

FROM NATURE TO NURTURE: A REVIEW OF HERBAL APPROACHES TO POLYCYSTIC OVARY SYNDROME (PCOS)

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Abstract

Polycystic Ovary Syndrome (PCOS) is a multifaceted, complicated endocrine condition that specifically impacts women during their reproductive years, demanding the innovation and deployment of progressive and sophisticated treatment approaches to accurately focus on and alleviate its diverse range of symptoms and manifestations. This detailed study explores the effects of thirty-two plant-based extracts on PCOS revealing the work through pathways like hormone balance, insulin sensitivity, antioxidants, anti-inflammatory properties, weight management, hair growth regulation and menstrual cycle normalization. Some extracts like maca root, fenugreek and cinnamon are proven to help regulate blood sugar levels, control weight changes and enhance insulin sensitivity. Others like maca root, saw palmetto and vitex are effective in balancing hormone levels in individuals, with PCOS. Some other extracts like aloe vera, cohosh and spearmint have antioxidant and anti-inflammatory properties that reduce stress and inflammation commonly associated to PCOS patients This study highlights the benefits of incorporating remedies and plant extracts into overall treatment plans for PCOS. The main goal of this analysis is to explore treatment options that show potential in managing PCOS symptoms while also encouraging further scientific research to uncover the full therapeutic benefits of these botanical interventions.

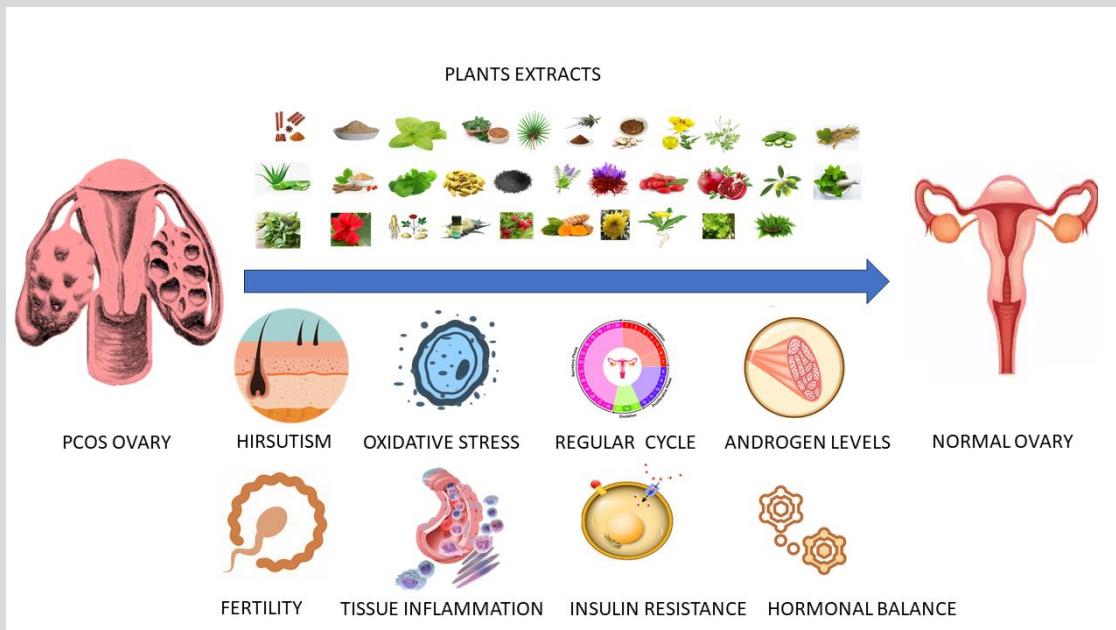


Figure 1: Graphical abstract elucidating the effects of different plant extracts on polycystic ovary syndrome

Keywords: Androgen levels, Fertility, Hirsutism, Hormonal balance, Insulin sensitivity, Menstrual regularity, Oxidative stress, Plant extracts, Polycystic ovary syndrome.

INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is a disorder that can be challenging for women's health during their reproductive years. It presents a variety of symptoms, including hormone imbalances and metabolic issues. The causes of PCOS involve environmental and lifestyle factors, highlighting the importance

of an approach to understand and treat it. Despite its occurrence and impact on women's well being PCOS is diverse in nature. Requires further investigation into its underlying mechanisms. In India, the prevalence of PCOS among women varies between 3.7% to 22.5% depending on the population studied and diagnostic criteria used. Different criteria yield prevalence rates.

10% with Rotterdam and AES criteria and 5.8% with NIH criteria. International studies suggest that PCOS prevalence can range from 4% to as high as 26%, in populations. [81], [82], [83], [84], [86].

