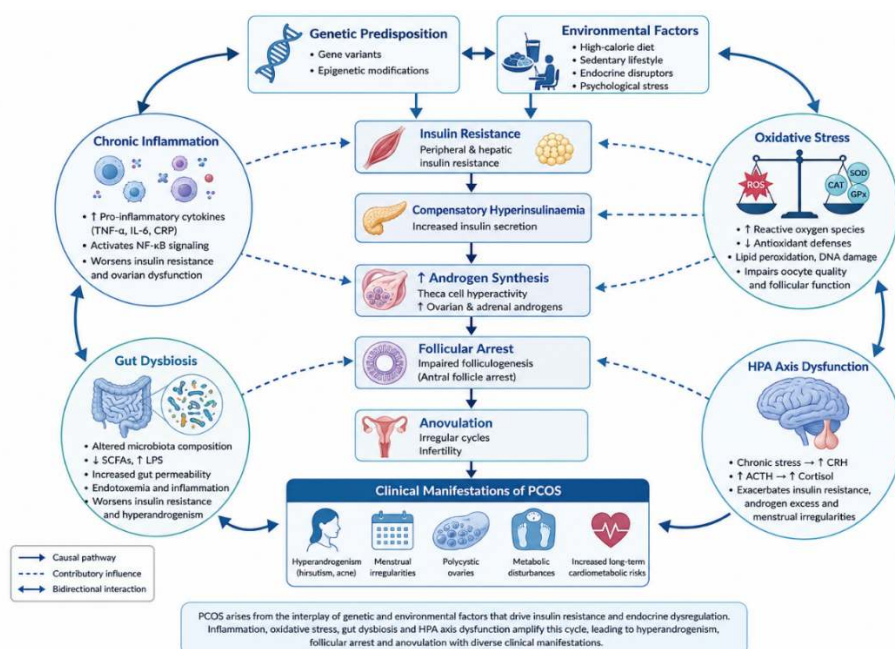


Fig 1: PCOS Pathophysiology

2. Concept of Phytotherapeutic Regimens

Shift from a symptomatic therapy to one that is capable of attacking multiple disease-causing pathways simultaneously has been enabled by an enhanced knowledge of PCOS as a complex endocrine metabolic disorder. Controlling hyperandrogenism, ovulatory dysfunction, insulin resistance, and infertility still requires conventional pharmacological management; however, the majority of therapeutic agents are made to address specific





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clinical manifestations rather than the interrelated metabolic and endocrine abnormalities that sustain disease progression. As a result, phytotherapeutic interventions with broad-spectrum biological activity and the ability to simultaneously affect multiple molecular targets are receiving more attention.

Medicinal plants contain a variety of phytochemicals, such as polyphenols, flavonoids, alkaloids, terpenoids, lignans, saponins, and organosulfur compounds, which together affect metabolic, inflammatory, oxidative, and endocrine networks, in contrast to synthetic drugs that usually interact with a single receptor or signalling pathway. These bioactive components have been shown in experiments to control insulin signalling through the AMPK and PI3K/Akt pathways, enhance endogenous antioxidant defence through Nrf2 signalling, improve glucose utilisation through GLUT4 activation, suppress NF- κ B-mediated inflammatory responses, restore mitochondrial function, and modulate ovarian steroidogenesis. The idea that phytotherapy functions through interconnected metabolic and reproductive pathways rather than discrete molecular targets is further supported by emerging data showing that a number of botanicals have positive impacts on intestinal barrier integrity and gut bacteria composition.

Additionally, phytotherapy has evolved from a conventional complementary practice into an evidence-based therapeutic field due to the increasing amount of experimental and clinical data. The use of specific botanicals to improve insulin sensitivity, reduce androgen excess, attenuate oxidative stress and chronic inflammation, restore ovulatory function, and improve reproductive and metabolic outcomes in women with PCOS is increasingly supported by randomised clinical trials, controlled experimental studies, and mechanistic investigations. Crucially, the therapeutic potential of phytotherapy is found in both individual medicinal plants and well-planned therapies that incorporate botanicals with complementary modes of action. Compared to isolated herbal supplementation alone,





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these regimen-based methods recognise the molecular complexity of PCOS and provide a more integrated framework for addressing its various clinical manifestations.

This being the case, this chapter opts for a regimen-centered analysis instead of herb-centered in categorizing phytotherapeutic treatment approaches based on the purposes of therapy instead of herbs used. This method takes note of the current understanding that the simultaneous treatment of insulin resistance, hyperandrogenism, oxidative stress, inflammation, microbial imbalance in the intestines, and ovarian disorders is essential to the effective treatment of PCOS. Phytotherapeutic treatments have thus been categorized in different but mutually reinforcing therapy regimens that take care of the processes mentioned above, as the disorder has a complex pathogenesis. Taking note of the modes of action, preclinical and clinical data, treatment effects, safety, and translational possibilities, the major phytotherapy regimens investigated for PCOS will be critically analyzed in the following chapters.

Table 1: Overview of Major Phytotherapeutic Regimens Investigated for PCOS

Regimen	Primary therapeutic target	Representative botanicals/formulations	Principal evidence-supported outcomes
Insulin-sensitizing botanical therapy	Insulin resistance, hyperinsulinemia	Berberine, myo-inositol, D-chiro-inositol, cinnamon, curcumin	Enhanced ovulation, metabolic profile, and insulin sensitivity
Anti-androgenic therapy	Hyperandrogenism, ovarian steroidogenesis	Spearmint, licorice, peony-based botanicals	Enhanced endocrine, metabolic, and stress response
Functional foods & nutraceutical	Inflammation, oxidative stress, metabolic	Omega-3 fatty acids, flaxseed, probiotics, coenzyme Q10	Enhanced metabolic, antioxidant





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als	dysfunction		, and inflammatory indicator
Polyherbal formulations	Multitarget endocrine and metabolic regulation	Ayurvedic and standardized polyherbal formulations	concurrent enhancement of metabolic and reproductive result
Seed cycling	Hormonal balance, menstrual cyclicity	Flax, pumpkin, sesame and sunflower seeds	Enhanced regularity of menstruation and specific metabolic factor

3. Major therapeutic regimens

3.1 Insulin-sensitising botanical therapy

Introduction

One of the common metabolic disturbances in PCOS is insulin resistance, which is related to hyperinsulinemia, ovarian androgen excess, reduced production of sex hormone-binding globulin, anovulation, and irregular menstrual cycles. Additionally, dyslipidemia, oxidative stress, chronic inflammation, and a higher risk of cardiometabolic problems are linked to it. Metformin remains the cornerstone of therapy; however, due to its limitations, such as gastrointestinal irritation and unreliable efficacy, there has been increased interest in plant-based alternatives. The bioactive compounds derived from plants provide complementary action with regard to oxidative stress, insulin signaling, glucose metabolism, inflammatory responses, and ovarian functions. It has been proven that they





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can positively affect metabolic and reproductive parameters of women with PCOS as adjuvant treatment.

Major Botanicals

The composition of insulin-sensitizing phytomedicine includes phytochemicals which influence different aspects of the syndrome of polycystic ovaries. Such phytochemicals include berberine which positively impacts lipid metabolism, insulin sensitivity, glucose uptake, and inflammation management. The insulin signaling, metabolic health, and ovulation are positively influenced by MI and DCI in the ratio of 40:1. Quercetin, cinnamon polyphenols, ginsenosides, and astragalosides have the ability to act as an insulin sensitizer during experiments while curcumin and resveratrol work on the basis of their antioxidant, anti-inflammatory, and metabolic properties.

Mechanism of Action

Through the coordinated modification of cellular pathways controlling insulin responsiveness and glucose homeostasis, insulin-sensitizing botanicals produce therapeutic benefits. In insulin-responsive tissues, experimental research consistently shows that the IRS–PI3K/Akt signaling cascade is activated, improving insulin signaling, encouraging GLUT4 translocation, and raising glucose uptake. Berberine, ginsenosides, astragalosides, and paeoniflorin are examples of phytochemicals that further activate AMP-activated protein kinase (AMPK), which enhances glucose utilization, inhibits hepatic gluconeogenesis, and controls lipid metabolism. While activation of the Nrf2 pathway increases cellular antioxidant defense, concurrent suppression of NF- κ B, JNK, and MAPK signaling reduces chronic inflammation linked to insulin resistance. Additionally, a number of botanicals potentiate insulin receptor signaling by inhibiting protein tyrosine phosphatase 1B (PTP1B). By these complementary mechanisms, insulin-sensitizing botanicals improve metabolic homeostasis, decrease compensatory





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hyperinsulinemia, and indirectly mitigate ovarian hyperandrogenism, thereby supporting their multitarget therapeutic role in the management of PCOS.

Preclinical Evidence

As a result of the modification of the pathways regulating insulin sensitivity and glucose homeostasis, the use of botanical insulin sensitizers leads to beneficial effects. The experiments have confirmed that the insulin signaling pathway, IRS-PI3K/Akt, becomes active in the insulin-sensitive tissue, thus increasing the activity of insulin signaling, promoting GLUT4 translocation and increasing the level of glucose uptake. Examples of the phytochemicals leading to additional activation of AMP-activated protein kinase (AMPK) include berberine, ginsenosides, astragalosides, and paeoniflorin. AMPK activation is associated with increased glucose utilization, inhibition of hepatic gluconeogenesis, and regulation of lipid metabolism. Moreover, Nrf2 pathway activation increases the level of cellular antioxidant defense, while inhibition of NF- κ B, JNK, and MAPK signaling decreases chronic inflammation connected to the development of insulin resistance. Several botanicals also increase the activity of insulin receptor signaling by inhibiting protein tyrosine phosphatase 1B (PTP1B). Due to such mechanisms, insulin sensitizing botanicals enhance metabolic homeostasis, decrease hyperinsulinemia, and reduce ovarian hyperandrogenism.

Clinical Evidence

Many insulin sensitizing plants have been proved to have a positive impact on PCOS affected patients in clinical studies. Improved insulin sensitization, lowered levels of insulin while fasting, return of ovulation, as well as menstrual cycles' normalization have been reported to be associated with the use of myo-inositol (MI) and D-chiro-inositol (DCI) at their physiological ratio of 40:1. Supplementation of berberine has been associated with the improvement in hyperandrogenic traits, insulin resistance and the process of glucose and lipids metabolism in some cases when its effectiveness is similar





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to that of classical insulin sensitizers. Clinical trials with curcumin have revealed positive outcomes in the management of glycaemia and insulin resistance, as well as in oxidative stress and inflammation.

Therapeutic Outcomes

Insulin sensitizers that are derived from plant sources appear to decrease symptoms related to hyperandrogenism and oxidation along with enhancing insulin sensitivity, glucose control, ovulation, menstrual cyclicality, and lipids metabolism. It can be concluded that the use of such natural compounds as adjuvants for treating disorders associated with PCOS is well-founded.

Limitations

Existing research lacks large enough sample sizes, a lack of adequate duration of treatment, inconsistency in botanical formulation used, as well as in dosage regimen utilized. In cases where there are inconsistencies in design and methodology of studies, the results for long-term efficacy and safety remain uncertain.

Safety

Despite their excellent tolerability and minimal side effects when administered in recommended doses, the poor standardisation, varying quality, and absence of safety data make it necessary to cautiously interpret and monitor these herbal compounds.

Future Directions

Future investigations on PCOS must centre on large-scale, multicentre randomised control trials that use standardised botanical extracts and an effective dosage regimen and follow patients for a long time. The use of biomarker-based endpoints and mechanistic studies would make insulin sensitising botanicals more applicable in evidence-based treatment of PCOS.





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3.2 Adaptogenic therapy

Introduction

It is now known that the pathophysiology of polycystic ovarian syndrome (PCOS), involving neuroendocrine regulation, oxidative stress, inflammation, and ovarian dysfunction, is also affected by chronic stress of both psychological and physiological nature. The concept of stress regulation being another treatment modality is justified on the basis that the disruptions caused by stress can further aggravate the hyperandrogenism, ovulatory dysfunction, and other metabolic disturbances. Botanical compounds called adaptogens have the ability to increase resistance to biological, pharmaceutical, and physical stimuli without disturbing physiological balance. Some of the best-studied adaptogenic plants include *Withania somnifera*, *Panax ginseng*, *Ocimum tenuiflorum* (Tulsi), and *Asparagus racemosus* (Shatavari).

Major Botanicals

Herbs with adaptogenic properties that increase the capacity to tolerate stress along with modulating neuroendocrine, inflammation, and metabolic pathways form the cornerstone of adaptogenic therapy in cases of PCOS. Biologically active withanolides are responsible for the antioxidant, immune-modulatory, and hormonal regulatory effects of *Withania somnifera* (Ashwagandha), one of the most commonly used adaptogenic herbs. *Panax ginseng*, rich in ginsenosides, has shown promise as an adaptogen in improving ovarian and metabolic functions in experimental setups. Eugenol, ursolic acid, and rosmarinic acid, present in *Ocimum tenuiflorum* (Tulsi), have been proven to have beneficial effects in experimental PCOS.

Traditional Ayurvedic adaptogens with immunomodulatory and homeostatic qualities include *Tinospora cordifolia* (Guduchi), which contains diterpenoid lactones and alkaloids, and *Asparagus racemosus* (Shatavari), which is distinguished by steroidal





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saponins (shatavarins). *Rhodiola rosea*, potentiated by rosavins and salidroside, has also been demonstrated to possess adaptogenic properties because of its ability to increase physiological resistance to stress. Collectively, these plants have a large number of bioactive components that form the basis of adaptogenic treatment for PCOS stress-induced endocrine disorders.

Mechanism of Action

The neuroendocrine, inflammatory, oxidative, and metabolic mechanisms associated with PCOS can be effectively regulated through adaptogenic herbs. The HPA axis undergoes regulation in experimental studies, leading to reduction in stress-induced neuroendocrine dysfunction. The process of limiting reactive oxygen species formation and the induction of the expression of antioxidant enzymes through endogenous activation of antioxidant mechanisms like the Nrf2 pathway allows protection of the ovaries from any oxidative injury. Adaptogens have the ability to inhibit the activation of the NF- κ B pathway and decrease the production of inflammatory factors like inducible nitric oxide synthase, IL-1b, and IL-6. Moreover, some adaptogenic herbs also improve steroidogenesis, hypothalamic-pituitary-ovarian axis activity, and enhance mitochondrial performance and energy metabolism as well as immunomodulatory effects. Such complimentary molecular actions facilitate the improvement of ovarian function and metabolic stability due to reduction in oxidative stress, chronic inflammation, and neuroendocrine dysfunction. The biological basis for the application of adaptogenic herbs in the treatment of PCOS is provided by these processes.