The cause of PCOS is complex involving a combination of environmental and lifestyle factors emphasizing the importance of a treatment approach. Managing PCOS typically includes a mix of lifestyle changes, medications, cosmetic procedures and hormonal therapies. Recent advancements, in research have shed light on the aspects contributing to PCOS development. Scientists are currently exploring the imbalances and underlying mechanisms of PCOS to better understand their impact on the body. Studies have shown that PCOS goes beyond health concerns increasing the risk of conditions like insulin resistance, type 2 diabetes and heart diseases. However, diagnosing PCOS can be tricky due to its presentation among populations. Researchers are striving to develop methods for more precise diagnosis. The influence of PCOS on fertility and pregnancy outcomes is a focus area in medicine. Lifestyle changes such as diet adjustments and increased physical activity play a role, in managing ovary syndrome (PCOS). Research indicates that these modifications can help relieve symptoms boost fertility levels and address the metabolic challenges linked with PCOS. [86], [87].

Recent research has pinpointed factors that impact the severity of symptoms related to PCOS including levels of the Müllerian hormone, gut bacteria composition and blood compounds. It's crucial to understand that PCOS manifestations can differ significantly among individuals and evolve over time. While scientists are delving into the root causes of PCOS and the influence of environmental factors, on its onset continuous studies are vital for enhancing its detection, treatment and overall management. Further investigation is needed to ascertain the safety and efficacy in the run of therapies for PCOS. With the prevalence of this condition in mind exploring the potential advantages of using plant extracts to alleviate PCOS symptoms as indicated by recent research findings is imperative. Additionally, researchers are delving into medications and customized treatment approaches tailored to presentations of PCOS with a goal to enhance patient outcomes. They are also examining PCOS impacts on pregnancy outcomes like diabetes risk and preeclampsia risk in order to improve healthcare for women with PCOS before and, during pregnancy. [85], [87], [88], [89], [90].

Hormonal imbalances can be effectively managed with remedies, like calcarea carb for individuals advised to undergo hormone treatment or surgery. Various studies have shown the effectiveness of calcarea carb in treating syndrome especially for those experiencing symptoms like irregular menstrual cycles, breast tenderness before periods, painful menstruation and weight gain. While other remedies such as pulsatilla, sepia, lycopodium, natrum mur, nux vomica, phosphorus, silicea, kali carb, arsenic and graphite have shown promise too; calcarea carb has been identified as the remedy in many instances. However it's important to note that the full effectiveness of remedies in managing PCOS has not been thoroughly studied. Further research is needed through designed trials and comparative studies with treatments to determine the potential benefits of natural remedies for PCOS. [44], [45], [96], [97], [98].

In medicine practices for ovary syndrome (PCOS) metformin is commonly used as a treatment option. Some studies suggest that letrozole, pioglitazone and clomiphene citrate are equally effective in inducing ovulation and promoting pregnancy in patients, with PCOS. The potential of drug candidates Irosustat

(STX64) and STX140, in treating PCOS is promising due to their ability to regulate hormones and reduce inflammation both factors in the development of the condition. Metformin, known for its insulin-sensitizing properties improves cell sensitivity to insulin counteracting insulin levels that contribute to androgen levels better menstrual regularity and improved ovulation. Contraceptive Pills (OCPs) lower androgen. Increase sex hormone binding globulins offering relief from symptoms like hirsutism, acne and hair loss. Despite the benefits seen in some studies with Metformin, OCPs and other treatments for PCOS symptoms they may not work effectively for all women with the condition. This highlights the importance of exploring treatment options, for PCOS management. [44], [45], [96], [97], [98].

Traditional treatment approaches typically target symptoms, like menstrual cycles, excess androgens and insulin resistance in individuals with PCOS. Recent research has shed light on impact of plant extracts on aspects of PCOS. [91], [92], [93].

In this analysis, our goal is to explore the connection between PCOS and specific plant extracts to understand to deal with the condition. By examining findings and considering implications we hope to contribute to the development of more personalized and evidence-based strategies for managing PCOS.

The investigation into plant-based remedies for health issues has picked the interest of the scientific community leading to a deeper exploration of their potential in addressing complex endocrine disorders like PCOS. The diverse effects of plant compounds, on managing syndrome are detailed in the table below [12].