Preclinical Evidence

In experimental models of PCOS, preclinical research continuously shows the therapeutic potential of adaptogenic botanicals. Panax ginseng and Korean Red Ginseng decreased the development of ovarian cysts, restored oestrous cyclicity, regulated the expression of steroidogenic enzymes, and attenuated hyperandrogenism in PCOS mice generated by





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dehydroepiandrosterone and letrozole. *Ocimum tenuiflorum* decreased ovarian oxidative damage, increased antioxidant enzyme activity, corrected hyperglycaemia and dyslipidaemia, and improved hormonal profiles. *Asparagus racemosus* has been shown in experiments to protect against stress-induced reproductive failure by improving ovarian physiology and reducing oxidative stress. In letrozole-induced PCOS, *Vitex negundo* decreased cystic ovarian alterations, enhanced glucose tolerance, restored oestrous cyclicity, and restored reproductive hormone levels. All of these results point to the biological effectiveness of adaptogenic botanicals in reducing PCOS-related metabolic and reproductive problems.

Clinical Evidence

Although there is currently no clinical data to support adaptogenic therapy in PCOS, it may have advantages for metabolic and reproductive health. Major decreases in urine bisphenol A and malondialdehyde concentrations were shown in a randomised clinical trial assessing Korean red ginseng in women, along with benefits in monthly irregularity, menstrual pain, and other gynaecological problems without major side effects. The study confirms the significance of ginseng in lowering oxidative stress and enhancing female reproductive health, even though it was not limited to patients with PCOS.

Furthermore, Ashwagandha's adaptogenic activity related to stress-associated endocrine diseases has been regularly shown to reduce subjective stress and anxiety in placebo-controlled clinical studies. Strong randomised controlled trials that specifically assess adaptogenic botanicals in PCOS-affected women are still hard to come by, which emphasises the need for more extensive, carefully planned clinical trials to determine efficacy and improve treatment regimens.

Therapeutic Outcomes





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In animal models, adaptogenic herbal therapy has been shown to improve menstrual regularity, lower oxidative stress, restore ovarian function, and normalise metabolic and hormonal abnormalities, all of which have positive impacts on stress-associated endocrine dysfunction. Improvements in gynaecological symptoms and stress reduction are further supported by limited clinical evidence, suggesting that it may be used as an adjuvant therapy for the integrative management of PCOS.

Limitations

Lack of PCOS specific trials, smaller samples, varied dosages, inconsistency in botanical preparation, and inadequate follow-up time limit the amount of information. Such limitations make it harder to compare different studies and hinder the development of consistent treatment guidelines.

Safety

Botanical adaptogens usually enjoy excellent acceptability in clinical trials, although side effects may be observed in a few cases, although minor.

Future Directions

Botanical adaptogens usually enjoy excellent acceptability in clinical trials, although side effects may be observed in a few cases, although minor.

3.3 Gut hormone axis therapy

Introduction

In recent studies, it has been shown that gut-hormone axis is a key component that regulates endocrine and metabolic abnormalities that cause polycystic ovarian syndrome (PCOS). Decreased microbial diversity, reduced abundance of beneficial bacteria, impaired intestinal barrier function, and changes in microbial metabolic products are all signs of gut microbial dysbiosis in PCOS. These changes are linked to insulin resistance,





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hyperandrogenism, chronic inflammation, and ovulatory dysfunction. Through the estrobolome, a group of bacterial enzymes that controls oestrogen deconjugation and enterohepatic recirculation, the gut microbiota also affects oestrogen homeostasis by influencing the availability of circulating hormones. As a result, phytotherapeutic approaches that improve gut barrier integrity, boost the generation of short-chain fatty acids, restore microbial balance, and reduce inflammatory signalling have become viable supplemental therapies. Gut-directed phytotherapy offers a mechanistically integrated approach to PCOS management by addressing the reciprocal connections between intestinal microbiota, metabolism, immunology, and ovarian endocrine function rather than focusing on a single disease mechanism.

Major botanicals

Numerous medicinal plants improve PCOS-related metabolic and endocrine problems while also restoring microbial balance, which has therapeutic benefits on the gut-hormone axis. One of the phytochemicals that has been studied the most is berberine, which is isolated from *Berberis* species. It lowers hyperinsulinemia and androgen excess by increasing the number of bacteria that produce short-chain fatty acids, strengthening the intestinal barrier, lowering inflammation brought on by lipopolysaccharide, and improving insulin sensitivity. Recent research has shown that *Scutellaria baicalensis* can improve ovarian morphology, insulin resistance, and reproductive function in experimental PCOS by enriching beneficial genera like *Phocaeicola*, restoring microbial diversity, lowering serum lipopolysaccharide concentrations, and inhibiting the TLR4/NF- κ B inflammatory pathway. Through estrobolome-dependent pathways, soy isoflavones, such as daidzein and genistein, undergo microbial biotransformation to equol, a metabolite with a higher affinity for oestrogen receptors than its precursor. This process supports oestrogen homeostasis. Instead of focusing on a single pathological pathway, herbal formulations high in flavonoids, polysaccharides, and polyphenols also support the growth of beneficial





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microbes, boost the production of short-chain fatty acids, control the metabolism of bile acids, and improve intestinal barrier function.

Mechanism of Action

By re-establishing intestinal microbial balance and modifying human metabolic and endocrine signalling, gut–hormone axis phytotherapy has therapeutic effects. By increasing beneficial short-chain fatty acid-producing bacteria and decreasing dysbiosis-associated taxa, botanicals alter the makeup of gut microbes, improving intestinal barrier integrity and minimising endotoxin translocation, according to experimental research. Reduced exposure to lipopolysaccharides inhibits the TLR4/NF- κ B inflammatory pathway's activation, reducing the chronic low-grade inflammation linked to ovarian malfunction and insulin resistance. Additionally, a number of phytochemicals improve insulin sensitivity and glucose utilisation via influencing PI3K/Akt and AMPK signalling. At the same time, β -glucuronidase-mediated oestrogen recycling is modified by modification of the estrobolome, which helps maintain hormonal balance. By coordinated control of the gut-metabolic-endocrine axis rather than a single molecular target, these interrelated pathways improve metabolic regulation, decrease hyperandrogenism, and restore ovarian function.

Preclinical Evidence

Preclinical research repeatedly shows that altering the gut microbiome improves PCOS-related metabolic and reproductive problems. A causal role for gut dysbiosis in disease pathogenesis was established in a seminal faecal microbiota transplantation study where recipient mice colonised with microbiota from women with PCOS developed insulin resistance, disrupted oestrous cyclicity, elevated testosterone concentrations, cystic ovarian morphology, and decreased fertility. In PCOS rats, an experimental intervention with *Scutellaria baicalensis* enhanced ovarian shape, insulin sensitivity, and endocrine function while also restoring microbial diversity, enriching *Phocaeicola*, and reducing





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intestinal inflammation through suppression of the LPS/TLR4/NF- κ B pathway. Further research on animals has demonstrated that phytochemical-mediated improvement of intestinal barrier integrity and short-chain fatty acid-producing bacteria attenuates metabolic dysfunction and systemic inflammation, supporting gut-directed phytotherapy as a mechanistically validated treatment for PCOS.

Clinical Evidence

The therapeutic promise of gut-directed phytotherapy is supported by clinical evidence; however, there are still few well-designed human studies. Berberine has been shown to improve fasting insulin, HOMA-IR, waist circumference, testosterone concentrations, and overall metabolic profile in trials. These improvements are accompanied by favourable modulation of gut microbial composition and decreased endotoxin-associated inflammation. Additionally, new clinical evidence suggests that treatments that support the production of short-chain fatty acids and beneficial microbial taxa enhance endocrine parameters, menstrual regularity, and insulin sensitivity. Successful colonisation with *Bifidobacterium lactis* V9 raised short-chain fatty acid levels, decreased the LH/FSH ratio, and enhanced hormonal balance in one clinical investigation, demonstrating the functional significance of microbiota restoration. All of the available clinical data point to the potential benefits of gut microbiota-targeted phytotherapeutic approaches for PCOS patients' metabolic and reproductive health. Larger randomised controlled trials are necessary because the database is still limited by relatively small cohorts, varied therapies, and a lack of long-term follow-up.

Therapeutic Outcomes

By re-establishing microbial balance, gut–hormone axis phytotherapy shows concurrent benefits in metabolic and reproductive outcomes. Clinical and experimental data show improvements in ovarian function, endocrine regulation, and general metabolic





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homeostasis along with decreases in menstrual dysfunction, hyperandrogenism, insulin resistance, and inflammatory activity.

Limitations

Small sample sizes, inconsistent microbiome assessment techniques, varied treatment durations, different phytotherapeutic approaches, and inadequate long-term follow-up all restrict the current clinical evidence. Establishing repeatable clinical recommendations requires standardised procedures and multicentre randomised controlled trials.

Safety

Studies that are currently available show that gut-directed phytotherapeutic interventions have favourable tolerability and no significant side effects. Standardised dosage, herb-drug interactions, and long-term safety, however, call for more clinical assessment.

Future Directions

Standardised botanical formulations, microbiome-guided patient classification, mechanistic validation, and extensive multicentre clinical trials combining microbiome sequencing with endocrine and metabolic outcome evaluation should be the top priorities for future research.

3.4 Anti-androgen therapy

Introduction

Anovulation, irregular menstruation, hirsutism, acne, and poor follicular growth are all consequences of hyperandrogenism, which is a hallmark of polycystic ovarian syndrome (PCOS). Androgen regulation is a major therapeutic goal since persistent androgen excess exacerbates ovarian dysfunction and metabolic disorders. Because some medicinal plants can control androgen production, androgen receptor function, and related endocrine disorders, anti-androgenic phytotherapy has become a supplemental strategy. Botanicals





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with the ability to lower circulating androgen levels, enhance ovulatory function, and restore hormonal homeostasis have been found through experimental and clinical research. These results highlight the need for an evidence-based assessment of the safety and effectiveness of anti-androgenic botanicals as supplemental therapies in the integrative therapy of PCOS.

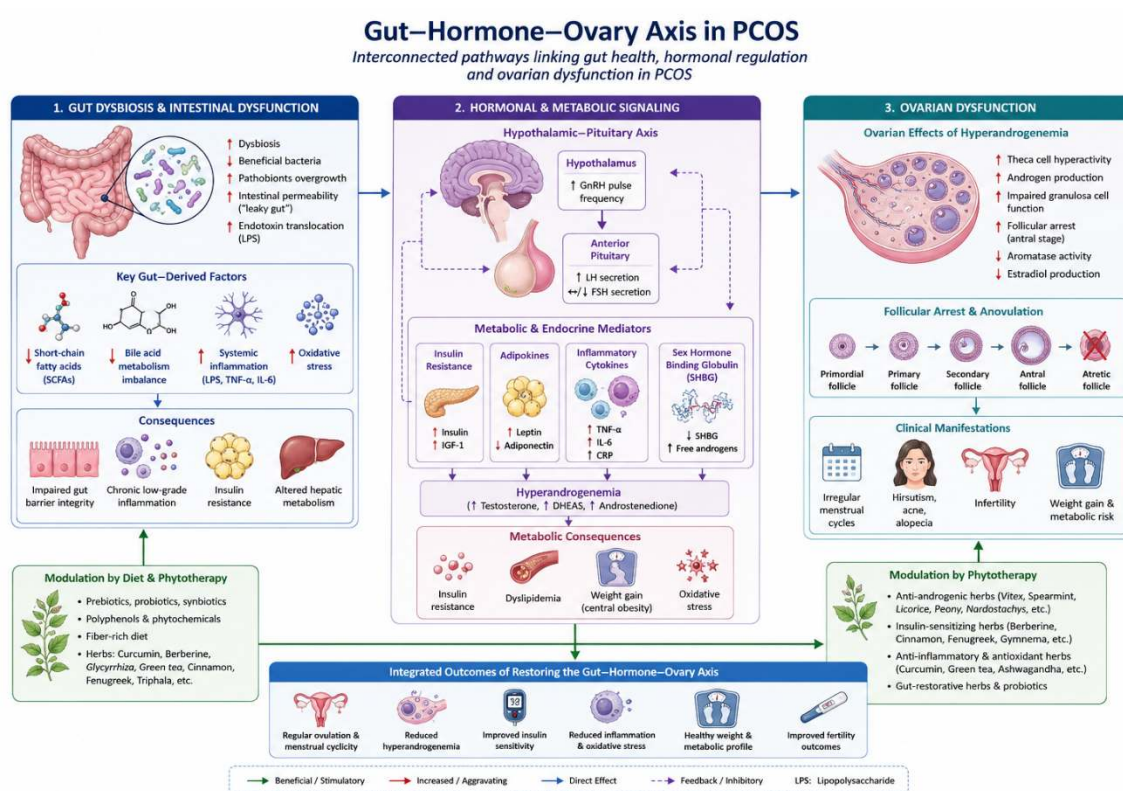


Fig 2: Gut Hormone Ovary Axis

Major Botanicals

By altering androgen production, metabolism, or receptor signalling in PCOS and associated hyperandrogenic illnesses, a number of botanicals have shown anti-androgenic





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action. Combining *Glycyrrhiza* spp. (licorice) with traditional anti-androgen medication has been found to increase its efficacy in lowering circulating testosterone. Chinese peony, or *Paeonia lactiflora*, is sometimes used alongside licorice to enhance ovulatory outcomes and reproductive endocrine function. *Mentha spicata*, or spearmint, has been shown to reduce free testosterone and lessen hyperandrogenism's clinical symptoms. The Chaste tree, *Vitex agnus-castus*, mainly controls pituitary hormones and helps to restore ovulatory function. Black cohosh, or *Cimicifuga racemosa*, has been studied as a supplement to ovulation induction and has shown advantages in reproductive endocrinology. *Tribulus terrestris*, *Nardostachys jatamansi*, *Symplocos racemosa*, and *Zingiber officinale* (ginger) are among the botanicals that have been shown to minimise androgen excess, restore ovarian shape, and improve hormonal profiles in animal models or clinical investigations. When taken as a whole, these plants are the main phytotherapeutic agents being studied for the treatment of PCOS-related hyperandrogenism.