S.No	Name of the Plant	Phytochemicals	PCOS mechanism	References
1.	<i>Vitex agnus castus</i>	Monoterpenoids, diterpenoids, flavonoids, iridoids	suppresses cyst formation, improves the ovulatory cycles, suppresses the prolactin levels	12, 20, 21, 22, 23, 80
2.	<i>Curcuma longa</i>	Curcuminoids	Enhances corpus luteum development, displays estrogenic, antihyperlipidemic, antioxidant, and hypoglycemic properties, and prevents ovarian cell dysfunction; improves ovulation and fertility	12, 33,34,35,36,42
3.	<i>Glycyrrhiza glabra</i>	flavonoids, isoflavonoids, glycyrrhizin, phytoestrogens	Possess anti-androgen properties, promote insulin secretion, and decrease blood sugar levels.	3, 10, 38
4.	<i>Cinnamomum species</i>	polyphenols	Enhances insulin selectivity and hypoglycemic effects by activating the insulin signalling pathway, regularizes menstrual cycles, and exhibits strong anti-inflammatory and antioxidant properties.	1,2,5,6,12,32
5.	<i>Punica granatum</i>	Flavonoids, phytosterols	Normalizes levels of free testosterone, serum estrogen, and androstenedione hormone in the blood and reduces androgen levels.	4, 12, 67, 68
6.	<i>Aloe species</i>	anthraquinone derivatives, flavonoids, phytosterols, polyphenols	Partial reversion of estrous cyclicity, suppresses overall androgen secretion, and restores glucose sensitivity.	7, 12, 29
7.	<i>Trigonella foenum-graecum</i>	phytosterols, terpenoids, flavonoids, alkaloids, saponins	Suppresses cyst formation, reduces the LH/FSH ratio and helps to maintain a regular menstrual cycle.	5,6,7,8,9,10
8.	<i>Panax ginseng</i>	saponins	Improves fertility by regulating the estrous cycle, which involves suppressing the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH)	11,12,66
9.	<i>Cimicifuga racemosa</i>	triterpene glycosides and phenolic acids	suppresses cysts, and reduces LH production.	12, 27, 28
10.	<i>Mentha spicata</i>	Carotenoids, phenols, flavonoids	Spearmint has anti-inflammatory, anti-diabetic, and anti-cancer properties, regulates LH and FSH blood ratio, reduces testosterone levels and hirsutism, and improves ovarian cysts in PCOS by reducing atretic follicles and enhancing graafian follicles.	12, 13

The following sections thoroughly explore a spectrum of plant extracts, elucidate their documented effects on PCOS, and lay the foundation for a more detailed comprehension of these botanical interventions.

1. Cinnamon (*Cinnamomum species*)

Cinnamon has been discovered to have an impact, on the way insulin works on glucose in individuals with polycystic ovary syndrome (PCOS). It is believed that hormonal imbalances play a role in managing the cycle, studies have looked into cinnamon's potential to lower androgen levels, which could

cause hair growth and acne in PCOS patients. Its antioxidant and anti-inflammatory properties also help reduce inflammation and oxidative stress related to PCOS. Cinnamon is also helpful in managing body weight, which is crucial for handling symptoms associated with PCOS. High body fat can worsen insulin resistance in those with PCOS. [2], [32].

Aqueous cinnamon extracts made by soaking the bark in water have been found to enhance insulin sensitivity and decrease insulin resistance in both animal models and human trials. Ethanol extracts of cinnamon, created by steeping the bark in ethanol are thought to have effects on insulin sensitivity and resistance. Both forms contain compounds like cinnamaldehyde and cinnamic acid which aid, in regulating the cycle and improving insulin sensitivity. [1], [5], [6].

2. Maca root (*Lepidium species*)

Maca root, a plant known for its qualities has been discovered to aid in balancing hormones for women with ovary syndrome (PCOS). Its intake can improve cycle regularity, fertility, energy levels and antioxidant capacity. The use of maca root to address PCOS symptoms is widespread, with yellow or cream maca being the variety. Maca root can be ingested in forms such as powder, capsules or as an ingredient in smoothies and other dishes. Studies have shown that maca roots have the ability to promote balance reduce androgen levels and boost ovulation frequency leading to fertility. Additionally, maca roots offer benefits for insulin sensitivity improvement and blood glucose regulation which is crucial given the insulin resistance seen in PCOS. Its antioxidants fight stress linked to PCOS and inflammatory properties aiding in reducing inflammation in rodent models of PCOS. [16], [17], [79], [80].

3. Spearmint (*Mentha spicata*)

Research conducted on rodents indicates that spearmint, a plant known for its inflammatory and antioxidant properties has been found to alleviate hirsutism, a common symptom of polycystic ovary syndrome (PCOS) by reducing androgen levels, especially free testosterone levels. This process is believed to be regulated through pathways. Spearmint's ability to balance hormones also plays a role, in regulating the cycle and promoting regularity in women with PCOS. Its antioxidative and anti-inflammatory properties aid in addressing inflammation and oxidative stress associated with PCOS. Spearmint helps in the regulation of hormones like luteinizing hormone (LH) and follicle stimulating hormone (FSH) which are often imbalanced in individuals with PCOS. Spearmint can be consumed either as tea or as a supplement although the appropriate dosage and frequency may vary. The use of spearmint leaf extract is common for research purposes and its potential therapeutic benefits for individuals, with PCOS. [13].

4. Fenugreek (*Trigonella foenum-graecum*)

Fenugreek, a herb known for its uses in cooking and medicine over the years has been studied in animals to explore its impact, on polycystic ovary syndrome (PCOS). Studies indicate that fenugreek can enhance the body's response to insulin and reduce resistance to it aiding in managing blood sugar levels and alleviating PCOS symptoms. It also plays a role in restoring balance by regulating luteinizing hormone (LH). Follicle stimulating hormone (FSH) levels are often disrupted in PCOS. Compounds like quercetin, luteolin, genistein and vitexin found in fenugreek have demonstrated effects on addressing PCOS symptoms. Additionally, fenugreek may boost ovulation frequency. Potentially enhance fertility. The herbs antioxidants

help combat stress associated with PCOS while also exhibiting inflammatory properties given the connection between chronic inflammation and PCOS, fenugreek aids in improving profiles by lowering cholesterol and triglyceride levels that can be elevated in individuals, with PCOS. [5], [6], [8], [9].

5. Saw Palmetto (*Serenoa repens*)

The use of extract, from the saw palmetto plant has been researched for its impact on PCOS. Addressing specific symptoms of the condition. Studies have shown that it possesses androgenic properties that can decrease androgen activity. These properties include reducing testosterone levels enhancing balance and promoting frequent ovulation all of which enhance the chances of conception. For women with PCOS, this may help alleviate hirsutism and other symptoms related to androgens. While not the cause of PCOS inflammation can exacerbate its symptoms. Research on saw palmetto in rodents has provided insights into the effect of herbal remedies on factors linked to PCOS. The antioxidant attributes of saw palmetto may enhance well being by diminishing inflammation and symptoms associated with PCOS. [18], [19], [29].

6. Chasteberry (*Vitex agnus-castus*)

Vitex, also known as chasteberry or *Vitex agnus castus* is a remedy, for PCOS that helps maintain balance by regulating the hypothalamus and pituitary gland. This aids in monitoring ovulation and enhancing fertility in women with PCOS. Additionally Vitex supports the restoration of a cycle and prevents skin issues like acne that result from elevated androgen levels in PCOS. Studies on animals particularly rodents have shown potential benefits of Vitex for PCOS. The imbalance between luteinizing hormone (LH) and follicle-stimulating hormone (FSH) is common, in PCOS. This equilibrium can assist in tracking ovulation boosting fertility regulating cycles potentially reducing acne and promoting skin health. [20], [21], [22], [23].

7. Licorice (*Glycyrrhiza glabra*)

Licorice root, a remedy has been discovered to enhance insulin sensitivity, an issue, in polycystic ovary syndrome (PCOS) that can cause elevated blood sugar levels and increase the risk of developing type 2 diabetes. Managing body weight is crucial for addressing PCOS and licorice root aids in weight management. Its anti-inflammatory properties reduce inflammation. Also boosts insulin sensitivity lowering the chances of high blood sugar levels and type 2 diabetes. Further, it plays a role in regulating hormones beneficial for individuals with PCOS who often face imbalances like elevated androgen levels. Licorice root extract is also beneficial for promoting cycles among women, with PCOS. [10], [38].

8. Evening Primrose Oil (*Oenothera biennis*)

Gamma linolenic acid (GLA) an omega 6 fatty acid can be found in evening primrose oil (EPO) a supplement that has been researched for its effects, on ovary syndrome (PCOS). EPO may impact hormone balance, a factor in PCOS. Studies indicate that GLA present in EPO plays a role in managing these imbalances and alleviating PCOS symptoms. Further, its anti-inflammatory properties aid in reducing inflammation benefiting women with PCOS. Notably, EPO can help alleviate acne and enhance skin health by regulating hormone levels in some individuals with PCOS. It also contributes to mitigating disturbances commonly associated with PCOS due to fluctuations, in hormone levels. [24], [25], [26].

9. Black Cohosh (*Cimicifuga racemosa*)

The extract, from the cohosh plant has been traditionally utilized for addressing health issues. This impacts hormonal equilibrium. Nevertheless, limited research has been carried out regarding its application in the context of syndrome (PCOS). It is currently under investigation for its potential to alleviate flashes and mood swings which are experienced by some women with PCOS during their transition to menopause along with menopausal symptoms. There is a scarcity of animal studies, on the effects of cohosh with studies focusing on menopausal symptoms. [27], [28].

10. Bitter Melon (*Momordica charantia*)

Several health conditions, such, as syndrome (PCOS) have been connected to bitter melon. Researchers are exploring its potential to enhance insulin sensitivity, a factor in managing PCOS. Studies indicate that substances present in melon can boost insulin sensitivity leading to glucose control and a reduced risk of type 2 diabetes. Further, its anti-inflammatory and antioxidant properties can alleviate the stress and inflammation often seen in PCOS cases. Maintaining a weight is crucial for managing PCOS and bitter melon may aid in achieving this goal. bitter melon has a history of use in regulating blood sugar levels, which can help enhance blood sugar management and reduce fluctuations – both beneficial for individuals, with PCOS. [30], [31], [32].