Mechanism of Action

Multiple targets implicated in androgen excess and ovarian dysfunction are modulated by anti-androgenic botanicals. Through the regulation of steroidogenic enzymes and decreased ovarian testosterone production, experimental studies show inhibition of androgen biosynthesis. Additionally, many botanicals decrease the conversion of testosterone to the more powerful dihydrotestosterone (DHT) by inhibiting 5 α -reductase or antagonistic androgen receptor signalling. To help restore endocrine balance, other medications encourage the aromatisation of testosterone to oestrogens. Furthermore, there have been reports of decreases in prolactin, fasting insulin, and luteinizing hormone, which indirectly reduce ovarian androgen synthesis and enhance follicular maturation. Additionally, certain phytochemicals raise sex hormone-binding globulin (SHBG), which decreases androgen absorption and circulating free androgens. The rationale for anti-





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androgenic phytotherapy in the treatment of PCOS is supported by these complementary activities, which together restore ovulatory function, regulate steroid hormone profiles, and reduce hyperandrogenic symptoms without focusing on a single endocrine pathway.

Preclinical Evidence

The anti-androgenic potential of several botanicals in experimental PCOS models is consistently supported by preclinical studies. *Tribulus terrestris* and *Nardostachys jatamansi* exhibited anti-androgenic activity in vitro and subsequently restored oestrous cyclicity, improved follicular development and normalised testosterone, oestradiol and progesterone levels in oestradiol valerate-induced PCOS rats. Likewise, *Symplocos racemosa* significantly reduced elevated testosterone and restored oestrogen and progesterone levels, ovarian histoarchitecture, and normalised ovarian and uterine weights in letrozole-induced PCOS. Additional evidence from experimental endocrine models further supports the ability of selected botanicals to modulate excess androgens via restoration of reproductive hormone balance and ovarian function. In summary, these findings provide mechanistic and biological evidence that anti-androgenic phytotherapy is a promising approach for the management of hyperandrogenism in PCOS.

Clinical Evidence

Some anti-androgenic botanicals may improve endocrine and reproductive outcomes in women with PCOS and hyperandrogenic disorders, according to clinical studies. *Mentha spicata* supplementation has been shown in randomised controlled trials to reduce free testosterone concentrations and improve hirsutism scores. Glycyrrhiza spp. alone or in combination with *Paeonia lactiflora* has been associated with significant reductions of circulating testosterone, increased menstrual cyclicity, and improved ovulatory function. Adjunctive use of *Cimicifuga racemosa* with clomiphene citrate has shown higher ovulation and pregnancy rates than clomiphene alone, suggesting that it may improve reproductive outcomes. In a similar vein, a larger review of clinical trials in women with





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PCOS, menstrual irregularities and hyperandrogenism, reported reductions in luteinizing hormone, fasting insulin and testosterone with selected herbal interventions, and improvements in ovulatory function and fertility-related outcomes. However, current evidence is limited by relatively small sample sizes, heterogeneous botanical formulations and short intervention duration.

Therapeutic Outcomes

In view of the present evidence, the principal outcome of phytotherapy with anti-androgenic plants appears to be the amelioration of hyperandrogenic traits along with reproductive gains. Decreased androgen concentrations, regularity of menstruation cycles, recovery of follicular development and ovulation processes, and positive changes in ovarian microstructure have all been described in clinical and preclinical research. In addition, some botanical preparations have been shown to exhibit the ability to enhance fertility outcomes.

Limitations

Present day research is limited by the small sample size, open label trial, non-standard botanical preparation, variable extraction methods, and short duration of treatment intervention. Well-designed studies using standardised botanical preparations and powerful randomized control trials are required to validate efficacy and reproducibility in women with PCOS.

Safety

Clinical studies conducted so far have indicated that there are no serious adverse effects associated with therapy. Nevertheless, the safety profile of these herbs has not been properly studied, and the herb-drug interactions have not been established.

Future directions





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Botanical extracts that are standardised and well-designed clinical trials, phenotypically specific assessments, pharmacokinetic profiling and long-term safety analysis are the objectives for future research in order to allow evidence-based integration of phytotherapy in PCOS.

3.5 Polyherbal formulations

Introduction

Because they simultaneously address the endocrine, metabolic, and reproductive problems that underlie PCOS, polyherbal formulations have drawn interest in its treatment. These formulations, in contrast to single-herb therapies, combine botanicals with complementary pharmaceutical actions, enabling simultaneous control of oxidative stress, insulin resistance, hyperandrogenism, ovulatory dysfunction, and chronic inflammation. Ovarian morphology, glucose homeostasis, lipid metabolism, and reproductive hormone profiles have all improved after treatment with standardised polyherbal formulations, according to experimental research. Their capacity to enhance menstrual cyclicity and specific metabolic markers while preserving a favourable safety profile is further supported by recent clinical studies. For all-encompassing PCOS treatment, polyherbal therapy is a multitarget phytotherapeutic approach that combines conventional medical knowledge with new experimental and clinical data.

Major Botanicals

By combining botanicals that target complementary disease pathways, many standardised polyherbal formulations have shown therapeutic potential against PCOS. In experimental PCOS models, DXB-2030—which contains *Trigonella foenum-graecum*, *Aloe vera*, *Sphaeranthus indicus*, *Nardostachys jatamansi*, and *Symplocos racemose* improved glucose tolerance, increased GLUT4 expression, decreased serum testosterone, restored oestrous cyclicity, and reduced ovarian cystic follicles.





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In letrozole-induced PCOS rats, a second formulation containing *Saraca asoca*, *Gymnema sylvestre*, *Pergularia daemia*, *Cinnamomum zeylanicum*, *Caesalpinia bonduc*, and *Withania somnifera* improved hormonal and lipid profiles, restored insulin receptor, AMPK, and GLUT4 expression, and improved reproductive performance.

In a similar vein, a polyherbal tablet including *Bauhinia variegata*, *Trigonella foenum-graecum*, *Berberis aristata*, *Curcuma longa*, *Commiphora myrrha*, and *Saraca asoca* decreased testosterone, corrected hyperglycaemia and dyslipidaemia, restored oestrous cyclicity, and significantly decreased the production of ovarian cysts. Clinical data from an open-label Unani formulation also showed improvements in blood insulin, ovarian volume, BMI, waist circumference, and menstrual regularity in PCOS-affected women while maintaining a satisfactory safety profile.

Mechanism of Action

PCOS-related endocrine and metabolic pathways are co-ordinately modulated by polyherbal formulations to produce therapeutic effects. AMP-activated protein kinase (AMPK) is activated, and insulin receptor (INSR) and GLUT4 expression is restored, according to experimental research, which improves insulin sensitivity and glucose absorption. By normalising the expression of important steroidogenic enzymes, lowering the free androgen index, raising sex hormone-binding globulin, and re-establishing the levels of progesterone and oestrogen in the blood, these formulations also control ovarian steroidogenesis. Ovarian architecture is further preserved, and follicular maturation is supported by concurrent decrease of oxidative stress and inflammatory signalling. Multiple phytoconstituents work together to create complementary effects across interconnected biochemical pathways that improve metabolic homeostasis and support endocrine balance and ovulation.