11. Nettle Root (*Urtica dioica*)

Nettle root, also known as *Urtica dioica* can help alleviate the symptoms of PCOS by reducing inflammation. Its anti-inflammatory properties target the chronic inflammation often linked to PCOS. By lowering sex hormone binding globulin (SHBG) levels nettle root aids, in balancing androgen levels that tend to be high in individuals with PCOS. The impact of root on SHBG, which affects androgen balance may play a role in regulating balance since elevated androgens are common in PCOS. Additionally, the diuretic properties of root can be beneficial for alleviating water retention and bloating. Promoting increased urine flow and reduced water retention often experienced by individuals, with PCOS. [39], [40], [41].

12. Aloe vera/ *Aloe barbadensis*

Aloe vera, a known plant, for its soothing gel is said to have health benefits due to its anti-inflammatory properties. Its anti-inflammatory effects can help alleviate symptoms related to inflammation those not typically linked to treating PCOS. Research has extensively looked into Aloe vera's ability to heal wounds in animal studies showing its capacity to aid in tissue regeneration and repair. It has been found effective in treating stomach ulcers and enhancing digestion indirectly contributing to well-being. The antioxidants present in Aloe vera combat radicals and reduce the oxidative stress associated with PCOS. In a research study, it was noted that Aloe vera enhances insulin sensitivity, which is relevant for PCOS management given that insulin resistance is a trait of the condition. Improved insulin sensitivity can lower the risk of developing type 2 diabetes. It helps regulate blood sugar levels [7], [29].

13. Amla or Indian Goose berry (*Emblica officinalis*)

Amla, a plant, in vitamin C and antioxidants has qualities that aid in fighting oxidative stress linked to PCOS. This stress can lead to inflammation and hormonal imbalances. The high vitamin C content of amla supports the system, which is vital for overall health and managing PCOS symptoms. Additionally,

amla possesses inflammatory properties that are beneficial for individuals with PCOS. Previous research suggests that amla offers metabolic advantages for treating PCOS, such, as regulating blood sugar levels and enhancing insulin sensitivity. [42], [43].

14. Ashwagandha (*Withania somnifera*)

Ashwagandha, a plant is known for its ability to address health concerns, including polycystic ovary syndrome (PCOS). Its benefits encompass maintaining balance reducing stress levels improving insulin sensitivity possessing inflammatory properties and promoting regular menstrual cycles. Ashwagandha is thought to assist in regulating sex hormone levels by lowering elevated androgen levels commonly seen in PCOS. Managing stress is vital, for individuals with PCOS as it can exacerbate symptoms and hormonal imbalances. Enhancing insulin sensitivity can aid in managing blood sugar levels and decreasing the risk of developing type 2 diabetes an issue among PCOS patients. Research on the inflammatory properties of ashwagandha in animal studies suggests that its ability to regulate hormones like testosterone can be advantageous for those, with PCOS. [50], [51].

15. Brahmi (*Bacopa Monnieri*)

Bacopa Monnieri, also known as Brahmi is a herb known for its qualities and ability to combat stress in individuals, with PCOS. Its antioxidant and anti-inflammatory properties play a role in reducing stress and inflammation linked to PCOS. Brahmi has been shown to assist in stress management due to its calming effects observed in animal research. The phytochemicals present, in Brahmi are believed to help alleviate stress and inflammation. [52], [53].

16. Cardamom (*Elettaria cardamomum*)

Individuals diagnosed with syndrome (PCOS) may find relief, in incorporating cardamom into their diet. This aromatic spice, commonly used in both medicine and culinary practices boasts anti-inflammatory properties that can help alleviate oxidative stress and inflammation associated with PCOS. Cardamom is known to support metabolic functions by reducing the likelihood of developing type 2 diabetes enhancing insulin sensitivity and regulating blood sugar levels. Further, it has the potential to ease bloating and gastrointestinal discomfort particularly beneficial for individuals managing PCOS. Some individuals also turn to cardamom aromatherapy for relaxation purposes, which inadvertently aids in stress management among those with PCOS. Despite its reputation for health benefits scientific evidence regarding its specific impact, on PCOS remains limited. [55], [56].

17. Black cumin (*Nigella sativa*)

Black cumin seeds, also referred to as *Nigella sativa* seeds, are recognized for their health benefits, in medicine. These seeds contain phytochemicals such as thymoquinones, known for their inflammatory and antioxidant properties. The anti-inflammatory nature of thymoquinone can help alleviate inflammation associated with ovary syndrome (PCOS) while its antioxidant properties may aid in reducing oxidative stress linked to PCOS. Studies indicate that black cumin seeds could assist in hormone balance commonly disrupted in PCOS. Many PCOS patients face insulin resistance and the risk of type 2 diabetes, these seeds contribute to regulating blood sugar levels, which are crucial, for managing the condition. [57], [58].

18. Sage (*Salvia officinalis*)

Sage, a herb commonly used in cooking is believed to have effects, on ovary syndrome (PCOS) and is valued in traditional medicine for its health benefits. It contains compounds, like flavonoids, known for their properties and rosmarinic acid a polyphenol that has both anti-inflammatory and antioxidant qualities. Since oxidative stress often contributes to PCOS these components are thought to possess antioxidant and inflammatory properties that could be beneficial. PCOS is also linked to inflammation. [59].

19. Saffron (*Crocus sativus*)

The dried stigmas of *Crocus sativus* flowers are utilized to create saffron, a spice known for its flavour and potential health benefits. The unique colour of saffron is attributed to phytochemicals, like crocin and its anti-inflammatory and antioxidant properties have been the subject of research. These attributes have the potential to combat stress linked to conditions such as PCOS (polycystic ovary syndrome). Saffron's anti-inflammatory characteristics aid in reducing inflammation, which plays a role, in treating PCOS. [60], [61].

20. Barberry (*Berberis vulgaris*)

Berberis plants contain a compound known as berberine, which has been extensively researched for its health benefits, especially in connection, with polycystic ovary syndrome (PCOS). Studies have revealed that berberine can help reduce fasting blood sugar levels enhance insulin sensitivity decrease insulin resistance and stabilize blood sugar levels. All factors for managing PCOS. It boasts inflammatory properties that aid in reducing chronic inflammation and shielding the body from oxidative harm. Apart from enhancing hormone balance and fertility in PCOS patients berberine plays a role in weight management since obesity can exacerbate PCOS symptoms. , it may contribute to maintaining cycles essential for fertility and overall well-being. Research also suggests that berberine can improve profiles by lowering LDL cholesterol levels, which is beneficial for individuals with PCOS who are, at higher risk of heart-related issues. [62], [63], [64].

21. Pomegranate (*Punica granatum*)

The fruit called pomegranate (*Punica granatum*) is packed with seeds and vibrant red juice. Its antioxidant and anti-inflammatory effects are linked to polyphenols, like anthocyanins, tannins, flavonoids and punicalagins which act as antioxidants. These components help combat stress related to PCOS and neutralize free radicals. Since chronic inflammation is a characteristic of PCOS, the anti-inflammatory qualities of a pomegranate can aid in mitigating PCOS symptoms. Some research suggests that pomegranates can enhance heart health reduce blood pressure improve cholesterol levels and lower the likelihood of issues. It may assist in regulating blood sugar levels. An advantage for individuals with PCOS who often face insulin resistance and are prone to developing type 2 diabetes, incorporating pomegranate into a treatment plan, for PCOS could offer health benefits. [4], [67], [68].

22. Olive (*Olea europaea*)

The olive leaf plant, scientifically known as *Olea europaea* is renowned for its inflammatory and antioxidant properties. Researchers have delved into the health advantages of this plant in managing polycystic ovary syndrome (PCOS). Oleuropein, a polyphenol found in olive leaves boasts both inflammatory and antioxidant characteristics. These antioxidants play a role, in

combating the stress linked to PCOS. The olive leaf extracts anti-inflammatory traits can help ease the inflammation often seen in individuals with PCOS. Some research suggests that incorporating olive leaf extract into one's routine may assist in regulating blood sugar levels. This is particularly significant for individuals with PCOS who face insulin resistance and an increased risk of developing type 2 diabetes. Further studies have explored how olive leaf extract may benefit health by reducing blood pressure and enhancing cholesterol profiles. Such discoveries could hold implications for individuals with PCOS who are more susceptible, to heart-related issues [69], [70], [71].

23. Peppermint (*Mentha × Piperita*)

Peppermint, known for its flavour and scent can be helpful, in managing PCOS. Its active components called glycosides offer a cooling effect. Have effects on health. Peppermint possesses inflammatory properties that contribute to overall well-being. The soothing aroma of peppermint is often linked to relaxation and stress relief which are crucial for individuals with PCOS. Peppermint oil is sometimes applied topically for pain relief, including headaches and muscle soreness. Research has also explored its efficacy in alleviating cramps, an issue among PCOS patients. [72].

24. Basil (*Ocimum basilicum*)

In Ayurvedic medicine, holy basil, sometimes called tulsi, is a revered herb with several possible health benefits. It contains phytochemicals with anti-inflammatory and antioxidant properties such as eugenol. Stress reduction, anti-inflammatory properties, antioxidant effects, blood sugar regulation, and hormonal balance are some of the possible benefits. PCOS-related chronic inflammation can be reduced by eugenol and other substances, and oxidative stress can be prevented by antioxidants. For PCOS patients, who often suffer from insulin resistance and are at risk of developing type 2 diabetes, holy basil can also help to control blood sugar levels. Holy basil has traditionally been used in Ayurvedic medicine to promote overall hormonal health, although there are few direct animal studies on its effects on hormonal balance in the context of PCOS. Further research is required to fully understand its potential impact on PCOS management. [73], [74].