This multitarget mechanism offers a mechanistic foundation for the therapeutic use of polyherbal formulations in PCOS and sets them apart from single-compound therapies.





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Preclinical Evidence

The effectiveness of polyherbal formulations in experimental PCOS models has been repeatedly shown by preclinical research. In testosterone propionate-induced PCOS rats, DXB-2030 improved glucose tolerance, restored oestrous cyclicity, decreased serum testosterone, increased GLUT4 expression, and significantly reduced ovarian cystic follicles. In letrozole-induced PCOS, a second polyherbal formulation containing *Saraca asoca*, *Gymnema sylvestre*, *Pergularia daemia*, *Cinnamomum zeylanicum*, *Caesalpinia bonduc*, and *Withania somnifera* normalised insulin receptor, AMPK, and GLUT4 expression, restored ovarian steroidogenic enzymes, enhanced lipid metabolism, and decreased follicular cysts. In a similar vein, a combination of *Bauhinia variegata*, *Trigonella foenum-graecum*, *Berberis aristata*, *Curcuma longa*, *Commiphora myrrha*, and *Saraca asoca* restored ovarian histoarchitecture, normalised reproductive hormone profiles, improved glycaemic and lipid parameters, and corrected hyperandrogenism. Collectively, these experimental results show broad treatment efficacy across PCOS-related endocrine, metabolic, and reproductive problems.

Clinical Evidence

Although there is still little clinical research on polyherbal formulations for PCOS, the results show promise. After three treatment cycles, 73.3% of patients in an open-label clinical research examining a Unani polyherbal formulation containing *Anethum sowa*, *Nigella sativa*, *Trigonella foenum-graecum*, *Ruta graveolens*, *Matricaria chamomilla*, and *Luffa echinata* reported regaining menstrual cyclicity. Ovarian volume, serum insulin, body mass index, and waist circumference also showed notable changes; objective improvements were noted in 53.3%, 36.7%, 13.3%, and 13.3% of women, respectively. During the research period, very mild side events were documented, and the formulation was usually well tolerated. Larger randomised trials are necessary to confirm the effectiveness of standardised polyherbal formulations in managing PCOS, even though





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these results support their clinical potential. Current evidence remains constrained owing to the scarcity of controlled clinical trials and long term follow up studies.

Therapeutic Outcomes

The endocrine, metabolic, and reproductive attributes of PCOS have all revealed to be effective with polyherbal formulations. Oestrous cyclicity restoration, ovarian morphology normalization, insulin sensitivity improvement, reduction of hyperandrogenism, and dyslipidaemia correction are some of the things that have been repeatedly noted from the experiments conducted. There is little evidence from the clinical studies regarding the improvement of monthly regularity, ovarian morphology, anthropometric measures, and insulin homeostasis.

Limitations

The lack of clinical trials, different forms, different herbal ingredients, and absence of follow-ups have made it difficult to make a direct comparison between studies and develop treatment guidelines accordingly.

Safety

Existing data show good tolerance with few side effects. However, standardized quality control and further safety evaluations are required for clinical use.

Future Directions

In order to incorporate the polyherbal therapy in PCOS management through evidence-based practice, future studies need to focus on standardized polyherbal therapy, randomized controlled multicenter trials, mechanism confirmation, and safety evaluations.

3.6 Seed cycling

Introduction





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A new nutritional intervention, termed "seed cycling", has gained attention as a supplementary method to address the endocrine and metabolic disorders associated with polycystic ovarian syndrome (PCOS). For achieving normal hormonal fluctuations, the dietary intervention involves the consumption of flaxseeds and pumpkin seeds in the follicular phase and sesame seeds and sunflower seeds in the luteal phase. Seed cycling has the ability to improve certain metabolic and menstrual parameters in patients with PCOS as per the latest scientific data. In a study conducted after three months of seed cycling, an open-label interventional study reported improved menstrual cycles along with reduced body mass index.

Major Botanicals

In order to treat the hormonal and metabolic abnormalities related to PCOS, seed cycling is an approach that utilizes four types of nutritious seeds on a phase-specific diet. The seeds that include the flaxseed (*Linum usitatissimum*) and pumpkin seeds (*Cucurbita pepo*) are consumed during the follicular stage to enhance insulin sensitivity, follicle development, and oestrogen metabolism. Randomized studies provide the strongest scientific support in terms of the treatment effect of flaxseed on body weight, waist circumference, insulin resistance, triglycerides, leptin, and HDL cholesterol of PCOS affected women. Sesame (*Sesamum indicum*) and sunflower (*Helianthus annuus*) seeds contain lignans, vitamin E, selenium, and fatty acids, which help in maintaining the reproductive hormones, regulate androgens, SHBG levels and antioxidants.

Mechanism of Action

While conventional drug therapy uses one specific drug as its therapeutic target, seed cycling relies on the synergistic biological effects of the four individual seeds involved. Pumpkin seeds contain zinc and magnesium that help increase insulin signaling, glucose metabolism, and steroidogenesis by ovaries. The lignans from the flax seeds work to alter





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the metabolism of oestrogen, increase SHBG, and reduce free androgen availability during the follicular phase.

Together, these effects reduce oxidative stress, enhance insulin responsiveness, restore normal gonadotropin secretion, and promote ovarian function restoration. These molecular changes are reliably linked in clinical and experimental investigations to improvements in endocrine balance, metabolic indices, and menstrual cyclicity in PCOS women undergoing systematic seed-cycling therapies.

Preclinical Evidence

The majority of experimental investigations assess individual seeds rather than the entire intervention, and preclinical evidence for seed cycling is still scarce. In experimental settings, components of flaxseed, pumpkin seed, sesame, and sunflower seed have shown antioxidant, anti-inflammatory, insulin-sensitising, and hormone-modulating activities. However, there are currently no direct animal or in vitro studies examining the effectiveness of the full seed-cycling approach in PCOS, indicating a significant gap in the body of evidence.

Clinical Evidence

Interventional trials that assess both the full seed-cycling procedure and individual seed supplementation provide clinical evidence in favour of seed cycling in PCOS. Women who received a portion-controlled diet together with seed cycling throughout a 12-week interventional trial showed improvements in hormonal balance and significant decreases in LH and FSH concentrations as compared to baseline.

78% of patients in another three-month intervention reported having regular menstrual cycles again, while another 19% reported having more frequent cycles. Menstrual cyclicity significantly improved during the intervention period, while hirsutism and random blood





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glucose did not significantly change. This suggests that reproductive effects were more prominent than androgenic symptoms.

Significant decreases in body weight, BMI, waist circumference, fasting insulin, HOMA-IR, triglycerides, and leptin were shown in randomised clinical trials examining flaxseed supplementation, a key element of seed cycling, whereas HDL cholesterol and adiponectin increased.

These results are corroborated by a large cohort study that showed improvements in waist circumference, waist-to-hip ratio, testosterone, prolactin, LH, FSH, fasting blood glucose, LDL-cholesterol, and total cholesterol after a 12-week seed-cycling intervention. A recent case report further demonstrated that six months of treatment was associated with the return of regular menstruation, reduced BMI, and improved hormonal regulation. When combined with comprehensive dietary therapy for PCOS, seed cycling improves menstrual function, metabolic health, and some endocrine parameters, according to current clinical research.

Therapeutic Outcomes

According to recent clinical research, seed cycling helps women with PCOS achieve better endocrine balance, menstrual regularity, and certain metabolic markers. Positive increases in gonadotropin levels, insulin resistance, lipid profile, anthropometric measurements, and ovarian morphology have been reported, which supports its use as a supplemental dietary intervention in addition to lifestyle management.

Limitations

Conclusions about the effectiveness of standardised seed-cycling procedures in PCOS are difficult to draw due to small sample sizes, inconsistent outcome assessments, varied intervention protocols, and a lack of randomised controlled trials.





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Safety

There were no significant adverse effects linked to seed cycling, and clinical investigations revealed high tolerance. However, additional assessment is necessary for long-term safety and adherence.

Future Directions

Standardised seed-cycling procedures, sufficiently powered randomised controlled trials, and long-term follow-up should be given top priority in future research to determine the best dosage, length of treatment, and phenotype-specific therapeutic advantages in PCOS.

3.7 Functional Foods and Nutraceuticals

Introduction

By addressing the metabolic abnormalities that underpin the development of polycystic ovarian syndrome, functional foods have become a popular supplemental dietary approach. Functional foods offer bioactive substances in a dietary matrix that can affect insulin sensitivity, oxidative stress, inflammation, gut flora composition, and endocrine homeostasis, in contrast to isolated phytochemicals. Beyond traditional nutritional counselling alone, clinical evidence suggests that dietary therapies enhanced with functional foods enhance metabolic and reproductive outcomes. To address the interrelated metabolic and hormonal abnormalities typical of PCOS while promoting long-term dietary adherence, there is growing interest in food-based interventions that combine biological activity with nutritional quality.

Major Functional Foods

Whole foods and fermented items enhanced with bioactive substances that affect metabolic and reproductive health are considered functional foods in PCOS research. Due in significant part to its lignans, α -linolenic acid, and dietary fibre, flaxseed has shown





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advantages in menstrual regularity, ovarian morphology, insulin resistance, and LH/FSH ratio in clinical investigations. Fenugreek seeds have been linked to decreased polycystic ovarian morphology and increased menstrual cyclicity. Additionally, a randomised dietary intervention that combined fenugreek with black raisins improved insulin resistance, body weight, hirsutism, and menstrual regularity more than dietary counselling alone. New research also supports probiotic-containing functional meals and fermented foods high in soy isoflavones, which target metabolic dysfunction by improving insulin sensitivity and modifying the gut microbiota. When taken as a whole, these food-based therapies offer complementary dietary methods that can help women with PCOS improve their reproductive and metabolic problems.

Mechanism of Action

Through the coordinated modification of metabolic, inflammatory, and endocrine pathways, functional foods have therapeutic effects in PCOS. By boosting the generation of short-chain fatty acids, enhancing the integrity of the intestinal barrier, and lowering metabolic endotoxemia linked to persistent low-grade inflammation, dietary fibre and fermented functional foods encourage positive changes in gut microbiota. By enhancing glucose utilisation and controlling cellular insulin signalling, polyphenols, lignans, and isoflavones improve insulin sensitivity. Additionally, their antioxidant qualities prevent oxidative stress and shield ovarian tissue from reactive oxygen species. Furthermore, bioactive food ingredients alter inflammatory mediators, which lowers pro-inflammatory cytokines in the blood and enhances metabolic balance. Clinical research also shows that these pathways can normalise reproductive hormone profiles, enhance lipid metabolism, reduce insulin resistance, and restore ovulatory function. Taken together, the synergistic effects of functional foods justify their inclusion as evidence-based dietary adjuncts in the management of PCOS.





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Preclinical Evidence

Functional dietary components have been shown in experiments to improve both metabolic and reproductive problems in PCOS animals. By modifying insulin-sensitive pathways and oestrogen receptor signalling, soy-derived isoflavones enhanced ovarian shape, decreased hyperandrogenism, and restored steroidogenic balance. Probiotic treatments that included *Lactobacillus* and *Bifidobacterium* species increased insulin responsiveness, decreased systemic inflammation, improved intestinal barrier function, and restored gut microbial balance. Following microbiome-targeted nutritional therapies, animal studies also showed better glucose metabolism, stabilisation of oestrous cyclicity, and reduction of ovarian oxidative stress. These results offer biological proof that functional meals alter interrelated metabolic, endocrine, and gut-ovarian processes linked to the pathophysiology of PCOS.

Clinical Evidence

According to clinical data, functional dietary interventions help women with PCOS achieve better metabolic and reproductive results. Participants in a randomised controlled trial who received structured dietary counselling along with daily supplements of 10g soaked fenugreek seeds and 20 g black raisins for 12 weeks showed greater reductions in body weight, BMI, insulin resistance, and hirsutism than the standard-care group. The intervention arm also reported full menstrual cycle normalisation. Reproductive hormone profiles, insulin sensitivity, lipid metabolism, and gut microbiota composition have all improved in other randomised trials assessing soy isoflavone–probiotic combinations, demonstrating the therapeutic benefit of microbiome-directed nutritional therapies. All things considered, recent clinical research indicates that functional meals, especially when combined with lifestyle changes, offer quantifiable advantages for PCOS patients' metabolic, endocrine, and reproductive parameters.





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Therapeutic Outcomes

Functional dietary therapies have proven clinically relevant changes in insulin sensitivity, body weight, menstrual regularity, hirsutism, lipid metabolism, and reproductive hormone profiles in women with PCOS. Dietary methods involving bioactive foods, particularly when paired with organised lifestyle modification, also promote positive changes in gut microbial composition and metabolic equilibrium, suggesting their potential as supplementary nutritional therapies in PCOS therapy.

Limitations

Small study populations, a variety of dietary treatments, different formulations, and varying treatment periods limit the current body of evidence. These elements limit the creation of standardised functional dietary recommendations for PCOS and lessen study comparability.

Safety

Clinical investigations showed that functional foods were generally well tolerated and had few side effects. However, more research across a range of patient types is necessary to determine long-term safety and consistent intake recommendations.

Future Directions

To bolster the evidence for individualised nutritional management of PCOS, future research should focus on standardised functional food formulations, well-powered randomised clinical trials, and phenotype-specific dietary interventions.

4. Comparative Evaluation of Phytotherapeutic Regimens for PCOS





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Table 2: Comparison of Phytotherapeutic Regimens for PCOS

Regimen	Primary therapeutic target	Strength of evidence	Clinical maturity
Insulin-sensitising botanical therapy	Insulin resistance, glucose homeostasis	Very strong	High
Adaptogenic therapy	HPA-axis dysfunction, stress modulation	Moderate	Moderate
Anti-androgenic therapy	Hyperandrogenism, steroidogenesis	Strong	Moderate–High
Functional foods & nutraceuticals	Oxidative stress, inflammation, metabolic dysfunction	Strong	High
Polyherbal formulations	Multitarget endocrine & metabolic regulation	Moderate–Strong	Moderate
Seed cycling	Hormonal balance, menstrual cyclicity	Moderate	Emerging

While all of the phytotherapeutic regimens discussed in this chapter aim to address the intricate pathophysiology of PCOS, there are significant differences in their degree of clinical translation and experimental confirmation. The strongest body of data now supports insulin-sensitizing herbal medicine, which has been shown to enhance insulin resistance, ovulatory function, and metabolic outcomes in numerous mechanistic studies, animal models, and randomised human trials. Additionally, functional foods and nutraceuticals exhibit significant clinical maturity, especially when it comes to lowering oxidative stress, chronic inflammation, dyslipidaemia, and insulin resistance through well-researched substances like flaxseed, curcumin, omega-3 fatty acids, and inositol.