25. Hibiscus

The health benefits of hibiscus a flowering plant have been extensively researched due, to its properties. Anthocyanins and vitamin C found in hibiscus help combat stress, an issue in individuals with polycystic ovary syndrome (PCOS). Hibiscus extract has been discovered to lower blood pressure by relaxing blood vessels and enhancing circulation along with reducing cholesterol levels for those with lipid profiles. Further, the plant contains compounds that possess inflammatory effects aiding in alleviating chronic inflammation often associated with PCOS. , hibiscus extracts exhibit properties that can be advantageous for individuals dealing with insulin resistance and fluctuating blood sugar levels. While there is research on the impact of hibiscus on PCOS specifically patients may find incorporating it into their diet beneficial due, to its potential advantages. [76], [77], [78].

26. Ginseng (*Panax ginseng*)

Polycystic ovary syndrome (PCOS) can be treated with ginseng or *Panax ginseng*, a popular medicinal herb that has long been used traditionally. Ginsenosides found in ginseng are believed to

play an important role in the potential health benefits of plants. People with PCOS need to learn to manage their stress, as it can affect hormone balance and overall health. The antioxidant and adaptogenic properties of these ginsenosides help the body to adapt to stress and maintain balance. According to previous studies, ginseng can help control blood sugar, which is important in PCOS patients who have insulin resistance and are prone to type 2 diabetes. Ginseng is often used to increase vitality and energy levels in PCOS patients who feel tired and have low energy intake. [66]

27. Eucalyptus

Studies have been conducted on the possible effects of eucalyptus, a plant known for its essential oil and use in aromatherapy, on polycystic ovary syndrome (PCOS). Although coughing, congested airways, and respiratory problems are not directly related to PCOS, oil has been shown to relieve these symptoms. The mild anti-inflammatory and antioxidant properties of eucalyptus essential oil, such as eucalyptol, help reduce oxidative stress and inflammation associated with PCOS. Stress management is important for PCOS patients because it affects hormone balance and overall health. [65].

28. Red raspberry (*Rubus idaeus*)

Red raspberry leaves are a popular herbal remedy for women's health, particularly during pregnancy and menstruation. It is known for its high content of vitamins and minerals, including calcium, vitamin C, and vitamin E, as well as tannins that give it an astringent taste. Potential benefits include promoting uterine health, easing menstruation, and strengthening uterine muscles, which can relieve cramps and other menstrual problems. Red raspberry leaves also contain antioxidants, such as vitamins C and E, which help combat oxidative stress associated with polycystic ovary syndrome (PCOS). However, little is known about the effects of red raspberry leaves in animal studies, particularly in PCOS treatment. [48], [49].

29. Turmeric (*Curcuma longa*)

Turmeric's bioactive ingredient, curcumin, has been studied for possible health benefits, including anti-inflammatory, antioxidant and metabolic properties. Although curcumin is not a direct treatment for polycystic ovary syndrome (PCOS), it has been studied in connection with several medical conditions. Its powerful antioxidant effects can combat the oxidative stress associated with PCOS, while its powerful anti-inflammatory properties can help relieve symptoms associated with PCOS. According to some studies, curcumin helps control blood sugar levels and improves insulin sensitivity. This is especially important for patients with PCOS who are insulin-resistant and at risk for type 2 diabetes. Promising results have been observed in a small number of animal studies, particularly regarding their anti-inflammatory, antioxidant, and metabolic properties. According to certain animal studies, curcumin can increase insulin sensitivity and control blood sugar levels by increasing insulin receptor function and the cellular uptake of glucose. [33], [34], [35], [36], [42].

30. Chrysanthemum

The flowering plant Chrysanthemum, which has aromatic flowers and is used in traditional herbal medicine, is known for its potential health benefits. It contains anti-inflammatory and antioxidant flavonoids and terpenoids that help combat the oxidative stress associated with polycystic ovary syndrome (PCOS). Chrysanthemum tea is known for its calming and

stress-relieving properties, because chronic stress can alter hormonal levels and overall well-being. These characteristics are particularly important in PCOS patients. [14], [15].

31. Maidenhair tree (*Ginkgo Biloba*)

Herbal supplements such as *Ginkgo biloba* can improve blood circulation and cognitive function. It contains bilobalide and ginkgolides, and its effects on the blood circulation and mental health have been studied. Flavonoids with antioxidant properties are also found in *Ginkgo biloba* and can improve cardiovascular health and blood circulation. It is believed to improve mental clarity and memory, which are linked to mood swings and cognitive changes in some patients with PCOS. *Ginkgo biloba's* flavonoids possess antioxidant properties that help combat oxidative stress, a condition linked to PCOS and potentially worsening this condition. Although the effects of *Ginkgo biloba* have not been thoroughly studied in animals, good blood circulation is vital to overall health. [46], [47].