Strong mechanistic and preclinical data, on the other hand, supports anti-androgenic and adaptogenic therapy. An increasing number of clinical studies have shown improvements





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in androgen excess, ovarian function, neuroendocrine modulation, and hormonal abnormalities associated to stress. However, before these therapies may be regularly integrated into evidence-based practice, more extensive standardised clinical studies are still required.

Although variations in formulation composition, standardisation, and dosage limit cross-study comparability, polyherbal formulations show the benefit of synergistic multitarget activity. The least developed routine is seed cycling, which has encouraging clinical results for metabolic health and regular menstruation but little direct preclinical data and few controlled clinical trials.

All of the research points to the fact that no single treatment plan can effectively treat every facet of PCOS. The motivation for customised, multitarget phytotherapeutic techniques is strengthened by the fact that therapeutic tactics that combine complimentary mechanisms seem more appropriate for the diverse endocrine and metabolic disorders typical of the illness.

5. Challenges and Future Directions

Despite promising experimental and clinical results, a number of obstacles still prevent phytotherapeutic approaches from being routinely used in PCOS clinical care. It is an important limitation since there are huge differences in the variety of botanical species used, methods of plant material extraction, phytochemical compositions, dosage, treatment duration, and methodology. Also, despite some positive outcomes observed, many studies have limitations such as relatively small samples, short intervention period, and inadequate follow-ups. These factors affect the quality and applicability of the clinical data available.

Incompleteness of the mechanism of action for some phytotherapies is another important limitation. In spite of the fact that there were reports on modulation of insulin signaling,





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oxidative stress, inflammatory pathways, steroidogenesis, mitochondria function, and gut microbiota, there is still controversy about mechanistic data in different studies. Insufficient information about pharmacokinetics and herb-drug interactions as well as differences in concentration and bioavailability of active phytochemicals remain limitations for clinical applicability of herbal remedies.

Therefore, the future work should focus on conducting multicenter randomized controlled trials with the use of standardized botanical extracts and unified assessment criteria. Such research would allow making comparisons between different studies possible. Precision phytotherapy would become achievable due to pharmacokinetics profiling, patient stratification based on biomarkers, and mechanism researches.

Long-term safety review, quality control of herbal formulations, and assessment of phytotherapeutic interventions as supplements to proven treatments like metformin and lifestyle management should all receive more attention. When taken as a whole, these developments will bolster the body of evidence and encourage the logical incorporation of phytotherapy into evidence-based PCOS treatment.

6. Conclusion

The complex endocrine-metabolic condition known as polycystic ovarian syndrome necessitates treatment strategies that may address its interrelated hormonal, metabolic, inflammatory, and reproductive problems. Phytotherapeutic therapies target several pathogenic pathways, such as insulin resistance, hyperandrogenism, oxidative stress, chronic inflammation, gut microbial dysbiosis, and altered ovarian function, as this chapter has shown. Numerous botanicals and phytochemical-based regimens enhance endocrine and metabolic results while supplementing conventional therapy techniques, according to evidence from mechanistic investigations, experimental models, and an increasing number of clinical studies. The most solid clinical data now supports insulin-





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sensitizing botanicals and some functional meals, whereas other regimens need additional validation through well planned randomized controlled trials. However, the strength of evidence differs across therapies. Standardized herbal formulations, thorough clinical evaluation, mechanistic validation, and long-term safety assessment to enable their integration into evidence-based practice will be necessary for future advancements. All things considered, phytotherapeutic regimens are a potential multitarget strategy that enhances traditional management and provides a scientifically supported method for tackling the intricate pathophysiology of PCOS while promoting more tailored and thorough patient care.

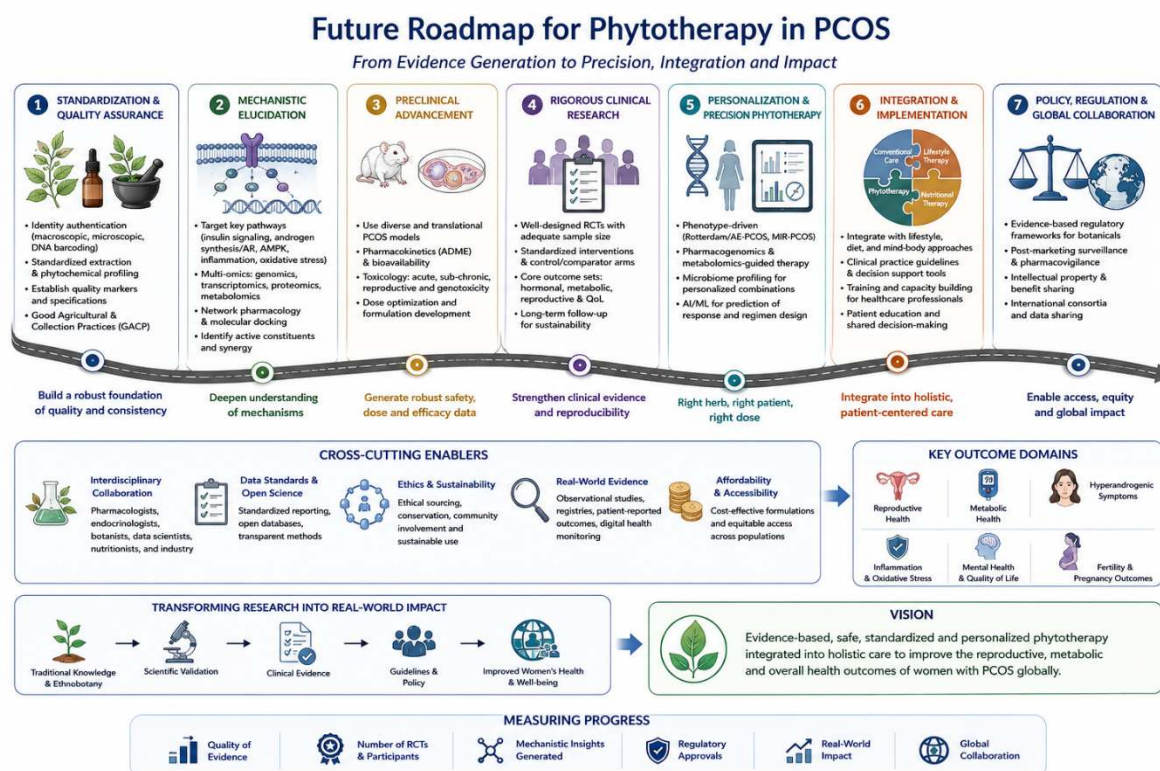


Fig 3: Future roadmap for Phytotherapy in PCOS





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