32. Neem (*Azadirachta indica*)

Neem extract has been found to increase serum glucose, total cholesterol, triglyceride, low-density lipoprotein, very-low-density lipoprotein, insulin, testosterone, and luteinizing hormone levels in PCOS-induced rats. It has been shown to reduce lipid peroxidation and increase antioxidant parameters in liver homogenates of PCOS-induced rats. Neem leaf extract has been found to have beneficial effects in treating PCOS by downregulating PI3K gene expression. [75].

DISCUSSION

The exploration of phytochemical interventions for Polycystic Ovary Syndrome (PCOS) opens a realm of promising possibilities, addressing the multifaceted challenges associated with this complex endocrine disorder. The following discussion synthesizes the findings on various phytochemicals and provides an understanding of their impact on PCOS from both animal studies and clinical perspectives.

Comparative Effectiveness of Phytochemicals

The range of phytochemicals, including cinnamon and ginseng, has been found to vary in their ability to manage PCOS symptoms. While cinnamon has been shown to significantly improve insulin sensitivity, maca root has emerged as a potent regulator of hormonal imbalances. This diversity highlights the need for a personalized approach to treatment for individuals with PCOS.

Exploring the Mechanisms of Action

Understanding the mechanisms underlying the effectiveness of phytochemicals is essential for informed treatment decisions. Cinnamon, along with its components such as cinnamaldehyde and polyphenols, has a profound effect on insulin resistance. Maca roots, which are rich in adaptogenic properties, contribute to the hormonal balance. Delving into these molecular details not only supports the observed clinical outcomes but also informs the development of targeted interventions.

Bridging the Gap: Insights from Animal Studies

Animal studies play a pivotal role in bridging the gap between mechanistic understanding and clinical application of phytochemical interventions. Exploration of these phytochemicals in preclinical settings often sheds light on their underlying pathways and potential adverse effects. However, it is crucial to exercise caution when extrapolating these findings

to human physiology. As an illustration, the observed anti-androgenic effects of saw palmetto in rodent models underscore the need for further investigation to establish the safety and efficacy of these interventions in humans.

Challenges and Future Directions

Despite progress made in understanding phytochemical interventions, several challenges remain. Inconsistencies across studies, variations in methodologies, and scarcity of long-term investigations pose difficulties in formulating clear-cut recommendations. Future research should focus on implementing standardized methodologies, enlarging sample sizes, and extending follow-up periods to address these limitations comprehensively.

Towards an Integrative Approach

Accumulating evidence suggests that an integrative approach that combines conventional treatments with selectively chosen phytochemical interventions holds promise for effective PCOS management. Recognizing the heterogeneity of PCOS presentations and adopting personalized strategies that capitalize on the strengths of specific phytochemicals can lead to more effective and targeted therapeutic interventions.

CONCLUSION

In this extensive review paper elucidating the management of polycystic ovary syndrome (PCOS) using herbal remedies, a diverse array of natural interventions has emerged. Ranging from the metabolic adjustments induced by cinnamon to the attainment of hormonal equilibrium facilitated by maca root, and the androgen-reducing impacts of spearmint to the manifold advantages of fenugreek, the spectrum of botanical options presents a new outlook for addressing PCOS.

Each botanical entity, spanning from saw palmetto to vitex and licorice root to evening primrose oil, imparts a distinctive characteristic to the potential therapeutic repertoire. The inclusion of non-conventional yet promising agents such as bitter melon and nettle root underscores the intricate and plentiful nature of the herbal landscape. Aloe vera, amla, and ashwagandha not only mitigate oxidative stress but also contribute to holistic well-being. The herbal discourse extends beyond conventional confines with the incorporation of herbs, such as barberries, pomegranates, and olive leaves, introducing additional layers of antioxidant and anti-inflammatory effects. Basil, chrysanthemum, and dandelion roots not only offer unique sensory attributes but also harbor potential health benefits, whereas Ginkgo biloba integrates cognitive enhancement into the intricate fabric of hormonal balance.

As one explores this lush landscape, it is essential to appreciate the intricate relationships between these botanical elements, acknowledging that they cannot be applied universally. This serves as a reminder of the need for personalized advice, with healthcare providers acting as guides in this complex herbal world. The growing interest in the treatment of Polycystic Ovary Syndrome (PCOS) combines scientific methods with intuition drawn from nature. The desired result is a future environment in which conventional wisdom, combined with evidence-based approaches, produces increasingly sophisticated and effective solutions. This involves combining scientific knowledge with traditional wisdom from nature to create a well-rounded personalized plan.

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